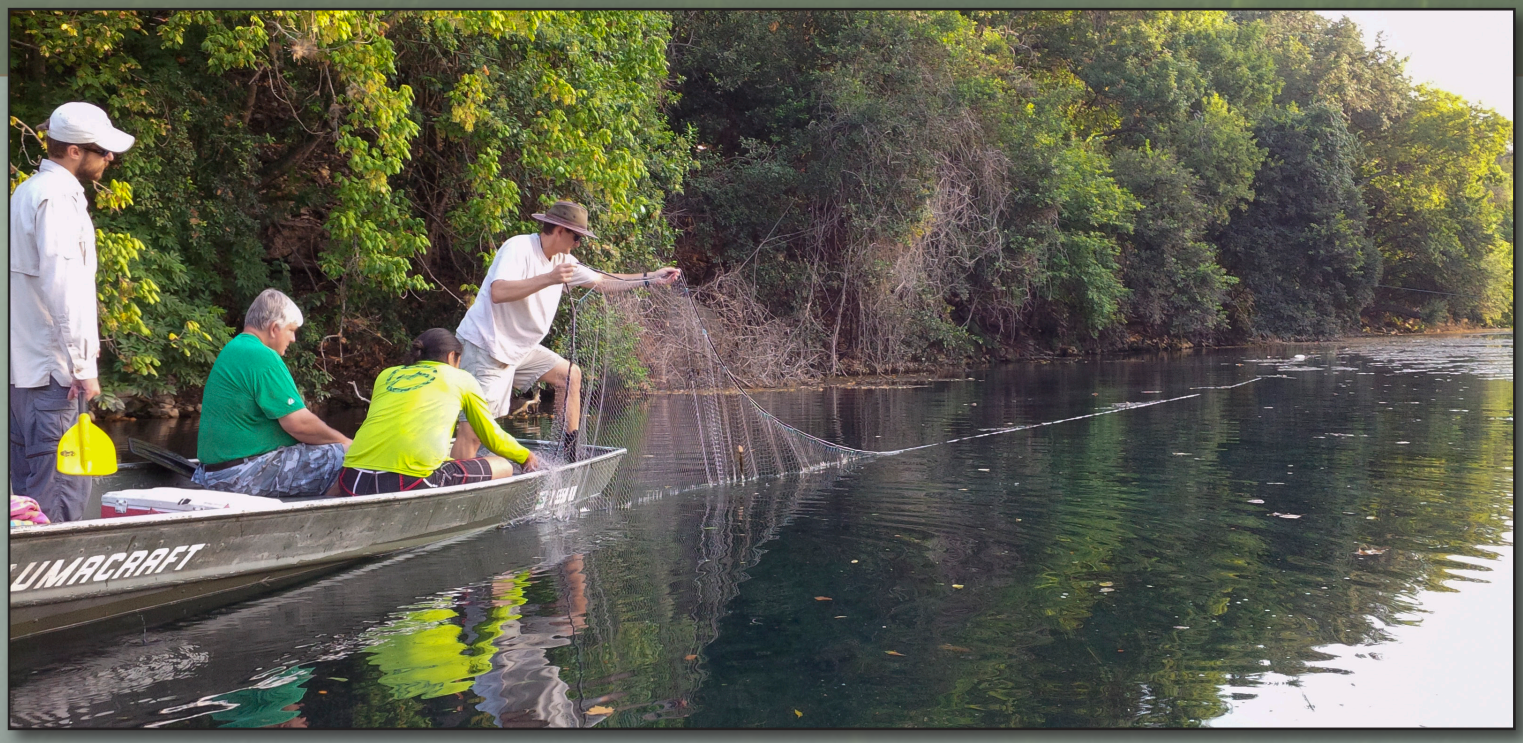
Edwards Aquifer
Habitat Conservation Plan ◆ 2014 Annual Report

Submitted to The U.S. Fish and Wildlife Service
March 19, 2015

On behalf of
The Edwards Aquifer Habitat Conservation Plan Permittees

HABITAT CONSERVATION PLAN EDWARDS AQUIFER

Prepared by
Blanton & Associates, Inc.
B&A Project No. 14114



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EXECUTIVE SUMMARY

What is the EAHCP?

The Edwards Aquifer Habitat Conservation Plan (EAHCP) is a cooperative effort to protect the water of the southern portion of the Edwards Aquifer both for people in the region and the endangered species that inhabit the aquifer. This effort began when regional stakeholders and the U.S. Fish and Wildlife Service (USFWS) initiated the Edwards Aquifer Recovery Implementation Plan (EARIP) in 2006. The Texas Legislature mandated participation in the process by the Edwards Aquifer Authority (EAA), Texas Commission on Environmental Quality, Texas Department of Agriculture, Texas Parks and Wildlife Department (TPWD), and Texas Water Development Board. The EARIP process led to the creation of the planning group known as the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan, which has now transitioned to the implementation group known as the Edwards Aquifer Habitat Conservation Plan, or EAHCP. The EAHCP was completed in November 2012 and led to the approval of an Incidental Take Permit (ITP) under the Endangered Species Act (ESA) issued by the USFWS in February March 2013 (included in the Annual Report as **Appendix A**). This Annual Report has been prepared for submittal to the USFWS, as required by Condition T of the ITP.

The Permittees under the EAHCP are the City of New Braunfels (CONB), the City of San Antonio (acting by and through the San Antonio Water System (SAWS)), the City of San Marcos (COSM), Edwards Aquifer Authority (EAA), and Texas State University (Texas State). Issuance of the ITP was a significant milestone to balance both the human and species needs of the Edwards Aquifer.

What are the Covered Species protected by the EAHCP?

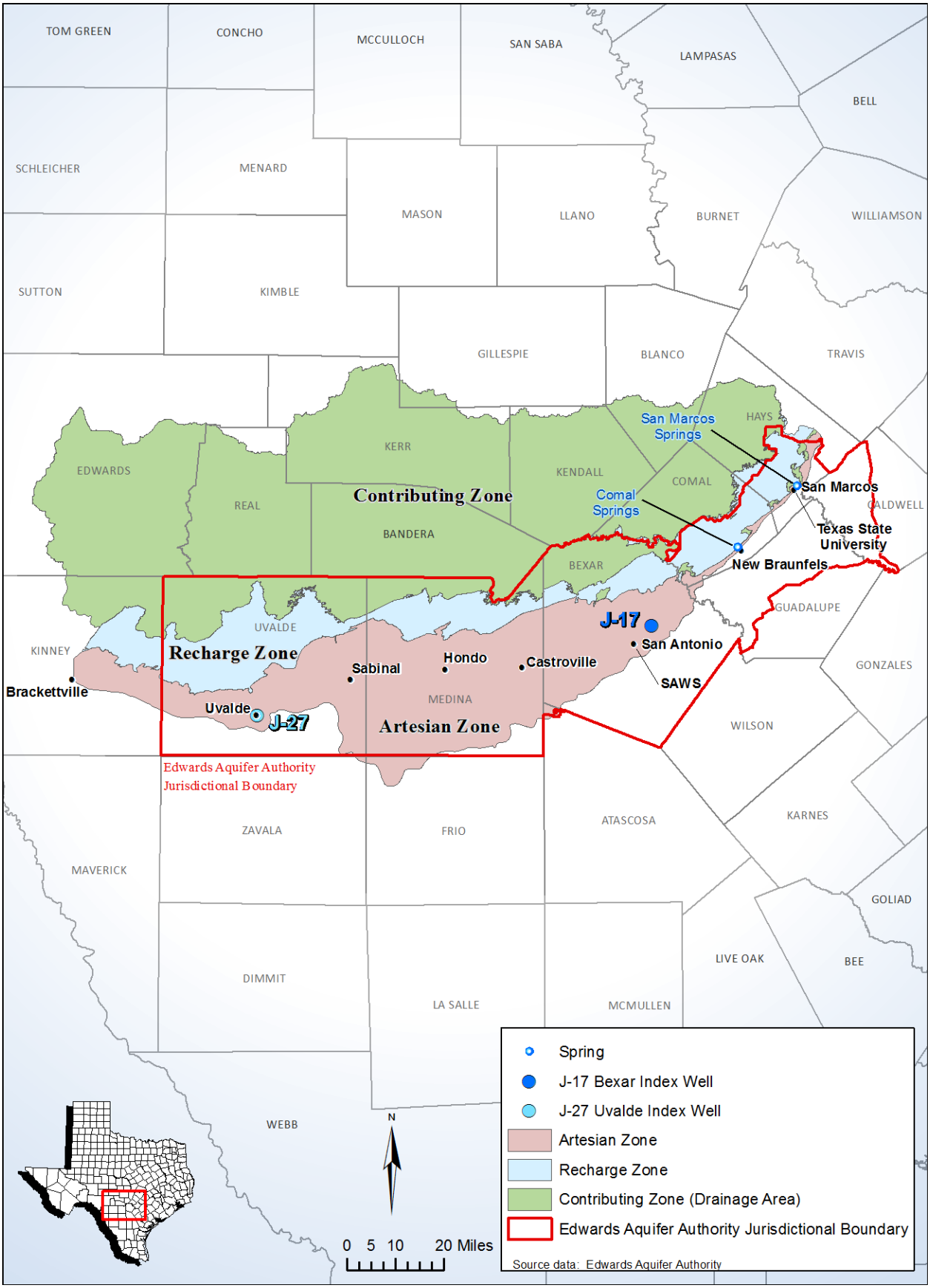
The EAHCP addresses the conservation needs of seven endangered species, one threatened species, and three species that have been petitioned for listing, as shown in the table below. Under the EAHCP, the Covered Species are covered by the ITP issued by the USFWS. The ITP allows "take" of the Covered Species listed in **Table ES-1**, as that term is defined in the ESA. [1]

[1] Take, as defined by the ESA, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct". "Harm" is also defined in the implementing regulations as "an act which actually kills or injures wildlife; such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly interfering with essential behavioral patterns including breeding, feeding and sheltering" (50 CFR 17.3). Disturbing or destroying occupied endangered species habitat could be a violation of the ESA if an individual of the species is prevented from breeding, feeding or sheltering and if this ultimately leads to the death or injury of the individual. If it is not possible to change a proposed action to avoid take of a listed species, a non-federal entity may request a permit under Section 10(a)(1)(B) to allow an exception for activities that may incidentally impact species. The USFWS may issue such permits, under the limited circumstances described in Section 10(a). Plants (e.g. Texas wild-rice) are treated differently under the ESA and are not subject to the take rules.

Common Name	Scientific Name	Federal Status	Associated Springs in the EAHCP
Fountain Darter	*Etheostoma fonticola*	Endangered	Comal & San Marcos
San Marcos Gambusia	*Gambusia georgei*	Endangered	San Marcos
Comal Springs Dryopid Beetle	*Stygoparnus comalensis*	Endangered	Comal
Comal Springs Riffle Beetle	*Heterelmis comalensis*	Endangered	Comal & San Marcos
Peck's Cave Amphipod	*Stygobromus pecki*	Endangered	Comal
Texas Wild-Rice	*Zizania texana*	Endangered	San Marcos
Texas Blind Salamander	*Eurycea (+Typhlomolge) rathbuni*	Endangered	San Marcos
San Marcos Salamander	*Eurycea nana*	Threatened	San Marcos
Texas Cave Diving Beetle	*Haideoporus texanus*	Petitioned	Comal & San Marcos
Comal Springs Salamander	*Eurycea sp.*	Petitioned	Comal
Texas Troglobitic Water Slater	*Lirceolus smithii*	Petitioned	San Marcos

What is the geographic area covered by the EAHCP?

As shown in the map below, the ITP provides incidental take coverage for authorized activities in all or parts of Bexar, Medina, Uvalde, Atascosa, Comal, Caldwell, Hays, and Guadalupe counties, Texas. This is the Plan Area in which pumping from the Edwards Aquifer is regulated by the EAA, and affects the springs and spring ecosystems inhabited by the Covered Species. The Plan Area also includes the recreational areas associated with Comal Springs and San Marcos Springs that are under the jurisdiction of the CONB, the COSM, and Texas State. The EAHCP also provides benefit downstream of the springs systems.


TOM GREEN
CONCHO
MCCULLOCH
SAN SABA
LAMPASAS
BELL
SCHLEICHER
MENARD
MASON
LLANO
BURNET
WILLIAMSON
SUTTON
KIMBLE
GILLESPIE
BLANCO
TRAVIS
HAYS
San Marcos Springs
KERR
EDWARDS
KENDALL
COMAL
San Marcos
CALDWELL
REAL
Contributing Zone
Comal Springs
BANDERA
Texas State University
BEXAR
New Braunfels
GUADALUPE
UVALDE
J-17
San Antonio
KINNEY
Recharge Zone
Sabinal
Hondo
Castroville
GONZALES
Brackettville
SAWS
MEDINA
Uvalde
J-27
Artesian Zone
WILSON
Edwards Aquifer Authority
Jurisdictional Boundary
ZAVALA
FRIO
ATASCOSA
KARNES
MAVERICK
GOLIAD
LIVE OAK
BEE
DIMMIT
LA SALLE
MCMULLEN
WEBB
N
0 5 10 20 Miles
Spring
J-17 Bexar Index Well
J-27 Uvalde Index Well
Artesian Zone
Recharge Zone
Contributing Zone (Drainage Area)
Edwards Aquifer Authority Jurisdictional Boundary
Source data: Edwards Aquifer Authority

How were the Covered Species affected in 2014?

Section 5.0 of the Annual Report (and **Appendix K**) provides an overview of net disturbance percentages and a summary of incidental take for 2014 (see **Table ES-2**). In the Comal Springs system, only the fountain darter had a net disturbance when considering the project footprint for HCP mitigation and restoration activities overlaid on occupied habitat. The net disturbance was 2.1 percent of the total occupied habitat for the fountain darter. No project footprints overlapped with any of the occupied habitat for the endangered Comal invertebrates. In the San Marcos Springs system, both the fountain darter and the San Marcos salamander had a net disturbance per this assessment. The fountain darter had 4.0 percent of its total occupied habitat disturbed, while the San Marcos salamander amount was lower at 1.4 percent. For the Texas blind salamander and Comal Springs riffle beetle, there were no activities conducted in 2014 that directly impacted any of the orifices where collections have routinely been made over the years. In summary, the 10 percent disturbance rule (items M1a and M2a of the ITP) was under the required limit for 2014.

Springflow in 2014 was lower than average. As expected, conditions in the Comal Springs system exceeded those observed in 2013, particularly with respect to the surface dwelling organisms (Comal Springs riffle beetle and fountain darter). Low springflow resulted in expanded amounts of exposed surface habitat within Comal Springs riffle beetle occupied habitat, and loss of habitat and elevated water temperatures relative to the fountain darter in the Upper Spring Run reach. For the San Marcos system, incidental take was reduced in 2014 because the system did not experience drought-related impacts as severe as those in 2013.

What were the EAHCP budget and expenses in 2014?

The 2014 adopted budget, as shown in the EAHCP Expense Report (**Appendix E**) was $20,609,987. This amount is the Annualized Implementation Costs adopted in the EAHCP. The EAHCP Expense Report also shows this adopted budget compared to the total approved 2014 Funding Application budget of $20,609,987 and the total 2014 Actual expenses of $8,232,490. The report also breaks down the Adopted budget, Funding Application budget and actual expenses for Spring Flow Protection, San Marcos, and Comal Springs projects, Modeling and Research projects and Refugia expenses.

Approximately 60.6 percent of the 2014 adopted budget remained at the end of the December 2014, which was due primarily to balances resulting from unexpended funds due to restrictions imposed by Condition M of the Incidental Take Permit and unexpended funds in the Aquifer Storage and Recovery (ASR) and Voluntary Irrigation Suspension Program Option (VISPO) programs. By the end of 2014, the reserve balance for the EAHCP was $34,780,742, which included unspent budgeted funds since the program's inception in 2013.

Table ES-2. Incental take of covered species

COVERED SPECIES PER SYSTEM	HCP Mitigation / Restoration		HCP Measures / Drought	Combined Impacted Habitat 2014 TOTAL (m^2)	INCIDENTAL TAKE		2014 INCIDENTAL TAKE TOTAL	ITP Maximum Permit Amount	2013 INCIDENTAL TAKE TOTAL	ITP Permit Maximum - (combined Year 1 and Year 2 Incidental Take)
	IMPACTED HABITAT (m^2)	NET Disturbance % OF TOTAL Occupied Habitat	IMPACTED HABITAT (m^2)		HCP Mitigation / Restoration	HCP Measures / Drought				
COMAL SYSTEM										
Fountain Darter	1,995	2.1%	2,484	**4,479**	2,993	20,067	**23,060**	797,000	10,482	763,459
Comal Springs Riffle Beetle	0	0.0%	237	**237**	0	1,564	**1,564**	11,179	681	8,933
Comal Springs Dryopid Beetle	0	0.0%	18	**18**	0	2	**2**	1,543	13	1,528
Peck's Cave Amphipod	0	0.0%	79	**79**	0	82	**82**	18,224	81	18,060
SAN MARCOS SYSTEM										
Fountain Darter	4,567	4.1%	3,372	**7,939**	6,851	5,058	**11,909**	549,129	16,698 +15*	520,508
San Marcos Salamander	30	1.4%	131	**161**	89	393	**482**	263,857	1,053	262,323
Texas Blind Salamander	0	0.0%	0	**0**	0	0	**0**	10	0	10
Comal Springs Riffle Beetle	0	0.0%	0	**0**	0	0	**0**	n/a	0	n/a

The EAHCP Expense Report also shows actual revenue for 2014 of $19,130,957 compared to the budgeted revenue of $19,061,614, which is a variance of only $69,343. Approximately 95 percent of the actual revenue comes from Aquifer Management Fees collected by the EAA. It is anticipated that revenue acquired in 2015 will be similar to the revenue amount received in previous years.

What activities were completed by the EAHCP in 2015?

As stated above, the five permittees under the EAHCP are the CONB, the COSM, EAA, SAWS, and Texas State. The TPWD is an additional cooperating agency. These are the primary agencies working to implement the EAHCP. The Permittees are each tasked with certain responsibilities for implementation of the EAHCP, as directed by the ITP. During Phase I of implementing the EAHCP, the Permittees are undertaking various measures for flow protection and habitat protection, and other measures identified in the EAHCP.

The permit requires this Annual Report to the USFWS to show progress towards permit implementation. Section 3 of the annual report describes permit actions by the Permittees and the TPWD, including subsections discussing their permit obligations, 2014 compliance actions, modifications due to drought conditions, and proposed activities for 2015. The table below summarizes the Permittees 2014 compliance actions, which are discussed more fully in the 2014 Annual Report.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	**Activities Undertaken in 2014**
Edwards Aquifer Authority (EAA)	
Applied Research (EAHCP §6.3.4; AR Section 3.1.1)	Tier A research projects conducted in 2014 were: • (Extended Low-Flow Effects on Comal Springs Riffle Beetle): Determination of Limitations of Comal Springs Riffle Beetle Plastron Use During Low Flow Study • (Extended Low Flow Effects on Comal Springs Riffle Beetle): Extended Low-Flow Period Effects on Comal Springs Riffle Beetle Study • (Test Spring Run Connectivity and Baseline Study): Study to Establish Comal Springs Riffle Beetle Baseline Population Distribution and Refine Riffle Beetle Collection Methods Tier B research projects conducted in 2014 were: • (Low-Flow Effects on Fountain Darter Movement, Survival and Reproduction): Effects of Low-Flow on Fountain Darter Fecundity Study • (Low-Flow Effects on Fountain Darter Movement, Survival and Reproduction): Effects of Predation on Fountain Darter Population Size at Various Flow Rates Study • (Low-Flow Effects on Fountain Darter Movement, Survival and Reproduction): Effects of Vegetation Decay and Water Quality Deterioration on Fountain Darter Movement Study Some applied research projects were delayed because of low flow conditions in Comal Springs resulted in further consultations with the USFWS. Texas State completed renovations to the Freeman Aquatic Building (FAB) totaling $321,288.37, for EAA applied research projects from January 1, 2014 – December 31, 2019.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
Edwards Aquifer Authority (EAA)	
Refugia (EAHCP §5.1.1 and 6.3.4; AR Section 3.1.2)	EAA and USFWS continued negotiations in 2014 but reached an impasse on issues related to location and ownership of refugia facilities, funding responsibilities, and advance payment requirements to commence construction and provide services. The EAA is seeking clarification from the State of Texas Attorney General's Office regarding its legal authority under Texas law. Until these matters are resolved, the EAA is pursuing three separate initiatives: 1) negotiating with USFWS for a long-term refugia contract; 2) issuing a RFQ/RFP for a long-term refugia contract; and 3) developing interim short-term refugia efforts for implementation until a long-term contract is established.
Voluntary Irrigation Suspension Program Option (VISPO) (EAHCP §5.1.2; AR Section 3.1.3)	Year 2014 program enrollment began in January and concluded in early October with a total combined enrollment of 40,921 ac-ft, with 25,471 ac-ft enrolled in the 5-Year program option, and 15,450 ac-ft in the 10-Year program option. The total enrollment amount exceeds the 40,000 ac-ft program goal contained in Section 5.1.2 of the EAHCP. The EAA also conducted public outreach efforts throughout the region to encourage and increase program participation.
Regional Water Conservation Program (RWCP) (EAHCP §5.1.3; AR Section 3.1.4)	In 2014, efforts continued to fully develop and begin implementing the Regional Water Conservation Program (RWCP). Highlights include: participating in the U.S. Bureau of Reclamation WaterSMART Grant Program; negotiating an Interlocal Cooperation Contract with the City of Universal City to implement a water conservation program; assisting communities in the region with implementing their water conservation measures; enlisting support from extension agents to inform Edwards Aquifer exempt well users about available RWCP opportunities; training plumbers and extension agents on high efficiency/low flow toilets and plumbing kits; holding a RWCP Lost Water Seminar; and continuing to identify ways to achieve the 10,000 ac-ft conserved water goal for this element of the EAHCP and the ITP.
Critical Period Management, Stage V (EAHCP §5.1.4; AR Section 3.1.5)	In 2014, the EAA enforced its Critical Period Management Program rules in both Edwards Aquifer pools. For the San Antonio Pool, Edwards Aquifer permitted pumpers were under either Stage II, III, or IV water use restrictions for the entire year, resulting in a total reduction to their annual permit amounts of 35.5 percent. Permitted pumpers in the Uvalde Pool were under Stage V restrictions for all of 2014, which resulted in a 44 percent reduction to their annual permit amounts. As of November 7, 2014, the San Antonio Pool was in Stage IV and the Uvalde Pool was in Stage V, and they are expected to remain in these current stages for the remainder of 2014.
Expanded Water Quality Monitoring (EAHCP §5.7.2; AR Section 3.1.6)	On January 1, 2014, the EAA implemented an expanded water quality monitoring program, which included collecting additional samples and sample types close to Comal and San Marcos springs to detect early signs of water quality impairments to the Comal River and headwaters of the San Marcos River systems. Sampling activities were minimally affected by on-going drought conditions, and while conditions did not require extreme low-flow sampling at selected wells, they did impact stormwater sampling efforts.
Biological Monitoring (EAHCP §§6.3.1, 6.4.3, and 6.4.4; AR Section 3.1.7)	Variable flow critical period monitoring in the Comal system began in April 2014, when flows dropped below 150 cfs and required a full monitoring event and weekly habitat evaluations, carried out in conjunction with regular and seasonal monitoring events. In August, declines in spring flows below 100 cfs necessitated another full monitoring event. EAHCP species-specific critical period monitoring was also conducted as required.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
Edwards Aquifer Authority (EAA)	
Groundwater Modeling (EAHCP §6.3.2; AR Section 3.1.8)	MODFLOW model updates were completed in December 2014, that included evaluating improvements to the conceptual model, and gathering and processing pumping and recharge data. The results of the model updates, calibration, and sensitivity analyses will undergo peer review. Finite-Element Model (FEFLOW) calibration was completed in December 2014. The Groundwater Model Review Panel (GMRP) helped to guide development of the model.
Ecological Modeling (EAHCP §6.3.3; Section 3.1.9)	In April 2014, the *Predictive Ecological Modeling for the Comal and San Marcos Ecosystems Project Interim Status Report* was completed and addressed fountain darter food source dynamics and response, and Comal Springs riffle beetle response to low flow conditions. Based on this report, a team of experts began developing two predictive ecological models for the Comal and San Marcos Spring/River ecosystems, and selected the Old Channel intensive study reach in the Comal River as the test case for ecological modeling efforts because of its extensive physical and biological data collected over a decade, and its driving variable is spring flow.
Program Management (Funding and Management Agreement)	Program management activities completed in 2014 consisted of: budget development, monitoring and reporting; contract management and administration; 2015 Work Plan, funding application, and interlocal funding contract approvals; meeting facilitation and support for all Committees, Work Groups, Science Review Panel and the National Academy of Sciences activities; EAHCP project-related federal and state permit compliance assessment; springs' tours to show drought impacts and highlight the status of EAHCP efforts; program communication frequency and openness; public outreach efforts; and regular and issue-specific communication, coordination, and/or negotiation with the USFWS. Two staff program positions were added: Director of EAA Projects position, and Senior Project Coordinator position.
Impervious Cover and Water Quality Protection (EAHCP §5.7.6)	All actions required by the EAA were completed prior to the current reporting period.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
City of New Braunfels (CONB)	
Flow-Split Management in the Old and New Channel (EAHCP §5.2.1; AR Section 3.2.1)	The CONB replaced and repaired existing gates and control mechanisms to restore the operability of water paths to the Old Channel from Landa Lake. This repair allows for the manipulation of flow into the Old Channel of the Comal River from Landa Lake for the protection of existing and restored native aquatic vegetation in the river. The CONB has developed a Standard Operating Procedure that is intended to guide the operation of the flow control gate structure and overall flow-split management.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
City of New Braunfels (CONB)	
Native Aquatic Vegetation Restoration and Maintenance (EAHCP §5.2.2; AR Section 3.2.2)	A total of 7,263 native aquatic plants were planted in 2014. Landa Lake received 3,528 plants, while the Old Channel received 2,648 plants. The Sediment Island Project area in the upper portion of the Old Channel received 1,097 plants. Newly planted area in Landa Lake covered 267 m² bringing the total planted area in Landa Lake to 887 m². New areas planted included the areas around the three islands and a bare area created by retaining wall construction. The planted area in the Old Channel was increased by 169 m² bringing the total planted area to 1,383 m² in the Old Channel including Sediment Island. Newly planted areas in the Old Channel included areas immediately above the second golf course bridge.
Management of Public Recreational Use of Comal Springs and River Ecosystems (EAHCP §5.2.3; AR Section 3.2.3)	Due to the Landa Walls Rehabilitation Project, access to Landa Lake was severely limited during the majority of 2014. Overall access to Landa Lake and the Comal Springs was either limited or completely eliminated due to construction.
Decaying Vegetation Removal and Dissolved Oxygen Management (EAHCP §5.2.4; AR AR Section 3.2.4)	The CONB continued water quality monitoring within Landa Lake to track dissolved oxygen (DO) and other water quality parameters. The aeration system and data sonde installed in 2013 was used to monitor DO, temperature, pH, conductivity, and turbidity. These data were used to guide management decisions related to maintaining adequate DO concentrations to support endangered species populations under periods of stress, such as droughts, vegetation die-off, or pollution discharge.
Control of Harmful Non-Native Animal Species (EAHCP §5.2.5; AR Section 3.2.5)	Removal efforts continued in 2014, with 294 vermiculated sailfin catfish, 1,602 tilapia, 5 nutria, and 1,099 giant ramshorn snails removed from Landa Lake.
Monitoring and Reduction of Gill Parasites (EAHCP §5.2.6; AR Section 3.2.6)	The CONB continued studies begun in 2013 to investigate fountain darter gill parasites, and to explore potential management techniques aimed at minimizing and mitigating for the impact of this parasite under low flows.
Prohibition of Hazardous Materials Transport Across the Comal River and its Tributaries (EAHCP §5.2.7; AR Section 3.2.7)	CONB and TxDOT staff exchanged correspondence and held meetings aimed at establishing new adjacent routes above the Comal Springs/Landa Lake area. These smaller routes will establish where signage needs to be installed, so that hazardous materials transport vehicles will not utilize those routes when traveling through the area (based on potential accidents/leaks into storm sewers above Comal Springs).
Native Riparian Habitat Restoration (Riffle Beetle) (EAHCP §5.2.8; AR Section 3.2.8)	The CONB continued to improve Comal Springs riffle beetle habitat by removing non-native vegetation along Spring Run 3 and the western shoreline, and re-vegetating with native species.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
City of New Braunfels (CONB)	
Reduction of Non-Native Species Introduction and Live Bait Prohibition (EAHCP §5.2.9; AR Section 3.2.9)	The CONB continued its work with local businesses to reduce the hazards of non-native species and aquarium dumping into local lakes and streams. The CONB has extended its reach into nearby cities (Canyon Lake, Seguin, Garden Ridge, Schertz, Selma, San Marcos, north San Antonio, and south Austin) to help educate shops that sell bait and aquariums.
Litter Collection and Floating Vegetation Management (EAHCP §5.2.10; AR Section 3.2.10)	The CONB instituted a weekly removal/dislodging of floating vegetation mats and litter collection in the Comal River (underwater cleanup). SCUBA activities in Landa Lake were temporarily stopped due to Condition M and did not commence again in 2014 due to low flow conditions.
Management of Golf Course Diversions and Operations (EAHCP §5.2.11; AR Section 3.2.11)	The CONB developed a new Integrated Pest Management Plan (IPMP) in 2013 and implemented the plan during 2014.
Native Riparian Habitat Restoration (Old Channel Improvements) (EAHCP §5.7.1; AR Section 3.2.12)	The final design for Old Channel bank stabilization was completed after review by the EAHCP Science Committee, and final review and approval of the Implementing Committee in early 2014. Based on input from the Science Committee that resulted in integration of riparian zone improvements into the plan, and presented to the Implementing Committee, a bid package was completed and the project is ready to be bid. Construction did not occur in 2014, due to low flows in the springs systems.
Management of Household Hazardous Wastes (HHW) (EAHCP §5.7.5; AR Section 3.2.13)	Three HHW collection events were held by the CONB in 2014. Each event had approximately 200 cars visit, and each was able to obtain approximately 10-12 tons of material.
Impervious Cover and Water Quality Protection (EAHCP §5.7.6; AR Section 3.2.14)	As required by the Edwards Aquifer Habitat Restoration Plan, the goal of the yearly report is to provide a guide to implementing Low Impact Development Best Management Practices (LID BMPs) that will protect and preserve the habitat of four endangered species identified within the study area.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
City of San Marcos (COSM)	
Texas Wild-Rice Enhancement and Restoration (EAHCP §5.3.1 and §6.3.5; AR Section 3.3.1)	Non-native aquatic vegetation was removed in areas suggested as optimal Texas wild-rice habitat, as well as in mixed stands of Texas wild-rice. Denuded areas were planted with Texas wild-rice obtained from the USFWS San Marcos Aquatic Research Center (SMARC), or from raceways located at the Freeman Aquatic Building (FAB), located on the Texas State campus. The estimated number of Texas wild-rice planted in the San Marcos River downstream of Sewell Park between December 2013 and November 2014 was 9,120 individuals. The net gain of Texas wild-rice area from April 2013 to November 2014 was 891 square meters (m^2).
Management of Recreation in Key Areas (EAHCP §5.3.2; AR Section 3.3.2)	The COSM managed recreation in key areas through a variety of strategies, including: access control; fencing; signage; activities undertaken by the Conservation Crew (CC) such as education, vegetation removal, Texas wild-rice surveys, litter removal, and support of the State Scientific Area (SSA); designating buffer zones; and developing a master plan for all EAHCP signage, and through their partnership with Texas State.
Management of Aquatic Vegetation and Litter below Sewell Park (EAHCP §5.3.3; AR Section 3.3.3)	Pristine Texas Rivers Inc. (PTR) removed inorganic litter from upper Sewell Park to City Park, and from Rio Vista to Stokes Island. PTR used SCUBA equipment to remove underwater litter from the substrate and surface. PTR consistently removed large debris primarily from the San Marcos River tributaries, including tires, road cones, PVC, and metal building materials.
Prohibition of Hazardous Materials Transport across the San Marcos River and Its Tributaries (EAHCP §5.3.4; AR Section 3.3.4)	The COSM initiated coordination with TxDOT to designate Wonder World Drive from IH-35 to RR 12 as a Non-Radioactive Hazardous Materials (NRHM) Route. A route analysis is currently underway and will be followed by public hearings and evaluation of the proposal by TxDOT.
Reduction of Non-Native Species Introduction (EAHCP §5.3.5; AR Section 3.3.5)	The COSM developed an education campaign outline (to be implemented by Atlas Environmental, the CC, and student interns) intended to increase public awareness regarding the harm of releasing non-native fish into the San Marcos River. The plan includes, but is not limited to, advertising, flyers, booths, drop-off locations for unwanted fish, and other strategies.
Sediment Removal below Sewell Park (EAHCP §5.3.6; AR Section 3.3.6)	Sediment removal was conducted using a three-inch hydrosuction hose to remove accumulations of fine sediment. Before dredging, vegetation was removed and the area was fanned to encourage fountain darters and other biota to move out of the area. Texas Sate continued sediment removal at two locations: upstream of City Park and at the confluence of Purgatory Creek. Approximately 77 m^2 of fine sediment was removed from the San Marcos River between November 2013 and February 2014.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
City of San Marcos (COSM)	
Designation of Permanent Access Points and Bank Stabilization (EAHCP §5.3.7; AR Section 3.3.7)	The COSM completed bank stabilization/access points at Dog Beach, Hopkins Street Bridge, Bicentennial Park, Rio Vista Park, and Ramon Lucio Park. The construction of access points in heavily eroded areas provides a balance between recreation and maintenance of a healthy riparian buffer and river bank.
Control of Non-Native Plant Species (EAHCP §5.3.8; AR Section 3.3.8)	Non-native aquatic vegetation removal focused on *H. verticillata*, *H. polysperma*, and *Nasturtium officinale*, as these species were the most actively invasive. Approximately 2,649 m^2 of non-native aquatic vegetation was removed from the San Marcos River downstream of Sewell Park to IH-35 between November 2013 and November 2014. Estimated reduction in non-native vegetation downstream of Spring Lake Dam through Sewell Park was 1,120 m^2, for the period between April 2013 and November 2014. The estimated number of native species planted in the San Marcos River downstream of Sewell Park was 17,413 individuals, between November 2013 and November 2014. The removal of non-native littoral vegetation (such as elephant ear) consisted of the use of herbicide treatments. Non-native vegetation was removed and treated areas were replanted with native vegetation.
Control of Harmful Non-Native and Predator Species (EAHCP §5.3.9; AR Section 3.3.9)	Non-native species control efforts in 2014 focused on tilapia, suckermouth catfish, red-rimmed melania, and giant ramshorn snails. From March through June (when tilapia are spawning), removal efforts focused on Spring Lake using gill nets, seine nets, bows, and pole spears. Suckermouth catfish were captured from Spring Lake to IH-35 using pole spears and hand-collection while snorkeling. Removal of red-rimmed malania and giant ramshorn snails consisted of hand-collection in areas of large concentrations in Spring Lake and near the Clear Springs Apartments.
Native Riparian Habitat Restoration (EAHCP §5.7.1; AR Section 3.3.10)	The COSM undertook non-native tree, shrub, and vine removal and native replanting in Upper Sewell, City, and Veteran's Parks in the spring and autumn of 2014. Replanting consisted of plants recommended by local experts, the US Department of Agriculture (USDA), USFWS, TPWD, and the Texas Commission on Environmental Quality (TCEQ) for riparian restoration. In City Park, additional erosion control measures were undertaken to promote seed bank germination. Monthly maintenance consisted of hand-removal of Johnson grass to prevent the mass use of herbicides.
Septic System Registration and Permitting Program (EAHCP §5.7.3; AR Section 3.3.11)	The San Marcos Environmental Health Department had registration records for 595 septic systems within COSM jurisdiction through the end of 2014, rincluding four new septic systems added into service in 2014. The total number of septic systems on December 4, 2014 was 599. These systems have been permitted and evaluated to prevent subsurface pollutant loadings into the Edwards Aquifer or San Marcos River.
Minimizing Impacts of Contaminated Runoff (EAHCP §5.7.4; AR Section 3.3.12)	The EAHCP calls for design and construction of two water quality best management practices located at Veramendi Park and the Hopkins Street bridge, to capture stormwater runoff before it enters the San Marcos River. John Gleason LLC intended to complete conceptual designs, but additional funding was required for the completion of the Water Quality Protection Plan.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
City of San Marcos (COSM)	
Management of Household Hazardous Wastes (EAHCP §5.7.5; AR Section 3.3.13)	The COSM operates a free household hazardous waste (HHW) collection program available to all San Marcos and Hays County residents in an effort to reduce the risk of pollution to local water resources. The annual outreach goal for the HHW in 2014 was 1,400 participants. The goal was exceeded by 76 percent, with a total of 2,462 participants. The HHW program collected approximately 81,714 kilograms of waste in 2014. The amount of HHW diverted from the waste stream through the reuse program total was 7,157 kg.
Impervious Cover and Water Quality Protection (EAHCP §5.7.6; AR Section 3.3.14)	In support of the 2014 Water Quality Protection Plan (WQPP), the COSM undertook a variety of activities, including (but not limited to): preparation of the 2014 WQPP report; watershed characterization modeling; revisions to the land development code; evaluation of potential water quality retrofits; presenting and soliciting input on WQPP recommendations; and meetings with Hays County representatives regarding potential collaboration on a City Land Conservation program.
Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	**Activities Undertaken in 2014**
Texas State University (Texas State)	
Texas Wild-Rice Enhancement and Restoration (EAHCP §5.4.1; AR Section 3.4.1)	Non-native aquatic vegetation was removed in areas suggested as optimal Texas wild-rice habitat, as well as in mixed stands of Texas wild-rice. Denuded areas were planted with Texas wild-rice obtained from the USFWS SMARC or from raceways located at the FAB, Texas State campus. The estimated number of Texas wild-rice planted in the San Marcos River from Spring Lake Dam downstream through Sewell Park, from November 2013 through December 2014, was 343 individuals. The net gain of Texas wild-rice area from April 2013 through November 2014 was 170 m^2.
Management of Recreation in Key Areas (EAHCP §5.4.2; AR Section 3.4.2)	Texas State managed recreation in key areas though a variety of strategies, including: access control, signage, activities undertaken by the CC such as education, vegetation removal, Texas wild-rice surveys, litter removal, and support of the State Scientific Area (SSA), establishment of a recreational baseline, and partnership with the COSM.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
Texas State University (Texas State)	
Management of Vegetation (EAHCP §5.4.3; AR Section 3.4.3)	Texas State undertook efforts to manage the aquatic vegetation in Spring Lake through the following measures: • Spring Orifice Maintenance: accumulated sediment was removed where necessary from target springs in Spring Lake by finning the substrate away. In addition, aquatic vegetation was removed from an approximately 1.5-meter radius of each target spring with a machete. • Harvester Boat: Maintenance of submerged and floating aquatic vegetation followed the protocols outlined in the EAHCP (Section 5.4.3.1) and the approved Spring Lake Management Plan. The total estimated harvest was approximately 1,112.5 cubic yards for the year. Texas State also collaborated with the COSM to control aquatic vegetation mats entrained on Texas wild-rice stands below Spring Lake Dam to the end of Sewell Park.
Sediment Removal in Spring Lake and Sewell Park (EAHCP §5.4.4; AR Section 3.4.4)	No dredging occurred in the San Marcos River in Spring Lake through Sewell Park during 2014.
Diversion of Surface Water (EAHCP § 5.4.5; AR Section 3.4.5)	Because total San Marcos River flows did not reach trigger points outlined in the EAHCP (§5.4.5) (i.e., < 80 cubic feet per second (cfs)), Texas State did not reduce permitted pumping in 2014. They did, however, continue to voluntarily suspend pumping from the San Marcos River at Sewell Park. The total volume of surface water diversions from Spring Lake was 38 ac-ft/year for 2014, which is below the permitted 100 ac-ft/year. Maximum instantaneous diversion rates did not exceed the permitted amount of 1.33 cfs. Texas State continued to use a 0.25-inch mesh screen to cover the intake for surface water diversions. The screens were routinely inspected and cleaned as part of regular operations. No fountain darters were observed when the screens were cleaned.
Sessom Creek Sand Bar Removal (EAHCP §5.4.6; AR Section 3.4.6)	The Adaptive Hydraulics Modeling System was utilized to model existing conditions and three alternative scenarios that ranged from full sediment bar removal versus differential channel configurations. The report recommended removal using backhoe and was approved by the Science Committee and the Implementing Committee. Low flows precluded removal of sediments from the river.
ing Classes in Spring Lake HCP §5.4.7; AR Section 3.4.7)	The Meadows Center for Water and the Environment (MCWE) updated the Spring Lake Management Plan to reflect all the requirements under the EAHCP and ITP. MCWE implemented a Diving Program Control Board that reviews all diving activities within Spring Lake to ensure they comply with the Spring Lake Management Plan and the EAHCP. These efforts also include the development of the Spring Lake Dive Accident Management Plan and revisions to the Diving for Science Program, which has implemented a more rigorous training program that includes expanded training and orientation on the endangered species.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
Texas State University (Texas State)	
Research Programs in Spring Lake (EAHCP §5.4.8; AR Section 3.4.8)	MCWE developed an online access request form in order to oversee access to Spring Lake. Each request is reviewed by the eight-member committee, and if a vertebrate animal is the target of research, the Institutional Animal Care and Use Committee is also consulted for approval. In the event that the proposed research involves diving, the application and methods are reviewed by the Spring Lake Diving Control Board and if necessary, Scientific Diving training is required prior to access.
Management of Golf Course and Grounds (EAHCP §5.4.9; AR Section 3.4.9)	The MCWE, in collaboration with the COSM, completed a revised Golf Course Management Plan that includes a draft Integrated Pest Management Plan (IPMP). The revisions follow the guidelines outlined in both the EAHCP (§5.4.9) and the Spring Lake Management Plan. Golf course operations followed the IPMP.
Boating in Spring Lake and Sewell Park (EAHCP §5.4.10; AR Section 3.4.10)	The Spring Lake Management Plan was modified to ensure consistency with the EAHCP measures outlined in EAHCP (§5.4.10) for activities in Spring Lake. A total of 7,526 glass-bottom boat tours and 802 glass-bottom kayak tours were conducted in 2014.
Reduction of Non-Native Species Introduction (EAHCP §5.4.11; AR Section 3.4.11)	Texas State collaborated with the COSM to look for a suitable location for a pond that would function as a drop-off location for unwanted fish and other aquaria species that students no longer want.
ntrol of Non-Native Plant Species AHCP §5.4.12; AR Section 3.4.12)	Non-native aquatic vegetation removal focused on *H. verticillata*, *H. polysperma*, and *Nasturtium officinale*, as these species are the most actively invasive. Approximately 314 m^2 of non-native aquatic vegetation was removed in the San Marcos River from Spring Lake Dam downstream through Sewell Park, from January 2014 to November 2014. Estimated area planted with native species was 236 m^2 in the San Marcos River within areas removed of non-native vegetation. The net area gain in native aquatic vegetation was 253 m^2 from April 2013 (i.e., prior to EAHCP activities) through November 2014 in the San Marcos River at Sewell Park.
Control of Harmful Non-Native and Predator Species (EAHCP §5.4.13; AR Section 3.4.13)	Texas State collaborated with the COSM to undertake control of harmful non-native and predatory species in Spring Lake and the San Marcos River upstream of City Park. In 2014, 235 tilapia and 764 suckermouth catfish were captured.
Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	**Activities Undertaken in 2014**
City of San Antonio through the San Antonio Water System (SAWS)	
Use of the SAWS ASR for Springflow Protection	Under an interlocal contract (IC) between the EAA and SAWS, SAWS is required to credit to the EAA as being in storage any permitted Edwards Aquifer water for which it receives a Notice of Availability (NOA) from the EAA by certain dates detailed further in the IC, or based on metered recharge for NOAs received by SAWS after certain dates.

Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	Activities Undertaken in 2014
City of San Antonio through the San Antonio Water System (SAWS)	
(EAHCP §§5.5.1 and 5.5.2; AR Section 3.5.1)	The initial NOA was issued by the EAA on January 8, 2014, for 6,080.757 ac-ft, though this amount was reduced by critical period cutbacks. A total of 4,031 ac-ft was credited to the EAA as being in storage in 2014.
Phase II Expanded Use of the SAWS ASR and Water Resources Integration Program Pipeline (EAHCP §5.5.2; AR Section 3.5.1)	The EAHCP discusses use of SAWS' Water Resource Integration Program as the Phase II presumptive action for the EAHCP. To date, Phase II is not yet effective, and not yet discussed with the EAHCP committees.
Minimization or Mitigation Measure (EAHCP Reference; 2014 Annual Report Section Reference)	**Activities Undertaken in 2014**
Texas Parks and Wildlife Department (TPWD)	
State Scientific Areas (EAHCP §5.6.1; AR Section 3.6.1)	TPWD designated a two-mile segment of the San Marcos River as a State Scientific Area (SSA), in conformance with 30 TAC 57.910. This scientific area is designed to protect Texas wild-rice by restricting recreation in these areas during flow conditions below 120 cfs. The TPWD, COSM and Texas State designed, produced and installed signs and information kiosks during the summer of 2013, and maintained them during 2014.

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ACRONYMS AND ABBREVIATIONS

ac-ft	Acre-Feet
AMP	Adaptive Management Process
ASR	Aquifer Storage and Recovery
B&A	Blanton & Associates, Inc.
BIO-WEST	BIO-WEST, Inc.
BO	Biological Opinion
BOD	Biological Oxygen Demand
BMP(s)	best management practice(s)
CC	Conservation Crew
CEF	Critical Environmental Features
cfs	cubic feet per second
cm	centimeter(s)
CO_2	carbon dioxide
COI	Certificate of Inclusion
CONB	City of New Braunfels
COSM	City of San Marcos
CPMP	Critical Period Management Program
DoD	U.S. Department of Defense
DPS	Department of Public Safety
DO	Dissolved oxygen
EAA	Edwards Aquifer Authority
EAHCP	Edwards Aquifer Habitat Conservation Plan
EARDC	Edwards Aquifer Research and Data Center
EARIP	Edwards Aquifer Recovery Implementation Program
ES	Ecological Services
ETJ	Extra-Territorial Jurisdiction
ERPA	Environmental Restoration and Protection Area
ESA	Endangered Species Act
FAB	Freeman Aquatic Building
FMA	Funding and Management Agreement
ft	feet/foot
ft^2	square feet
GBC	Guadalupe Basin Coalition
GBRA	Guadalupe-Blanco River Authority
GMRP	Groundwater Model Review Panel
HCP	Habitat Conservation Plan
HDR	HDR Engineering, Inc.
HFM	Hydrogeologic Framework Model
HHW	Household Hazardous Waste
HTC	Heritage Tree Care
IH	Interstate Highway
IC	Intergovernmental Contract

IPMP	Integrated Pest Management Plan
ITP	Incidental Take Permit
lbs	pounds
LDC	Land Development Code
LID	Low impact development
LL	Landa Lake
m	meters
m^2	square meters
m^3	cubic meters
MCL	Maximum Contamination Limit
MCWE	Meadows Center for Water and the Environment
mg/L	milligram(s) per liter
MGD	Million Gallons per Day
MS4	municipal separate storm sewer system
msl	mean sea level
NAS	National Academy of Sciences
NBU	New Braunfels Utility
NC	New Channel
No.	Number
NOA	Notice of Availability
NRHM	Non-radioactive Hazardous Material
NTU	Nephelometric Turbidity Units
NWF	National Wildlife Federation
O&M	Operations and Maintenance
OC	Old Channel
PCL	Protective Concentration Levels
PDS	Passive Diffusion Samplers
PEC	Probable Effect Concentration
PTR	Pristine Texas Rivers, Inc.
RTI	Real-time Instrumentation
RWCP	Regional Water Conservation Program
SARA	San Antonio River Authority
SAV	submerged aquatic vegetation
SAWS	San Antonio Water System (of the City of San Antonio)
SCUBA	Self Contained Underwater Breathing Apperatus
SCTWAC	South Central Texas Water Advisory Committee
SMARC	San Marcos Aquatic Research Center
SMRF	San Marcos River Foundation
SMWI	San Marcos Watershed Initiative
SRP	Science Review Panel
SSA	State Scientific Area
STM	Stormwater Technical Manual
SWCA	SWCA Environmental Consultants
TCEQ	Texas Commission on Environmental Quality

TDA	Texas Department of Agriculture
Texas State	Texas State University
THC	Texas Historical Commission
TN	total nitrogen
TP	total phosphorus
TPWD	Texas Parks and Wildlife Department
TRRP	Texas Risk Reduction Program
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
UNT	University of North Texas
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USR	Upper Spring Run
UT	University of Texas at Austin
UTSA	University of Texas at San Antonio
VISPO	Voluntary Irrigation Suspension Program Option
WPA	Works Progress Administration
WQPP	Water Quality Protection Plan

1.0 BACKGROUND

The Edwards Aquifer Habitat Conservation Plan (EAHCP) was approved by the U.S. Fish and Wildlife Service (USFWS or Service) as a regional plan to protect the Edwards Aquifer and its species while helping ensure water availability for the region. After approval of the EAHCP, the Service issued a permit under the Endangered Species Act (ESA), with an effective date of March 18, 2013.

The permit is an Incidental Take Permit (ITP, no. TE63663A-0, see **Appendix A**) issued to five cooperating Permittees: the Edwards Aquifer Authority (EAA); the City of New Braunfels (CONB); the City of San Marcos (COSM); Texas State University (Texas State); and the City of San Antonio acting by and through its San Antonio Water System (SAWS). The permit authorizes certain "Covered Activities" (described in EAHCP Section 2.0), even under circumstances where the activities may incidentally cause "take" of a covered species. The EAHCP identifies four categories of activities that may result in incidental take: "(1) the regulation and use of the Edwards Aquifer; (2) recreational activities in the Comal and San Marcos Springs and River ecosystems; (3) other activities in, and related to, the Comal and San Marcos Springs and River ecosystems; and (4) activities involved in and related to the implementation of the minimization and mitigation measures in these ecosystems" (see EAHCP Section 2.1). The Adaptive Management Process (AMP) may also result in incidental take (see EAHCP 2.8).

The ITP provides incidental take coverage for authorized activities in Bexar, Medina, Uvalde, Atascosa, Comal, Caldwell, Hays, and Guadalupe counties, Texas, within the area in which pumping from the Edwards Aquifer is regulated by the EAA (**Figure 1.1-1**).

The species covered under the EAHCP are listed in **Table 1.1-1**Error! Reference source not found.

Table 1.1-1. Covered Species under the EAHCP Incidental Take Permit

Common Name	Scientific Name	Federal Status	Associated Springs in the EAHCP
Fountain Darter	*Etheostoma fonticola*	Endangered	Comal & San Marcos
San Marcos Gambusia	*Gambusia georgei*	Endangered	San Marcos
Comal Springs Dryopid Beetle	*Stygoparnus comalensis*	Endangered	Comal
Comal Springs Riffle Beetle	*Heterelmis comalensis*	Endangered	Comal & San Marcos
Peck's Cave Amphipod	*Stygobromus pecki*	Endangered	Comal & San Marcos
Texas Wild-Rice	*Zizania texana*	Endangered	San Marcos
Texas Blind Salamander	*Eurycea (+Typhlomolge) rathbuni*	Endangered	San Marcos
San Marcos Salamander	*Eurycea nana*	Threatened	San Marcos
Texas Cave Diving Beetle	*Haideoporus texanus*	Petitioned	Comal & San Marcos
Comal Springs Salamander	*Eurycea sp.*	Petitioned	Comal & San Marcos
Texas Troglobitic Water Slater	*Lirceolus smithii*	Petitioned	San Marcos

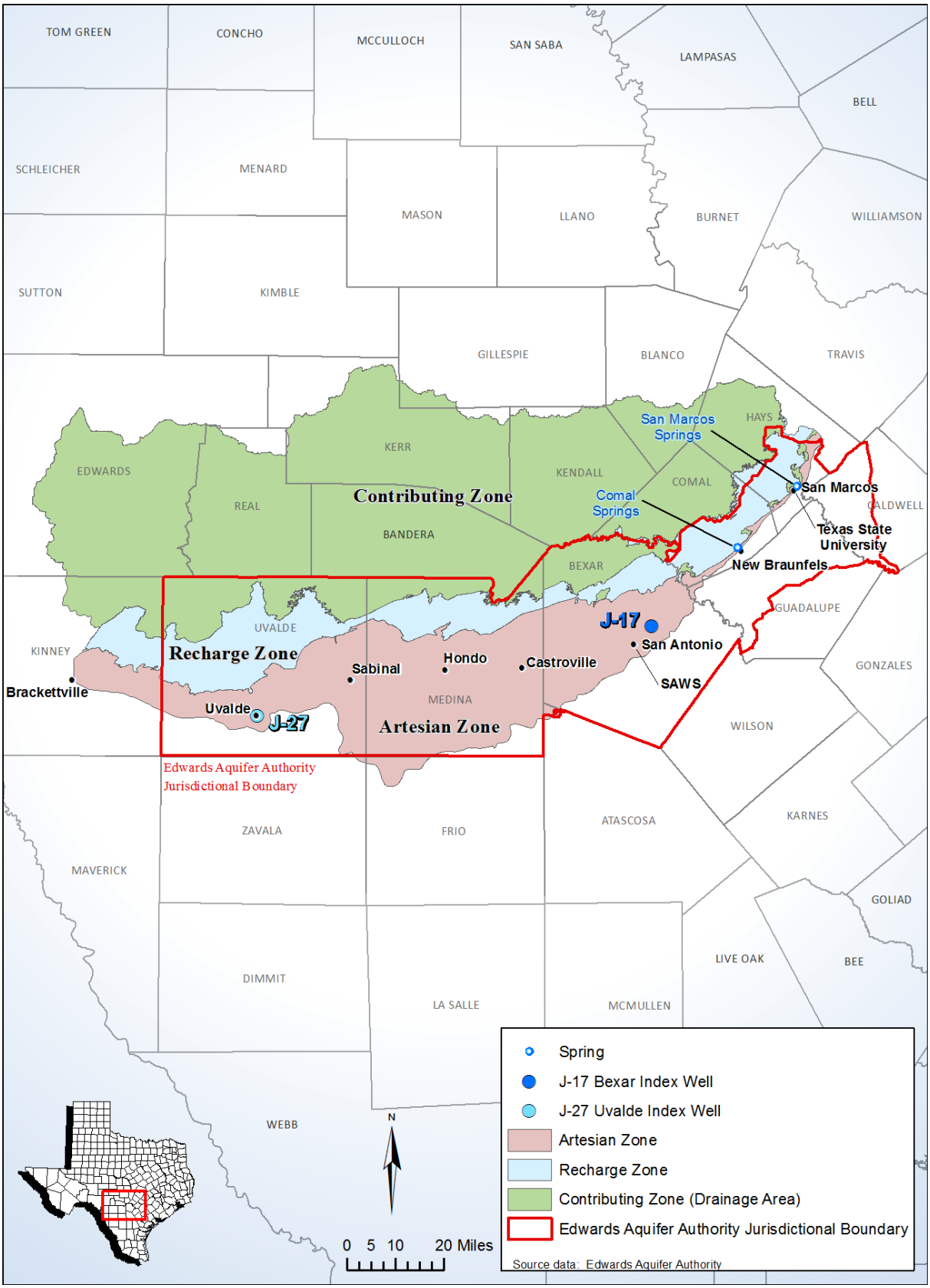


Figure 1.1-1. Incidental Take Coverage Area for ITP No. TE63663A-0 (EAA Jurisdictional Boundary)

1.1 Incidental Take Permit (ITP) Requirements

The ITP lists many requirements and conditions, among which are the elements to be included in an annual report. The ITP requires an Annual Report to the USFWS Austin Ecological Services Office and to the USFWS Albuquerque Region 2 Office by March 31 of each year. As specified by Condition T of the ITP (see **Appendix A**), "The report will document the Permittees' activities and permit compliance for the previous year, thus documenting progress toward the goals and objectives of the Edwards Aquifer Recovery Implementation Program (EARIP) Habitat Conservation Plan (HCP) and demonstrating compliance with the terms and conditions of [the] incidental take permit."

According to Condition T(2) of the ITP, the Annual Report will include the following:

- EAA permitted withdrawals
- Reference well levels
- Springflows at Comal and San Marcos springs
- Aquifer recharge
- Aquifer discharge from wells and springflow
- Critical period management reductions
- Water quality data
- Location of sampling sites
- Methods for data collection and variables measured
- Frequency, timing, and duration of sampling for these variables
- Description of the data analysis and who conducted the analysis

Condition T(3) of the ITP additionally requires documentation of the following management activities:

- Adaptive management undertaken during the year
- Expenditures by the EAA on implementation activities
- Proposed activities for the next year
- Report on the status of implementation of minimization and mitigation measures and their effectiveness
- Interim updates and final copies of any research, thesis or dissertation, or published studies accomplished in association with the EARIP or HCP
- Description of species-specific research and management actions undertaken with specific reference to the biological goals and objectives identified for each species
- Any changes to the Biological Goals and Key Management and Flow-related Objectives of the EAHCP and the reasons for such changes
- Any changes to the objectives for the monitoring program
- Effects on the Covered Species or Permit Area
- Evaluation of progress towards achieving the Biological Goals and Objectives
- Any recommendations regarding actions to be taken

This document serves as the Annual Report for the calendar year 2014. The 2013 Annual Report errata are provided in **Appendix B**. The comments received on earlier drafts of the 2014 Annual Report are included in **Appendix C**.

1.2 Edwards Aquifer Conditions/Management

In 2014, the effects of a persistent drought manifested themselves in declining aquifer levels across the region as a result of below-average recharge to the aquifer. These conditions prompted the EAA, under its Critical Period Management Program (CPMP), to require permit holders to curtail pumping from the aquifer by 44 percent in the Uvalde Pool (the maximum amount required by Stage V reductions) and 35.0 percent in the San Antonio Pool for the calendar year 2014. More detailed information regarding critical period management can be found in Section 3.1.5 of this report.

The drought and low aquifer levels also caused the Voluntary Irrigation Suspension Program Option (VISPO) to trigger. The VISPO is a springflow protection measure that provides financial incentives to irrigators to suspend withdrawal of groundwater enrolled in the program if the Edwards Aquifer is at or below a certain level. If the aquifer is at or below 635 feet (ft) above mean sea level (msl) in the J-17 index well on October 1, VISPO is triggered and withdrawal of all groundwater enrolled must be suspended for the following calendar year. The official reading of J-17 on October 1, 2014, was 630.6 ft msl; therefore, the use of 40,921 acre-feet (ac-ft) of enrolled water will be suspended for 2015, beginning January 1. This is only the seventh time since records have been kept (November 1932) that J-17 has been at or below 635 ft msl on October 1.

Permitted well data is included in **Appendix D**. Springflow, well discharge, and recharge data are included in the 2013 Hydrological Report (**Appendix D**). **Appendix D** contains additional information on permitted wells, reference wells, springflow data, groundwater modeling, and biological monitoring program. A more detailed and comprehensive report of aquifer conditions for 2014 will be available in the 2014 Hydrological Report upon publication.

1.3 Financial Report

The 2014 adopted budget, as shown in the EAHCP Expense Report (**Appendix E**) was $20,609,987. This amount is the Annualized Implementation Cost adopted in the EAHCP. The EAHCP Expense Report also shows this adopted budget compared to the total approved 2014 Funding Application budget of $20,609,987 and the total 2014 Actual expenses of $8,232,490. The report also breaks down the Adopted budget, Funding Application budget and actual expenses for Spring Flow Protection, San Marcos and Comal Springs projects, Modeling and Research projects, and Refugia expenses.

Approximately 60.6 percent of the 2014 adopted budget remained at the end of the December 2014, which was due primarily to balances resulting from unexpended funds due to restrictions imposed by Condition M of the Incidental Take Permit and unexpended funds in the Aquifer Storage and Recovery (ASR) and VISPO programs. By the end of 2014, the reserve balance for the EAHCP was $34,780,742, which includes unspent budgeted funds since the program's inception.

The EAHCP Expense Report also shows the actual revenue for 2014 of $19,130,957 compared to the budgeted revenue of $19,061,614, which is a variance of only $69,343. Approximately 95 percent of the actual revenue comes from Aquifer Management Fees. It is anticipated that revenue acquired in 2015 will be similar to the revenue acquired in previous years.

1.4 EAHCP Committee Activities

Article Seven of the Funding and Management Agreement (FMA) establishes the roles of four committees for the EAHCP: the Implementing Committee; the Stakeholder Committee; the Science Committee; and the Science Review Panel. The activies of those four committees and their work groups in 2014 are described in the following sections.

1.4.1 Activities of the Implementing Committee

The Implementing Committee supervises the implementation of the EAHCP and ensures compliance with documents such as the ITP, EAHCP, and FMA. There are five voting members of the Implementing Committee, who represent the five Permittees, and one representative of the Guadalupe-Blanco River Authority (GBRA), serves as a nonvoting member. **Table 1.4-1** lists the members of the Implementing Committee for 2014. The Implementing Committee met 11 times in 2014, and the agendas and minutes from those meetings are provided in **Appendix F**.

Table 1.4-1. Members of the Implementing Committee in 2014

Member	Entity	Alternate
Steve Ramsey	City of New Braunfels	Robert Camareno
Chuck Ahrens	San Aantonio Water System	Darren Thompson
Andrew Sansom	Texas State University	Juan Guerra
Tom Taggart*	City of San Marcos	Melani Howard
Roland Ruiz	Edwards Aquifer Authority	Brock Curry
Todd Votteler	Gudalupe-Blanco River Authority	Charlie Hickman

* Committee Chair

Highlights of the Implementing Committee meetings in 2014 are listed below.

- January 16:
  - Short meeting
- February 20:
  - Presentation and update on the Ecological Model
  - Presentation of 2013 Take Estimate and Habitat Disturbance
- March 20:
  - Creation of the Drought Outreach Work Group
  - Approval of 2013 Take Estimate and Habitat Disturbance
- April 17:
  - Presentation and approval of the New Braunfels Bank Stabilization Project
  - Presentation and approval of the Ecological Model Scope of Work through 2016

- May 15:
  - Presentations of the EAA 2015 Work Plans
  - Presentation of the Drought Outreach Work Group press releases
- May 29:
  - Presentation of the COSM and CONB Work Plans
- June 19:
  - Presentation and approval of the Drought Outreach Press Packet
  - Approval of all 2015 Work Plans
  - Creation of the Science Committee Member Nomination Work Group
- August 21:
  - Presentation and approval of Stakeholder Committee's recommendations for the Aquifer Storage and Recovery (ASR) and Voluntary Irrigation Suspension Program Option (VISPO) programs
  - Presentation and approval of a new Science Committee member – Dr. Conrad Lamon
- September 18:
  - Tour of San Marcos and Comal springs
  - Approved submittal of the Condition M clarification letter to USFWS
  - Approved the creation of the Regional Water Conservation Plan (RWCP) Work Group
- October 16:
  - Presentation and approval of 2015 EAHCP Funding Applications to be submitted to the EAA board
  - Presentation of staff report on the current status of Refugia implementation
- November 20:
  - Approved a contract with Boggess Communication to implement a quarterly EAHCP newsletter
  - Approved the submittal of the Refugia minor amendment letter to USFWS
- December 18:
  - Joint meeting of the Implementing, Stakeholder, and Science committees

1.4.1.1 Drought Outreach Work Group

The Implementing Committee formed the Drought Outreach Work Group on March 14, 2014. The Drought Outreach Work Group consisted of communications professionals from the Implementing Committee members. There were five meetings of the appointed Work Group members, who included Steve Ramsey, Jan Klein, Elizabeth Woody, LaMarriol Smith, Shane Townsend and William Peche. The goal of the work group was to develop effective, consistent outreach strategies for the Implementing Committee members to use collaboratively to raise public awareness and understanding. The Work Group developed the 2014 Drought Outreach Press Packet that consisted of various fact sheets, press releases, and social media posts to promote consistent regional messages that describe the reasons for the EAHCP, the importance of drought outreach, and the benefits of the cooperation of the Implementing Committee members. The minutes of these Work Group meetings can be found in **Appendix F**.

1.4.1.2 Science Committee Nomination Work Group

The Implementing Committee established the Science Committee Nomination Work Group on June 19, 2014, to fill a vacant position on the Science Committee created by the resignation of Miguel Acevedo. Representatives appointed to the Work Group were Colette Barron Bradsby, Jim Bower, Steve Raabe, John Waugh, Tyson Broad, and Todd Votteler. The Work Group held two meetings on July 2, 2014 and August 5, 2014, in New Braunfels. The first meeting established minimum and preferred qualifications for candidates for the Science Committee vacancy. At the second meeting, the Work Group reviewed and evaluated the nominations of four candidates, and recommended that the Implementing Committee appoint Dr. Conrad Lamon to the Science Committee. The minutes of these work group meetings can be found in **Appendix F**.

1.4.1.3 Regional Water Conservation Program Work Group

The EAHCP requires that the Regional Water Conservation Program (RWCP) conserves 20,000 acre-feet (ac-ft) of permitted and exempt Edwards Aquifer withdrawals and leaves half (10,000 ac-ft) of the conserved water un-pumped in the Edwards Aquifer. The RWCP Work Group was created to advise the Implementing Committee about ideas and methods to meet the required amount of conserved permitted or exempt Edwards Aquifer water. Members of this work group in 2014 included: Charlie Hickman (GBRA), Colette Barron Bradsby (Texas Parks and Wildlife Department [TPWD]), Diane Wassenich (San Marcos River Foundation [SMRF]); Karen Guz (SAWS); Randy Luensmann (Universal City); Richard Szecsy (Texas Aggregate and Concrete Association); Rick Illgner (EAA); and Tyson Broad (Sierra Club). The work group met four times in the fall of 2014 to compile, discuss and prioritize a list of possible recommendations for the Implementing Committee, and to provide direction in the development of the work group recommendations report. A recommendations report was prepared. The report and the minutes of these work group meetings can be found in **Appendix F**.

1.4.2 Activities of the Stakeholder Committee

The Stakeholder Committee met twice in 2014, and the agendas and minutes from those meetings are attached as **Appendix F**. **Table 1.4-2** lists the 27 Stakeholder Committee representatives, the entities they represented, the interests they represented, and their alternates, for the Year 2014.

Table 1.4-2. Members of the Stakeholder Committee in 2014

Member	Entity	Representing	Alternate
Carl Adkins	Texas BASS Federation Nation	Recreational interest in the Guadalupe River Basin	Tim Cook
Bruce Alexander	East Medina County SUD	A holder of an initial regular permit issued to a retail public utility located west of Bexar County	Bob Lee
Buck Benson	Alamo Cement/Pulman Law	A holder of an initial regular permit issued by the EAA for industrial purposes	Shanna Castro
Cary Betz	Texas Commission on Environmental Quality	TCEQ	Kelly Mills
Roger Biggers	New Braunfels Utilities	A retail public utility in whose service area the Comal Springs	Paula DiFonzo

Table 1.4-2. Members of the Stakeholder Committee in 2014

Member	Entity	Representing	Alternate
		or San Marcos Springs is located	
Jim Bower	City of Garden Ridge	A holder of an EAA initial regular permit issued to a small municipality located east of San Antonio	Tony Zugay
Doris Cooksey	CPS Energy	CPS Energy	Louisa Eclarinal
Kelley Faulk	Texas Department of Agriculture	Texas Department of Agriculture	Mike McMurry
Rader Gilleland	Gilleland Farms	A holder of an initial regular permit issued by the EAA for irrigation	Adam Yablonski
Renee Green	Bexar County	Bexar County	Kerim Jacaman
Juan Guerra	Texas State University	Texas State	Andrew Sansom
Myron Hess	National Wildlife Federation	Environmental Interest from the Texas Living Waters, National Wildlife Federation, or Sierra Club	Tyson Broad
Melani Howard	City of San Marcos	COSM	Laurie Moyer
Rick Illgner	Edwards Aquifer Authority	EAA	Elizabeth Woody
Jerry James	City of Victoria	A holder of a municipal surface water right in the Guadalupe River Basin	James Dodson
Gena Leathers	DOW Chemical	A holder of an industrial surface water right in the Guadalupe River Basin	Mike Uhl
Cindy Loeffler	Texas Parks and Wildlife	TPWD	Colette Barron
Gary Middleton	South Central Texas Water Advisory Committee	South Central Texas Water Advisory Committee	Bob Keith
Con Mims*	Nueces River Authority	Nueces River Authority	Kirby Brown
Kirk Patterson	Regional Clean Air and Water	Edwards Aquifer region municipal ratepayers/general public	Carol Patterson
Ray Joy Pfannstiel	Guadalupe County Farm Bureau	An agricultural producer from the Edwards Aquifer Region	Gary Schlather
Steve Raabe	San Antonio River Authority (SARA)	SARA	Julia Velez
Steven Ramsey	City of New Braunfels	City of New Braunfels	Zac Martin
Patrick Shriver	San Antonio Water System (SAWS)	SAWS	Steven Bereyso
Gary Spence	Guadalupe Basin Coalition	Guadalupe River Basin municipal ratepayers/general public	--
Todd Votteler	Guadalupe-Blanco River Authority (GBRA)	GBRA	Bill West
Dianne Wassenich	San Marcos River Foundation	A conservation organization	Annalisa Peace

* Committee Chair

At their May 28, 2014 meeting, the Stakeholder Committee formed the Aquifer Storage and Recovery /VISPO (ASR/VISPO) Work Group. To effectively provide recommendations for both programs, the ASR/VISPO Work Group was split into the ASR Sub-Work Group and the VISPO Sub-Work Group. The ASR/VISPO Work Group, chaired by Myron Hess, first met on June 17, 2014. The sub-Work Groups met

every two weeks from July 1 to July 31, and the full Work Group reconvened and held its final meeting on August 12, 2014.

Additional highlights of the Stakeholder Committee meetings in 2014 are listed below:

- May 28:
  - Elected new officers – Steve Raabe-Chair, and Myron Hess-Vice Chair
  - Created the ASR and VISPO Work Groups
- August 21:
  - Approved ASR and VISPO Work Group recommendation report
- December 18:
  - Joint meeting of Implementing, Stakeholder, and Science Committees

1.4.2.1 ASR Sub-Work Group

The members of the ASR Sub-Work Group were Steve Raabe (Vice-Chair), Earl Parker, Buck Benson, Patrick Shriver, Gena Leathers, Doris Cooksey, Jim Bower, and Julia Velez. The ASR Sub-Work Group made six recommendations to the Stakeholder Committee in the ASR/VISPO Work Group Recommendations Report. The report and the minutes of these sub-workgroup meetings can be found in **Appendix F**.

1.4.2.2 VISPO Sub-Work Group

The members of the VISPO Sub-Work Group were Adam Yablonski (Vice-Chair), Rick Illgner, Rader Gilleland, Ray Joy Pfannsteil, Bruce Alexander, and Myron Hess. The VISPO Sub-Work Group made three recommendations to the Stakeholder Committee in the ASR/VISPO Work Group Recommendations Report. The report and the minutes of these sub-work group meetings can be found in **Appendix F**.

1.4.3 Activities of the Science Committee

The Science Committee consists of experts with experience related to various components of the EAHCP who serve as an independent scientific panel to advise, consult, and provide recommendations to the Stakeholder and Implementing committees (**Table 1.4-3**). The Science Committee met seven times in 2014, and the agendas and minutes from those meetings are provided in **Appendix F**.

Table 1.4-3. Members of the Science Committee in 2014

Member	Entity	Expertise	Nominating Entity (Committee)
Tom Arsuffi	Texas Tech	Aquatic Biology Stream Ecology	Implementing
Janis Bush	UT San Antonio	Plant Ecology Experimental Design	Stakeholder
Jacquelyn Duke	Baylor University	Stream Ecology Riparian Ecohydrology	Implementing
Charlie Kreitler	LBG-Guyton Associates	Hydrogeology Groundwater Science	Implementing

Table 1.4-3. Members of the Science Committee in 2014

Member	Entity	Expertise	Nominating Entity (Committee)
Glenn Longley	Edwards Aquifer Research and Data Center	Biologist Edwards Aquifer Specialist	Stakeholder
Robert Mace	Texas Water Development Board	Hydrology Hydrogeology	Joint Nomination
Doyle Mosier*	Retired	Instream Flows Aquatic Habitats	Implementing
Chad Norris	Texas Parks and Wildlife Department	Aquatic Biology Aquatic Invertebrate Specialist	Stakeholder
Jackie Poole	Texas Parks and Wildlife Department	Botany/Taxonomy Texas Wild-rice Specialist	Stakeholder
Floyd Weckerly	Texas State University	Population Ecology Experimental Design	Stakeholder
Conrad Lamon	Statistical Ecology Associates LLC	Ecological Modeling	Implementing

* Committee Chair

Highlights of the Science Committee meetings in 2014 are listed below:

- February 5:
  - Presentation of 2013 Applied Research Results
- February 26:
  - Approval of 2014 Applied Research Methodologies and
  - Presentation of Take Estimate and Habitat Disturbance determination
- April 8:
  - Prioritization of the 2015 Applied Research Projects
- May 8:
  - Presentation and approval of the 2015 Work Plans
- May 12:
  - National Academies of Science meeting with the EAHCP Science Committee
- November 5:
  - Approval of the modified methods for calculating take
- December 18:
  - Joint meeting of Implementing, Stakeholder, and Science Committees

1.4.4 Activities of the Science Review Panel

In December 2013, the Implementing Committee entered into a contract with the National Academy of Sciences (NAS) for the creation of an independent Science Review Panel (SRP). **Table 1.4-4** lists the Science Review Panel members. The role of the SRP is to review and provide advice on four scientific initiatives with the EAHCP: 1) ecological modeling, 2) hydrologic modeling, 4) biological and water quality monitoring, and 4) research. The SRP met twice in 2014, and the agendas and minutes from those meetings are provided in **Appendix F**.

Table 1.4-4. Members of the Science Review Panel

Member	Entity	Area of Expertise
Danny Reible*	Texas Tech University	Chemical Engineering
Jonathan Arthur	Florida Geological Survey	Hydrogeology and Hydrochemistry
M. Eric Benbow	Michigan State University	Entomology of Aquatic Ecosystems
Robin Craig	University of Utah	Water Law
K. David Hambright	University of Oklahoma	Biology and Water Quality
Timothy Kratz	University of Wisconsin—Madison	Aquatic Ecology
Andrew Long	U.S. Geological Survey	Hydrology
Laura Murray	University of Maryland—Cambridge	Wetlands Ecology
Jayanthan Obeysekera	South Florida Water Management District	Hydrologic Modeling
Kenneth Rose	Louisiana State University	Population Modeling
Laura Toran	Temple University	Groundwater Monitoring and Modeling
Greg Woodside	Orange County Water District	Watershed Management and Planning

* Committee Chair

In 2014, the SRP first met at EAA's offices on February 13 through 15. In this meeting the SRP received information regarding the EAHCP Hydrologic Modeling, Ecological Modeling, Water Quality Monitoring, Biological Monitoring and Applied Research efforts. The three-day meeting included an "open-mic" session for the stakeholders and a tour of both spring systems. For its second meeting, the SRP met on May 12-14, where SRP members received additional details pertaining to the EAHCP Modeling and Monitoring efforts. Additionally, the EAHCP Science Committee met with the SRP to provide additional information about the scientific components of the EAHCP measures under review.

Also, the SRP held two closed meetings in 2014 in Washington D.C to develop its first report on the EAHCP. The Permittees expect to receive the first report by March 2015. It will include recommendations on the EAHCP Hydrologic Modeling, Ecological Modeling, Water Quality Monitoring, Biological Monitoring and Applied Research efforts.

2.0 BIOLOGICAL GOALS AND OBJECTIVES FOR COVERED SPECIES

The Biological Goals and Objectives of the EAHCP are set out in Section 4.1 of the EAHCP. The identification of biological goals and objectives is one of five components outlined in the HCP Handbook Addendum (USFWS and NMFS 2000), referred to as the "5-Point Policy." Long-term biological goals are the rationale behind the minimization and mitigation strategies and, conversely, minimization and mitigation measures are the means for achieving the long-term biological goals and objectives.

All long-term biological goals, accompanying management objectives, and flow-related objectives are subject to change under limited circumstances set out in the FMA. Any such change will be based solely on the best scientific and commercial data available.

3.0 PLAN IMPLEMENTATION IN 2014

A basic tenet guiding operation of the EAHCP is to maintain clear and open communication among all parties. Possible permit compliance issues are important to discuss with the USFWS and other affected parties as issues arise throughout the year. The importance placed on open and effective communication is a key factor in helping EAHCP implementation efforts end 2014 with no major outstanding issues.

Section 10(a)(2)(A) of the ESA requires that any application for an ITP be accompanied by a Habitat Conservation Plan (HCP). HCPs must include "measures the applicant will undertake to monitor, minimize, and mitigate such impacts [of the covered activities]" (USFWS HCP Planning Handbook, 3-10). This section discusses the progress achieved in 2014 towards meeting the minimization and mitigation measures outlined in the EAHCP.

The following sections describe the activities implemented in 2014 pursuant to the ITP and its conditions, as described in **Appendix A** of this report. The 2015 Work Plans are included in the current report as **Appendix G**.

3.1 Edwards Aquifer Authority

The EAA is a special regional management district established by the 73rd Legislature in May 1993, with the passage of the EAA Act to preserve and protect the Edwards Aquifer. As established by the Legislature, the EAA is governed by a 17-member board of directors representing the various stakeholder interests within an eight-county area, including all or parts of Atascosa, Bexar, Caldwell, Comal, Guadalupe, Hays, Medina, and Uvalde counties, and the South Central Texas Water Advisory Committee (SCTWAC). Geologists, hydrogeologists, environmental scientists, environmental technicians, educators, and administrative staff collaborate daily to fulfill the EAA's statutory mission of managing and protecting the Edwards Aquifer to the benefit of approximately two million South Texans who rely on the Aquifer as their primary source of water.

The EAA is responsible for the following minimization and mitigation measures under the EAHCP:

- Applied Research (EAHCP §6.3)
- Refugia (EAHCP §5.1.1)
- Voluntary Irrigation Suspension Program Option (VISPO) (EAHCP §5.1.2)
- Regional Water Conservation Program (EAHCP §5.1.3)
- Critical Period Management Program – Stage V (EAHCP §5.1.4)
- Expanded Water Quality Monitoring (EAHCP §5.7.2)
- Biological Monitoring (EAHCP §6.3.1, §6.4.3, and §6.4.4)
- Groundwater Modeling (EAHCP §6.3.2)
- Ecological Modeling (EAHCP §6.3.3)
- Impervious Cover and Water Quality Protection (EAHCP §5.7.6)
- Program Management (FMA §2.2)

All measures have been implemented according to the reviewed and approved 2014 Work Plan.

3.1.1 Applied Research (EAHCP §6.3.4)

The applied research program of the EAHCP is designed to expand the understanding of how the Covered Species interact with their environments given varied flow conditions. The applied research program is designed to provide data to support the development of the ecological model.

Obligations:

As development of the EAHCP was nearing completion, the lack of an appropriate applied research project facility was recognized. Therefore, Section 6.3.4.1 of the EAHCP called for construction of an experimental facility at the USFWS National Fish Hatchery and Technology Center, now known as the San Marcos Aquatic Research Center (SMARC).

The EAHCP Science Committee provided guidance on necessary criteria required in order to conduct the applied research. The requirements included the ability to contain the species in a suitable environment, the ability to manipulate water quality, the flexibility required to conduct numerous replications under various conditions, and the physical space required to implement the research. Additionally, all applied research projects described in the EAHCP require use of troughs, labs, raceways, ponds, channels and mesocosms.

Agreement:

It was later decided that appropriate facilities could be obtained through use of the Freeman Aquatic Building (FAB) on the Texas State campus. The infrastructure, with modifications, provided a more cost-effective option than making the necessary modifications to the SMARC. Meanwhile, several of the EAA's applied research contractors have been able to utilize the existing facilities at the SMARC.

The EAHCP initially identified three tiers of targeted research for applied research, summarized in **Table 3.1-1** below. Applied research studies are expected to fill critical data gaps and will be conducted as necessary (see *Proposed Activities for 2015* below).

Table 3.1-1. Applied Research as Outlined in §6.3.4.2 and §6.3.4.3 of the EAHCP

Tier	Research Activity
Tier A – Fountain Darter Habitat and Food Supply and Comal Springs Riffle Beetle Habitat Associations and Movement	Low-Flow Effects on Native Aquatic Vegetation
	Low-Flow Effects on Macro Invertebrates
	Effects of Low-Flows on Comal Springs Riffle Beetle Movement
	Extended Low-Flow Period Effects on Comal Springs Riffle Beetle
	Test Spring Run Connectivity
Tier B – Direct Impacts to Covered Species	Low-Flow Effects on Fountain Darter Movement, Survival, and Reproduction
	Low-Flow Effects on Comal Springs Riffle Beetle Survival and Reproduction
Tier C – Testing Repeat Occurrences of Low-Flows or a Combination of Effects	System Memory
	Ecological Model Validation

Table 3.1-1. Applied Research as Outlined in §6.3.4.2 and §6.3.4.3 of the EAHCP

Tier	Research Activity
Additional Studies	Aquatic Vegetation and Restoration and Non-Native Plant Removal • Evaluate transplant methodologies for various types of native aquatic vegetation • Evaluate the success of transplants over extended time periods • Evaluate methodologies for removal of non-native plants • Track maintenance required to keep non-native species from re-establishing
	Old Channel Environmental Restoration and Protection Area (ERPA) • Evaluate the need for channel manipulation for the enhancement of fountain darter habitat in the Old Channel (§5.2.2.1 of the EAHCP)

2014 Compliance Actions:

In 2014, the following applied research projects were conducted:

Tier A

- (Extended Low-Flow Effects on Comal Springs Riffle Beetle): Determination of Limitations of Comal Springs Riffle Beetle Plastron Use During Low Flow Study
- (Extended Low-Flow Effects on Comal Springs Riffle Beetle): Extended Low-Flow Period Effects on Comal Springs Riffle Beetles Study
- (Test Spring Run Connectivity and Baseline Study): Study to Establish Comal Springs Riffle Beetle Baseline Population Distribution and Refine Riffle Beetle Collection Methods

Tier B

- (Low-Flow Effects on Fountain Darter Movement, Survival and Reproduction): Effects of Low Flow on Fountain Darter Fecundity Study
- (Low-Flow Effects on Fountain Darter Movement, Survival and Reproduction): Effects of Predation on Fountain Darter Population Size at Various Flow Rates Study
- (Low-Flow Effects on Fountain Darter Movement, Survival and Reproduction): Effects of Vegetation Decay and Water Quality Deterioration on Fountain Darter Movement Study

Modifications Due to Drought Conditions:

During 2014, the flow in the Comal and San Marcos systems decreased to the point that Condition M of the ITP was triggered. In essence, Condition M stipulates that when the Comal Springs flows declines to 130 cubic feet per second (cfs) or lower, and when the San Marcos Springs flow declines to 120 cfs or lower, all of the habitat mitigation and restoration activities that might result in disturbance of the (a) substrate, (b) water quality, (c) plants, and (d) animals or invertebrates in the systems, must be suspended.

The Condition M low flow limits were reached in both systems in 2014 (Comal - July 9, 2014; San Marcos – August 8, 2014) and all EAHCP activities in the systems were suspended. The EAA and USFWS had several meetings that led to a formal request by the EAA seeking clarification. The USFWS issued a letter on September 30, 2014, clarifying the intent of Condition M and allowing EAHCP mitigation activities to resume provided that the Permittees would make every effort to minimize disturbance and reduce effects such as turbidity and siltation that could adversely impact the Covered Species at all times, and especially during low flow conditions (see **Appendix H1**).

However, implementation of some applied research projects were delayed while the interpretation of Condition M was being considered, causing difficulties completing some of the projects in 2014. One project (Comal Springs Riffle Beetle Population Estimate) received a no-cost extension, allowing the final report to be written and delivered in the first quarter of 2015.

Proposed Activities for 2015:

The applied research program is a dynamic process where existing research and data gaps are evaluated by EAA staff, the Science Committee and additional scientists. Additional applied research activities may be conducted as deemed necessary and appropriate through the Adaptive Management Process. The Science Committee is integral in the development of research methodologies and helping to resolve unforeseen conditions or challenges that may arise during applied research activities.

In 2015, the following applied research projects will be conducted:

- *Ludwigia repens* Interference Plant Competition Study
- Suspended Sediment Impacts on Texas wild-rice and other Aquatic Plant Growth Characteristics and Aquatic Macroinvertebrates
- Algae Dynamics and Dissolved Oxygen Depletion Study
- Comal Springs Riffle Beetle Habitat Connectivity Study

3.1.1.1 Freeman Aquatic Building (FAB)

In the fall of 2013, EAA staff and Texas State staff negotiated a contract to allow use of the FAB facilities to conduct applied research projects (**Appendix H2**). Texas State made renovations, which included two concrete-lined outdoor ponds, two large outdoor raceways, ten outdoor troughs, and an indoor wet lab, to the FAB with enhancements to accommodate and support EAHCP applied research (see **Figure 3.1-1** to **Figure 3.1-3**). Renovation details can be found in the Scope of Work section of Attachment A (of **Appendix H2**). The completed renovations totaled $321,288.37, and allow EAA staff and contractors' access to the renovated facilities starting January 1, 2014 and ending December 31, 2019 (**Appendix H2**)

Proposed Activities for 2015:

All 2015 EAHCP contractors' applied research projects will utilize the FAB facility for experimentation of the projects awarded by the EAA.

Figure 3.1-1. Replacement of aged troughs (left) with new valves and gauges (right)

Figure 3.1-2. Draining and dredging of the outdoor ponds (left) and installation of new electrical system (right)

Figure 3.1-3. Old stream simulator (left) and new living streams with updated electrical wiring and plumbing (right)

3.1.2 Refugia (EAHCP §5.1.1 and 6.3.4)

Obligations:

Pursuant to Sections 5.1.1 and 6.3.4 of the EAHCP, the EAA will support and coordinate with the USFWS on the work relating to the SMARC fish hatchery operation and maintenance of a series of off-site refugia.

Permit Condition K of the ITP requires that "the support of the refugia will augment the existing financial and physical resources of these facilities, and provide supplementary resources for appropriate research activities, as necessary, to house and protect adequate populations of Covered Species and expanded knowledge of their biology, life histories, and effective reintroduction techniques."

2014 Compliance Actions:

Prior to the issuance of the EAHCP ITP, the EAA began contract negotiations with the USFWS. Although contract negotiations are ongoing, the USFWS continues to provide research and refugia for a limited number of Covered Species that they have historically maintained.

Negotiations conducted during 2014 reached an impasse when USFWS advised that all facilities must be located on federal lands, be owned by the U.S. government, and be completely funded by the EAA, and that advance payment for all construction and services was required. This raised important constitutional and statutory issues under Texas law regarding the legal authority of the EAA to enter into the SMARC contract with USFWS. In order to resolve the state law issues, the procurement issues were submitted in September 2014 to the State of Texas Attorney General's Office for review, direction, and resolution in early 2015. In the interim, to ensure compliance with the EAHCP requirement to establish fully functional refugia for the EAHCP Covered Species, the EAA developed and is pursuing three separate initiatives: 1) negotiating with USFWS for a long-term refugia contract; 2) issuing a RFQ/RFP for a long-term refugia contract; and 3) developing interim short-term refugia efforts for implementation until a long-term contract is established.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

Consistent with the intent of Permit Condition K of the ITP, in 2015 the EAA will continue to undertake efforts to negotiate a refugia contract with the USFWS, who will use funding under the contract to increase personnel, enhance facilities, conduct life-cycle research, and provide refugia for the Covered Species identified in the EAHCP ITP at the SMARC, and the Uvalde and Inks Dam National Fish Hatcheries. The contract with USFWS for the remainder of the term of the ITP is contingent upon resolution of the state law procurement issues.

Recognizing that the state law issues may lead to an impasse, the EAA will also proceed with three separate initiatives, as described above. The entire 2015 Refugia Work Plan is included in **Appendix G**.

3.1.3 VISPO (EAHCP §5.1.2)

The VISPO is a voluntary springflow protection program designed to compensate irrigation permit holders for not pumping from the Edwards Aquifer during certain drought conditions. Participants may enroll in a 5-year, or 10-year, program participation option. Enrollment commits the permit holder to suspend pumping of enrolled water for one calendar year if, on the previous October 1 trigger date, the aquifer level at the J-17 index well is at or below 635 ft msl. At all other times, a participant's use of enrolled water is not restricted. Participants are paid an annual stand-by fee for their enrollment in the program, and are provided an additional forbearance payment in years where water use suspension is mandated by the terms of their VISPO forbearance agreements. Copies of the forbearance agreements and a flyer about the VISPO program are provided in **Appendix H3**.

Obligations:

Pursuant to Section 5.1.2 of the EAHCP, the EAA is responsible for administering VISPO. The goal for this program is 40,000 ac-ft of enrolled EAA-issued irrigation permits. The target distribution for enrollment is 10,000 ac-ft/yr in Atascosa, Bexar, Comal, and Hays counties, and 15,000 ac-ft/yr each in Medina and Uvalde counties. This program accepts both "Base Irrigation Groundwater" and "Unrestricted Irrigation Groundwater" withdrawal rights. Unrestricted Irrigation Groundwater is not restricted as to its place or purpose of use, while base water is restricted to irrigation use only at the historically irrigated areas to which it is appurtenant.

2014 Compliance Actions:

Irrigators have two program options - a five-year program option and a ten-year program option - that provide the following payment schedules:

- Five-year program:
  - standby fee of $50/ac-ft that increases 1.5 percent per year; and
  - forbearance payment of $150/ac-ft that also increases 1.5 percent per year.
- Ten-year program:
  - standby fee of $57.50/ac-ft for years 1-5, and a "step-up" to $70.20/ac-ft for years 6-10; and
  - forbearance payment of $172.50/ac-ft for years 1-5, and a "step-up" to $210.60/ac-ft for years 6-10.

Initial enrollment for VISPO began in December 2012 and concluded October 1, 2013, with 22,427 ac-ft of enrolled water. Year 2014 program enrollment began in January and concluded in early October with a total combined enrollment of 40,921 ac-ft as shown in **Table 3.1-2**.

Table 3.1-2. VISPO Total Enrollment (in ac-ft)

Enrollment Option	Atascosa	Bexar	Comal	Hays	Medina	Uvalde	Total
5-Year Base	354	829	0	67	2,920	14,532	18,702
5-Year Unrestricted	0	55	0	56	773	5,885	6,769
Subtotal	354	884	0	123	3,693	20,417	25,471
10-Year Base	0	1,451	0	0	6,152	4,183	11,786
10-Year Unrestricted	0	122	0	0	1,651	1,891	3,664
Subtotal	0	1,573	0	0	7,803	6,074	15,450
Totals	354	2,457	0	123	11,496	26,491	40,921

Modifications Due to Drought Conditions:

At this point, the perceived impact of drought does not warrant suggesting or making any changes to the operation or implementation of VISPO. However, drought appears to have impacted VISPO enrollment in two very different ways during the two years of enrollment.

First of all, the drought appears to dampen VISPO enrollment during summer because of the possibility of increased reductions on water rights. Secondly, the likelihood of a triggering condition on October 1, led to significant enrollment activities, particularly in 2014 when a trigger condition was eminent. More than 14,000 ac-ft of enrollment was received in September 2014.

The J-17 level on October 1, 2014 was 630.6 ft msl, so VISPO will trigger for the calendar year 2015.

2014 Compliance Actions:

The EAA initiated an event called "The Road Show" in 2013 that entails sending staff to remote locations throughout the EAA twice a year for one week so that it was easier for permit holders to get help or have questions answered. The summer Road Show was the first week in June, and staff was in Uvalde on June 4 and Castroville on June 5 to discuss VISPO.

As enrollment waned in the middle of the year, the VISPO Sub-work Group was organized to discuss the program and make recommendations to the Implementing Committee for improvement. The work group met five times from mid-June to mid-August, and made three recommendations:

1. Distribute a marketing message;

2. If VISPO triggers on October 1, extend enrollment; and

3. Consider using the recently created Edwards Aquifer Conservancy to provide a compensation alternative.

Recommendations 1 and 2 were followed and the final enrollment was accepted approximately one week after the October 1 trigger date. The third recommendation was not necessary to consider. A complete

summary of the work group's activities and recommendations is included in **Appendix F**. A news piece was mailed to irrigators in early August and a story on VISPO was featured in the August and October EAA newsletters (see **Figure 3.1-4**).

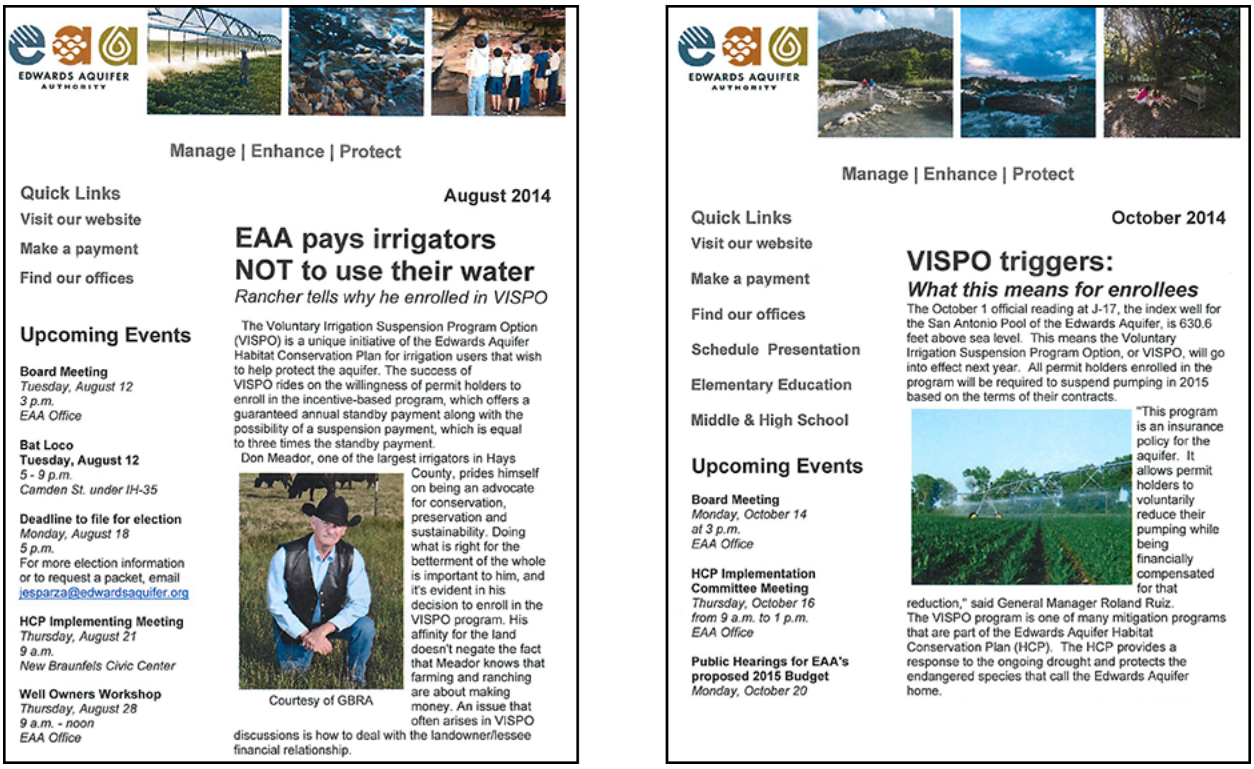


Figure 3.1-4. August and October EAA Newsletters

Finally, two lunch meetings were held the last week of August in Castroville and Uvalde to discuss the VISPO program. Although attendance was limited, the results were very positive.

Proposed Activities for 2015:

No enrollment will occur as the 40,000 ac-ft goal has been met. Since 2015 is a trigger year, stand-by and forbearance payments will be made in March to all enrolled participants.

3.1.4 RWCP (EAHCP §5.1.3)

The RWCP was included in the EAHCP to provide an opportunity for permit holders not currently engaged in conservation programs to be provided a mechanism for implementing water conservation to off-set their current levels of pumping. This program creates opportunities for municipal and industrial use permit holders as well as exempt well owners.

Obligations:

Pursuant to Section 5.1.3 of the EAHCP, the goal of the RWCP is to conserve 20,000 ac-ft of permitted or exempt Edwards Aquifer water. Of this amount, 10,000 ac-ft will be held by the EAA in a groundwater

trust where it will remain un-pumped for the term of the ITP to reduce stress on the Aquifer. The other 10,000 ac-ft of conserved groundwater will remain available for withdrawal by the participating entity.

To show that this measure is reasonably certain to occur, the EAA's goal was to obtain 'initial commitments' in the amount of 10,000 ac-ft/yr in 2013. As conserved water is committed to the groundwater trust, the initial commitment water is to be returned to the committing entity. At present SAWS, Texas State, and COSM have made initial commitments in the amount of 8,400 ac-ft.

To meet the EAHCP goal of 10,000 ac-ft, the RWCP includes the following programs:

- Lost Water and Leak Detection
- High-Efficiency Plumbing Fixtures and Toilet Distribution
- Commercial/Industrial Retrofit Rebate
- Water Reclamation

2014 Compliance Actions:

The goal for 2014 was to fully develop and begin implementation of the four individual elements of the RWCP: lost water and leak detection; high efficiency plumbing fixtures and toilet distribution; commercial industrial retrofit rebate; and water reclamation for efficient water use.

2014 Activities:

- Texas AgriLife continued to represent the EAA in assisting Edwards Aquifer water users in participating in the conservation programs listed above through the Interlocal Agreement executed in January 2013.
- In 2014, EAA interacted with the U.S. Department of Defense (DoD) Chief of Command to explain the benefits accrued by the DoD from the EAHCP and to request participation by DoD in the form of allowing the EAHCP to receive credit for 1,600 ac-ft of DoD water not withdrawn. At the request and interest of the DoD, EAA HCP staff created a fact sheet to educate other DoD staff about the RWCP (**Appendix H4**). However, shortly thereafter, the Chief of Command was transferred and no additional direct conversation occurred between EAA and DoD. Subsequently, the EAA developed a strategy for re-engaging the DoD. Because the Texas Agrilife team had previous DoD work experience and relationships, as the RWCP contractor, Texas Agrilife assisted with development of this strategy. As a result of implementing that strategy, discussions were held between the contractor and the DoD. The result of the discussions yielded questions from DoD that staff responded to in November 2014. However, no final response has been received from DoD to date. Additionally, Texas AgriLife staff met with a civilian DoD employee to discuss opportunities for conservation programs. Again, no formal arrangements or agreements have been made.
- As part of the implementation of the RWCP, the EAA continued to meet the obligations described in the U.S. Bureau of Reclamation WaterSMART Grant, which is funded through September 2015.
    - To date, the EAA has received $210,721.93 in reimbursement for high efficiency/low flow toilets and plumbing kits, and leak detection/water loss programs, and expects the remainder to be reimbursed during 2015.

- Texas AgriLife continued to contact communities from the priority matrix developed in 2013, however, with the continuing drought, many communities are hesitant to participate in the program.
- The EAA negotiated and entered into an Interlocal Cooperation Contract with the City of Universal City to implement a water conservation program and commit 163.684 ac-ft of conserved water to the groundwater trust. (**Appendix H5** is a copy of the transfer of water rights to the EAA Groundwater Trust.).
- Texas AgriLife continued to assist the City of Uvalde in implementation of their water conservation measures (primarily distribution of high efficiency/low flow toilets and plumbing kits). In 2014, the installation of high-efficiency toilets and plumbing kits resulted in an estimated savings of 59.820 ac-ft; one-half of that amount (29.910 ac-ft) were transferred into the EAA Groundwater Trust (**Appendix H5** same as Universal City). In addition, Texas AgriLife provided training to Uvalde area plumbers and extension agents on the operation and installation of high efficiency/low flow toilets and plumbing kits. At the writing of this report, the City of Uvalde had distributed 631 high efficiency/low flow toilets and plumbing kits to city residents (**Figure 3.1-5**).
- Texas AgriLife enlisted the support of AgriLife Extension Agents in Bexar, Comal, Hays, Medina, and Uvalde counties in reaching out to Edwards Aquifer exempt well users and informing them about available RWCP opportunities.
- Texas AgriLife conducted a RWCP Lost Water Seminar aimed at identifying lost water issues that can be addressed to result in a water savings for the groundwater trust.
- A sub-group of the Implementing Committee (called the RWCP Work Group) was formed to make recommendations to the Implementing Committee on achievable methods to secure the remaining balance of 10,000 ac-ft of Edwards Aquifer water to be placed in the groundwater trust in order to meet the requirement of the ITP.






Figure 3.1-5. City of Uvalde high efficiency/low flow toilet distribution program

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, the EAA will continue activities directed at achieving the remaining goal of 10,000 ac-ft/yr established by the initial commitments made by SAWS, COSM, and Texas State.

Specifically, EAA staff and/or their contractor Texas AgriLife will:

- Continue to work with the City of Uvalde to find additional opportunities for reducing their use of the Edwards Aquifer;
- Contact large municipalities to discuss participating in a high efficiency, low-flow plumbing program;
- Continue to reach out to communities in the EAA jurisdictional area and determine their willingness to participate in the RWCP; and
- Identify other opportunities to place groundwater in the trust.

3.1.4.1 Regional Water Conservation Program Monitoring Committee

The EAA is responsible for coordinating the activities of the RWCP Monitoring Committee. Representation on the Monitoring Committee includes one representative each from SAWS, CONB, COSM, and a small water purveyor utilizing the Edwards Aquifer. It is the responsibility of this committee to provide technical input and expertise, seek additional funding, advise the EAA on the efficiency and significance of RWCP activities, consider each activity in the context of achieving the overall EAHCP goal for the RWCP, rank proposed activites, comment on the potential of each activity, consult with the EAA board regarding conserved water determinations, make specific recommendations regarding program implementation, and develop periodic updates tracking the progress of the program.

The RWCP Monitoring Committee, as prescribed in the EAHCP, met on March 24, 2014; the agenda for this meeting are included in **Appendix H6**. At this meeting, the Committee received presentations on the Leon Valley Assessment Report and Proposed Implementation Plan, the 2014 High Efficiency/Low Flow Toilets and Plumbing Fixture contract with Moore Supply, the implementation contracts with the City of Uvalde and Universal City, and the RWCP Direction Memorandum, which was written by EAA staff to provide guidance and direction to Texas AgriLife staff in pursuing their contractual goals.

3.1.5 Critical Period Management Program – Stage V (EAHCP §5.1.4)

Obligations:

Stage V of the EAA Critical Period Management Program (CPMP) mandates a 44 percent reduction in water use, and is applicable to permit holders in both the San Antonio and Uvalde pools. Stage V is designed to be triggered only when other measures have not proven sufficiently effective in maintaining springflow

during drought conditions. For the San Antonio Pool, Stage V is triggered when the 10-day average aquifer level at the J-17 index well drops below 625 ft-msl or if the springflows at Comal Springs decline below 45 cfs based on a ten-day rolling average, or below 40 cfs based on a three-day rolling average. In the Uvalde Pool, Stage V is triggered when the Uvalde County Index Well J-27 aquifer level drops below 840 ft-msl.

2014 Compliance Actions:

Stage V became effective on March 28, 2013, ten days following formal approval of the ITP. On March 28, 2013, conditions warranted implementing Stage V reductions in the Uvalde Pool and continued for the remainder of the year. In 2014, Stage V was in effect in the Uvalde Pool for the entire year. **Table 3.1-3** and **Table 3.1-4** below show the requirements for Stage V reductions in relationship to the first four CPMP stages for both the San Antonio and Uvalde Pools, respectively.

Table 3.1-3. Critical Period Management Program Triggers, Stages, and Reductions for the San Antonio Pool of the Edwards Aquifer

Wells/Springs	Critical Period Stage I*	Critical Period Stage II*	Critical Period Stage III*	Critical Period Stage IV*	Critical Period Stage V**
Index Well J-17 Level (msl)	<660	<650	<640	<630	<625
San Marcos Springs Flow rate (cfs)	<96	<80	N/A	N/A	N/A
Comal Springs Flow rate (cfs)	<225	<200	<150	<100	<45** or <40**
Withdrawal Reduction	20%	30%	35%	40%	44%

* A change to a critical period stage with higher withdrawal reduction percentages, including initially into Stage I for the San Antonio Pool and Stage II for the Uvalde Pool, is triggered if the 10-day average of daily springflows at the Comal Springs or the San Marcos Springs or the 10-day average of daily Aquifer levels at the J-17 or J-27 Index Wells, as applicable, drop below the lowest number of any of the trigger levels for that stage. A change from any critical period stage to a critical period stage with a lower withdrawal reduction percentage, including exiting from Stage I for the San Antonio Pool and Stage II for the Uvalde Pool, is triggered only when the 10-day average of daily springflows at the Comal Springs and the San Marcos Springs and the 10-day average of daily Aquifer levels at the J-17 or J-27 Index Wells, as applicable, are all above the same stage trigger level.

** In order to enter into Critical Period Stage V, the applicable springflow trigger is either less than 45 cfs based on a ten-day rolling average or less than 40 cfs based on a three-day rolling average. Expiration of Critical Period Stage V is based on a ten-day rolling average of 45 cfs or greater.

Table 3.1-4. Critical Period Management Program Triggers, Stages, and Reductions for the Uvalde Pool of the Edwards Aquifer

Wells/Springs	Critical Period Stage I*	Critical Period Stage II*	Critical Period Stage III*	Critical Period Stage IV*	Critical Period Stage V**
Index Well J-27 Level (msl)	N/A	<850	<845	<842	<840
San Marcos Springs Flow rate (cfs)	N/A	N/A	N/A	N/A	N/A
Comal Springs Flow rate (cfs)	N/A	N/A	N/A	N/A	N/A
Withdrawal Reductions	N/A	5%	20%	35%	44%

* A change to a critical period stage with higher withdrawal reduction percentages, including initially into Stage I for the San Antonio Pool and Stage II for the Uvalde Pool, is triggered if the 10-day average of daily springflows at the Comal Springs or the San Marcos Springs or the 10-day average of daily Aquifer levels at the J-17 or J-27 Index Wells, as applicable, drop below the lowest number of any of the trigger levels for that stage. A change from any critical period stage to a critical period stage with a lower withdrawal reduction percentage, including exiting from Stage I for the San Antonio Pool and Stage II for the Uvalde Pool, is triggered only when the 10-day average of daily springflows at the Comal Springs and the San Marcos Springs and the 10-day average of daily Aquifer levels at the J-17 or J-27 Index Wells, as applicable, are all above the same stage trigger level.

** In order to enter into Critical Period Stage V, the applicable springflow trigger is either less than 45 cfs based on a ten-day rolling average or less than 40 cfs based on a three-day rolling average. Expiration of Critical Period Stage V is based on a ten-day rolling average of 45 cfs or greater.

Implementation / Modification Due to Drought Conditions:

Due to the drought conditions in south central Texas in 2014, the EAA enforced critical period in both pools of the Edwards Aquifer. As of November 7, 2014, the San Antonio Pool was in Stage IV and the Uvalde Pool in Stage V, and both pools are expected to remain in their current stages for the remainder of the calendar year. **Table 3.1-5** shows the expected number of days each pool was in a stage of critical period cutbacks in 2014.

Table 3.1-5. 2014 Critical Period Management Enforced Reductions

CPM Stage	Total Days in Uvalde Pool	Total Days in San Antonio Pool
No CPM reduction	0	0
Stage I	0	0
Stage II	0	96
Stage III	0	127
Stage IV	0	142
Stage V	365	0
Total Reduction	44%	35%

Proposed Activities for 2015:

In 2015, the EAA will continue to enforce critical period management restrictions consistent with the agency's rules and as discussed in the EAHCP.

3.1.6 Expanded Water Quality Monitoring (EAHCP §5.7.2)

Obligations:

The EAA will continue its historical groundwater and surface water quality monitoring programs. In addition to historical monitoring, the EAA will provide oversight while SWCA Environmental Consultants (SWCA) conducts the groundwater, surface water, stormwater, sediment, and passive diffusion samplers (PDS) sampling in Landa Lake, the Comal River, Spring Lake, and the San Marcos River. Comal River water quality sampling sites are shown in **Figure 3.1-6,** and **Figure 3.1-7** identifies the San Marcos River water quality sampling sites. The Comal River passive diffusion sampler sites are shown in **Figure 3.1-8**, and **Figure 3.1-9** displays the locations of the San Marcos River passive diffusion sampler sites. All four of these figures are located in subsection 3.1.6.2, Location of Sampling Sites, located later in this report section.

2014 Compliance Actions:

On January 1, 2014, the EAA contracted with SWCA to implement the expanded water quality monitoring program (Section 5.7.2 of the EAHCP) to include collection of additional samples and sample types in the immediate vicinity of Comal and San Marcos springs. The expanded water quality sampling program was developed in accordance with the directives of the EAHCP and provides a means for early detection of

potential impairments to water quality within the Comal River and the headwaters of the San Marcos River systems.

Modifications Due to Drought Conditions:

Sampling activities were minimally affected by ongoing drought conditions in the area. No extreme low-flow sampling was initiated at wells (Sections 6.4.3.3 and 6.4.4.3 of the EAHCP) as flows at Comal Springs did not drop below 30 cfs or below 50 cfs at San Marcos Springs. However, the ongoing drought made stormwater sampling exceedingly difficult to perform. Rain events were generally scattered in nature and often too small in magnitude to generate sufficient runoff to sample. Furthermore, if the region does not receive sufficient amount of rainfall in the near future, there is a possibility low-flow sampling may be initiated during the summer of 2015.

Proposed Activities for 2015:

In 2015, an additional water quality data logging point is recommended for installation at the lower (south) end of the sample area for San Marcos. The additional station will help with the timing of storm sample collection as well as improved monitoring of the IH-35 and Willow Creek runoff impacts. The location of the proposed new monitoring point is coincident with surface water sample point HSM170 (Capes Dam/Willow Creek area in Figure 3.1-7).

3.1.6.1 Water Quality Data

Water quality data provided by SWCA is included in **Appendix D** – *Edwards Aquifer Habitat Conservation Plan Expanded Water Quality Monitoring Report December 2014*.

3.1.6.2 Location of Sampling Sites

Figure 3.1-6. Comal River water quality sampling sites

Figure 3.1-7. San Marcos River water quality sampling sites

Figure 3.1-8. Comal River passive diffusion sampler sites

Figure 3.1-9. San Marcos River passive diffusion sampler sites

3.1.6.3 Methods for Data Collection and Variables Measured

Surface Water

The preferred method for obtaining a surface water sample is to wade to the sample location and on the upstream side of the sampler (assuming stream is flowing), obtain field parameters (pH, specific conductivity, dissolved oxygen, and temperature) then insert the sample bottle directly into the water (**Table 3.1-6.** Analytical Parameters by Sample Type). In March and September of 2014, SWCA field staff collected samples by utilizing the preferred method, and samples were collected in their respective containers directly from the surface water. Samples were collected in accordance with the criteria set forth in the *EAA Groundwater Quality Monitoring Plan.*

Sediment

Sediment samples were collected surface to bottom of the river. Two samples were collected from each sample site by SWCA field staff in a sample tube using a Shelby sampler. Sediment samples from each site were individually homogenized at the contract laboratory prior to analysis. Sediment collection points included an area up to several feet in diameter, which varied based on the amount of available sediment at each location. The Shelby sampler utilized plastic liners to hold the sediment collected within the probe. Once the plastic liner was filled with sediment, SWCA field staff removed the plastic liner from the Shelby sampler and wrapped both ends with laboratory film (Parafilm) before capping it with end pieces. Liners were individually labeled. Sediment samples were collected in accordance with the criteria set forth in the *EAA Groundwater Quality Monitoring Plan*.

Stormwater

Stormwater samples were collected across the storm-affected stream hydrograph at the rise, peak, and recession limb. In general, the turbidity and conductivity data from the Real Time Instrumentation (RTI) at each site were utilized as a surrogate for the stream hydrograph due to immediate availability of the data. SWCA field staff obtained field parameters by inserting the sonde as close to the sample location as possible. Next, SWCA field staff utilized a clean amber bottle to collect samples. After collecting each sample, water was transferred from the amber bottle into the appropriate sample bottle. Stormwater samples were collected in accordance with the criteria set forth in the *EAA Groundwater Quality Monitoring Plan*.

Passive Diffusion Samplers

Passive Diffusion Samplers (PDS) were deployed by SWCA field staff during the months of March, April, June, August, October, and December of 2014 using a passive diffusion-type sampling device, which was obtained from Amplified Geochemical Imaging (AGI) LLC. Sample locations for PDS samples are coincident with surface water and sediment sampling points. PDS samples were retrieved by SWCA field staff after a two-week interval at the same locations as the base flow surface water samples. PDS samples were collected in accordance with the criteria set forth in the *EAA Groundwater Quality Monitoring Plan*.

Real Time Instrumentation

The objective for implementing the use of RTI was to measure changes in basic water quality parameters in near real time. The RTIs record data at 15-minute intervals (or nearly continuous basis). As such, the instrumentation provides a mechanism for recording water quality changes related to season, time of day, weather, and various other influences. The instrumentation measures the following parameters.

- Dissolved oxygen (DO) in mg/L
- pH (no units)
- Conductivity in micro-Siemens per centimeter (µS/cm)
- Turbidity in nephelometric turbidity units (NTU)
- Temperature in degrees Celsius (°C)

The resulting data are stored locally on the instrument and also reported to, and stored on, a secure internet site. The data are subsequently downloaded monthly and permanently stored on the EAA computer network and can be accessed via the internet at: http://www.eahcp.org/index.php/supporting/ water_quality_and_protection.

Table 3.1-6. Analytical Parameters by Sample Type

Analytical Parameter	Surface Water (Base Flow) Samples	Sediment Samples	Stormwater Samples	Passive Diffusion Sampling
Volatile Organic Compounds (VOCs)	Yes	Yes	Yes	No
Semi-volatile Organic Compounds (SVOCs)	Yes	Yes	Yes	No
Organochlorine Pesticides	Yes	Yes	Yes	No
Polychlorinated Biphenyls (PCBs)	Yes	Yes	Yes	No
Herbicides	Yes	Yes	Yes	No
Metals (Al, Sb, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, and Zn)	Yes	Yes	Yes	No
General Water Quality Parameters (GWQP; Total Alkalinity (as $CaCO_3$), Bicarbonate Alkalinity (as $CaCO_3$), Carbonate Alkalinity (as $CaCO_3$); Cl, Br, NO_3, SO4, Fl, pH, TDS, TSS, Ca, Mg, Na, K, Si, Sr, CO_3,)	Yes	No TDS or TSS	Yes	No
Phosphorus (total)	Yes	Yes	Yes	No
Total Organic Carbon (TOC)	Yes	Yes	Yes	No

Table 3.1-6. Analytical Parameters by Sample Type

Analytical Parameter	Surface Water (Base Flow) Samples	Sediment Samples	Stormwater Samples	Passive Diffusion Sampling
Dissolved Organic Carbon (DOC)	Yes	Yes	Yes	No
Total Kjeldahl Nitrogen (TKN)	Yes	No	Yes	No
Bacteria (E. coli)	Yes	No	Yes	No
Field Parameters (DO, pH, Conductivity, Turbidity, Temperature)	Yes	No	Yes	No
TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene.	No	No	No	Yes

3.1.6.4 Frequency, Timing, and Duration of Sampling for the Variables

Surface water quality grab samples were collected biannually from five sites throughout the Comal Springs complex and seven sites throughout the San Marcos Springs complex. According to the EAHCP Work Plan, the sample dates were to be six months apart.

Sediment samples were collected annually at five sites for the Comal Springs complex and seven sites for the San Marcos Springs complex. Locations were generally coincident with surface water samples at each spring complex.

Stormwater samples were collected twice annually from each spring complex. Stormwater samples were collected when rainfall amounts were adequate to initiate a significant rise at the respective USGS gauging locations for each spring complex.

PDS samples were collected six times at five sites for the Comal Springs complex and seven sites for the San Marcos Springs complex. Locations were generally coincident with surface water and sediment samples at each of the spring complexes.

3.1.6.5 Description of the Data Analysis

Samples were analyzed for parameters of interest by the contracted laboratory Eurofins Calscience, Inc. SWCA staff evaluated the results of the laboratory's analysis by sample type and applicable standards.

Surface Water

Regulatory standards for surface water quality vary depending on type of use. For this report, surface water results are compared to drinking water quality standards (30 TAC, Chapter 290, Subchapter F) for detected constituents of concern. These guidelines were selected for use since, in general, they provide the most stringent quality standards. For detections of interest that do not have an established maximum contaminant level (MCL) under 30 TAC 290, the Texas Risk Reduction Program (TRRP) from 30 TAC 350 was substituted. The TRRP standards used are the Tier I, residential standards and are referred to as protective concentration levels (PCLs). Other guidelines may be more useful or appropriate for particular research; however, for the scope of this report these standards provide appropriate and applicable guidelines with regard to water quality.

Sediment

Analytical results for sediment samples are compared to the sediment quality guidelines published in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al., 2000). These guidelines are based on determination of probable sediment toxicity in freshwater ecosystems and provide a numerical sediment quality guideline for 28 chemicals of concern. The guidance provides two basic standards for comparison: 1) threshold effect concentration (TEC), and; 2) probable effect concentration (PEC). Analytical results with concentrations below the TEC are predicted to have no toxic effect on sediment-dwelling organisms, while results with concentrations above the PEC have a higher probability of having a toxic effect on sediment dwelling organisms. Detected compounds with concentrations between the TEC and PEC are considered equally likely to be toxic or non-toxic. While numerous other guidelines for sediment quality exist, these guidelines provide a good reference for the scope of the current investigation. Future researchers may apply other guidelines that are more specific to particular concerns of interest.

Stormwater

As previously mentioned, standards for surface water quality vary depending on type of use. For this report, stormwater results are compared to drinking water quality standards (30 TAC, Chapter 290, Subchapter F)

for detected chemicals of concern. These guidelines were selected for use since, in general, they provide the most stringent quality standards. For detections of interest that do not have an established MCL under 30 TAC 290, the TRRP from 30 TAC 350 was substituted. The TRRP standards are for Tier I, residential standards, and are referred to as PCLs. Other guidelines may be more useful or appropriate for particular research; however, for the scope of this report these standards provide appropriate and applicable guidelines with regard to water quality.

Passive Diffusion Samplers

As previously mentioned, standards for surface water quality vary dependent upon type of use. For this report, PDS results are compared to drinking water quality standards (30 TAC, Chapter 290, Subchapter F) for detected chemicals of concern. These guidelines were selected for use since in general they provide the most stringent quality standards. For detections of interest that do not have an established MCL under 30 TAC 290, the TRRP from 30 TAC 350 was substituted. The TRRP standards are for Tier I, residential standards and are referred to as PCLs. Other guidelines may be more useful or appropriate for particular research; however, for the scope of this report these standards provide an appropriate and applicable guideline with regard to water quality.

3.1.7 Biological Monitoring (EAHCP §6.3.1, §6.4.3, and §6.4.4)

The purpose of the Biological Monitoring program is to continue the EAA's Variable Flow Study initiated in 2000 and amended to include critical period, and EAHCP-specific monitoring to provide a means of monitoring changes to habitat availability and the population abundance of the Covered Species that may result from the covered activities included in the EAHCP.

Obligations:

Pursuant to Section 6.3.1 of the EAHCP, the EAA will continue the Biological Monitoring program (as amended) that includes additional sampling during critical periods, additional nutrient testing, as well as additional sampling to include the Texas Cave diving beetle and the Texas troglobitic water slater, both petitioned species under the ESA. The amended Biological Monitoring program also includes additional sampling as required by the EAHCP to monitor natural changes occurring in the system and those determined to be appropriate through the Adaptive Management Process.

The Biological Monitoring program includes the triggered monitoring activities outlined in Sections 6.4.3 and 6.4.4 of the EAHCP. Triggered monitoring, as outlined in these sections, requires additional sampling and vegetation mapping activities not originally anticipated in the variable flow critical period sampling program. Copies of the 2014 Biological Monitoring reports for the systems will be available on the EAHCP website in May 2015: (http://www.eahcp.org/index.php/supporting/biological_monitoring).

2014 Compliance Activities:

The biological monitoring activities are included in **Appendix D**.

Modifications Due to Drought Conditions:

Variable flow critical period monitoring in the Comal system triggered by drought conditions began in April 2014 (Task 15 below), while EAHCP-specific critical period monitoring activities began in June 2014 (Task 16 below). Springflow levels required continued critical period monitoring starting in April, and are ongoing at this time.

Task 15 – Critical period full events and associated monitoring

- April – <150 cfs full event conducted in conjunction with spring comprehensive event
- Weekly habitat evaluations and memos started in April 2014 and ongoing at present (29 weeks and counting)
- August – <100 cfs full event conducted independently
- Next full event not until < 50 cfs

Task 16 – EAHCP species-specific

- Fountain darter presence/absence dip netting and aquatic vegetation mapping– triggered at < 150 cfs in April – first conducted independently in June – still active
- Comal Springs riffle beetle sampling – started at < 120 cfs in July – still active
- Comal Springs salamander sampling – started at < 120 cfs in July – still active

Copies of the weekly critical period reports are available on the EAHCP website: (http://www.eahcp.org/index.php/supporting/biological_monitoring).

Proposed Activities for 2015:

In 2015, the EAA will continue the biological monitoring program consistent with the requirements outlined in the EAHCP.

3.1.8 Groundwater Modeling (EAHCP §6.3.2)

Obligations:

By December 31, 2014, the EAA will (1) take appropriate steps to reduce the level of uncertainty in the MODFLOW model by filling in data gaps to the extent practicable and by reducing the number of structural limitations in the model, and (2) create a new finite-element model to reduce uncertainty in the model results for use during the Adaptive Management Process and to provide assurance/confirmation that modeling results for the Edwards Aquifer and springflows are more reliable and defensible.

2014 Compliance Actions:

MODFLOW Model

The MODFLOW model updates listed below were completed in December 2014. The first half of 2014 was spent evaluating improvements to the conceptual model and gathering and processing the pumping and recharge data for input. Model changes include modification of the locations representing conduit flow and hydrologic barriers. Several of the conduit features represented in the original MODFLOW model are

removed from this model and locations of several barrier features were modified. The model inputs were updated to reflect monthly recharge and pumping from January 2001 through December 2011. Improvements over the original model include better representation of pumping locations and a substantial increase in the number of observation wells used as targets in the model calibration. Calibration of the model consisted of using both trial-and-error to test the effects of different conceptual changes, and inverse methods using PEST code to optimize estimates of aquifer hydraulic conductivity, storativity, hydraulic barrier, and drain conductance. The results of the model updates, calibration, and sensitivity analyses will be summarized in presentation format that will be used to obtain feedback and peer review.

Finite-Element Model

The new finite-element model calibration was completed on schedule in December 2014. The report documenting this new model is included in **Appendix D**. This model was developed for EAA under a contract with Southwest Research Institute. This model differs significantly from the MODFLOW model in that it includes representation of the entire catchment area, referred to as the "Contributing Zone," north of the Aquifer Recharge Zone. Inclusion of the Contributing Zone gives the model added capability to investigate potential concepts of interformational flows into the Edwards formation from north of the Recharge Zone.

A preliminary two-dimensional, single-layer model was developed in early 2014. However, it became clear that a multi-layer model would be needed to adequately represent the transition of flow from the Contributing Zone, where the Edwards formation is largely unsaturated, into the Recharge and Artesian Zones. The final model grid contains three model layers to represent the Edwards Aquifer, the underlying upper Glen Rose formation, and a portion of the lower Glen Rose Formation. FEFLOW groundwater modeling software was used as the development platform.

A pre-processing algorithm was developed to apply recharge to the model based on precipitation history, using a data set of calibrated radar rainfall data for the region as the primary input. Recharge applied to the model is split between distributed recharge and focused recharge along stream channels leading directly to the Recharge Zone. The split between distributed and focused recharge was adjusted as part of the model calibration process. The finite-element model uses the same monthly pumping and observation data as the MODFLOW model for the period January 2001 through December 2011. Similar to the approach used for the MODFLOW model, calibration of the FEFLOW model included a combination of trial-and-error and inverse methods. Trail-and-error calibration was used to test different conceptual approaches, features such as conduits and barriers, and adjustments to the recharge algorithm. Inverse methods for calibration included the use of FE-PEST, which is part of the FEFLOW software suite, to fine-tune and optimize parameter estimates.

To support the transparency and defensibility of the finite-element model, a Groundwater Model Review Panel (GMRP) was formed at the beginning of the development process in 2012. The four-member GMRP convened three times during 2014 to review the progress of the model and provided valuable feedback and guidance.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

After completion of the calibrated finite-element model and draft model report in 2014, the GMRP will review the draft report and model results, and convene for a final meeting in February 2015. The draft model report may be revised to address substantive comments or recommendations from the panel. The final model report is due by March 1, 2015. After the final meeting the GMRP will prepare a report to summarize their findings on the overall technical defensibility of the model and its suitability as a groundwater resource management tool. This report is due by March 31, 2015. Results of both the updated MODFLOW model and the new finite-element model will also be presented to interested EAHCP stakeholders and committees in early 2015.

The existing management module is a set of computational pre-processing and post-processing utilities developed to simulate the effects of pumping reductions and other conservation measures during a drought-of-record scenario and may need to be revised. A similar set of utilities and a drought-of-record model scenario will be developed for the finite-element model. Initial uses of the models may include additional sensitivity analyses and model scenarios to establish confidence in the models for use as resource management tools, and to compare and evaluate the results of the two models to better understand any potential differences in model results.

3.1.9 Ecological Modeling (EAHCP §6.3.3)

Obligations:

The EAA oversees the development of a predictive mechanistic ecological simulation model that will be used to predict the effectiveness of various mitigation and minimization activities, and will inform the Adaptive Management Process.

2014 Compliance Actions:

The original (2013) scope of work for the ecological modeling project identified six tasks: (1) Literature Review; (2) Data Acquisition; (3) Modeling; (4) Recommendations for Future Work; (5) Draft and Final Reports; and (6) Meetings and Presentations. Task 1 was completed in spring 2014 with the delivery of the report *Predictive Ecological Modeling for the Comal and San Marcos Ecosystems Project Interim Status Report* (April 2014). This review focused on addressing information deficiencies related to two key EAHCP issues: (1) fountain darter food source (aquatic macroinvertebrates) dynamics and response; and (2) Comal Springs riffle beetle response to extreme low flow conditions. Tasks 2 and 3 of the ecological modeling contract involve gathering data and developing models. The modeling task and associated data gathering represents the majority of work to be done under the contract.

The EAA extended the contract with BIO-WEST, Inc. (BIO-WEST) in June 2014 through December 31, 2016, to coordinate the initial development of predictive ecological models for the Comal and San Marcos

Spring/River ecosystems. In addition to its own staff expertise, BIO-WEST has assembled a team of experts that includes faculty and staff members from Texas A&M University, Texas State, Baylor University, Watershed Systems Group, the U.S. Army Corps of Engineers (USACE) Environmental Laboratory and the University of Texas at Austin (UT).

During 2014, the modeling team concentrated on model development on the Old Channel intensive study reach in the Comal River. This reach was selected because extensive physical and biological data has been collected from it for over a decade and this area has experienced a flow-related shift in habitat conditions following the installment of a new culvert in the mid-2000s. The fountain darter populations in the Old Channel reach were affected by the shifting habitat conditions. Thus, the Old Channel reach provides an excellent test case for the ecological models whose driving variables are flow, both high and low, and physical disturbance and removal of vegetation from the systems. Following development and calibration within the Old Channel study reach of the Comal River, model development and application will be performed for the City Park reach in the San Marcos River.

Two modeling efforts were underway in 2014. The first is undertaking the development of a model for the principal categories of submerged aquatic vegetation (SAV) in the Comal and San Marcos systems. The modeling team determined that a model combining the key metabolic processes from the ERDC and MEGAPLANT models, with additional capabilities specific to the Comal and San Marcos, will be most suitable for the EAHCP. This requires substantial new model coding (primarily FORTRAN). The present version of the model includes temperature, light penetration into the water with attenuation due to turbidity, photosynthetic increase in biomass, both above-ground and below-ground, respiration, and mortality. Work is underway to include plant dispersal in the model. This will address revegetation after scour events, recreational impacts, or impacts associated with low-flow conditions.

As part of the project team, Baylor University researchers have undertaken several observational studies to better quantify the behavior of the vegetation communities. These studies include laboratory and field determinations of the relationships between the fraction of area covered (which is the measurement of the extent of each species of SAV in the field) to biomass (which is the parameter modeled), and a literature survey of scour behavior of the dominant SAV species in the two rivers.

The second main modeling effort addresses the fountain darter population. NETLOGO was selected to be the model-development platform for the darter model, because (1) it is a widely accepted, freely distributed software platform for individual-based models, (2) it can represent the spatially varying environments of the two rivers, (3) it can accommodate a wide range of behavioral and physiological “rules”, and (4) it employs a versatile, high-level scripting capability, which will facilitate programming. The team developed a strategy for handling the outputs from the 2-D hydraulic model and the 1-D temperature model, already developed in previous studies, converting these into appropriate input files for the NETLOGO model.

A member of the NAS panel expressed concern whether NETLOGO could efficiently operate the multiple iterations necessary for EAHCP future-scenario simulations. In response, the model team developed an alternative model in C++, which has an order-of-magnitude increase in running time. Much of the work in the fountain darter modeling effort during 2014 was devoted to further data mining, examining various

mathematical means of extracting information from the considerable data holdings from previous studies on the two rivers, and specifying the mathematical rules that encode the relations between environmental parameters and response of the fountain darter.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions. However, it should be noted that the drought conditions (which continue to the present) have offered an unusual opportunity for observations of the spring and river systems during conditions that may approach the limits of the EAHCP proposed flow regime. Data collected under such conditions are of immense value in validating the models and testing the management specifications of the EAHCP.

Proposed Activities for 2015:

The current contract and activities related to Ecological Modeling in 2014 will extend into 2015. The goal is to develop and calibrate working models for SAVs and fountain darters for study reaches in both the Comal and San Marcos systems during early 2015. By Spring 2015, the BIO-WEST project team will prepare a detailed Year 3 scope of work outlining activities for the remainder of 2015 and 2016, and will present this scope of work first to the Science Committee, and then to the Implementing Committee for review, comment, and approval. It is anticipated that in 2015, the scope or work will involve 1) the refinement of the fountain darter and aquatic vegetation models with 2014 applied research results, and 2) an expansion of the spatial domain of the models to include additional representative reaches in both systems.

3.1.10 Program Management

Per Section 2.2 of the FMA, the EAA is responsible for the general management and oversight of the program, including the duties and responsibilities of the other ITP Permittees, in accordance with the ITP, EAHCP, FMA and other program documents. Section 5.6.5 of the FMA allows for use of EAHCP funds to fund EAA administrative costs and employee salaries, so long as all incurred costs and salaries are 100 percent related to "general management and oversight" of the EAHCP.

Part of EAA's responsibility includes facilitating the employment of the Program Manager, who is responsible for managing the EAHCP program and ensuring compliance with all relevant program documents. (Although referred in the FMA as the "Program Manager," the title for this position under the EAA organizational structure is "Executive Director – Habitat Conservation Plan.") In 2014, two positions were added to the EAHCP staff team – a Director of EAA Projects position, and a Senior Project Coordinator position. These positions were added and intended to assist in implementation of EAA's required springflow protection activities. Both positions were funded by the EAA. See **Figure 3.1-10**.

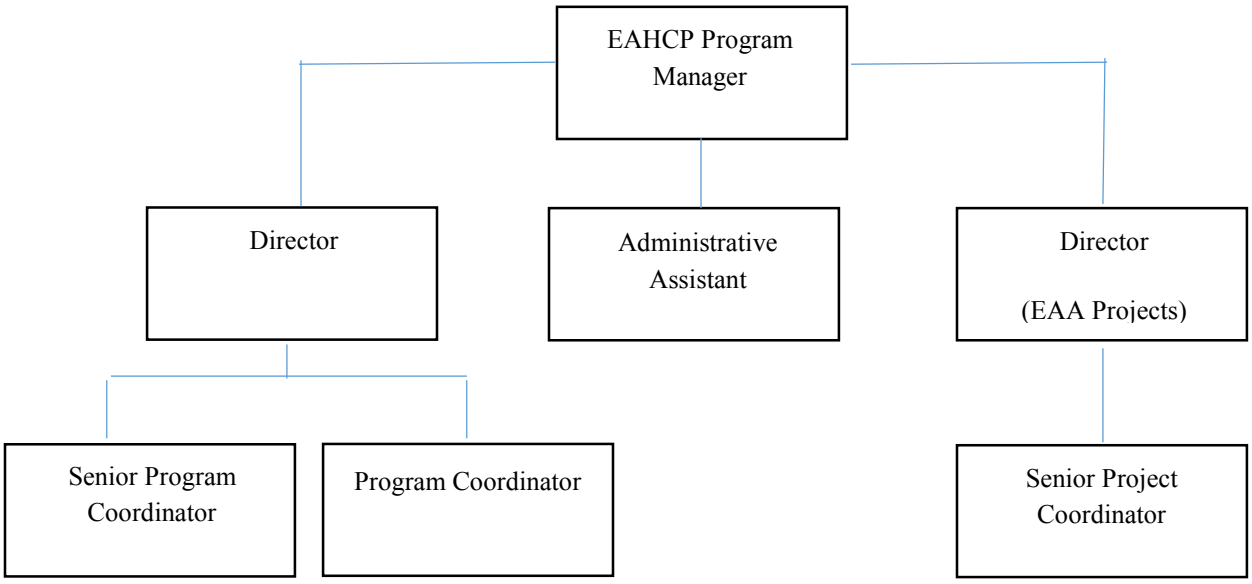


Figure 3.1-10. EAHCP Staff Organizational Chart

Selected Program Management activities that were completed in 2014 are listed below.

1. The EAHCP staff successfully facilitated the budgeting process and financial duties as assigned by the FMA. Staff tracked the budget throughout 2014, providing monthly updates to the Implementing Committee and timely reimbursement to the Permittees. This process included managing and tracking more than 30 contracts.

2. In 2014, Condition M of the ITP was triggered and caused restoration activities in the San Marcos and Comal Springs to stop. Due to this barrier in project implementation, staff assisted the Permittees through the budget process, by facilitating budget amendments and approval of additional fund expenditures in 2015.

3. Staff successfully coordinated the 2015 budget process, including the timely approval of: 1) 2015 Work Plans from all Permittees; 2) funding applications from EAA, CONB, COSM, and Texas State; and 3) and Interlocal Funding Contracts for reimbursement with CONB, COSM, and Texas State. Additionally, program management staff assisted EAA staff with getting all necessary budget items approved by the EAA Board of Directors.

4. Staff successfully facilitated meetings and activities of the Implementing Committee, Science Committee and Stakeholder Committee during 2014. Additionally, staff facilitated and executed the development of four Work Groups during 2014. Three of the four Work Groups executed a report that was presented to and approved by the Implementing Committee. These Work Groups included:

- The Drought Outreach Work Group: consisted of public relations specialists appointed by the Implementing Committee to provide the EAHCP sufficient input on appropriate methods of notifying the region of various EAHCP efforts underway during low-flow conditions.
- Science Committee Nomination Work Group: In 2014, Miguel Acevedo, member of the Science Committee, resigned his position as Ecological Modeling specialist. With the assistance of EAHCP staff, a work group, built of individuals assigned by the Implementing Committee, conducted a course of action to solicit nominations from interested parties throughout the region. Within a month's time, staff received interest letters and resumes from four qualified individuals. From this work group the nomination of Conrad Lamon was presented to, and approved by, the Implementing Committee to replace Miguel Acevedo as Ecological Modeling specialist on the Science Committee.
- ASR/VISPO Work Group: A work group of the Stakeholder Committee split into two Sub-Work Groups committed to analyze the ASR and VISPO programs and provide recommendations to be considered in order to increase program participation.
- RWCP Work Group: A work group was created by the Implementing Committee to analyze the RWCP and provide various recommendations that could be implemented to increase program participation.

5. In 2014 staff contracted with HDR Engineering, Inc. (HDR), in a permit oversight effort to provide assistance to the CONB, the COSM, and Texas State in acquiring permits for EAHCP project implementation, which include: USACE Nationwide general permit 27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities); TPWD Sand & Gravel permits; and Texas Historical Commission (THC) permits. This effort is described in the subsection 3.1.10.1, Permit Oversight later in this report.

6. Staff successfully coordinated two public meetings of the National Academy of Sciences, whose role as the Science Review Panel is defined on page 8. Both meetings required presentations from EAHCP staff and contractors as well as satisfying information requests from NAS throughout 2014. The first meeting in February 2014, included a tour of the spring systems in San Marcos and New Braunfels where onsite presentations were given by EAHCP staff, contractors, and Permittees. NAS also held two closed session meetings in late 2014, where the first EAHCP NAS report was discussed and reviewed. Staff anticipates delivery of the first report in March of 2015. NAS will produce a second and third report in 2016 and 2018, respectively.

7. In February of 2014, EAHCP staff contracted with Wyatt McSpadden to conduct a second round of photographs in San Marcos and New Braunfels to follow-up with the effort conducted in 2013. EAHCP staff will continue to photograph the progress of the restoration activities in the cities including annual baseline photos for future years.

8. In the summer of 2014, EAHCP staff coordinated with the CONB, the COSM, and Texas State,and their contractors, in presenting all the projects underway in the Comal and San Marcos Springs systems. This all-day tour with the Implementing, Stakeholder and Science committees gave everyone an opportunity to see the systems in drought conditions and witness the benefits of the EAHCP mitigation projects.

9. For better program transparency, EAHCP staff helped promote an open line of communication and dialogue with the public and Permittees though monthly meetings between the EAHCP Program Manager and the Chair of the Implementing Committee, as well as quarterly meetings between the Program Manager and all Implementing Committee members. Additionally, the EAHCP Director and the Chair of the Science Committee, as well as the chairs of all four Work Groups, met to share ideas for meeting facilitation and agenda building. Staff also made extra efforts to provide the public with a seven-day meeting notice and public posting of all meeting documents approximately six days in advance. Furthermore, an effort to better organize the website's documents library by contracting with a web designer allowed staff and the public better access to all background information. This open line of communication and dialogue increased program transparency.

10. Through an interlocal agreement, EAHCP staff coordinated with Texas State to use the Freeman Aquatic Building for all EAHCP applied research projects. Staff assisted in logistical and species-related tasks in 2014 and will continue the effort throughout the term of the agreement.

11. For outreach efforts in 2014, EAHCP staff worked to produce a program implementation pamphlet and educational banners to better inform the public of all projects underway in the region to protect the springs (**Appendix H7**). Additionally, staff gave multiple presentations to describe in detail the current implementation of EAHCP mitigation measures as well as more fundamental background about the EAHCP and the EARIP process. Presentations to organizations included the following:
    - 2014 One Water Leadership Summit hosted by the U.S. Water Alliance in Kansas City;
    - GBRA Clean Rivers Program;
    - Natural Resource Committee of the New Braunfels Chamber of Commerce; and
    - SCTWAC.

3.1.10.1 Permit Oversight

Obligations

EAHCP staff is committed to maintain all regulatory permits necessary for the implementation of projects in the San Marcos and Comal systems to ensure compliance with the ITP. This does not include permits required for contractors to perform their specific tasks identified in the scope of work of a contract.

Agreement

In the summer of 2014, EAHCP staff entered into a contract with HDR to assist in the oversight of all permits the EAA, CONB, COSM, and Texas State are required to hold for proper implementation of identified projects in the EAHCP. These permits are necessary to maintain compliance with the various federal and state regulatory agencies, which exercise jurisdiction over the activities carried out in the San Marcos and Comal springs systems.

The purpose of the permit oversight effort was to first determine current compliance with all federal and state regulatory permits needed for current and future projects. HDR provided technical assistance to the EAHCP staff to identify all mitigation projects currently underway and those proposed for the next two years. Additionally HDR identified which regulatory permits were needed for implementation for each individual mitigation project. A permit tracking matrix was developed from the information gathered to assist EAHCP staff and Permittees in identifying additional permits needed.

3.1.10.2 Amendments, Informational Memorandums and Clarifications

Pursuant to Section 9.2 of the EAHCP, from time to time it may be necessary to clarify or make amendments to the EAHCP, the IA, the FMA, or the ITP to deal with issues that arise during implementation. In 2014, the Program Manager submitted, with authorization from the Permittees, and/or received responses from the USFWS on the following issues:

- Response on a Minor Administrative Amendment[2] related to FMA § 5.6.5 (Limitation on Use of Funds – Employees and Administrative Costs), Appendix R (Funding and Management Agreement) of the EAHCP;
- Response on an informational memorandum related to the NAS;
- Sedimentation removal in the San Marcos River system;
- Submittal on Minor Administrative Amendment related to the Refugia Program; and
- Submittal and response on Clarification to Condition M of the ITP.

These submittals were not considered major changes or substantive amendments to the EAHCP, IA, FMA, or ITP. In 2014, the Program Manager did not submit any substantive amendments[3].

To ensure transparency on these issues, the Permittees provided multiple opportunities for the public to comment on each of these issues before the correspondence was submitted. Specifically, the Program Manager presented these issues to the Implementing Committee and/or the Science Committee at multiple meetings. The minutes from these meetings were included as exhibits with each submittal. The following paragraphs summarize each implementation issue and correspondence to and from the USFWS (included in **Appendix H1**).

[2] Minor administrative amendments and informational memorandums are used when the change is minor and has no substantive affect to the species or objectives. Response from the USFWS may come from the Ecological Services Office in Austin, or the Regional Office in Albuquerque.

[3] Substantive amendments to the ITP are required for major changes in location, activity, amount or type of take or species covered by the permit.

Minor Administrative Amendment of the EAHCP related to Appendix R (Funding and Management Agreement)

As stated in the 2013 Annual Report, the Implementing Committee authorized the Program Manager to submit a Minor Administrative Amendment (dated November 22, 2013) to amend Section 5.6.5 of the Funding and Management Agreement to allow employees of Texas State to be employed as contractors to the EAA when performing EAHCP-related activities. On October 1, 2014, USFWS responded verbally with an approval of this amendment, because no additional take would result from this change.

Informational Memorandum related to the National Academy of Sciences

Also stated in the 2013 Annual Report, the Implementing Committee authorized the Program Manager to submit an informational memorandum regarding the FMA and the number of panel members selected to serve on the Science Review Panel in Section 7.10.0 of the FMA and the number of meetings of the Science Review Panel in Section 7.11.2. On October 1, 2014, USFWS responded with a verbal approval because no additional take would result from this change.

Informational Memorandum related to the EAHCP Sections 5.3.6 and 5.4.4 – sediment removal in the San Marcos River system

As described in the EAHCP, sediment and silt in the San Marcos River system will be vacuumed using a hose with a screen mesh size no greater than 0.25-inch diameter to prevent suctioning biota. In implementing this methodology, Texas State and the COSM also used many other methods to minimize take of the Covered Species, including removing all vegetation and fanning the area to be treated. However, they found that using a 0.25-inch screen mesh size resulted in frequent clogging and equipment malfunctions.

Since the other methods were successful in minimizing "take", the Permittees determined that the 0.25-inch screen mesh size was not critical and authorized the Program Manager to submit an informational memorandum (dated October 20, 2014), to inform the USFWS of a minor modification in the methodology to remove sediment from the San Marcos River system. The memorandum informed the USFWS that future sediment removal will be conducted without a screen.

The Implementing Committee unanimously approved the submittal of the memorandum in September 2013 and reviewed an updated memorandum in October 2014. The Program Manager subsequently submitted it to the USFWS. The USFWS responded (email communication from Tanya Sommer to Nathan Pence dated October 21, 2014) that they had no comments on the change, except that if results in the field indicate an increase in take, the screen should be reinstalled or other protective methods be considered.

Minor Administrative Amendment of the EAHCP and the ITP related to the Refugia Program

As stated in Section 3.1.2, negotiations between the EAA and the USFWS on a contract, scope of work and budget for a Refugia Program were suspended when EAA expressed concerns that it may not have the legal authority to contract with the USFWS under the terms and conditions proposed by the USFWS. While

waiting on a legal opinion from Texas Attorney General on this issue, the Program Manager, with authorization from the Permittees, sought an administrative amendment to the EAHCP and the ITP.

In this minor administrative amendment, the Program Manager submitted a letter to USFWS, (dated December 4, 2014), seeking acceptance to amending the language of both the EAHCP, Section 5.1.1, and the ITP, Condition K, to allow the EAA to develop a Refugia Program with contractors other than the USFWS. Both the EAHCP and the ITP state that the EAA will support a series of off-site refugia at the USFWS's San Marcos, Uvalde, and Inks Dam facilities.

If approved, this amended language would not change the requirement to provide a series of refugia, nor does it result in additional take of the Covered Species, but will allow the EAA to contract with other entities for a Refugia Program. The public had the opportunity to provide comment on this amendment during both the October 16, 2014, and November 20, 2014, Implementing Committee meetings.

At the time of this report's publication, the USFWS has not provided a formal response to this request for a minor administrative amendment.

Clarification of Condition M of the ITP

In 2014, because of the low flows in both spring systems, the Permittees suspended implementing all habitat mitigation and restoration activities as defined in Chapter 5 of the EAHCP. The Permittees understood the USFWS's need to include reasonable and prudent measures, such as Condition M of the ITP, to minimize the incidental take of the Covered Species during reduced flows.

However, this year, after numerous discussions with the USFWS's biologists and with the Permittees' staff, the Program Manager, with authorization from the Permittees, submitted a letter (dated September 23, 2014) clarifying the Permittees' interpretation of Condition M, while maintaining compliance with the conditions in the ITP. This clarification letter specified ten habitat mitigation and restoration activities in the Comal Springs system and 13 activities in the San Marcos Springs system that should not be suspended, because they are specifically designed to benefit the Covered Species during reduced flows.

The Permittees determined that the following specific habitat mitigation and restoration activities will either not disturb the substrate, water quality, plants, and animals or invertebrates, or will reduce the amount of disturbance when it is unavoidable. **Table 3.1-7** and **Table 3.1-8** below separate the clarification by each springs' system.

Table 3.1-7. ITP Condition M Clarification for Comal Springs System

Comal Springs Conservation Measure	Interpretation	Specific activities that may continue at all flows.
Management of river flow between old and new channels of the Comal River (§5.2.1 EAHCP)	The actual management of the flow that is split between the New Channel and the Old Channel is designed to minimize and mitigate the impacts of incidental take in reduced flow conditions.	Manipulation of gates in accordance with the City of New Braunfels flow-split system standard operating procedures to be in accordance with EAHCP Table 5.3.
Restoration and maintenance of native aquatic vegetation (§5.2.2 EAHCP)	Maintenance of native aquatic vegetation includes gardening to increase preferred fountain darter habitat during reduced flow conditions.	Gardening, such as removal of non-native vegetation, in previously restored areas such as in the Old Channel and Landa Lake. Extra precautions, such as minimizing the number of gardeners in water, working from downstream to upstream and not tilling the substrate to remove vegetation will be employed to reduce disturbance of sediment.
Management of public recreational use (§5.2.3 EAHCP)	Continuing management of public recreation areas assures minimal impact and disturbance from recreational users.	Printing and distribution of educational materials, signage, and workshops.
Removal of decaying vegetation and dissolved oxygen management (§5.2.4 EAHCP)	The removal of the vegetative mats and the implementation of a dissolved oxygen management program helps to maintain healthy, preferred fountain darter habitat during reduced flows.	Gardening, such as the removal of decaying vegetation by working from a flat-bottom boat or kayak when practical, minimizing the number of workers in the water and working upstream to downstream to limit increased disturbance, such as pushing floating vegetative mats downstream. When Comal springflows drop below 80 cfs, the CONB will deploy artificial aerators.
Management of harmful non-native animal species (§§5.2.5 and 5.2.9 EAHCP)	Low flow conditions reduce the area that non-native fish have, making it easier to spear or net them. Greater numbers will be removed from the system at a time when they are most likely to cause damage.	Spear and bow fishing of non-native animals from bank, flat-bottom boat, or barge.
Prohibition of hazardous material transport (§5.2.7 EAHCP)	Not conducted in the aquatic ecosystem.	No further detail needed.
Live bait prohibition (§5.2.9)	Not conducted in the aquatic ecosystem.	No further detail needed.
Litter collection and floating vegetation management (§5.2.10 EAHCP)	The removal of litter and removal of floating vegetation management has a positive effect on the system by helping to maintain habitat with a very limited impact on the substrate.	Removal of floating vegetation and litter by working from a barge, flat-bottom boat or kayak when practical, with a minimum number of workers in the water that limits increased disturbance, such as pushing floating vegetative mats downstream. All areas for maintenance will be represented in vegetation maps.
Management of golf course diversions and operations (§5.2.11 EAHCP)	Continued planning and management of the golf course assures minimal impact or disturbance of the aquatic ecosystem.	No further detail needed.

Table 3.1-7. ITP Condition M Clarification for Comal Springs System

Comal Springs Conservation Measure	Interpretation	Specific activities that may continue at all flows.
Management of household hazardous wastes (§5.7.5 EAHCP)	Management of household, hazardous wastes is a terrestrial activity.	No further detail needed.

Table 3.1-8. ITP Condition M Clarification for San Marcos Springs System

San Marcos Springs Conservation Measure	Interpretation	Specific activities that may continue at all flows.
Enhancement and restoration of Texas Wild Rice (§§5.3.1 and 5.4.1 EAHCP)	Suspending gardening and maintenance of restored areas will allow non-native plants to regrow, negating the work already done.	Gardening, such as the removal of non-native plant regrowth, in previously restored areas, Sewell and City Parks, in a manner that limits increased disturbance.
Management of public recreational use (§§5.3.2 and 5.4.2 EAHCP)	Continuing management of public recreation areas assures minimal impact and disturbance from recreational users.	University students are trained to assist the public, and increase the awareness of the issues.
Management of aquatic vegetation and litter below Sewell Park (§§5.3.3 and 5.4.3 EAHCP)	The removal of litter and removal of floating vegetation management has a positive effect on the system by helping to maintain habitat with a very limited impact on the substrate.	Removal of floating vegetation and litter by working from a barge, flat-bottom boat or kayak when practical, with a minimum number of workers in the water to limit increased disturbance, such as pushing floating vegetative mats downstream. All areas for maintenance will be represented on vegetation maps.
Prohibition of hazardous materials transport (§5.3.4 EAHCP)	Management of household, hazardous wastes is a terrestrial activity	No further detail needed.
Reduction of non-native species introduction (§5.3.5 and 5.4.11 EAHCP)	Not conducted in the aquatic ecosystem.	No further detail needed.
Management of non-native plant species (§§5.3.8 and 5.4.12 EAHCP)	Removal of non-native plants is more efficient during low flows. Suspending this activity will allow non-native plants to regrow, negating work already done.	Gardening, such as removing one-meter sections adjacent to restored Texas wild-rice stands from Spring Lake to Ramon Lucio Park. All areas for maintenance will be represented on vegetation maps.
Management of harmful non-native and predator species (§§5.3.9 and 5.4.13 EAHCP)	Low-flow conditions reduce the area that non-native fish have, making it easier to spear or net them. Greater numbers will be removed from the system at a time when they are most likely to cause damage.	Bow fishing of non-native animals from shore or flat-bottom boats. Spear fishing will be done in the water.
Research programs in Spring Lake (§5.4.8 EAHCP)	Continuing review and education of researchers to ensure there is no impact on the Covered Species.	No further detail needed.
Management of golf course and grounds (§5.4.9 EAHCP)	Continued planning and management of the golf course assures minimal impact or disturbance of the aquatic ecosystem.	No further detail needed.
State Scientific Areas (§5.6.1 EAHCP)	Continuing management of public recreation assures minimal impact or disturbance of the aquatic system at reduced flows.	Maintenance and installation of signage and barriers, by standing from a boat.
Implementation of septic system registration and permitting program (§5.7.3 EAHCP)	Not conducted in the aquatic ecosystem.	No further detail needed.

Table 3.1-7. ITP Condition M Clarification for Comal Springs System

Comal Springs Conservation Measure	Interpretation	Specific activities that may continue at all flows.
Management of potentially contaminated runoff (§5.7.4 EAHCP)	Construction of two sedimentation ponds to help reduce contaminated materials will not disturb Covered Species habitat.	No further detail needed.
Management of household hazardous wastes (§5.7.5 EAHCP)	Management of household, hazardous wastes is a terrestrial activity.	No further detail needed.

The Permittees provided the public the opportunity to comment on this clarification of Condition M at four separate meetings – three Implementing Committee meetings held on June 19, 2014, August 21, 2014 and September 18, 2014, and one Science Committee meeting held on August 6, 2014.

The USFWS responded in a letter (dated September 30, 2014) from Adam Zerrenner, USFWS Austin Ecological Services Field Supervisor, to Nathan Pence, EAHCP Program Manager, in support of the Permittees' interpretation of the clarification with the understanding that the Permittees shall make every effort to minimize disturbance and reduce effects that could impact the Covered Species, especially during low flow conditions.

3.1.11 Challenges Observed and Identified Solutions

Unquestionably, drought was a major factor in impeding progress on successful completion of all EAHCP mitigation measures. The EAA region has experienced significant drought for the last several years, which has been a significant issue during the summer months when water use peaks. Except for the Stage V drought restrictions and the RWCP, the other flow protection mitigation measures of the EAHCP involve an aspect of a permit holder forebearing (VISPO) or leasing (SAWS ASR) for mutually beneficial purposes all or a portion of their permit to the EAA for demand management. Drought has slowed mitigation implementation because of fear of not having sufficient water.

Many of the mitigation measures, such as the VISPO, are prototype programs that are being developed for the unique circumstances related to the EAHCP. Therefore, complications and unforeseen startup issues should be expected in the first year and a half of operation. Two examples are the RWCP and the ASR. A premise of the RWCP is that municipalities would participate in conservation initiatives and dedicate one half of the saved water to the EAA Groundwater Trust for several years and that has not proven to be the case. Part of the reason for lack of interest appears to be the length of placement in the Groundwater Trust and another part is the drought, which will be discussed later.

The ASR mitigation is predicated on the EAA leasing or obtaining options to lease a total of 50,000 ac-ft of EAA permits in three 16,666 ac-ft tiers and transferring them to SAWS for injection and storage and later use during severe drought. Based on market analysis, three terms were initially offered for Tier I leases (15-year, 10-year, and 7-year lease terms). However, the response by permit holders was weak, and new shorter-term products were developed. It appears the tepid response is due to drought and also the unexpected hesitation by permit holders to wait for increased leasing rates.

Insights from Early Experience

After only one and a half years of implementing an extremely complicated EAHCP, four points are observable. First, unique circumstances require unique remedies. The EAHCP contains many mitigation measures that are original and have been developed to address the particular physical, legal, and political issues. While many persons devoted enormous time and energy to find consensus on appropriate mitigation measures to include in the EAHCP, the measures need to be given time to be successful. Not having all measures fully complete in 18 months should not be unexpected.

Second, while the EAHCP has been developed to provide appropriate protection against the drought of record, beginning such an undertaking in the midst of a severe drought is fraught with challenges. The big picture goal of the EAHCP is to provide adequate springflow during the worst month of the drought of record; consequently, many of the mitigation measures rely on managing existing EAA water rights in ways that will increase Aquifer levels and springflows. Drought within the EAA means a reduction in the use of a water right at a time when rainfall deficits and high temperatures drive up demand. Reluctance on the part of permit holders to lose access to their water rights, even a portion, is unsurprising. Patience is appropriate to allow weather conditions to return to normal and increase the chances for successful mitigation implementation.

Third, the EAA water market is the most sophisticated in Texas and requires diligence to remain competitive. To fully implement all of the ASR and VISPO elements of the EAHCP, 90,000 ac-ft of EAA water rights need to be acquired and repurposed. Development of both strategies involved many meetings and hours of discussions with ad hoc work groups and the larger EARIP stakeholder group to fully understand all aspects and agree on program protocols. However, beginning leasing efforts during a drought was not foreseen.

Finally, the most outstanding observation to date is the high level of success and accomplishments overall, despite challenges in some areas. Putting an effective and transparent administrative process in place for a program that will spend over $260 million in 15 years requires skill, dedication, effort and a lot of support from many parties. Clearly, the EAHCP has benefitted from each of those criteria.

3.2 City of New Braunfels

The CONB has authority to manage the ecosystems of Comal Springs, Landa Lake, and the Comal River within its geographical boundaries. The ecosystems are utilized for recreational activities. In addition, the CONB diverts surface water from the Comal River, which is authorized by permits issued by the TCEQ. The CONB is covered under this EAHCP, and associated ITP, for categories, which include: 1) recreational activities occurring within its jurisdiction; 2) the management of the ecosystems of the Comal Springs, Landa Lake, and Comal River; 3) the diversion of water from the Comal River; and 4) the minimization and mitigation measures that the CONB will either implement or have responsibility for implementation. The four endangered species whose habitats are impacted by this study are the Comal Springs riffle beetle, the Comal Springs dryopid beetle, Peck's cave amphipod, and the fountain darter. This section specifically addresses the CONB's minimization and mitigation measures describing: A) the CONB's obligations under the EAHCP and ITP; B) actions taken in 2014 to meet these obligations; C) any modifications that may

have occurred relating to the 2014 drought and other activities; D) proposed and planned activities to occur in 2015. **Appendix I** contains five individual reports compiled for the CONB that address the issues discussed below in further detail.

The CONB is responsible for the following minimization and mitigation measures under the EAHCP:

- Flow-Split Management in the Old and New Channel (EAHCP §5.2.1)
- Native Aquatic Vegetation Restoration and Maintenance (EAHCP §5.2.2)
- Management of Public Recreational Use of Comal Springs and River Ecosystems (EAHCP §5.2.3)
- Decaying Vegetation Removal and Dissolved Oxygen Management (EAHCP §5.2.4)
- Control of Harmful Non-Native Animal Species (EAHCP §5.2.5)
- Monitoring and Reduction of Gill Parasites (EAHCP §5.2.6)
- Prohibition of Hazardous Materials Transport Across the Comal River and its Tributaries (EAHCP §5.2.7)
- Native Riparian Habitat Restoration (Riffle Beetle) (EAHCP §5.2.8)
- Reduction of Non-Native Species Introduction and Live Bait Prohibition (EAHCP §5.2.9)
- Litter Collection and Floating Vegetation Management (EAHCP §5.2.10)
- Management of Golf Course Diversions and Operations (EAHCP §5.2.11)
- Native Riparian Habitat Restoration (Old Channel Improvements) (EAHCP §5.7.1)
- Management of Household Hazardous Wastes (EAHCP §5.7.5)
- Impervious Cover and Water Quality Protection (EAHCP §5.7.6)

3.2.1 Flow-Split Management in the Old and New Channels of the Comal River (EAHCP §5.2.1)

Introduction:

Four flow control structures (i.e., gated culverts/pipes) are used to directly govern the flow from Landa Lake into the Old Channel of the Comal River (**Figure 3.2-1**). Three of these culverts are used to convey water from Landa Lake to the Old Channel. An additional culvert diverts water into a man-made pool impoundment which discharges into the Old Channel approximately 400 ft downstream of the gated inlet structure. Prior to 2014, only one culvert conveyed water continuously, and the pool inlet gates were operable in a limited capacity, thus limiting the CONB's ability to manage flow conditions through the main culvert (48”) for the benefit of riverine habitat. Previously, the inability to easily manipulate the amount of flow entering the Old Channel has led to the scouring of preferred native vegetation types for fountain darters, and the establishment and eventual dominance of non-native, non-preferred aquatic vegetation. Flow-split management is intended to compliment the ecological restoration of native aquatic vegetation in the Old Channel by reducing long-duration high flows by meeting flow targets specified in the EAHCP. This allows for inter-year and seasonal variability in the flow regime thereby mimicking a more natural flow pattern.

The ultimate goal of the flow-split project is to: 1) provide an appropriate level of flow variability during average to high flow conditions; and 2) allow proportionally more water to flow through the Old Channel

versus the New Channel during periods of critically low-flow, with the ultimate goal of preserving high-quality fountain darter habitat within the Old Channel as long as possible.

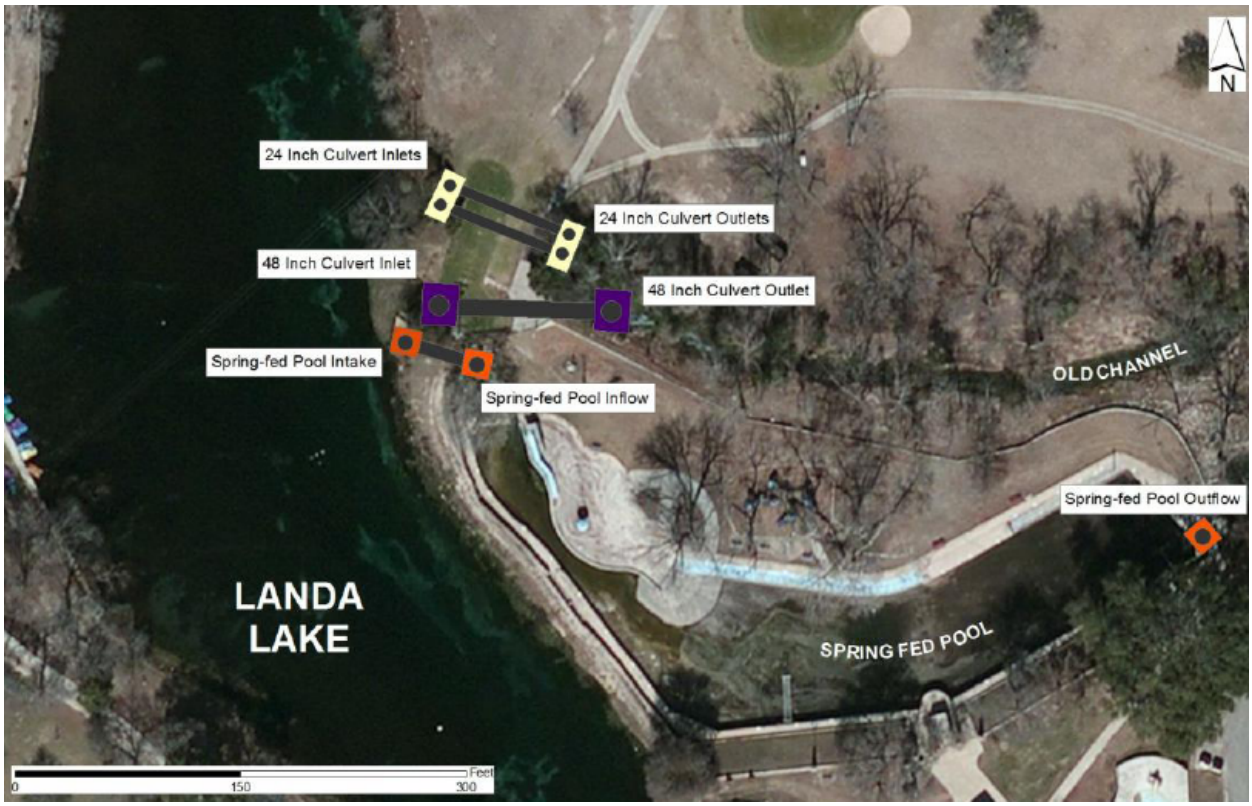


Figure 3.2-1. Flow control structures from Landa Lake into Old Channel

Obligations:

The CONB will control the flows entering the old and new channels of the Comal River using the culverts and flow-control structure that has been installed between Landa Lake and the Old Channel of the Comal River. The purpose of this activity is to maintain optimal habitat conditions for the listed species under varying total flow conditions in the system per the flow-split management plan and flow-split goals described in the EAHCP and summarized in **Table 3.2-1** below.

Table 3.2-1. Flow-split Management for Old and New Channels

Total Comal Springflow (cfs)	Old Channel (cfs)		New Channel (cfs)	
	Fall, Winter	Spring, Summer	Fall, Winter	Spring, Summer
350+	80	60	270+	290+
300	80	60	220	240
250	80	60	170	190
200	70	60	130	140
150	60		90	
100	60		40	
80	50		30	
70	50		20	
60	40		20	
50	40		10	
40	30		10	
30	20		10	

2014 Compliance Actions:

In 2014, the CONB replaced and repaired existing gates and control mechanisms to restore the operability of water paths to the Old Channel from Landa Lake (see **Figure 3.2-2** through **Figure 3.2-8**). This repair allows for the manipulation of flow into the Old Channel of the Comal River from Landa Lake per the flow split strategy in **Table 3.2-1**, thus preventing uncontrolled high flows in the Old Channel that have previously resulted in channel scouring.

Figure 3.2-2. Construction process

Figure 3.2-3. Two 24-inch culvert outlets to the Old Channel of the Comal River (prior to capping)

Figure 3.2-4. Two 24-inch culverts outlets to the Old Channel of the Comal River (following capping)

Figure 3.2-5. Flow Control Gate Structure (A)

Figure 3.2-6. Flow Control Gate Structure (B)

Figure 3.2-7. New culvert outlet into the Old Channel of the Comal River

Figure 3.2-8. 48-inch culvert flowing from Landa Lake into Old Channel

Since the 48-inch culvert and the gate system has been installed, potential impacts of low and high flows (to the degree practical), have been eliminated. The two 24-inch pipes that previously transmitted water from Landa Lake into the Old Channel of the Comal River have been capped-off and are currently not in operation.

The CONB staff can now manipulate the main 48-inch culvert and the gate system to the Old Channel and New Channel of the Comal River for the protection of existing and restored native aquatic vegetation in the river. The CONB has developed a Standard Operating Procedure (SOP) that is intended to guide the operation of the flow control gate structure and overall flow-split management. Beginning in October 2014, the CONB began to manipulate the gate structure, per the established SOP, to meet the flow guidance described in **Table 3.2-1**.

Modifications Due to Drought Conditions:

There were no modifications to this design measure resulting from drought conditions experienced in 2014. However, the project had multiple stop and start dates in April, May and June due to low flow conditions. All work stopped when flows were under 130 cfs. Once flows were over 130 cfs (based on USGS flow gauge data), work resumed. With the combined efforts of CONB, the contractor (AFSI) and subcontractors (Bio West), this project was accomplished quickly and under budget, while maintaining compliance with the ITP.

Proposed Activities for 2015:

The CONB will continue to monitor USGS streamflow gauges in the Comal system and manipulate the flow control gate structure, per the established SOP, to achieve the goals described in Table 5.3 of the HCP. The main objective will be to maximize the quality of aquatic habitat in the Old Channel.

3.2.2 Native Aquatic Vegetation Restoration and Maintenance (EAHCP §5.2.2)

Introduction:

As described in the EAHCP, native aquatic vegetation restoration involves activities over time throughout the Comal system. However, special emphasis is noted regarding the importance of specific work to be conducted in the upper sections of the Old Channel and central portion of Landa Lake. Activities conducted in 2014 focused solely on these priority areas in Old Channel and Landa Lake. Individual components of the Native Aquatic Vegetation Restoration and Maintenance task include the Old Channel Environmental Restoration and Protection, Comal River Restoration, and Native Aquatic Vegetation maintenance.

Obligations:

The CONB will implement native aquatic vegetation restoration in the Comal River. This will be done by systematically removing invasive vegetation from the stream bed and replacing it with native vegetation suitable for fountain darter habitat. The CONB will additionally perform minor channel modifications to increase aquatic vegetation coverage and improve habitat.

The CONB will determine areas with potential to support fountain darters between the Last Tubers Exit and the confluence of the Guadalupe River. This will involve designation of permanent access points, improved aquatic vegetation, and ongoing monitoring of restored and existing habitat zones.

It is expected that activities related to native aquatic vegetation restoration will require continued annual maintenance to achieve the most successful program possible. The CONB will regularly monitor and enhance new and existing habitat areas within the Comal River. Fountain darter habitat goals as outlined the EAHCP are summarized in **Table 3.2-2**.

Table 3.2-2. Fountain Darter Habitat Goals (area in m^2)

Study Reach	Bryophytes	Hygrophila	Ludwigia	Cabomba	Sagittaria	Filamentous Algae	Vallisneria
Upper Spring Run	1,850	650	150	0	600	0	0
Landa Lake	4,000	250	900	500	1,250	0	13,500
Old Channel	150	200	1,500	0	0	300	0
New Channel	150	1,350	0	350	0	0	0
Total	**6,150**	**2,450**	**2,550**	**850**	**1,850**	**300**	**13,500**

2014 Compliance Actions:

Non-native aquatic vegetation, most notably *Hygrophila polysperma* (*Hygrophila*), has become predominate in the Comal System. While *Hygrophila* is considered fountain darter habitat, it is not considered prime habitat for the species. Biological monitoring sponsored by the EAA over the last 14 years indicates that higher fountain darter densities are found within certain native aquatic plant species (BIO-WEST 2014). As a result the CONB has enacted an aquatic vegetation restoration plan as part of the EAHCP. The initial project areas outlined in the EAHCP include the middle reach of Landa Lake and the Old Channel of the Comal River from the Landa Lake outflow downstream past Elizabeth Street. **Figure 3.2-9** shows the project areas outlined in red. It also shows the location of the 2013 and 2014 Old Channel restoration activities in green, and the location of suspended 2014 and future activities in blue.

At specific locations within these project areas, *Hygrophila* has become predominant. Increasing native vegetation will benefit the fountain darter by increasing available habitat and improving the quality of existing habitat. The improvement and increase in area of fountain darter habitat is also beneficial to many other native aquatic species. During Phase I and beyond, the aquatic vegetation restoration in Landa Lake and habitat restoration in the Old Channel are vital to provide the protection necessary to support the fountain darter while uncertainty regarding habitat change, species' response, and effects of other related EAHCP projects are being addressed. The overall goal for these projects is to improve habitat conditions for the fountain darter by increasing the amount of usable habitat, and by improving the quality of existing habitat in both project areas.

In order to initiate restoration activities certain methods were developed to remove *Hygrophila*, as well as propagate and plant native aquatic plant species. Removal of *Hygrophila* consisted of surrounding the removal area with a netted boom to collect fragments and removing top growth and root mass via hand using hand tools and snorkel or SCUBA gear. The majority of the top growth of the *Hygrophila* was removed with garden rakes, allowing it to float into the net. This method provided a chance for any organisms present in the *Hygrophila* growth to swim or fall out. Plant parts were removed regularly from the net and placed into tubs and removed from the water. Once a majority of the top growth was removed,

the area was raked over to disturb and loosen the *Hygrophila* roots from the sediment. The roots were allowed to float to the surface and then drift into the net, where they were collected and removed. **Table 3.2-3** highlights the *Hygrophila* coverage within the restoration areas in response to removal efforts over the course of the aquatic habitat restoration periods to date.

Figure 3.2-9. Location of the Landa Lake and Old Channel Restoration Areas

Table 3.2-3. *Hygrophila* Coverage Within the Restoration Areas

	Landa Lake (m^2)	Old Channel* (m^2)
Pre-Restoration	523	2,177
Fall 2013	207	1,313
Fall 2014	47	381

*Old Channel area from Landa Lake outfall to second golf course bridge

Native aquatic plants were provided via several methods. First, a novel method of *in situ* propagation was devised to grow native plants in Landa Lake. This method allowed easy access to plants, provided optimal growing conditions, and lessened transport stress. Second, plants were collected from parent colonies and transplanted into areas to be restored. Third, an off-site nursery was set up to provide small quantities of additional plants.

The methods utilized in 2013 for native aquatic plant restoration were continued in 2014. Despite a short planting window between February and July, a total of 7,263 native aquatic plants were planted. Landa Lake received 3,528 plants while the Old Channel received 2,648 plants. The Sediment Island project area in the upper portion of the Old Channel received 1,097 plants. The newly planted area in Landa Lake covered 267 m² bringing the total planted area in Landa Lake to 887 m². New areas planted included the

areas around the three islands and a bare area created by retaining wall construction. The planted area in the Old Channel was increased by 169 m² bringing the total planted area to 1,383 m² in the Old Channel including Sediment Island. Newly planted areas in the Old Channel in 2014 include locations immediately above the second golf course bridge.

Native aquatic plant coverage has increased considerably in the immediate restoration areas since pre-restoration, although certain factors such as water flow, competition, light availability and seasonality cause total coverage to vary. As such, several areas have been supplemented with plants in 2014 to improve coverage and success.

Modifications Due to Drought Conditions:

Due to drought conditions and issues related to the implementation of ITP Condition M, all restoration activities and aquatic gardening activities were suspended for brief periods in May 2014. Restoration activities, including removal of *Hygrophila*, were suspended once again in July 2014 for an indefinite period of time (until total discharge for the Comal River returned to above 130 cfs).. Aquatic gardening and monitoring were allowed to resume in October 2014 upon clarification of Condition M by the USFWS. In 2013, restoration activities were carried out across 10 months, while in 2014 restoration activities were carried out for only four months. Since aquatic gardening is currently the only allowable activity, modifications to restoration activities include: limiting removal of *Hygrophila* to small patches (< 1m X 1m) and fragments by hand; reducing sediment disturbance by not digging into substrate; limiting the number of people working in a given area; and suspending *in situ* nursery restocking using native soil from Landa Lake.

Challenges Observed and Identified Solutions:

Due to low flows and high algae growth, floating aquatic vegetation mats formed early in 2014. Vegetation mats are typically formed as excessive algae, bryophyte and plant growth senesces and floats to the surface. With low flow and decreased water depths, this material accumulates around branches, on *Vallisneria* leaves, and around shallow water areas. If vegetation mats become too dense they can block out light to the aquatic vegetation beneath, as well as restrict water flow limiting light and carbon dioxide availability resulting in a die-off.

Vegetation mats were mapped twice in 2014. In April 2014, vegetation mats covered 1,505 m², and by September of 2014, the area covered by vegetation mats expanded to 3,877 m². While vegetation mats cover a relatively small area of Landa Lake overall, they tend to form in areas where a majority of the habitat restoration has taken place, such as the Three Island area. Over the four-month maintenance hiatus, vegetation mats had a considerable impact on restored areas planted with *Ludwigia repens.*

Vegetation mats were not an issue in the Old Channel throughout 2014. However, vegetation did suffer negative impacts from peak water discharges (during construction activities related to the flow split management project), which caused scouring of shallow vegetated areas in the Sediment Island area.Upon return of stable discharge in this reach, native aquatic vegetation cover has rebounded.

Proposed solutions for issues in Landa Lake include routine dislodging of vegetation mats as well as trimming and removal of emergent *Ludwigia repens* so that it remains below the water surface. Solutions for the Old Channel include providing velocity shelters for vegetation, consistently controlling discharge into the Old Channel and consistently maintaining restored areas to keep them clear of trash and debris.

Proposed Activities for 2015:

Aquatic gardening and monitoring activities will continue in compliance with Condition M. When total system discharge returns to above 130 cfs, removal of *Hygrophila* and planting of native species will resume following the same methods used in previous years. Removal of *Hygrophila* from the spring-fed pool, which has an estimated coverage of 1,400 m² along the gravel bottom, should be evaluated and accomplished if appropriate. Additionally, areas in Landa Lake and Spring Run 1 that have been denuded of *Hygrophila* due to retaining wall construction, will be planted with native aquatic plants. These areas will provide optimum habitat for restored native plant species. In the Old Channel restoration will continue downstream past Elizabeth Street and upstream to the Landa Lake dam as conditions warrant.

3.2.3 Management of Public Recreational Use of Comal Springs and River Ecosystems (EAHCP §5.2.3)

Obligations:

The CONB will continue to enforce recreation restrictions on the Comal River that were in place at the time of EAHCP development through the duration of the permit. This specifically applies to regulations limiting recreation on Landa Lake, the Spring Runs in Landa Park, and the Old Channel of the Comal River. The CONB will additionally extend its take protection to commercial outfitting businesses that are willing to meet the conditions of such protection through a Certificate of Inclusion (COI) Program to be developed by the CONB.

2014 Compliance Actions:

The CONB continues to enforce City Ordinance section 142-5, which restricts access to Landa Lake, the spring runs, and portions of the Comal River. The CONB Parks Department utilizes Park Rangers who routinely patrol Landa Lake Park to prevent access to these water bodies. Due to the Landa Walls Rehabilitation Project, access to the spring runs and Landa Lake was further limited.

Modifications Due to Drought Conditions:

Drought conditions have had no effect on this activity.

Proposed Activities for 2015:

The CONB will continue to enforce City Ordinance section 142-5 and provide patrol by Park Rangers to minimize access to Landa Lake, the spring runs, and portions of the Comal River. The CONB will also continue outreach to river recreation outfitters on EACHP educational activities and promotion of the voluntary COI program.

3.2.4 Decaying Vegetation Removal and Dissolved Oxygen Management (EAHCP §5.2.4)

Obligations:

The CONB will develop a DO management program for Landa Lake. When springflow drops below 80 cfs, this program will be implemented. The goal will be to maintain sufficient DO levels to sustain the ecosystem of Landa Lake.

2014 Compliance Actions:

CONB extended their contract with SWCA in 2014 to maintain water quality monitoring equipment within Landa Lake to track DO and other water quality parameters and, if necessary, take practicable steps to mitigate for depressed DO. In particular, SWCA installed a data sonde and aeration system in the main body of Landa Lake with associated telemetry, compressors, and solar power collectors during 2013. Other than interruptions associated with maintenance and repairs, this equipment has provided near-continuous monitoring of DO, temperature, pH, conductivity, and turbidity since 2013. These data provide guidance for management decisions related to maintaining adequate DO concentrations to support endangered species populations under periods of stress such as droughts, vegetation die-off, or pollution discharge.

This report summarizes the water quality data gathered during 2014 for DO and other related constituents as measured in the main body of the lake near the lake bottom. Through the monitoring of DO, SWCA was able to assess general oxygen dynamics as needed to qualify the need to employ aerators or take other steps to maintain minimum DO necessary to support aquatic species within Landa Lake.

3.2.4.1 Equipment Installation and Implementation

Sonde Deployment

Although no additional equipment was installed during the 2014 field season, the monitoring station did not operate without interruption. During mid-December, 2013, a communication error by the sonde (**Figure 3.2-10** and **Figure 3.2-11**) was identified as the source of several erroneous measurements taken between December 10th and 19th. The error was thought to be caused by a loose screw in the communication cable attaching the sonde to the telemetry unit. Although the communication problem was addressed through a field repair, brief, intermittent communication errors persisted. A replacement sonde was provided by Measurement Specialties during March and April, 2014, so the malfunctioning sonde could be removed from service for repair of the connection. However, this repair to the sonde was discovered to be insufficient when, during the June calibration, the sonde was found to have substantial condensation in the main chamber of the housing. This problem required decommissioning the sonde throughout the month of June for replacement of a failed O-ring and the repair of damaged electronics by the manufacturer. Unfortunately, no replacement sonde was available during this repair, so measurements were not taken until the sonde was placed back into service on July 1, 2014. Since reinstallation, the sonde has been in continuous operation without significant incident.

Water Quality

During May 2013, SWCA established diel baseline DO patterns using data coinciding with increased temperatures and limited vegetation conditions (SWCA 2013). These data were used to determine the target DO concentration in the lake. Because of the relatively stable water temperatures, it was expected that DO would demonstrate a fluctuating pattern based on the influence of photosynthesis and respiration, resulting in depressed measurements at dawn and peak concentrations near midday. SWCA used these baseline patterns to detect deviations and trends toward low DO (≤2.0 mg/L).

SWCA performed monthly on-site calibration for the monitored parameters to ensure the continued accuracy of the measured parameters. During each calibration event, the sonde probes for DO, temperature, pH, conductivity, and turbidity were inspected for signs of damage and maintained as needed (e.g., wipers replaced, electrolyte solutions replenished). As in 2013, discrete measurements continued to be collected every 30 minutes. To ensure prompt response to emergency conditions, SWCA maintained email and text message alarms on the telemetry system. **Figure 3.2-12** shows the general study area, and the precise locations of the monitoring and telemetry stations are provided in **Figure 3.2-13**.

Figure 3.2-10. The water quality sonde being installed in Landa Lake in 2013

Figure 3.2-11. The water quality sonde after installation in Landa Lake

Water Quality Results and Discussion

Since May 2013, daily water quality data have been collected every 30 minutes, with calibration, maintenance, and necessary repairs being the only interruptions in data collection over that span. The data were regularly reviewed on ienvironet.com by SWCA staff to evaluate current and recent water quality trends. Additionally, ienvironet.com allows the user to set pre-defined alert criteria based on measured values. Based on initially collected DO values, SWCA elected to receive email alerts if DO concentrations were below 2.0 mg/L. Through October 31, 2013, this alert was only triggered four times, each of which

was an anomalous event that was apparently related to an electronics problem. However, the low water conditions and equipment communications during 2014 led to a total of 86 triggered events. The vast majority of these likely resulted from communications and electronics problems prior to July; however, there were several incidents that were associated with overnight anoxia. Most of these cases were single measurements, but others were indicative of prolonged periods (i.e., longer than one hour) of low DO at the probe.

All monitoring data were downloaded and interpreted to make inferences regarding water quality in Landa Lake. SWCA removed values that were known to be aberrant (e.g., values recorded during the calibration and sonde cleaning events, or values otherwise known to be false).

It is important to note that long-term (i.e., interannual) inferences regarding water chemistry patterns were not possible based on the brevity of the monitoring period (i.e., May, 2013 through present).

Daily Water Quality Patterns

Water Temperature

As in the 2013 dataset, water temperature remained relatively constant throughout the monitoring period. The mean water temperature for 2014 was 23.5ºC with a standard deviation of 0.973ºC, meaning that 95 percent of all measured temperatures for the monitoring year were between 21.54 and 25.43ºC. Unlike 2013, the 2014 data set was sufficiently long to provide an idea of expected annual water temperature dynamics in Landa Lake. As with other temperate water bodies, Landa Lake experienced decreased water temperature throughout the winter months and increased temperatures during the summer (see **Figure 3.2-16** below).

As was observed in 2013, the daily difference between low and high water temperatures varied narrowly throughout 2014. In most days, minimum temperatures were recorded in the overnight and early morning hours and maximum temperatures were recorded during early afternoon hours. Impingent solar radiation only caused an average difference of 1.54ºC between the daily high and low water temperature during 2014 (compared to 1.6 ºC during 2013).

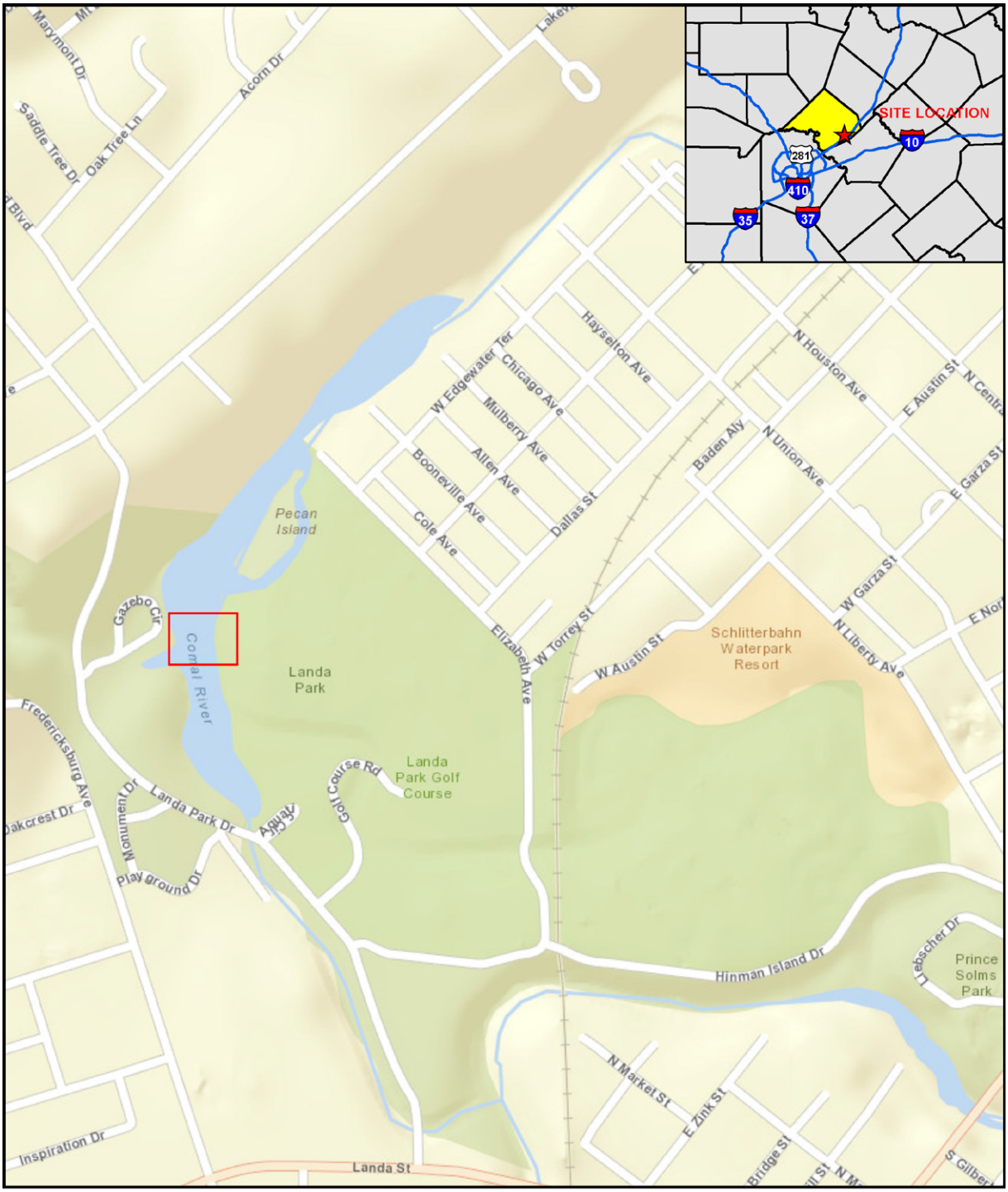


Figure 3.2-12. Water Quality Study Area

Figure 3.2-13. Aerator and Sonde Locations

DO

DO in a water body is typically driven by many factors, chiefly temperature at the air-water interface, epilimnetic photosynthesis and respiration, and hypolimnetic sediment oxygen demand (Staehr et al. 2010). Temperature, the most important physical variable, has a well-established negative correlation with DO content in a water body. However, increased air and water temperature are typically driven by increases in ambient solar radiation. Therefore, although increased temperature should be associated with decreased DO, it is also strongly related to photosynthesis and its products (i.e., oxygen and carbohydrates). In a highly productive, photosynthesis-dominated system this would lead to increased DO during bright, mid-day hours as oxygen production vastly overwhelms respiration. However, sunset reverses this pattern as plants respire the glucose produced during daylight hours which, in turn, causes DO levels to decline through the night.

As was observed in the 2013 data, 2014 diel oxygen fluctuation patterns observed in Landa Lake were as expected for an aquatic system rich with photosynthetic organisms. DO typically oscillated between daily minima and maxima during the overnight (i.e., 10:00 p.m. to 4:00 a.m.) and early afternoon (i.e., 1:00 p.m. to 3:00 p.m.) hours, respectively (**Figure 3.2-17**).

DO measurements at the probe ranged from 0.76 to 25.83 mg/L with percent saturation ranging from 9.5 percent to 317.25 percent; however, instantaneous high DO levels frequently exceeded 12mg/L (**Figure 3.2-17**). Even through periods of high DO, daily mean DO remained relatively stable (generally between 5 and 10 mg/L). The stability of the mean DO suggests that days during which extremely high DO is observed also experience marked or prolonged periods of lower DO.

Throughout 2014, instantaneous measures of low DO value (<2.0 mg/L) were collected 86 times out of the 17,521 possible measurements collected (**Figure 3.2-18**). Although many of these were associated with communications errors, others were confirmed by comparing with the immediate proceeding and/or subsequent measurements.

pH

As expected for a limestone-bed stream system, pH values were generally basic. Over the monitoring period, pH ranged from 6.28 to 9.2 standard pH units (SU) and averaged 7.36 (**Figure 3.2-19**), roughly 1 SU lower than what was observed in 2013. Spring and fall months were noted for higher instantaneous pH readings.

Similarly to DO, pH measurements demonstrate a fairly consistent daily cycle driven by photosynthesis and respiration (Wurts and Durborow 1992). As photosynthesis increases throughout the morning hours, dissolved carbon dioxide (CO_2) is taken up by plants and algae to produce carbohydrates and oxygen. The removal of CO_2 causes water pH to increase; however, as the temperature and DO increase, respiration by non-photosynthetic organisms also increases until CO_2 production exceeds CO_2 uptake by photosynthetic organisms. The transition of photosynthetic organisms to respiration during the night further increases dissolved CO_2, thereby depressing pH. In Landa Lake, this pattern is borne out by maximum daily pH readings recorded in the early afternoon (e.g., 1:00 P.M.) and minimum daily pH throughout the evening

and early morning hours (**Figure 3.2-20**). Daily mean pH ranged between 7.08 and 8.94 SU with little variation from day to day.

Turbidity

As in 2013, there were no distinctive diel or annual patterns associated with turbidity. Rather, variations in turbidity appear to be predicated by conditions beyond the spring runs or Landa Lake. Specifically, reliably measured turbidity in the lake varied between from 0 to 5,685 nephelometric turbidity units (NTU). However, it was assumed that values of over 2,000 NTU were outliers possibly related to biota on or near the sonde rather than accurate representations of the water quality in Landa Lake. With these values removed, turbidity ranged between 0 and 1,814 NTU, with an average of 27.6 NTU throughout the monitoring period (**Figure 3.2-21**). As in 2013, there were several days during which the measured turbidity did not exceed 1 NTU, as is consistent with the routinely transparent water within Landa Lake and the spring runs.

An unexpected result of the 2014 turbidity monitoring shows an initial increase in the frequency of high turbidity readings. As mentioned in the 2013 report, this may be correlated with storm events, but it may also be related to siltation around the sonde and biological activity (e.g., fish, snails) on or near the turbidity probe. SWCA will compare these high readings to storm events with the upcoming 2015 monitoring report, assuming additional data supporting these observations is collected and analyzed.

Specific Conductivity

During 2014, no daily cycle was evident for specific conductivity, which remained relatively consistent throughout the monitoring period. In general, specific conductivity remained close to 558.6 microsiemens per centimeter (µS/cm), with values ranging between 180.9 and 685 µS/cm (**Figure 3.2-22**). As mentioned in the 2013 report, maintaining consistent specific conductivity measurements is indicative of an aquatic system that is not heavily influenced by surface water. Likewise, the occasional decreases in specific conductivity are possibly related to storm events. SWCA will compare the specific conductivity measurements to recorded storm events with the 2015 monitoring report, assuming additional data supporting these observations is collected.

Relationships Among Variables

To better model the core relationships among the measured variables to a principal controlling physical variable, SWCA plotted all DO, pH, turbidity, and specific conductivity values against water temperature. As with the 2013 data, pH, turbidity, and specific conductivity values lacked any discernable relationship to water temperature (see **Figure 3.2-24**, **Figure 3.2-25 Figure 3.2-21**, and **Figure 3.2-22** for pH, turbidity, and conductivity, respectively). For all of these variables, the correlation coefficient was exceptionally low ($r2<0.01$). However, dissolved oxygen once again showed a stronger correlation with water temperature than all other variables (see **Figure 3.2-23**), though this relationship is far weaker than what was observed in 2013 ($r2=0.27$ in 2014, $r2=0.57$ in 2013). This relationship is likely based on positive relationships of both water temperature and primary production with ambient solar radiation. In a highly productive, eutrophic system, increased water temperature and photosynthetic output (oxygen) are generally related to

peak solar radiation and, therefore, correlated. In the case of Landa Lake, this relationship is likely limited by the relatively narrow range of water temperatures. Further data collection is necessary to better elucidate these relationships.

Aerators

Although oxygen depletion never reached 0 mg/L, aerators were activated with the timers set to run during the overnight hours starting in July and continuing into October when minimum DO levels were observed to be >4.0 mg/L, at the request of the CONB. The paucity of data prevents any clear evidence that the aerators substantially increased dissolved oxygen throughout Landa Lake at this time. Photos of an aerator in Landa Lake and solar panels that power the aerators are provided in **Figure 3.2-14** and **Figure 3.2-15**.

Figure 3.2-14. An aerator operating in Landa Lake

Figure 3.2-15. Solar panels that power the aerators

Recommendations

Data from this first full year of water quality monitoring have supported the tentatively identified relationships observed in the 2013 monitoring year. As in 2013, the water quality parameters remained relatively stable with DO, pH, and water temperature fluctuating on daily patterns and seasonal patterns, as expected. Turbidity and specific conductivity did not demonstrate any discernible patterns over the same period. To draw more substantial conclusions, SWCA recommends the continued monitoring of this station to identify long-term (e.g., seasonal, annual) water quality patterns and to better define the preliminary relationships identified in this report. Additionally, SWCA recommends examining the data in relation to climatological information (e.g., storm events, impingent light) to refine the patterns observed among the water quality parameters, especially DO.

As with any monitoring activity, decision making for Landa Lake will benefit from continued data collection efforts. There is a tendency to overstate the need for additional data and broadening monitoring efforts, which typically involve the costly addition of monitoring stations or performing large scale experiments over extensive time periods. In the case of Landa Lake, the current monitoring station appears to be subject to fluctuations in aquatic vegetation and sedimentation that may influence the ability to draw inferences across the entirety of the lake. As such, the addition of more monitoring stations will provide CONB with an improved ability to monitor data and correlate measurements from multiple observation sites. This will help CONB validate measurements and add assurance for management plans.

Finally, the relationships among sediment deposition, DO, and oxygen demand (both from the decay of autochthonous material and respiration) require additional consideration to improve oxygen management strategies. The DO measurements throughout the year demonstrated a Poisson distribution skewed toward lower DO concentrations (**Figure 3.2-17**), indicating that there is greater variability in high DO measurements than low measurements. The degree to which these overnight lows are caused by biological oxygen demand or chemical oxygen demand may require different management techniques than would be necessary for dealing with thermally based DO depletion, or exceptionally high DO from robust stands of vegetation. Identifying the influence of these variables will help tease out their effects and assist in designing specific, improved management strategies that address the root of the problem. This influence is especially of concern during periods of low discharge from the spring runs, such as those observed throughout 2014. Abnormally low spring discharge leads to lower than normal water movement in Landa Lake, a condition that almost certainly complicates DO concerns with respect to native endangered species. Identifying the relationships among these variables will allow CONB as well as the EAA to better manage Landa Lake and its biota.

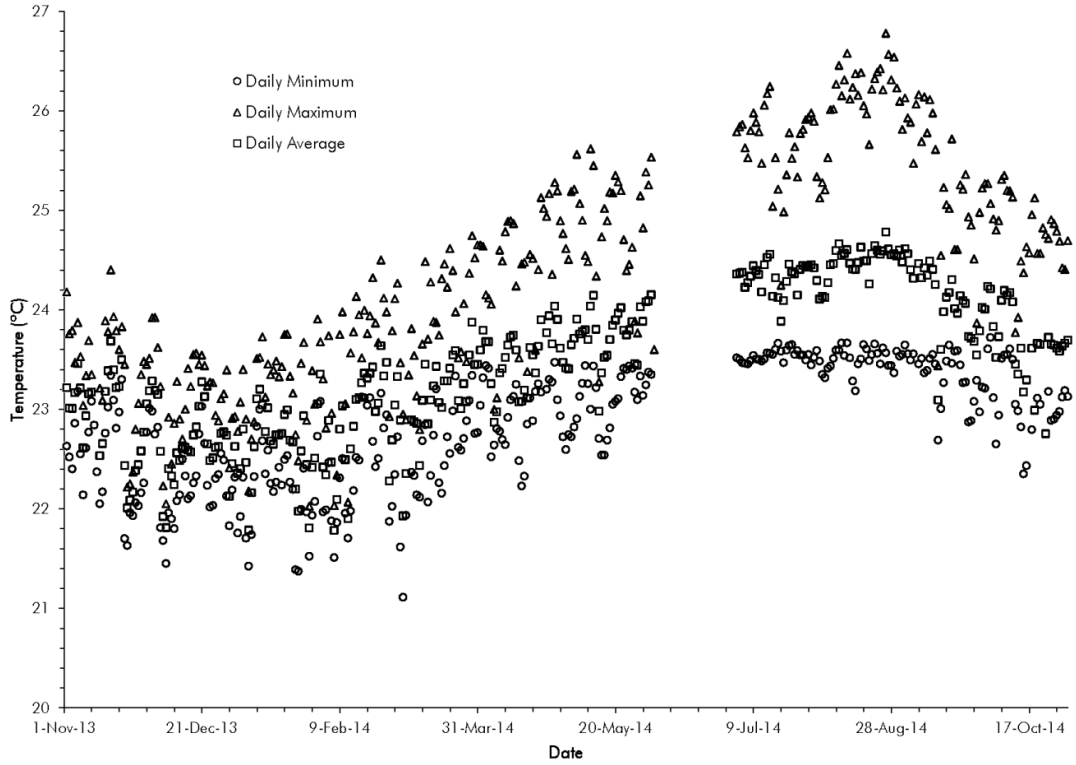


Figure 3.2-16. Measured water temperature in Landa Lake during 2014

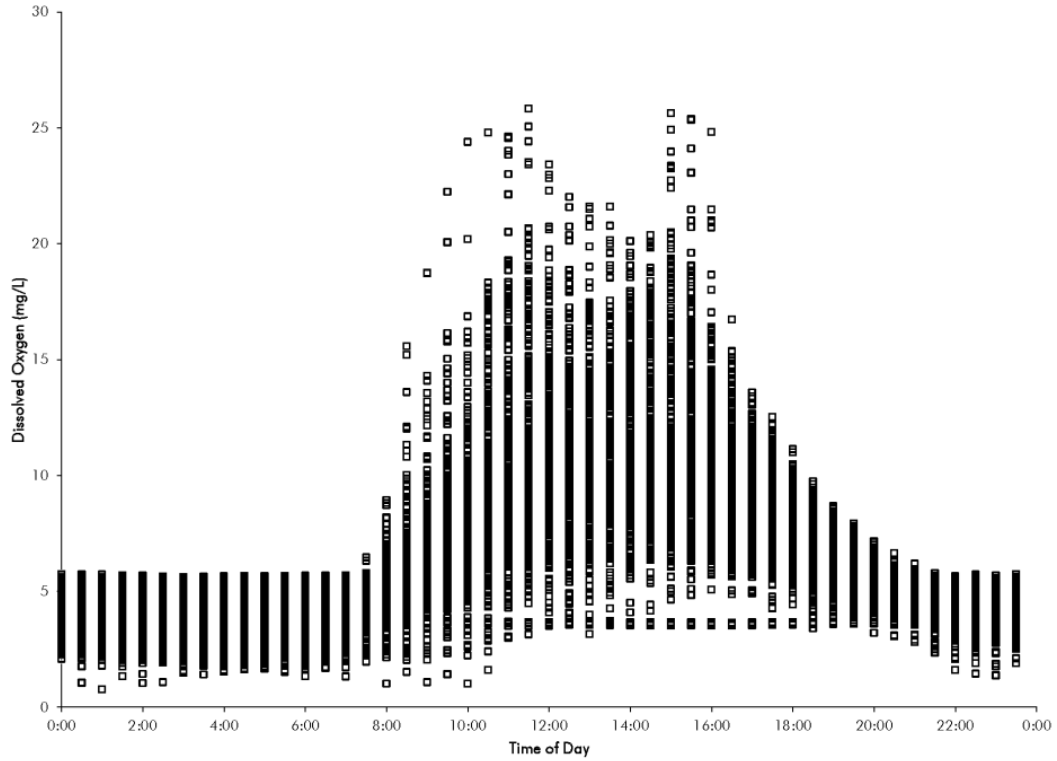


Figure 3.2-17. Daily dissolved oxygen in Landa Lake during 2014

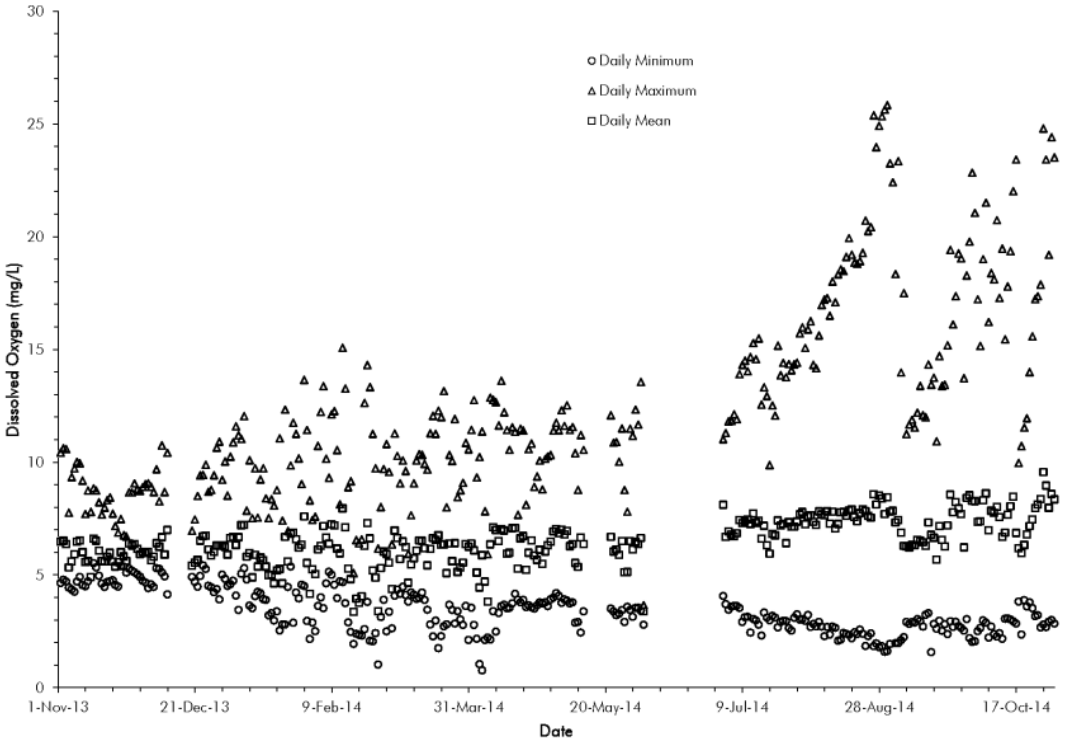


Figure 3.2-18. Annual dissolved oxygen in Landa Lake during 2014

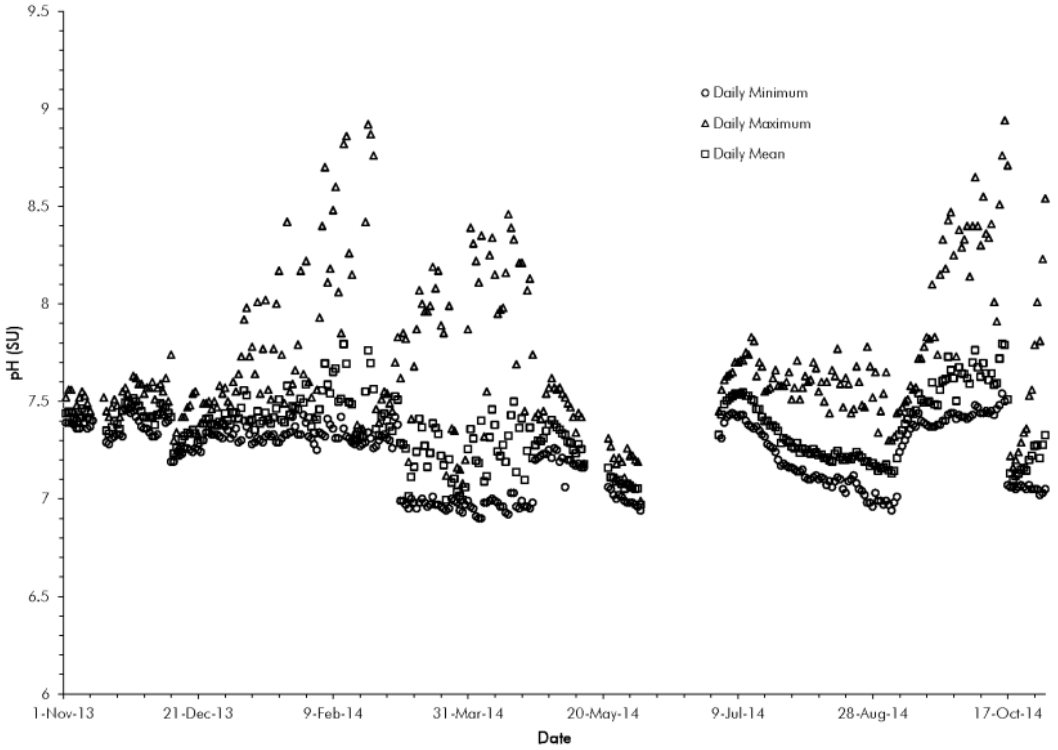


Figure 3.2-19. pH measurements for Landa Lake during 2014

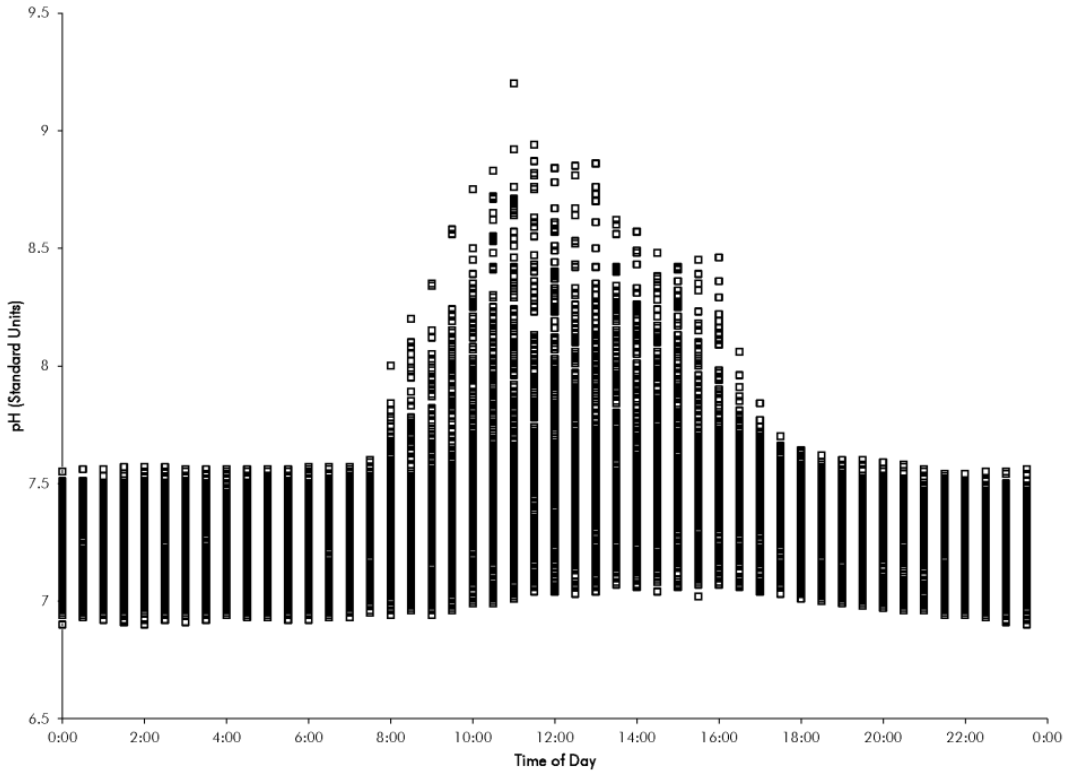


Figure 3.2-20. Daily pH in Landa Lake during 2014

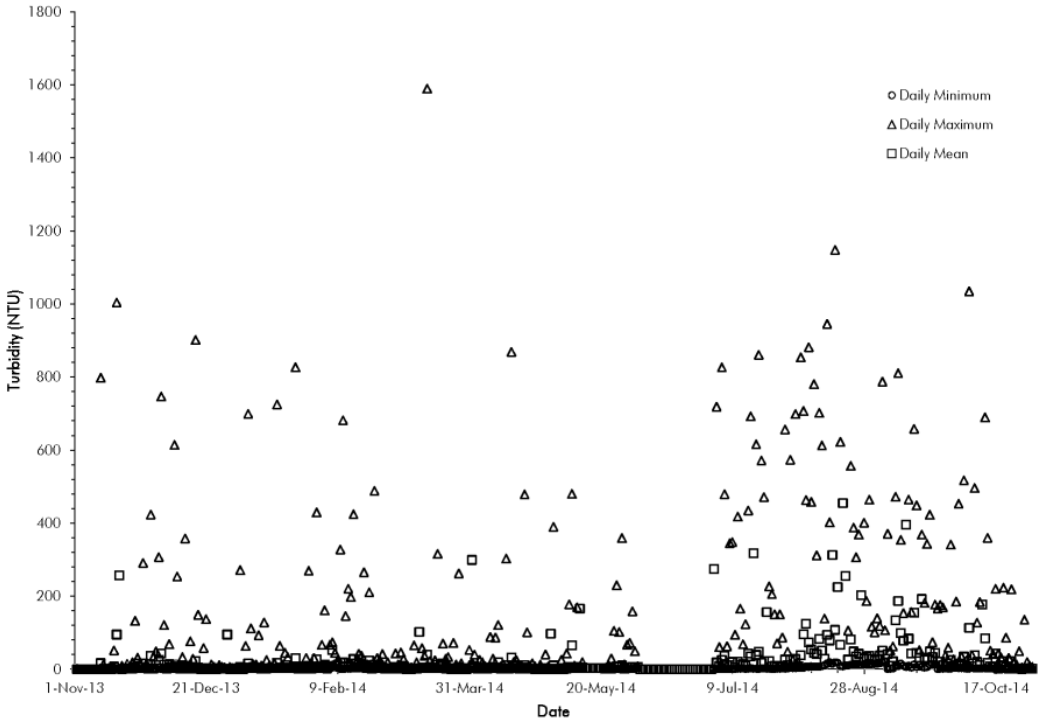


Figure 3.2-21. Measured turbidity in Landa Lake during 2014

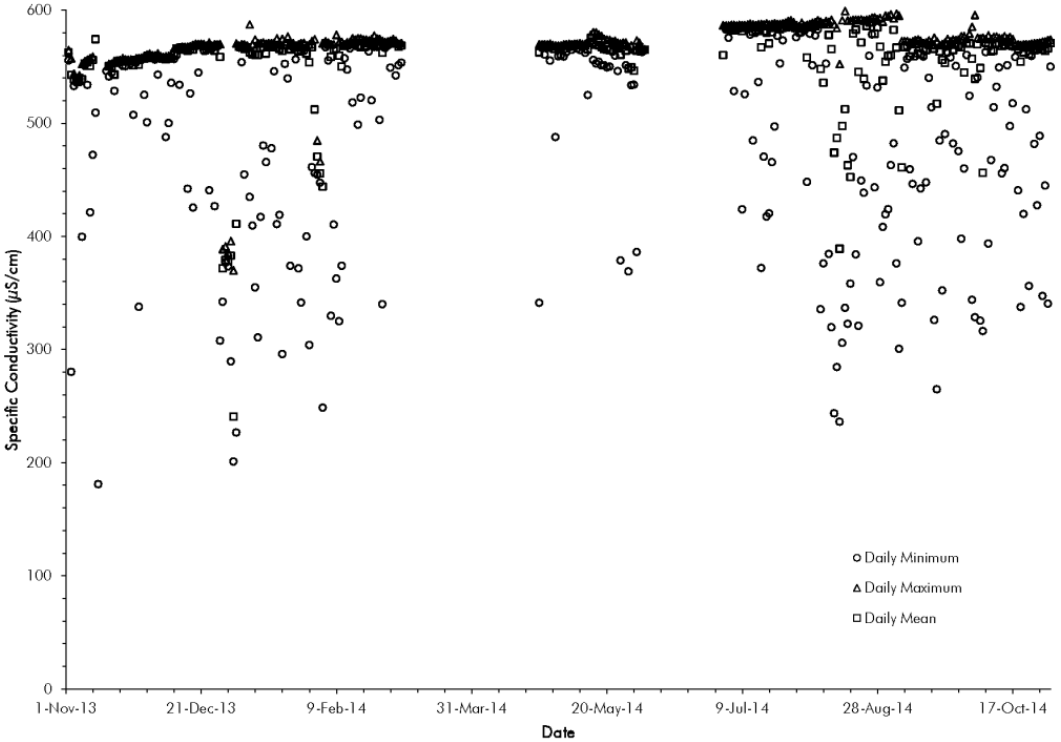


Figure 3.2-22. Measured specific conductivity in Landa Lake during 2014

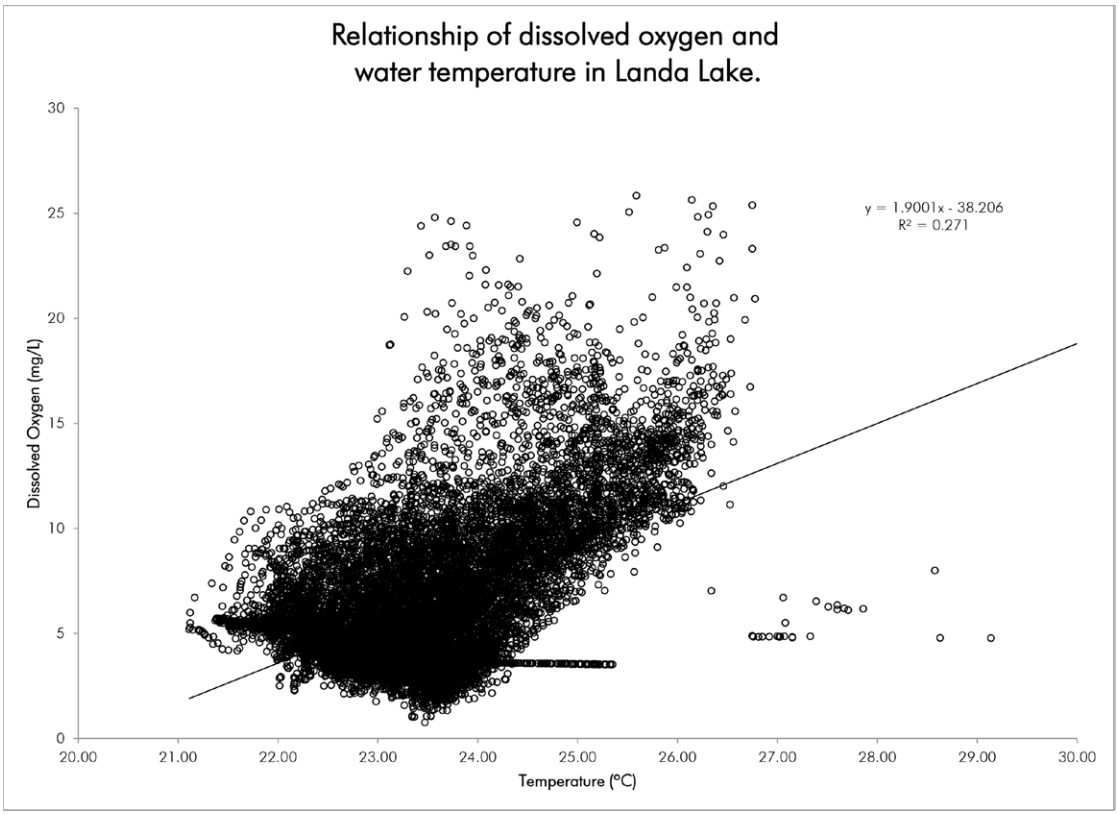


Figure 3.2-23. Relationship of dissolved oxygen and water temperature in Landa Lake

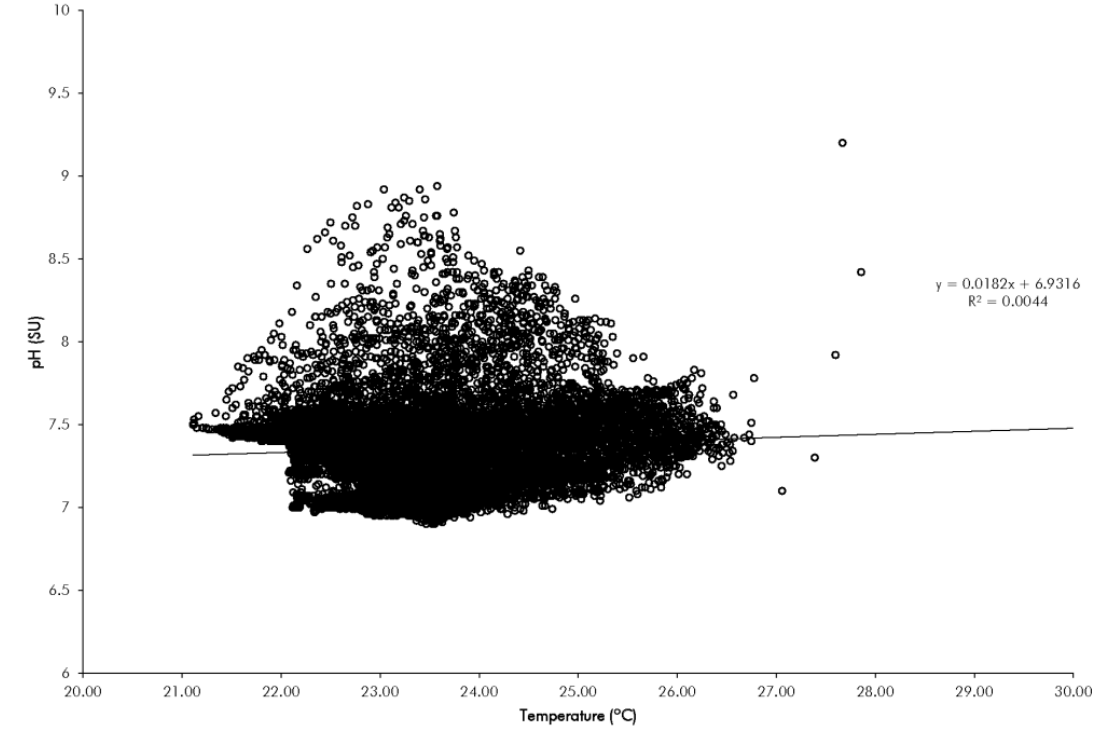


Figure 3.2-24. Relationships of pH and water temperature in Landa Lake

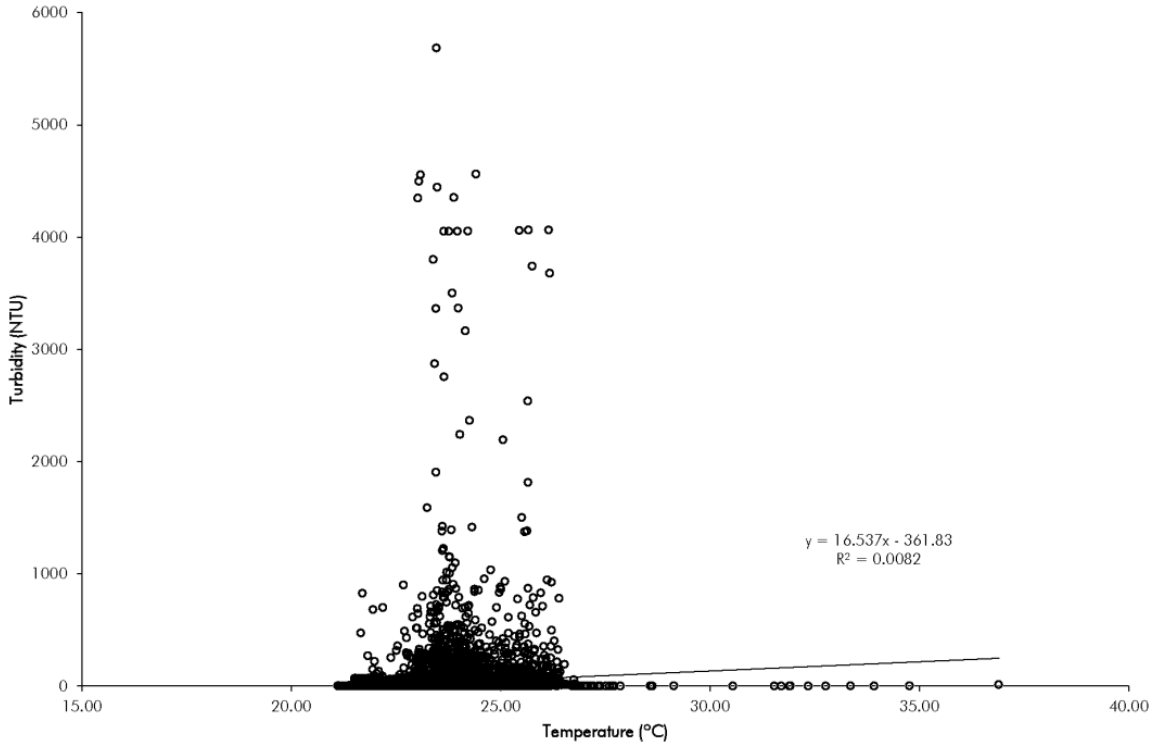


Figure 3.2-25. Relationship of turbidity and water temperatures in Landa Lake

Modifications Due to Drought Restrictions:

Modifications due to drought were minor, in that management and maintenance of the aerator system and research did not require being in Landa Lake to perform any necessary updates.

Proposed Activities for 2015:

The CONB will continue and build upon work completed in 2014. In 2015, the City will contract services to continue the operation and maintenance of the water quality sonde in Landa Lake. Additional work activities regarding the management of DO in Landa Lake will be completed in 2015. These activities include:

- Conducting research to evaluate DO levels and any relationships with Biological Oxygen Demands (BOD) trends throughout fountain darter habitat in Landa Lake. The research will focus on collecting additional DO/BOD data and defining a more suitable overall DO management program.
- Evaluating the oxygen demand of aquatic vegetation and decaying vegetation in Landa Lake.
- Purchasing and installing additional aerators, as needed and based on research findings, to further supplement DO concentrations in Landa Lake.
- Developing a Standard Operating Procedure to further define aeration deployment triggers, triggers for initiating removal of decaying/ floating vegetation mats, optimal locations for targeted removal, and procedures for fully utilizing aerators.

3.2.5 Control of Harmful Non-Native Animal Species (EAHCP §5.2.5)

Introduction:

The CONB desires to eliminate or reduce the density of non-native animal species to minimize their impact to the Comal River ecosystem (see **Figure 3.2-26**). The target non-native species include the vermiculated sailfin armored catfish (*Pterygoplichthys disjunctivus*), other species within the Loricariidae family, tilapia (*Oreochromis aureus*), nutria (*Myocastor coypus*), and giant ramshorn snail (*Marisa cornuarietis*). These non-native species are believed to compete for resources (e.g., habitat and food) with the native Covered Species of EAHCP concern. Additionally, the life history traits of armored catfish and nutria are potentially responsible for a substantial amount of the damage observed along Landa Lake's embankments. Nutria and armored catfish both burrow into the sides of river and lake banks when they nest. This constant burrowing action causes soil destabilization and subsequent erosion. Tilapia also dig into substrate for their nests, destroying vegetation.

SWCA was hired to conduct a formal on-site invasive species investigation and removal. Prior to these efforts, a desktop review of these invasive species was conducted. SWCA's field efforts involved five sessions, each four days in length, in March, April, June, October, and November of 2014. The project was suspended in July, August, and September due to low water flow levels.

Obligations:

The CONB will implement an aggressive non-native species control program that targets the suckermouth catfish (*Pterygoplichthys disjunctivus*), tilapia (*Oreochromis aureus*), nutria (*Myocastor coypus*), and giant ramshorn snail (*Marisa cornuarietis*). The City will conduct annual monitoring and maintenance activities to ensure continued control of the invasive population within the Comal system.

2014 Compliance Actions:

SWCA conducted five week-long removal efforts throughout 2014. Removal efforts were conducted in March, April, June, October, and November. This sporadic sampling was the result of the ongoing drought and substantially low flow rates observed in July, August, and September, when work was suspended during those months due to the low flow rates. After clearance from the CONB and the USFWS, SWCA was allowed back in the water to commence removal efforts in October. Removal efforts were conducted in a similar manner as in 2013. Invasive species were targeted during multiple removal efforts throughout 2014. Areas of possible nutria habitation were found and trapped. All of this effort resulted in over 4,500 lbs of additional removed biomass in addition to last year's, approximately 6,000 lbs. In two years' time, approximately 4,000 tilapia, 700 armored catfish, 50 nutria, and several thousand snails have been removed.

In the two years of removal efforts, noticeable impacts have already been observed on both the nutria and armored catfish populations. Subsequent removal efforts must be made every year for the foreseeable future in order to fully remove, or to significantly impact, their breeding populations. In regards to the tilapia population within the lake, the numbers given above demonstrate the desired trend in reduction in overall

body size. SWCA has removed approximately 3,745 tilapia and suspect that there could still be several hundred left in the lake

Extensive monitoring should continue for years to come to observe the impacts that this biomass removal has on the system. Native fish species should have less competition pressures and populations should be able to rebound because of it. It is worthy to note that certain native species that should be present in a waterbody like Landa Lake have not been observed during the entire removal effort. For instance no native catfish has been sighted in the two-year project. This could be a result of competition removal due to the invasive species. Species such as catfish help regulate nutrient flow in lake systems. With the large removal of tilapia and armored catfish (addressing this nutrient issue) problems revolving around nutrient loading could occur. A native species reintroduction may be possible in the future. However, more study is needed before this effort is undertaken.

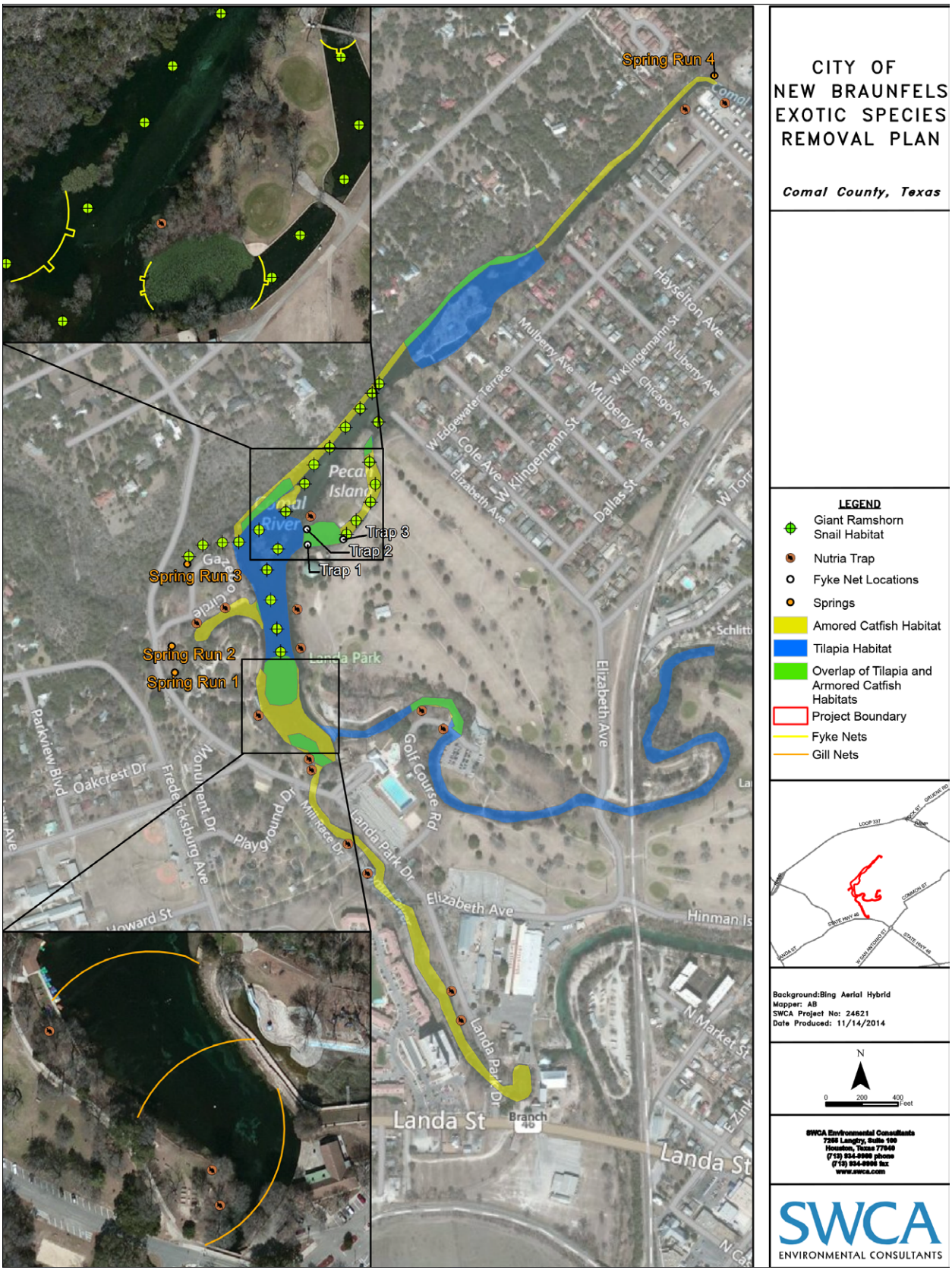


Figure 3.2-26. City of New Braunfels Exotic Species Removal Plan

Invasive Removal

Over the 21 field days in 2014 that SWCA performed invasive species removal, 294 vermiculated sailfin catfish, 1,602 tilapia, 5 nutria, and 1,099 giant ramshorn snails were removed from Landa Lake. **Table 3.2-4** shows the results of each sampling session completed from March 2014 to November 2014. The total biomass, average length, and sex ratios are reported for each species. Some of the invasive species removed are shown in **Figure 3.2-27Figure 3.2-28.** A fykenNet with tilapia through **Figure 3.2-32**.

Table 3.2-4. Non-native Species Removal Biometrics for 2014

Session 1, March 2014

Species	Number Removed	Biomass (kg)	Biomass (lbs)	Avg. Length (cm)	Sex ratio
Armored Catfish	188	170.10	375.0	45.3	0.79:1
Tilapia	366	321.05	707.7	37.3	0.43:1 Male bias
Nutria	0	0	0	NA	0
Giant Ramshorn Snail	113	NA	NA	3.69	NA
Totals	**667**	**421.15**	**1,082.70**	**NA**	**NA**

Session 2, April 2014

Species	Number Removed	Biomass (kg)	Biomass (lbs)	Avg. Length (cm)	Sex ratio
Armored Catfish	66	61.41	135.4	44.4	1.10:1
Tilapia	535	445.26	981.6	36.3	1.22:1 Female Bias
Nutria	2	3.1	6.8	NA	1:1
Giant Ramshorn Snail	115	NA	NA	3.69	NA
Totals	**718**	**509.77**	**1,123.8**	**NA**	**NA**

Session 3, June 2014

Species	Number Removed	Biomass (kg)	Biomass (lbs)	Avg. Length (cm)	Sex ratio
Armored Catfish	18	18.9	41.7	47.9	0.13:1
Tilapia	271	225.4	497.0	36.1	1.15:1 Female Bias
Nutria	1	1.5	3.3	NA	1 Male
Giant Ramshorn Snail	0	0	0	NA	NA
Totals	**290**	**245.8**	**542.0**	**NA**	**NA**

Session 4, October 2014

Species	Number Removed	Biomass (kg)	Biomass (lbs)	Avg. Length (cm)	Sex ratio
Armored Catfish	21	21.5	47.4	45.5	1.10:1
Tilapia	430	372.9	822.1	35.6	0.73:1 Male Bias
Nutria	2	9.4	20.7	NA	2 Males
Giant Ramshorn Snail	871	NA	NA	3.34	NA
Totals	**1,324**	**403.8**	**890.2**	**NA**	**NA**

Figure 3.2-27. Captured tilapia ready to be processed

Figure 3.2-28. A fykenNet with tilapia

Figure 3.2-29. Vermiculated armored catfish being speared

Figure 3.2-30. Captured female koi

Figure 3.2-31. Giant Ramshorn Snail on eelgrass in Landa Lake.

Figure 3.2-32. Processing the Giant Ramshorn Snail

Modifications Due to Drought Conditions:

Drought conditions have had a significant effect on this activity due to the drought/low flows occurring during prime non-native species removal. Timing of project activity had to be carefully timed with reviewing daily flow measurements.

Proposed Activities for 2015:

Based on 2014 data and observations, the CONB will continue with the best approach regarding removal of non-natives, and will continue to work with TPWD to see if current research on armored catfish breeding is influenced by the current EAHCP non-native species removal program.

3.2.6 Monitoring and Reduction of Gill Parasites (EAHCP §5.2.6)

Obligations:

The CONB will develop and implement a gill parasite monitoring and reduction program that will target the removal of red-rimmed melania (*Melanoides tuberculatus*) snails in the Comal River. Additional research will be conducted through the AMP to determine the most appropriate strategy for gill parasite control in the system.

2014 Compliance Actions:

Beginning in 2013, the CONB retained contractors to further investigate the gill parasite, and to explore potential management techniques aimed at minimizing and mitigating for the impact of this parasite under low flows. Key objectives of these efforts were to obtain a better understanding of the potential impacts of the gill parasite on the fountain darter; investigate appropriate means and methods to alleviate concerns; and establish a long-term monitoring program. The underlying goal was to enhance the protection of the fountain darter, especially under future low-flow scenarios.

Based on the initial literature review, it was evident that one of the most critical gaps in knowledge was system-wide information on the distribution and abundance of both the parasite and snail host. In order to determine areas of high snail abundance, a stratified host snail monitoring system was developed to provide analysis of snail populations on multiple scales using a system-wide survey, and then investigating these areas with additional refined sampling to estimate snail densities in these areas. A system-wide snail survey was first conducted in 2013 to document the distribution of *M. tuberculatus* throughout the Comal River system, and then repeated in 2014 to investigate temporal changes in distribution such as potential local colonization or extinction events (**Figure 3.2-33**). The 2014 survey presented similar results to the 2013 baseline survey, showing the snail to be extremely abundant in areas of Landa Lake, the New Channel above the old power plant, and parts of the Upper Spring Run near Spring Island (**Figure 3.2-34**). To quantify the density of *M. tuberculatus* in "hot spot" areas of the system, density sampling was conducted both in areas sampled previously in 2013 (providing for detection of trends) as well as new hot spot areas identified in the 2014 survey. In 2013, average densities of *M. tuberculatus* in these areas ranged from 179/m^2 to over 1,000/m^2, while in 2014 densities observed ranged from 50/m^2 to 850/m^2. The highest

observed densities in 2013 were observed in the New Channel between Landa Lake and the power plant, while in 2014 the highest observed densities were in the Upper Spring Run. When reach average densities are compared among years, and their variation (standard error) considered, density estimates are relatively static across years (**Table 3.2-5**). In 2014, the first density estimates were made for the Old Channel reach, at hot spots uncovered in the 2014 comprehensive survey (**Table 3.2-5**).

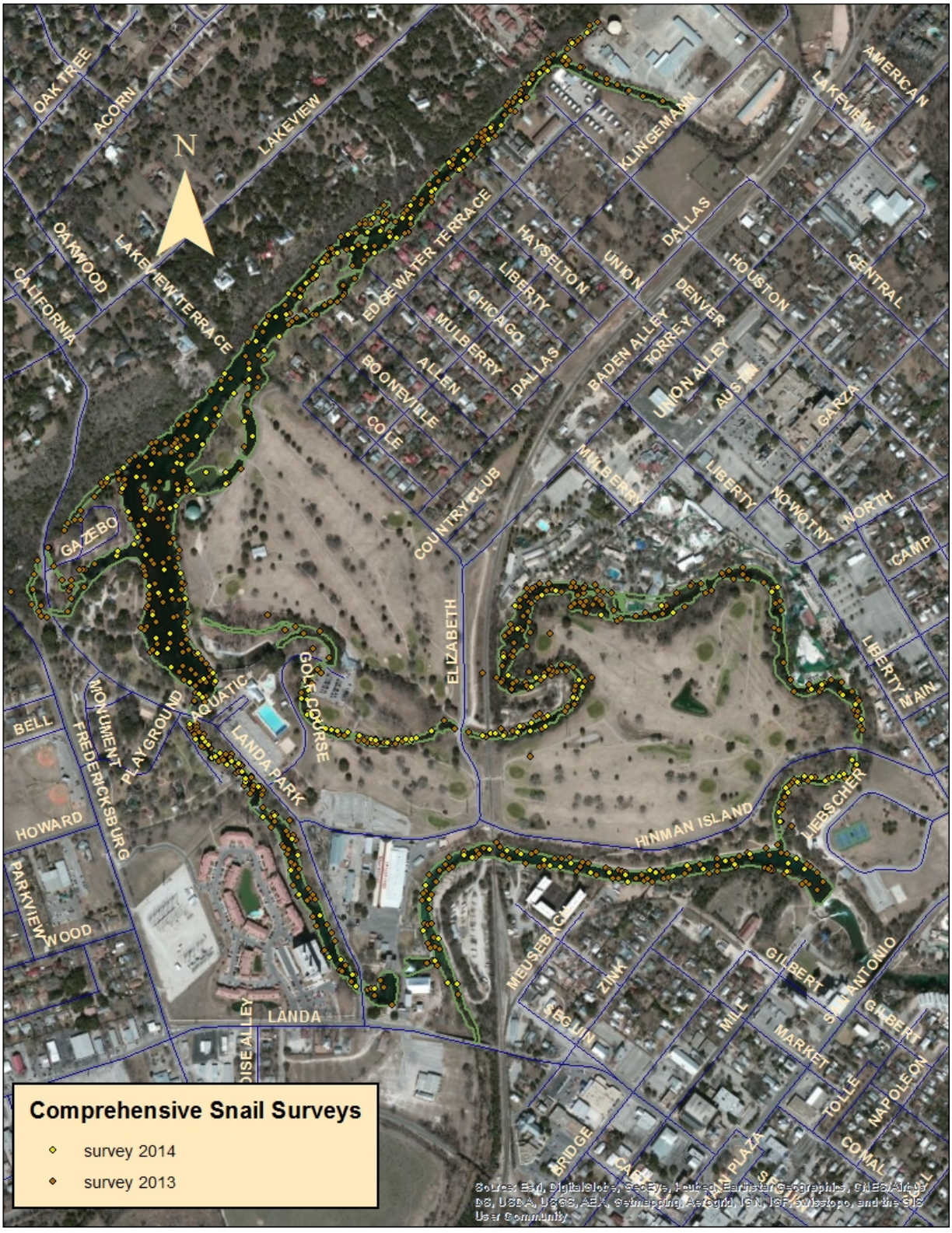


Figure 3.2-33. Points Sampled for Snails During 2013 and 2014 Comprehensive Snail Surveys

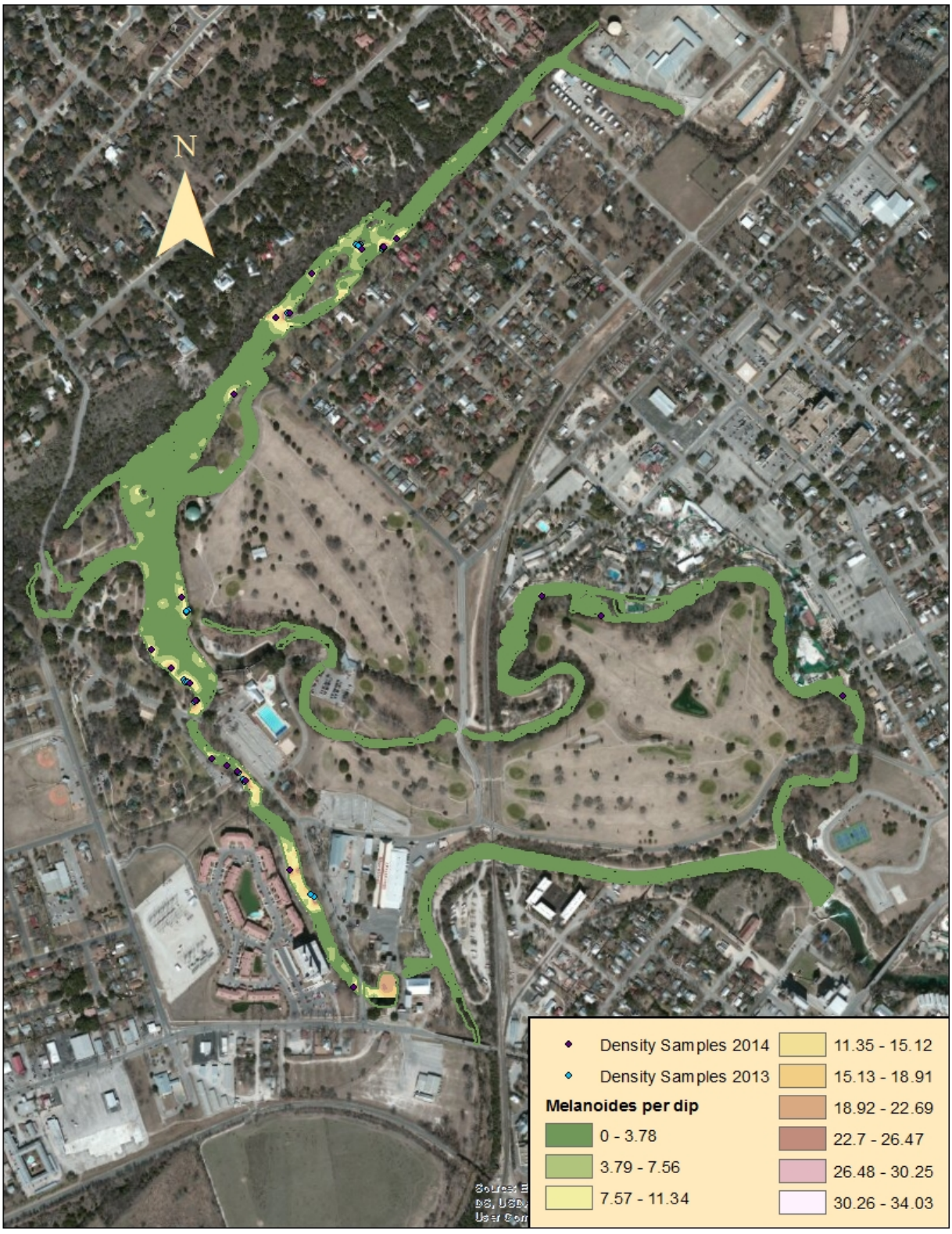


Figure 3.2-34. Results of Comprehensive Snail Survey and Snail Density Sampling Areas

Table 3.2-5. Yearly Snail Density Estimates (mean ± SE) Averaged Over Samples Within Each Reach

Year	USR	LL	NCA	OCR
2013	371.7 (±115.6)	399.3 (±70.9)	607.1 (±221.2)	---*
2014	426.9 (±114)	350 (±103.3)	343.7 (±37.8)	146.2 (±32.6)

* No density samples were taken in the Old Channel in 2013.

To monitor temporal changes in the distribution and abundance of *C. formosanus* cercariae in the Comal River, four of the 2013 cercariometry sites (Spring Island (SI), LL, OCR, and RV Park (RVP)) (**Figure 3.2-35**) were chosen to continue monitoring while the remaining two (Houston Street (HS), Confluence (CF)) were dropped. In **Figure 3.2-35**, the locations of cross-sections used for monitoring of drifting cercariae in the water column (cercariometry) are shown in red. Blue areas are sampling regions for parasite infection prevalence, labeled with the three-letter area designation, percent of snails infected by *Centocestus formosanus*, and the sample size in parentheses.

Cercariae abundance/density/concentrations exhibited interesting variation among sites and in relation to season and discharge (**Figure 3.2-36**). Monthly mean discharge values from the USGS gauge on the Comal River (gauge # 08169000) are included in **Figure 3.2-36** to illustrate discharge trends observed during the sampling period in 2014. Concentrations at the downstream end of LL clearly increased through the year as discharge decreased. However, the RVP site (downstream of power plant in New Channel), which showed the highest cercariae concentrations in 2013, exhibited a decline in apparent cercariae concentrations from summer 2014 to fall 2014. One potential explanation for this would be that reductions in current due to low flows resulted in the settling out of cercariae (probably above the power plant dam in the eddy) before reaching this area. Cercariae production increased over the year for the LL and OCR sites, while it peaked in June and declined in the late summer/fall for the SI and RVP sites. This may suggest that cercariae production continued to increase in LL as flows declined, but that cercarial drift from the lake to further reaches (e.g. New Channel below power plant) was interrupted (possibly due to low flows). This may also suggest that although fountain darters in Landa Lake will be exposed to increased parasite concentrations under low flows, effects may be lessened on darters further downstream. However, the trends observed may not be due to discharge alone. Additional data is needed to confirm this and separate the effects of seasonality and other factors from discharge.

Additional data was collected in 2014 to investigate the infection rates of snail hosts in the wild. Based on results from initial infection studies carried out in 2013, as well as data from comprehensive surveys and cercariometry, eight main areas were chosen for intensive sampling. Due to Condition M restrictions, all snails for this study were required to be collected by divers rather than dip nets. Sample points within each sample area were chosen *a priori* using GIS software. While the GIS generated grid points were adhered to as much as possible, in the event sufficient snails could not be found or observations/conditions in the field dictated adjustment, additional sample points were added and coordinates collected with GPS. Samples were collected at least ten meters apart, and up to 50 snails/sample were collected. A new method was used in 2014 to investigate infection rates, involving cutting of the snail shells, excising the digestive gland and processing it under a microscope. This method proved highly effective for detection of *C. formosanus* infection. Two other species of parasite known from the system were also detected (*Haplorchis sp*. and *Philopthalmus sp*.), and an additional novel parasite previously unknown in the Comal was discovered.

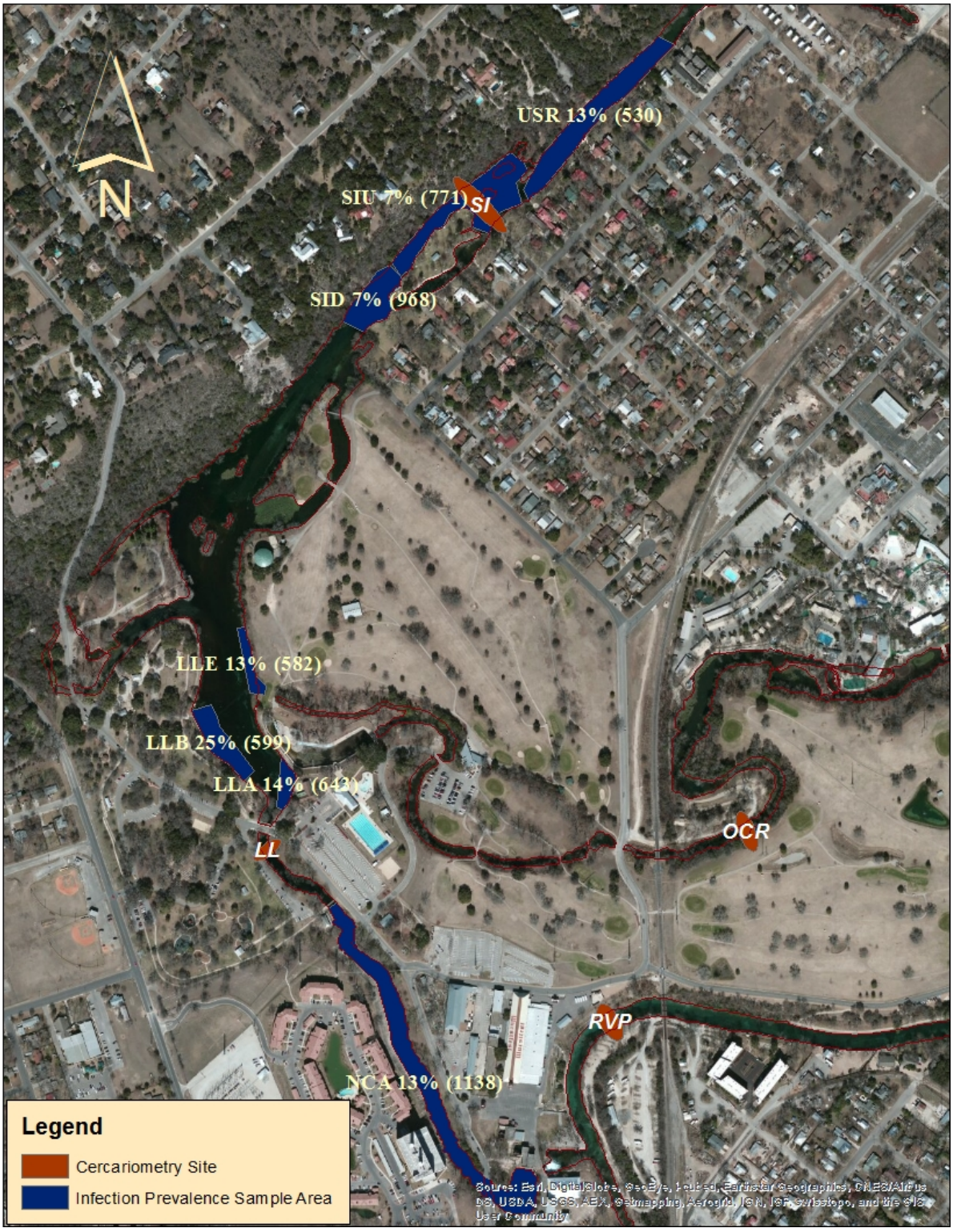


Figure 3.2-35. Monitored *C. formosanus* Cercariometry Sites

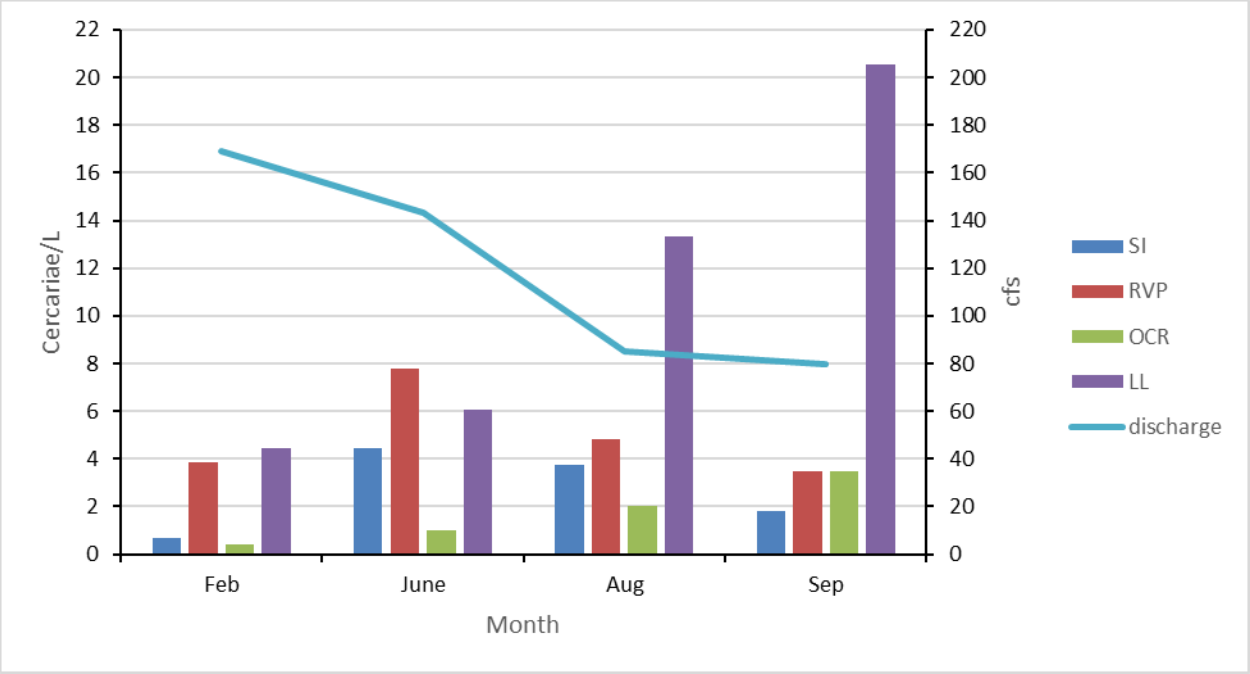


Figure 3.2-36. Density of *C. formosanus* (Gill Parasite) Cercariae in Samples Taken From the Water Column at Four Sites During 2014

Centrocestus infection rates per sample ranged from 0 to 80 percent, with an overall mean of all areas sampled of 13.7 percent. The silty area along the southwest shoreline of Landa Lake was found to have some of the highest infection rates (LLB, **Figure 3.2-35**). Extremely high infection rates were fairly isolated, and spatial aggregation of infected snails was apparent. These data could make future snail removal efforts more successful in reducing parasite loading, as the areas of greatest infection prevalence could be located and targeted. Future investigations may be targeted on elucidating the causes for the aggregation of infected individuals.

In addition to studies on the host snails and drifting parasites, an effort was also made in 2014 to quantify parasite concentrations in the gills of wild fountain darters. Previous data has shown infection rates in fountain darters to be extremely variable, and little data has been collected in recent years, despite the suggestion that drifting parasite concentrations are declining in some areas (Johnson et al. 2012). To do this with minimal impact, gills of fountain darters previously collected for EAA applied research fecundity studies were examined under microscopes and recently encysted *C. formosanus* metacercariae were counted. Only darters collected from the New Channel / RV Park (RVP) and Old Channel (OCR) sites were used, since these sites were also sampled for drifting cercariae. Parasite counts ranged from zero to 51 per fish in the RVP, and 1-72 per fish in the OCR. No significant correlation was found between the number of parasites on the gills and those collected using cercariometry, though this may be due to sampling error resulting from low sample size, or differential infection risk in individual fountain darters. Previous studies have concluded that approximately 800 or more encysted metacercariae, which is a tail-less late larva of a

digenetic trematode that is usually the form which is infective for the definitive host. They are known to cause mortality in fountain darters (Mitchell et al. 2000), and laboratory experiments have indicated that adult fountain darters can survive accumulation of more than 600 during an eight-hour trial, while over 1,000 caused mortality in the same time period (McDonald, Brandt, & Trevino, 2006). It should be noted, however, that McDonald et al. (2006) also found that the lethal effects of metacercariae were correlated positively with fish length, and that an average of only 60.2 metacercariae caused mortality in larval fountain darters.

Modifications Due to Drought Conditions:

Due to low flows experienced during summer 2014, sampling methodologies and activities had to be adapted to comply with Condition M of the ITP. To minimize impact to the system and disturbance of substrate, dipnets were no longer used for snail collection. Instead, snails were collected by hand-picking using dive/snorkel gear.

Proposed Activities for 2015:

Based on results of 2014 work, the CONB will continue monitoring the distribution and density of both host snail and drifting cercariae in 2015. Further data will aid in monitoring temporal trends of both species within the system, and provide additional insight into the mechanisms behind such trends. For example, additional data may help in determining if trends observed are seasonal, interannual, or discharge dependent.

Continued monitoring of parasite prevalence in the host snail and in the fountain darter is also scheduled in 2015. Understanding spatial and temporal patterns in fountain darter infection prevalence are critical in managing parasite impacts under low flows. Only a subset of the fountain darters collected during the fecundity study was analyzed. Parasite concentrations in the remainder of these fish will be quantified during 2015. Given the results of 2014 investigations of snail infection prevalence, it is possible that large scale removal may be appropriate to attempt again in some areas, such as LLB, where removal of silty habitat would have additional benefits for other species of concern (fountain darters, salamanders, Comal Springs riffle beetle) as well as recreation and aesthetics.

Re-examination of definitive hosts (birds) and host dynamics may also be in order. Understanding more about the dynamics of the avian to snail infection pathway could certainly be beneficial for parasite management under low flow scenarios. Given the aggregated nature of highly infected populations, identification of definitive hosts would allow analysis of habitat conditions that promote transmittal of the parasite to snails in these areas. If such habitat features are determined, they could be evaluated for future management to mitigate potential gill parasite impacts.

3.2.7 Prohibition of Hazardous Materials Transport Across the Comal River and Tributaries (EAHCP §5.2.7)

Obligations:

The CONB will continue efforts to prohibit transportation of hazardous materials along routes crossing the Comal River and its tributaries therefore minimizing the potential for impacts to Covered Species (see **Figure 3.2-37** and **Figure 3.2-38**).

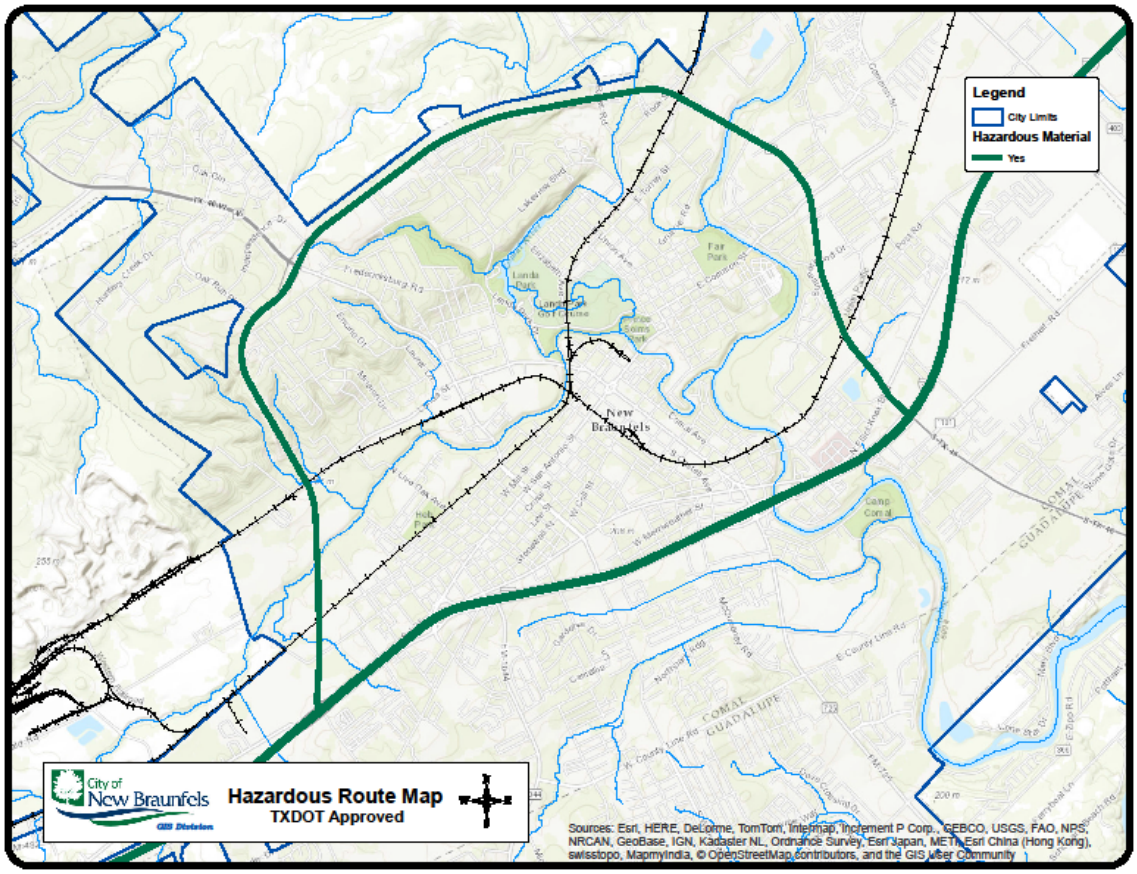


Figure 3.2-37. Original Route for Hazardous Waste (TXDOT)

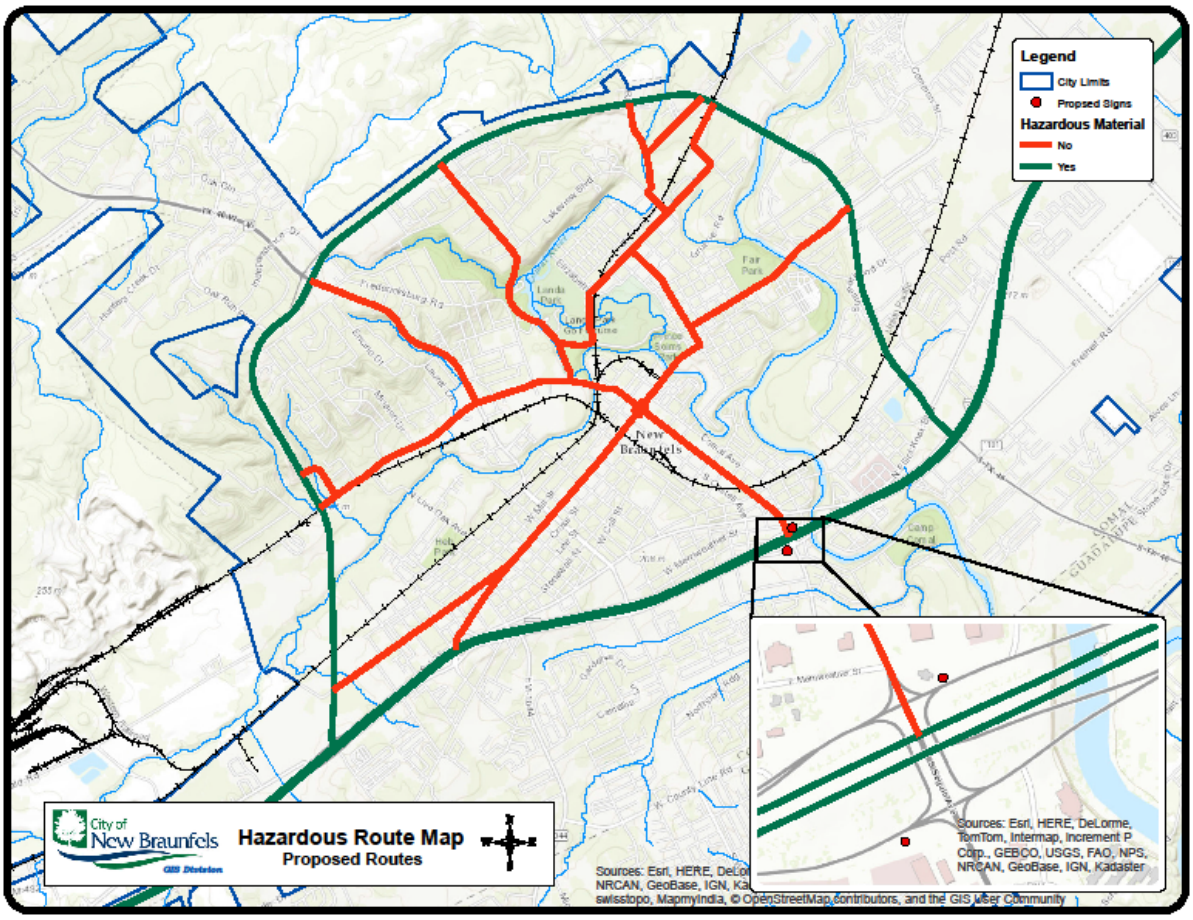


Figure 3.2-38. EAHCP Proposed Additional Routes That Should Not Have Access (With Coordination by TxDOT)

2014 Compliance Actions:

Correspondence and meetings between CONB and TxDOT have been accomplished to further identify existing hazardous materials routes and proposed route prohibitions in the vicinity of Comal River and its tributaries. These smaller routes will establish where signage needs to be installed so that hazardous materials transport vehicles will not use those routes when traveling through the area (based on potential accidents/leaks into storm sewers above the Comal Springs).

Modifications Due to Drought Conditions:

There were no notable modifications due to drought conditions.

Proposed Activities for 2015:

The CONB will present identified hazardous transportation route prohibitions to the New Braunfels City Council to potentially gain approval to install signage that will inform operators of vehicles containing hazardous materials of prohibited routes. The CONB will continue to work with TxDOT.

3.2.8 Native Riparian Habitat Restoration (Riffle Beetle) (EAHCP §5.2.8)

Obligations:

To improve riffle beetle habitat, the CONB will remove non-native vegetation along Spring Run 3 and the western shoreline of Lake Landa, and revegetate with native species. Restoration will target plants and trees with extensive root systems to provide the greatest opportunity for riffle beetle habitat. The City will additionally remove fine sediments currently covering small springs along the shoreline.

2014 Compliance Actions:

Below is a summary of specific work activities completed in 2014.

Exotic Vegetation Removal

The two exotic species chosen for removal during 2013 were again targeted in 2014: elephant ear (*Colocasia* spp.), and Chinese privet (*Ligustrum* spp.). Overall, elephant ear presence has greatly declined due to efforts in Year 1 (**Figure 3.2-39**, **Figure 3.2-40**, and **Figure 3.2-41**), although only a single herbicide (Clearcast) treatment was conducted on elephant ear in June 2014. One remaining area of concern for future elephant ear invasion is an adjacent private land area. Ligustrum trees were removed during the April, July, and November site visits. All cut ligustrum were utilized to create sediment catchments, while stumps were left to aid in support of these catchments. All stumps were treated to prevent sprouting.

Figure 3.2-39. Elephant ear stand at Location 341 prior to restoration activities

Figure 3.2-40. Few individual elephant ear plants remain at Location 341 in March 2014

Figure 3.2-41. Location 341 in November 2014

Vegetation Planting

Plantings in 2014 consisted of the native species planted the previous year (i.e. Muhly grass, meadow sedge, etc.). New sites were established and planted. Individual plant survival was recorded for each site visit and survivability was calculated as the fraction of original plantings. The average survivability for each vegetation type is: 0.28 for sedges; and 0.39 for Muhly. Average survivability for each location type is: 0.46 for shoreline rows; and 0.31 for hillside rows.

Erosion Controls

Erosion control structures throughout the site have provided natural catchments for sediment that would otherwise inundate the shoreline water. The areas also provide excellent bed structure for plantings and grass seed growth (**Figure 3.2-42** and **Figure 3.2-43**). Along with providing maintenance to previously installed erosion control structures, additional structures were installed as needed. In June and November, seven structures were built or greatly upgraded to aid in erosion control in the upper run of the site (above the lake gazebo). An estimated 1.7 cubic yards have been collected at select monitoring sites since January 1, 2014, as shown in **Table 3.2-6**.

Table 3.2-6. Estimated Volume of Captured Sediment

Location	Captured Sediment (yds^3)
10	0.4
51	0.1
81	0.3
95	0.4
Site 2	0.5
New Site 1	0.1
Site 6	-0.1
Total	**1.7**

Figure 3.2-42. Erosion control structure and revegetation at location 173

Figure 3.2-43. Structure built to capture erosion before entering Spring Run 3

Irrigation

The irrigation system installed initially consisted of diffusers and drip hoses, but was upgraded to all drip hoses in July. As was the case in 2013, the project area maintained high animal population densities.This was evidenced in various ways, including human vandalism of the irrigation system components (e.g. shut valves, loosened caps, broken pieces) and obvious wildlife damage to hoses.

Riffle Beetle Monitoring

Fabric traps were placed on-site in June. However, the only site where riffle beetles were observed was near the lake gazebo, where adults and juveniles were found. Deeper water areas, targeted for being cobbled or silted, did not contain any beetles.

Comal Springs riffle beetle project activities will continue in 2015 focusing on creating additional erosion sediment traps in a way that redirects pedestrian traffic away from near-shoreline and planting areas, and promoting additional lake-bottom springflows at low elevations to benefit habitat under low lake levels.

The most effective restoration activity in 2013 was construction of shoreline erosion control measures. The erosion control sediment traps captured multiple cubic yards of sediment before sediment could enter Spring Run 3 or LL (**Figure 3.2-44**). Non-native elephant ear was successfully reduced along the shoreline by cutting and repeat herbicide application. Treated areas were replanted with native sedge species that are having significant success. Non-native *ligustrum* trees were removed which allowed for more sunlight to penetrate some areas of the shoreline. Cut *ligustrum* log and brush material was utilized on-site for construction of erosion control sediment traps. Shoreline planting of native ground cover and tree species was less successful because of the rocky terrain, shallow soils, heavy canopy cover, wildlife grazing and foot traffic. Accumulated fine sediment was removed from the lake bottom by suction dredging. Following dredging activities in areas without previously documented springs, a localized increase was observed in the spatial extent and frequency of spring discharge, as observed by gas bubbles resulting from degassification at spring orifices.

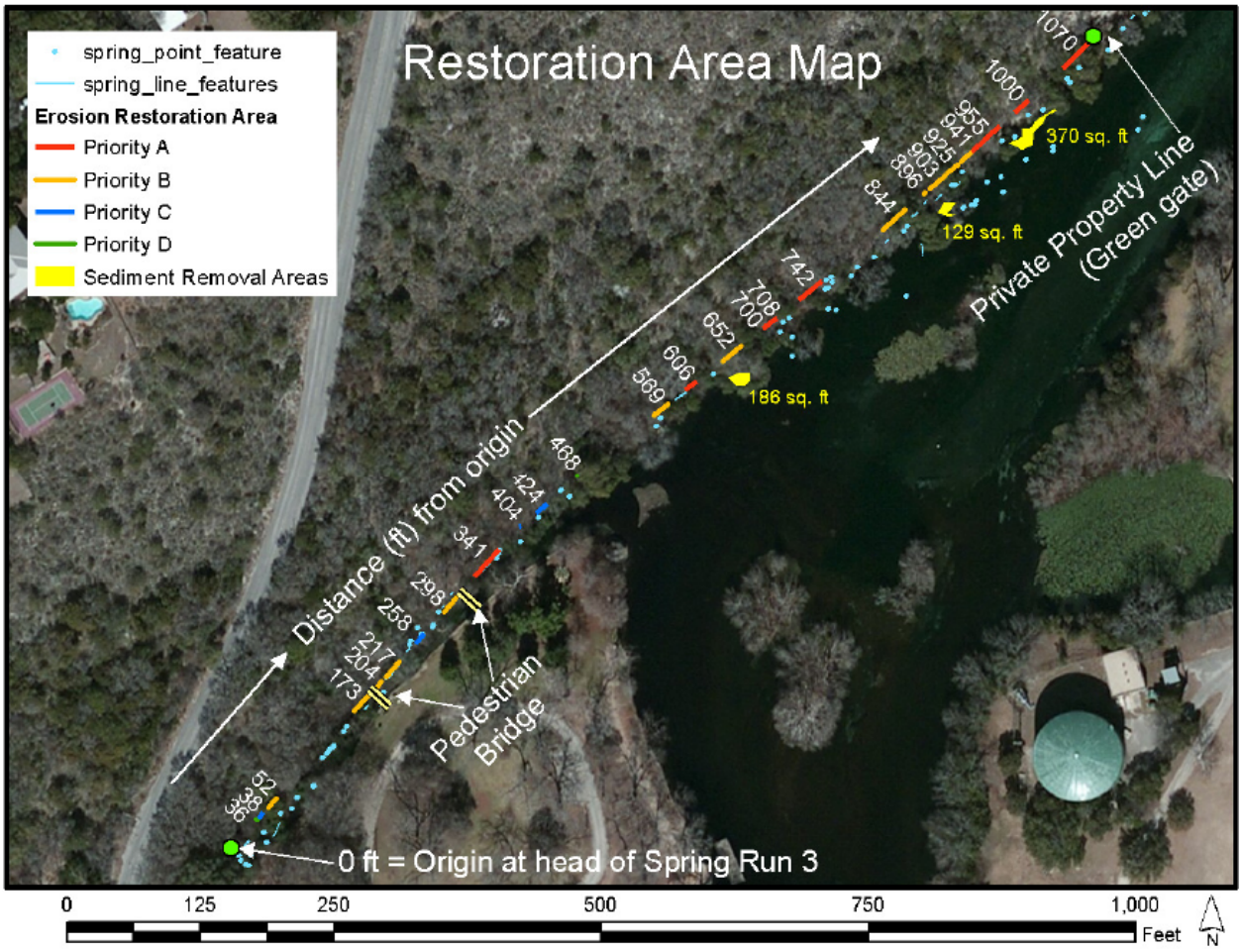


Figure 3.2-44. Priority Riparian Shoreline Areas and Sediment Removal Areas (RPS 2013)

Modifications Due to Drought Conditions:

Multiple timelines for projects were altered/changed due to Condition M. There were multiple failures of revegetation due to drought conditions. Nearly six months of work activity was lost due to Condition M.

Proposed Activities for 2015:

Continue to establish native vegetation to further increase slope stability along Spring Run 3 and the northwestern shoreline of Landa Lake. Install additional erosion control berms, as nesessary, to decrease sedimentation in Spring Run 3. In order to increase the stability of areas immediately upgradient of existing erosion control structures where sediment has accumulated, additional native vegetation will be planted in these locations. Continue to plant and establish native vegetation further upstream along the northwestern shoreline of Landa Lake.

3.2.9 Reduction of Non-Native Species Introduction and Live Bait Prohibition (EAHCP §5.2.9)

Obligations:

The CONB will act to stop or limit through city ordinance the amount of non-native species being introduced into the river system from aquariums, and will undertake measures to prohibit the use of live bait species for local fishing.

2014 Compliance Actions:

The CONB has continued to educate local businesses on the EAHCP and endangered species program, and how it is affected by the non-native species in LL and the Comal River. All local bait shops and aquarium stores have been approached and educated on potential hazards of non-native species and aquarium dumping into the local lakes and streams. Based on a small amount of bait and aquarium shops, the CONB has extended its reach into nearby cities (Canyon Lake, Seguin, Garden Ridge, Schertz, Selma, San Marcos, north San Antonio, and south Austin) to educate shops that sell bait and aquariums.

In addition, the CONB has develped educational materials designed to inform the public of invasive species issues and the negative impacts of aquarium dumping (**Figure 3.2-45**). This material was published in a local CONB Parks and Recreation Program Guide referred to as "The Fun Things in Life." This information will also be incorporated into flyers that will be distributed in CONB parks offices to be made available to incoming park visitors.

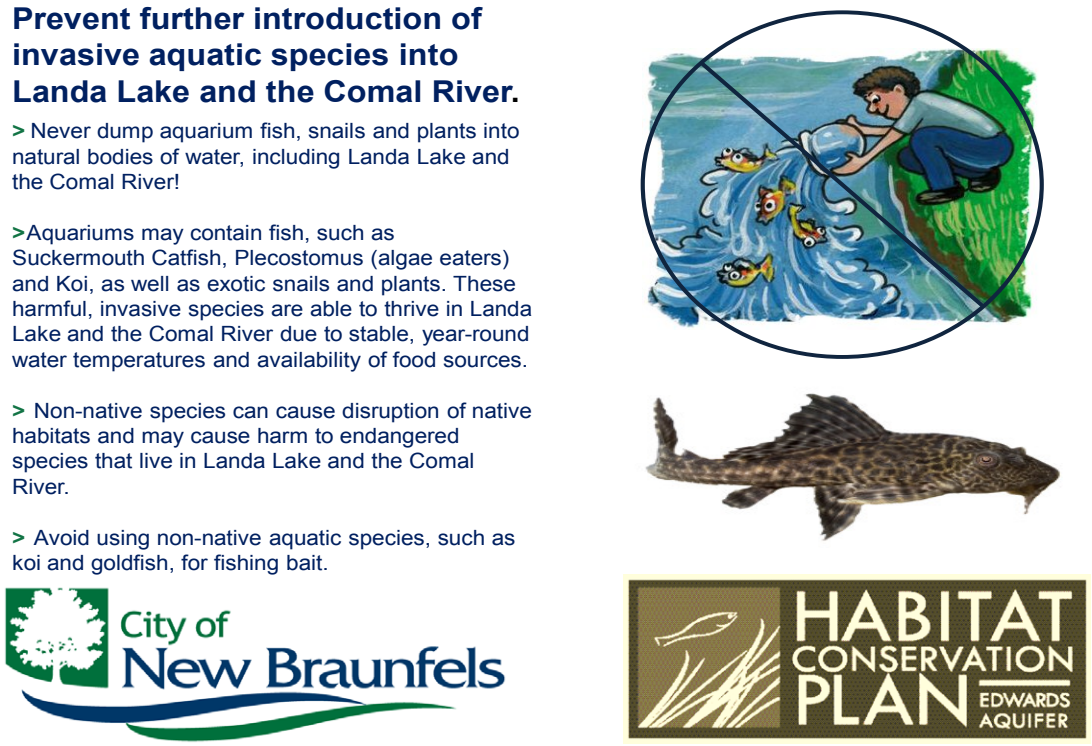


Figure 3.2-45. Non-native species introduction educational materials

Modifications Due to Drought Conditions:

No notable modifications were needed during drought conditions.

Proposed Activities for 2015:

The CONB will continue to expand the level of EAHCP information on introduction of non-native species into the Comal System, through educational outreach and signage posted. It is anticipated that the monthly bio-monitoring program will detect the potential presence of newly-introduced species into the Comal system.

3.2.10 Litter Collection and Floating Vegetation Management (EAHCP §5.2.10)

Obligations:

The CONB will remove litter and floating debris from the Comal Springs, LL, and the Comal River. Additionally, floating vegetation mats will be cleaned of litter and dislodged to allow them to move freely downstream.

2014 Compliance Actions:

The CONB continued to implement a program to remove litter and dislodge floating vegetation mats from Landa Lake and portions of the Comal River where Covered Species habitat is present. Litter collection efforts in 2014 consisted of litter removal from the surface of Landa Lake and the Spring Runs. Litter collection efforts also included removal of litter from the bottom of Landa Lake and portions of the Comal River utilizing SCUBA. Floating vegetation mats were dislodged (and allowed to move downstream) at five locations within Landa Lake where mats have been known to accumulate. Following the clarification of Provision M, floating vegetation mats were also removed from other locations within Landa Lake where the mats were obstructing sunlight from reaching previously restored areas.

Modifications Due to Drought Conditions:

All work was stopped during low flow conditions based on Condition M, until such time as a clarification was issued from USFWS. Removal of floating vegetation mats was resumed following the issuance of the clarification.

Proposed Activities for 2015:

CONB will continue the existing program to control floating vegetation and litter within Covered Species habitat. Floating vegetation mat control will be expanded to include locations in the vicinity of the flow-split culvert and the Three Islands Area in Landa Lake where large weed mats formed in 2014 and affected flow-split management and aquatic vegetation restoration programs.

3.2.11 Management of Golf Course Diversions and Operations (EAHCP §5.2.11)

Obligations:

The CONB will develop and implement a Golf Course Management Plan that will include an Integrated Pest Management Plan (IPMP) designed to target techniques to protect water quality and minimize potential negative effects to Covered Species.

2014 Compliance Actions:

The CONB has completed an extensive evaluation of their entire golf course and has developed a new IPMP. Based on multiple reviews from internal staff and outside agencies (EAA, SAWS, Texas State, and COSM), minor upgrades were made in Fall 2013 and a final plan was completed by December 2013. The New Braunfels Golf Course was closed in October 2013 for renovation and re-opened in October 2014. This new IPMP plan is currently being implemented.

Modifications Due to Drought Conditions:

This project was not affected by drought conditions in 2014.

Proposed Activities for 2015:

The CONB will continue to update the IPMP, as needed, and maintain a vegetative buffer between the golf course and Landa Lake and the Old Channel of the Comal River in order to provide increased water quality protection.

3.2.12 Native Riparian Habitat Restoration (Old Channel Improvements) (EAHCP §5.7.1)

Obligations:

The CONB will implement final design of bank stabilization and begin construction in 2014.

Based on low flows, all 2014 work was halted and is planned to be implemented in 2015, if flows are significant enough to allow this work.

2014 Compliance Actions:

The final design for bank stabilization was completed after review by the EAHCP Science Committee, and final review and approval of the Implementing Committee in early 2014 (see **Figure 3.2-46** through **Figure 3.2-49**). Based on input from the Science Committee, riparian zone improvements were integrated into the plan, and presented to the Implementing Committee. A bid package was completed and the project is ready to be bid. Construction did not occur in 2014, due low flows in the springs systems.

Figure 3.2-46. The Old Channel Where Bank Stabilization Will be Implemented

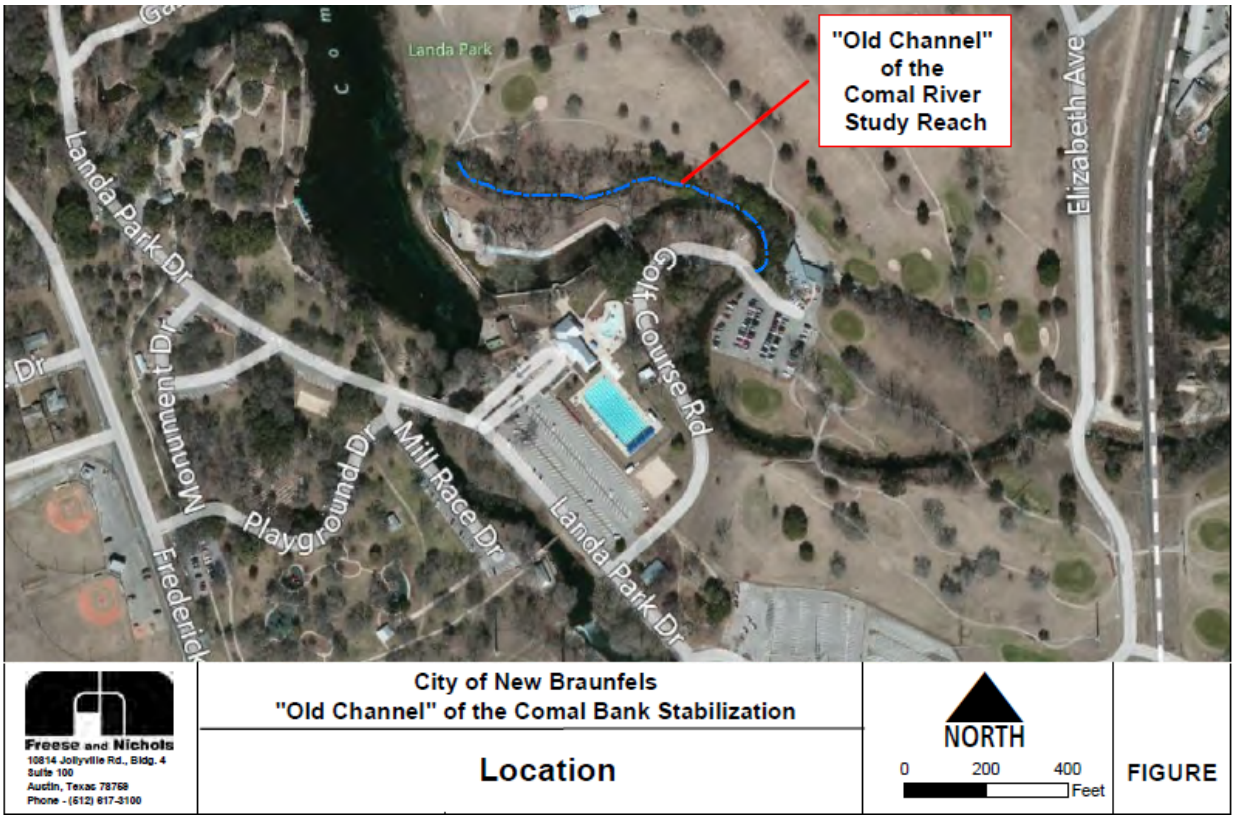


Figure 3.2-47. Location of Old Channel Bank Stabilization

Figure 3.2-48. Bank Stabilization Site Recommendations

Figure 3.2-49. Conceptual Design of Bank Stabilization Efforts

Modifications Due to Drought Conditions:

This project was delayed due to Condition M and existing drought conditions. The project was in final design phase in early 2014. However, springflows dropped below 130 cfs when the project was set to go out to bid and start construction.

Proposed Activities for 2015:

If springflows are at 160 cfs (preferred) or higher, design plans are in place to be sent out to bid to start construction in 2015. USACE, USFWS and THC have already reviewed and approved the final design plans for construction. Considering the long delay on this project, all state and federal permits will be reevaluated before any work activity commences. Throughout the construction phase, there will be ongoing communication with applicable agencies.

Management of Household Hazardous Wastes (EAHCP §5.7.5)

Obligations:

The CONB will continue the Household Hazardous Waste (HHW) program. The CONB will continue to enhance its HHW program to generate additional participation by the general public.

2014 Compliance Actions:

The CONB held three HHW collection events in 2014. Each event had approximately 200 cars visit, and each was able to obtain approximately 10-12 tons of material. Each HHW collection event has incorporated an outreach and education component. The media outlets used included newspaper inserts, television, local

radio, and handouts and other education materials distributed at local elementary and middle schools (see **Figure 3.2-50** through **Figure 3.2-52**).

Figure 3.2-50. HHW collection event

Figure 3.2-51. Collection of HHW

Figure 3.2-52. Collection of HHW

Proposed Activities for 2015:

Continue offering HHW events for the citizens of New Braunfels. The goal is to hold four events per year for the residents of the CONB.

3.2.13 Impervious Cover/ Water Quality Protection (EAHCP §5.7.6)

Obligations:

The CONB will identify target impervious cover limits and will provide incentives to public and private landowners who are willing to convert existing impervious cover to pervious cover. Target programs will be identified consistent with the recommendations of the Low Impact Development (LID)/Water Quality Work Group Report developed during the EARIP and included as Appendix Q to the EAHCP.

2014 Compliance Actions:

As required by the Edwards Aquifer Habitat Restoration Plan, the goal of the yearly report is to provide a guide to implementing LID Best Management Practices (BMPs) that will protect and preserve the habitat of four endangered species identified within the study area. This study focuses on the watersheds of the Comal River and Blieders Creek that convey runoff to Covered Species habitat (**Figure 3.2-53** and **Figure 3.2-54**).

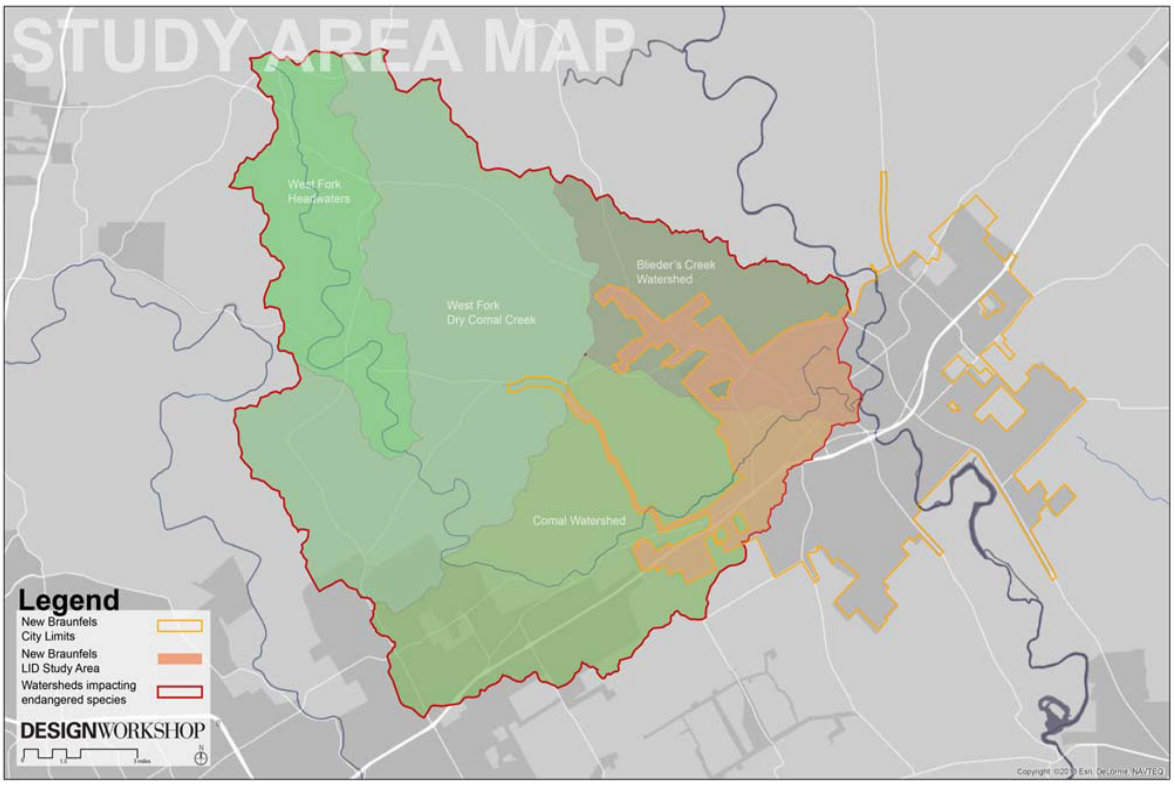


Figure 3.2-53. Low Impact Development (LID) Study Area

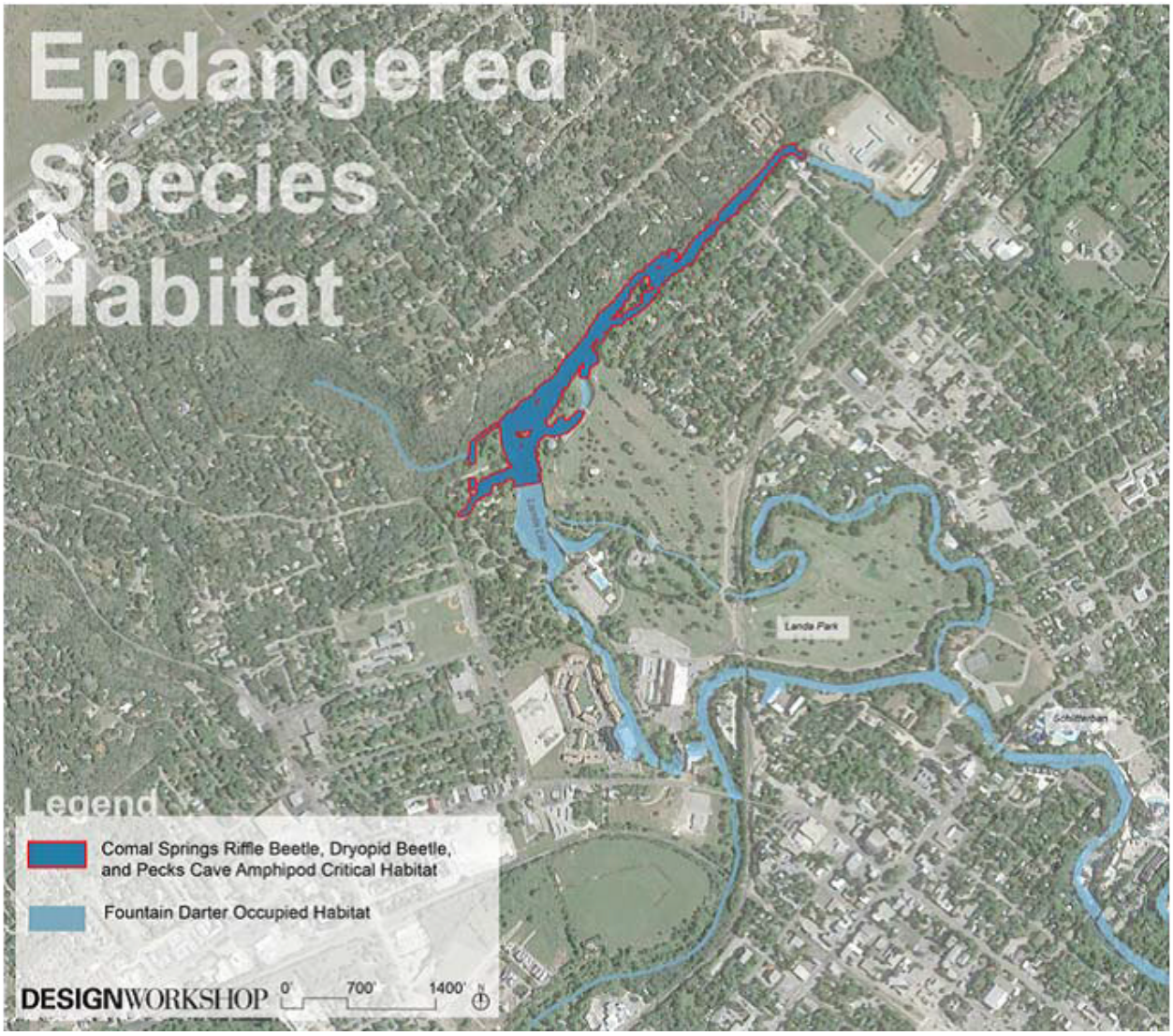


Figure 3.2-54. Endangered Species Habitat

Most water quality impairments are linked to dispersed threats and non-point source pollution, such as fertilizer runoff from agricultural fields and residential homes, excessive water use, and chemicals washed into rivers and lakes from adjacent streets, driveways, roofs, and parking lots. Because of the dispersed nature of this threat, the report seeks to identify LID BMPs that can be adopted on a community-wide scale in order to reach the desired improvement and maintenance of the endangered species' habitats.

The BMPs were prioritized according to seven key goals of the project: 1) fiscal benefit; 2) reduction of impervious cover; 3) reduction in stream sediment; 4) increase of groundwater recharge; 5) reduction of groundwater pollution; 6) easily understandable and implementable; 7) aesthetically pleasing. Those BMPs that met the most goals are recommended for early implementation.

Public information and education was a key recommendation in the report. The second year of implementation was to focus on educating the public with events and public information. The development of rebates for LID BMPs, such as rain barrels, rain gardens, native plant landscaping, and permeable

pavement, was designated as a high-priority item. Finally, the implementation of pilot programs (i.e. integrating LID BMPs in public projects) was recommended as an education tool in the community.

The implementation strategy in the report illustrates how these key recommendations are to be launched and sustained over the next six years. The first year focuses on education and outreach while preparing for the launch of a rebate program and implementation of pilot projects. In subsequent years, the pilot projects are to be installed and public awareness of the rebate program will grow, requiring less and less public outreach. More funds in later years can be spent on the actual implementation of LID BMPs. The LID process was delayed in 2014 when the CONB was requested to present by the Implementing Committee, the differences between their MS4 program and the proposed HCP LID program.

Educational materials were created in 2014 but not distributed to the public. A brochure/door hanger and a web page (to be linked to the CONB website) were considered to further educate the public of LID initiatives. The brochure and website are in the developmental stages and were not finalized in 2014 (see **Figure 3.2-55** and **Figure 3.2-56**).Additionally, recent collaboration with the New Braunfels High School has been achieved and continued expansion and integration of EAHCP LID projects are set to be started in early 2015. These LID projects will merge with existing New Braunfels High School science curriculum programs as well as the agriculture group at the high school. These LID projects will ultimately benefit the local students and the nearby community.

Figure 3.2-55. Draft LID newsletter

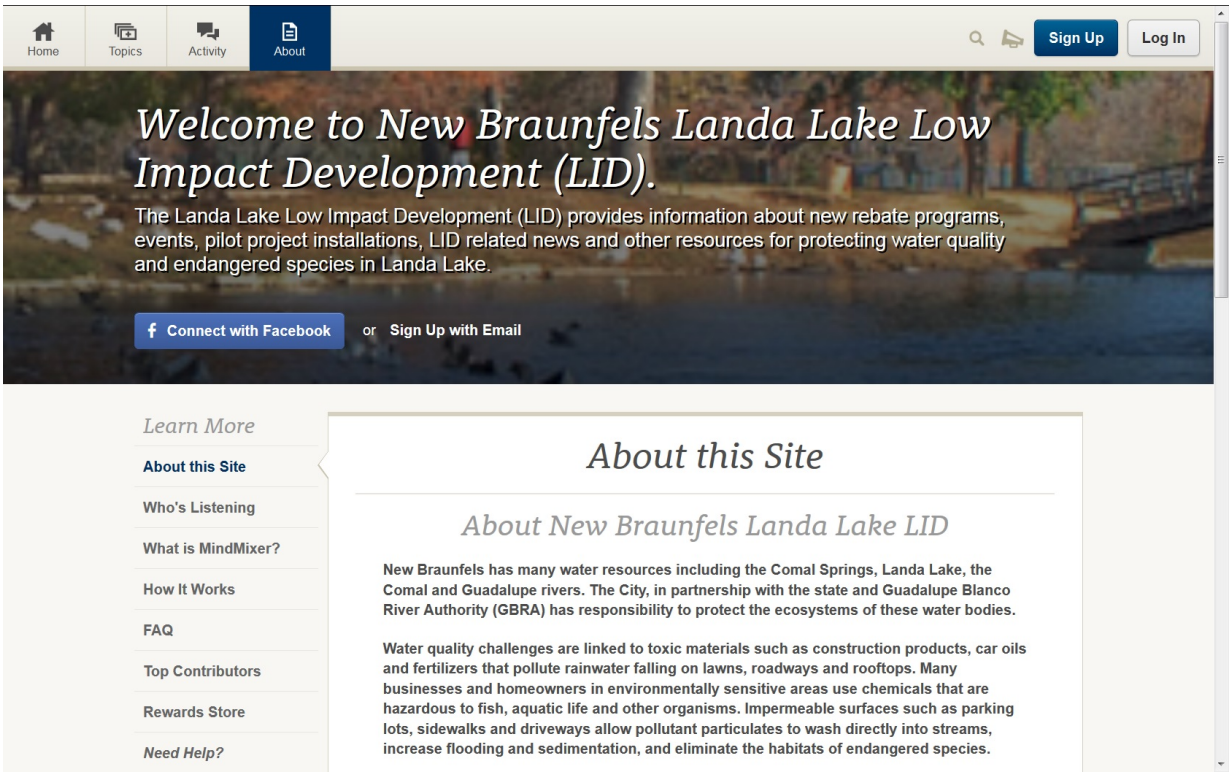


Figure 3.2-56. Draft LID website created for the CONB

Modifications Due to Drought Conditions:

Issues regarding low flows in the springs resulted in work delays throughout a significant portion of the year.

Proposed Activities for 2015:

The CONB will continue to develop and implement LID initiatives such as education, residential LID rebate program, and LID pilot projects. The CONB will continue to work towards implementing an example project at the New Braunsfels High School incorporating LID elements as well as an educational component. Impervious cover criteria will also be further considered in 2015. All BMPs and LID initiatives developed and implemented as part of the program will directly benefit Landa Lake, the Comal Springs complex, and Covered Species. Any BMPs and initiatives implemented as part of this program will be above and beyond the requirements of CONB's MS4 permit program.The CONB sponsored and encouraged multiple activities designed to protect water quality in the Comal River watershed including "Bulky Goods Drop-Off" events, HHW recycling programs and a prescription medication disposal program. These activities were established to reduce the likelihood of the improper disposal of potential pollutants to the Comal River watershed. Numerous signs have been placed within CONB parks and in other areas within the Comal River watershed in order to inform the public of local endangered species, water quality, and benefits of native vegetation.

3.2.14 Public Outreach Initiatives

Obligations:

The public outreach activities of the CONB are conducted voluntarily by the City, not because of particular permit obligations.

2014 Compliance Actions:

During 2014, EAHCP education outreach continued to be integrated into New Braunfels and regional communications. These outreach efforts utilized radio, newspaper, public meetings, brochures, workshops, presentations at local parks, and related events throughout the city. Additionally, presentations for the EAHCP were given to local non-profit, civic, and children's groups. Presentations were also given at local schools and universities which covered aspects of the EAHCP and regional efforts on the management of water resources within the Edwards Aquifer region (see **Figure 3.2-57** to **Figure 3.2-59**).

Figure 3.2-57. EAHCP Presentation to Elementary School Students

Figure 3.2-58. EAHCP Presentation to Elementary School Students

Figure 3.2-59. Zackary Martin (right, CONB) and Melani Howard (left, COSM) presenting the EAHCP program at Texas Lutheran University

Modifications Due to Drought Conditions:

Drought conditions have had no effect on this activity.

Proposed Activities for 2015:

The CONB will continue to promote the EAHCP program, and its benefits to the community, by continuing educational outreach efforts with local schools, citizens, local businesses and civic organizations.

3.2.15 Non-HCP Activities

CONB Golf Course:

For years the CONB has been considering upgrades to the Landa municipal golf course, and during 2012 and 2013 design was completed. The golf course was closed for construction in late 2013 and re-opened in October 2014. Adjacent projects, and water quality benefits, were considered during project design and incorporated into construction. Upgrades to the existing vegetative buffer along the perimeter of the course, adjacent to the shoreline of Landa Lake and the Old Channel, were established. Improvements associated with water quality protection also include re-grading to direct stormwater runoff to ponds and vegetated swales designed to filter stormwater runoff and increase infiltration (**Figure 3.2-60** and **Figure 3.2-61**).Golf course construction activities were coordinated with adjacent EAHCP projects which include the Flow-Split Management Project and Old Channel Restoration Project. Coordination with these and other EAHCP projects was accomplished on an ongoing basis to minimize conflicts between the projects.

Figure 3.2-60. City of New Braunfels Golf Course – First Phase of Construction

Figure 3.2-61. City of New Braunfels Golf Course – Last Month of Construction

An overflow (spillway) constructed for major flood events was installed as part of the golf course design and is adjacent to the Flow-Split Management and Old Channel Restoration projects. This area also has high-density erosion matting installed to prevent short-term erosion and scour. This material will encourage natural re-growth of vegetation to ensure stability of the spillway.

Landa Lake Dam:

The crest of Landa Lake Dam was stabilized in 2014 by the CONB to improve its overall structural integrity. This structure was initially constructed in the mid- to late-1800's and improvements to the top of the dam were completed in order to prevent dam breech. Should the structure fail, habitat areas upstream in Landa Lake and Comal Springs would drain and be compromised. The CONB coordinated design and permitting for the project over a number of years, leading to construction in 2014. Cable-locked erosion blocks were used to reinforce the crest of the dam (**Figure 3.2-62** and **Figure 3.2-63**).

An overflow (spillway) to accommodate flood events was installed as part of the golf course project in 2014 (**Figure 3.2-64** and **Figure 3.2-65**). The spillway is located just north of the dam near the Flow-Split Management and Old Channel Restoration EAHCP projects. Spillway erosion matting was installed which minimizes erosion and scour. Matting materials also accommodate natural vegetation re-growth essential to ensuring spillway stability.

Figure 3.2-62. Landa Dam (Landa Lake on Right Side)

Figure 3.2-63. Landa Dam (as Viewed from Landa Lake)

Figure 3.2-64. Spillway (Next to Landa Lake)

Figure 3.2-65. Spillway leading towards Old Channel (adjacent to 48-inch culvert)

Landa Walls Rehabilitation Project (Summary):

The Landa Walls Rehabilitation Project (Walls Project) started in late 2013 and continued into 2014. The project includes replacing masonry wall structures located around Landa Lake (**Figure 3.2-66** to **Figure 3.2-69**). Many of the existing failing walls were built in the 1940's by the Works Projects Administration (WPA). The CONB coordinated design and permitting (with the USACE and other agencies) for several years prior to construction. Construction is estimated to be complete in March 2015.

The Walls project included coordination with USACE and USFWS prior to and throughout construction. As field issues were encountered, the USACE and USFWS were contacted to provide input. Communication was open and continuous to keep all stakeholders current on springflow conditions, endangered species considerations and construction issues. The Walls project has a distinctly separate USFWS permit and was not affected by Condition M guidelines in the EAHCP ITP. Additional coordination with USFWS occurred during periods of low-flow to ensure overall system and site-specific work was in compliance with all permitting requirements.

Careful coordination between the Walls Project and adjacent EAHCP projects occurred during construction. The CONB also coordinated work between ongoing water and endangered species research and other projects. Coordination included working with the EAA, USGS, USFWS, USACE, TPWD and TCEQ. Communication was challenging at times due to multiple projects (and involved entities) occurring in the project area. The CONB established processes in which all agencies and contractors were asked to sign in at the CONB Parks Office and contact the CONB Watershed Manager or Walls Project engineer to coordinate activities. The Walls Project engineer held bi-weekly meetings with multiple contractors and

city departments to coordinate project construction activities. These meetings allowed continuous communication regarding all activities occurring in the area.

Figure 3.2-66. Landa Lake Bank

Figure 3.2-67. Immediately Downstream of Spring Run 2

Figure 3.2-68. Immediately Downstream of Spring Run 1

Figure 3.2-69. Next to Headwaters of Spring Run 1

3.3 City of San Marcos

The COSM is responsible for the following minimization and mitigation measures under the EAHCP:

- Texas wild-rice Enhancement and Restoration (EAHCP §5.3.1 and §6.3.5)
- Management of Recreation in Key Areas (EAHCP §5.3.2)
- Management of Aquatic Vegetation and Litter below Sewell Park (EAHCP §5.3.3)
- Prohibition of Hazardous Materials Transport across the San Marcos River and Its Tributaries (EAHCP §5.3.4)
- Reduction of Non-Native Species Introduction (EAHCP §5.3.5)
- Sediment Removal below Sewell Park (EAHCP §5.3.6)
- Designation of Permanent Access Points and Bank Stabilization (EAHCP §5.3.7)
- Control of Non-Native Plant Species (EAHCP §5.3.8)
- Control of Harmful Non-Native and Predator Species (EAHCP §5.3.9)
- Native Riparian Habitat Restoration (EAHCP §5.7.1)
- Septic System Registration and Permitting Program (EAHCP §5.7.3)
- Minimizing Impacts of Contaminated Runoff (EAHCP §5.7.4)
- Management of Household Hazardous Wastes (EAHCP §5.7.5)
- Impervious Cover and Water Quality Protection (EAHCP §5.7.6)

All measures have been implemented according to the reviewed and approved 2014 Work Plans. Implementation of these measures has been accomplished in partnership with Texas State as specified in the EAHCP. Any measures specified above modified in response to drought conditions and any other changes are noted under each EAHCP measure. The COSM extended its EAHCP obligations in partnership

with Texas State to maintain consistency in implementation of EAHCP measures that jointly affect the listed species and their habitats in the San Marcos River.

3.3.1 Texas wild-rice Enhancement and Restoration (EAHCP §5.3.1 and §6.3.5)

Obligations:

The COSM, in partnership with Texas State, will identify optimal habitat areas for Texas wild-rice and target those areas for restoration. Restoration will involve the removal of non-native plant species, propagation of new wild-rice plants, and continued monitoring of the new stands. The City will use modeling results from Texas State to determine appropriate sites for restoration to ensure the highest possible success rate.

2014 Compliance Actions:

Non-native aquatic vegetation was removed in areas suggested as optimal Texas wild-rice habitat based on modeling results from Hardy et al. 2010. Non-native vegetation was also removed in mixed stands of Texas wild-rice and the original Texas wild-rice stand monitored for expansion. Similarly, for Texas wild-rice stands occupying optimal areas with adjacent non-native vegetation, the non-native vegetation was removed and the Texas wild-rice monitored for expansion. Non-native vegetation was fanned to displace fountain darters (*Etheostoma fonticola*) prior to uprooting the vegetation. After removal, all non-native vegetation was sorted and twenty-six fountain darters were salvaged and returned to the river. Further details regarding fountain darters and the potential for "take" are discussed in **Section 5.0** of this report. The non-native vegetation was disposed at the COSM composting facility or the Spring Lake composting facility. Denuded areas were planted with Texas wild-rice obtained from the SMARC or from raceways located at the FAB, Texas State campus.

An estimated number of Texas wild-rice planted between December 2013 – November 2014 in the San Marcos River downstream of Sewell Park was 9,120 individuals that covered 20 to50 percent of the denuded area. Estimated area planted for Texas wild-rice was 1,304 m^2 (**Table 3.3-1**). **Figures 3.3-1** through **3.3-3** illustrate planting density (plants/m^2) as well as planting location of Texas wild-rice and other native species in the San Marcos River downstream of Sewell Park. Net gain of Texas wild-rice area from April 2013 – November 2014 was 891 m^2 within areas denuded of non-native vegetation followed with Texas wild-rice planting in the San Marcos River downstream of Sewell Park.

Table 3.3-1. Date, Estimated Number (N), Area Planted (m2), and Density Planted of Texas wild-rice in the San Marcos River Downstream of Sewell Park (December 2013 – November 2014)

Date	Estimated Number (N)	Area planted (m^2)	Density Planted
12/2/2013	420	21.16	19.85
12/12/2013	128	20.64	6.20
12/16/2013	276	25.98	10.62
12/17/2013	294	39.36	7.47
12/19/2013	269	6.68	40.27
12/19/2013	56	25.23	2.22
1/10/2014	176	275.87	0.64
1/15/2014	108	197.80	0.55
2/3/2014	100	177.86	0.56
2/14/2014	269	15.94	16.87
2/21/2014	472	47.47	9.94
3/19/2014	77	9.42	8.18
3/19/2014	195	6.74	28.92
4/4/2014	148	7.83	18.90
4/4/2014	240	6.20	38.74
4/9/2014	160	4.28	37.40
4/9/2014	160	6.88	23.24
4/23/2014	94	35.13	2.68
4/28/2014	148	15.97	9.27
5/30/2014	328	14.12	23.22
6/2/2014	332	87.89	3.78
6/18/2014	312	26.11	11.95
6/26/2014	117	16.53	7.08
6/26/2014	117	19.50	6.00
6/26/2014	117	4.65	25.16
6/27/2014	112	23.49	4.77
6/30/2014	275	16.73	16.44
7/1/2014	252	35.75	7.05
7/9/2014	112	3.07	36.44
7/9/2014	112	1.66	67.56

Table 3.3-1. Date, Estimated Number (N), Area Planted (m2), and Density Planted of Texas wild-rice in the San Marcos River Downstream of Sewell Park (December 2013 – November 2014)

Date	Estimated Number (N)	Area planted (m^2)	Density Planted
7/15/2014	140	15.88	8.81
7/16/2014	336	22.90	14.67
7/17/2014	92	11.74	7.84
7/23/2014	264	6.36	41.52
7/24/2014	116	7.55	15.37
7/29/2014	124	4.09	30.35
7/30/2014	236	6.91	34.17
7/30/2014	484	9.86	49.09
7/31/2014	392	5.46	71.84
8/6/2014	700	5.70	122.77
11/4/2014	260	11.91	21.83
Total	**9,120**	**1,304.60**	-

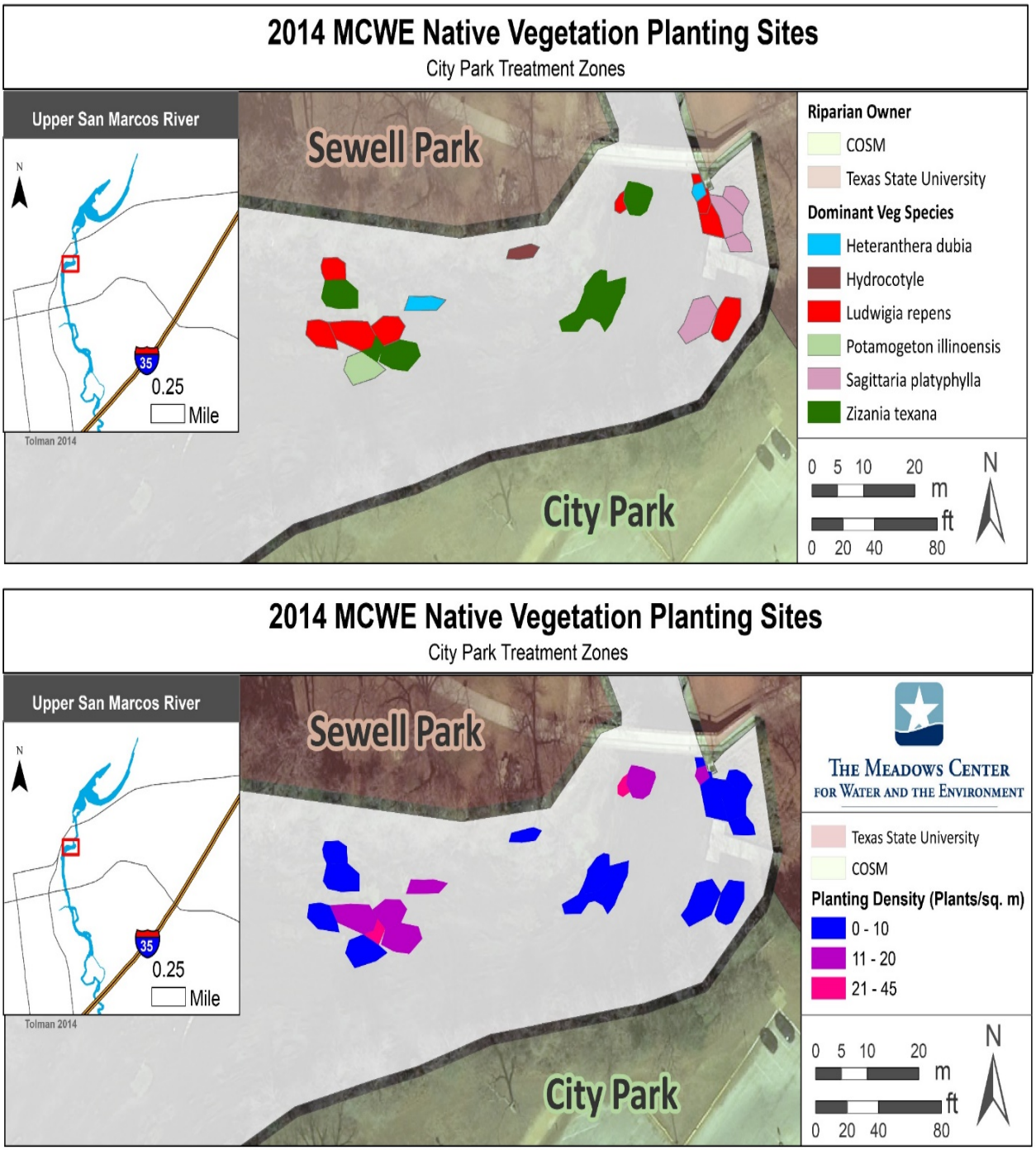


Figure 3.3-1. 2014 MCWE planting locations (top) and planted densities (bottom) of Texas wild-rice and other native species just downstream of Sewell Park

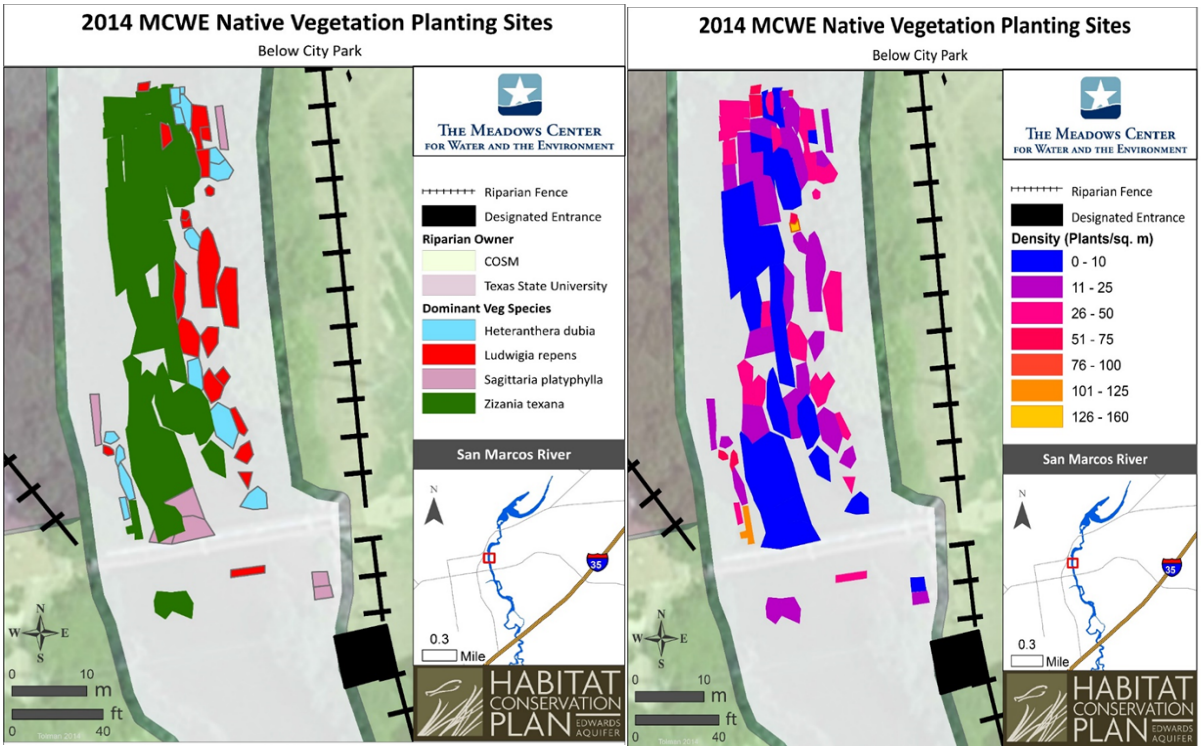


Figure 3.3-2. 2014 MCWE planting locations (left) and planted densities (right) of Texas wild-rice and other native species just downstream of City Park

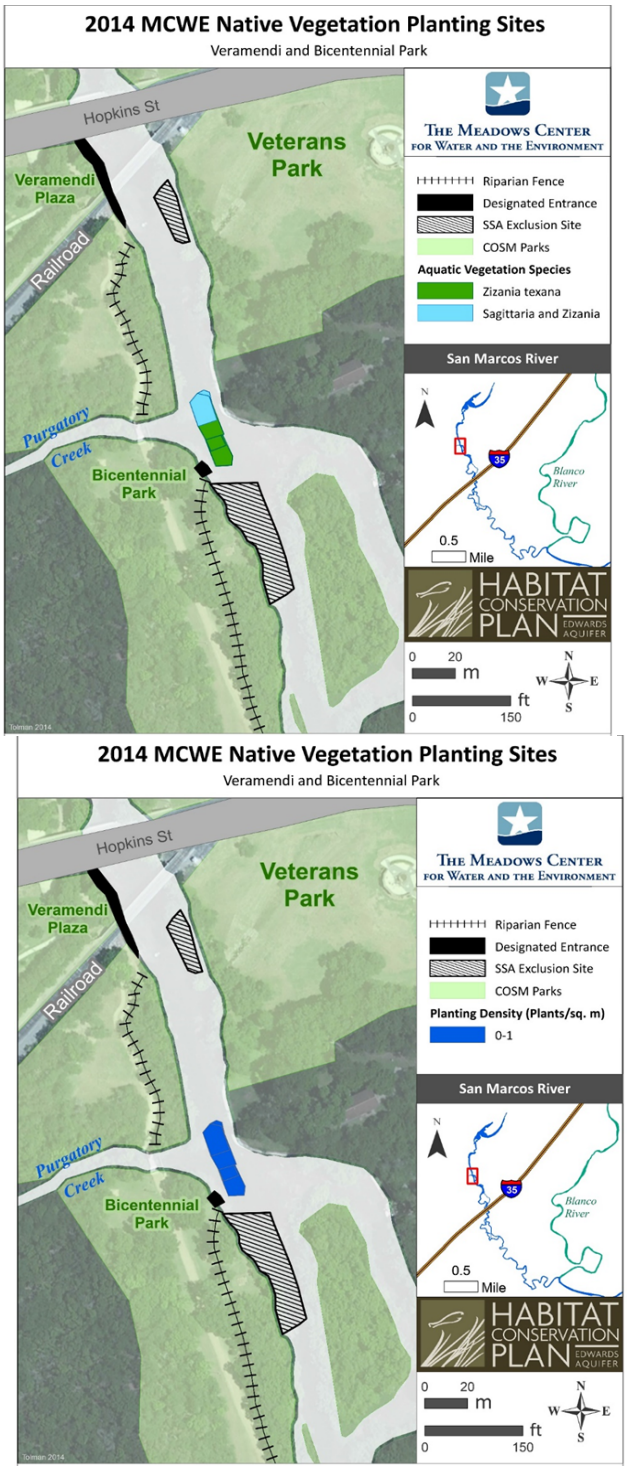


Figure 3.3-3. 2014 MCWE planting locations (left) and planted densities (right) of Texas wild-rice and other native species at the confluence of Purgatory Creek and the San Marcos River

Modifications Due to Drought Conditions:

Texas wild-rice plantings were shifted to areas of greater depth to prevent the stand from becoming emergent with any further decrease in flow.

Proposed Activities for 2015:

In 2015, the COSMwill continue to maintain existing Texas wild-rice stands and plant stands in areas where new habitat has been created through sediment removal and aquatic vegetation restoration. The 2015 goal is to add 1,100 m^2 of additional Texas wild-rice to the system.

3.3.2 Management of Recreation in Key Areas (EAHCP §5.3.2)

Obligations:

The COSM will continue to implement recreation mitigation measures approved by the San Marcos City Council on February 1, 2011 (Resolution 2011-21). These include, but are not limited to, trespassing enforcement on private riverfront property, implementation of buffer zones around designated recreation areas, a robust river education program, removal of silt to restore the river to more natural conditions, increasing enforcement measures for violators of river-related recreation management restrictions, and the issuance of COI to river outfitters to extend the protections of the ITP to those entities.

2014 Compliance Actions:

Several strategies were used by the City to manage recreation in key areas:

1. Access control: A strategy using hardened access points with a dense riparian buffer between all access points was implemented in 2013 and 2014. These objectives are discussed in detail as part of two other EAHCP measures (Section 3.3.6 Designation of Permanent Access Points and Bank Stabilization (EAHCP §5.3.7) and Section 3.3.9 Native Riparian Habitat Restoration (EAHCP §5.7.1)).
2. Fencing: As part of the riparian restoration measure (Section 3.3.9 Native Riparian Habitat Restoration (EAHCP §5.7.1)), the City constructed fence for new sites and maintained existing fence line on the upland edge of the riparian plantings to protect them from trampling. This fence will be in place for multiple years to allow time for the plants to mature, which offers an effective opportunity for public outreach through the placement of signage.
3. Signage: In 2013, the City used the EAHCP sign template created by the EAA to produce ten signs discussing each EAHCP project, listed species and their uniqueness of the San Marcos River, and placed them at each of the fence sites. In 2014, the City added six bank stabilization signs, replaced fading riparian signs, and have five bank access signs/kiosks under development. Additionally, the three display signs produced by TPWD, two of which are located in Sewell Park and one in Bicentennial Park, were refurbished. One Sewell Park kiosk was removed because it was redundant. The other kiosk had a TPWD sign and roof replaced. Signage was added at each of the four State Scientific Areas to inform the public of the purpose.
4. Conservation Crew (CC): This work team was developed to educate the public about the EAHCP and to monitor and protect Texas wild-rice stands in high recreation areas. In 2014 the CC was composed of twelve university students. For the first time, these students were paid by *both* EAHCP and City funding. They began work on May 21st with an orientation at the SMARC. On May 22nd, the CC began working Wednesday-Sunday, and worked through the Labor Day weekend. Four crewmembers worked in teams of two each day from 11:00 AM –

7:00 PM, with two crew members kayaking the river and two crewmembers walking the banks in an effort to maximize river user contact.

5. The CC accomplished many tasks under the EAHCP, such as education, protection of endangered species and their habitats - primarily Texas wild-rice, monitoring, project maintenance, and litter removal. (**Figure 3.3-4**)
6. Education was accomplished through the creation and installation of signage and speaking with river users about the importance of EAHCP projects and listed species habitat protection. The involvement of university students is an added benefit. These students leave the CC Program with a deep understanding of endangered species and the unique nature of the San Marcos River. Additionally, the EAHCP is advertised through these students and the City's EAHCP intern program is becoming increasingly popular.
7. The CC also removed floating vegetated mats (consisting of mostly *Hydrilla verticillata* and *Hygrophila polysperma*.) from four Texas wild-rice enclosures and other Texas wild-rice stands to ensure their health. They also accomplish regular maintenance of the enclosure infrastructure that protects Texas wild-rice stands by restricting access from river users.
8. CC assisted with other projects including the Texas wild-rice Survey with USFWS and TPWD, a graduate student study on Texas wild-rice, exotic invasive removal, and native plantings. Areas with an abundance of people such as Rio Vista, City Park and upper Sewell Park are frequently monitored in an effort to reduce negative impacts to the river and to ensure park and university rules are observed. Riparian fences and signs are inspected for damage or graffiti and any problem areas along the river are reported.
9. Over 2,500 lbs of litter and mixed recyclables were removed from the river substrate, litter boats, and parks along the river. The two litter boats in the river are emptied by kayak three to four times a day, helping to prevent litter from entering the river by providing a convenient receptacle for disposal. For a complete list of accomplished tasks and public outreach, see **Appendix J**.
10. State Scientific Area (SSA): In support of the SSA, the CC provided barriers, signage, and informational kiosks as seen in **Figure 3.3-4** and described in the CC report (**Appendix J**).
11. Buffer Zones. Rio Vista Falls has a 100-ft buffer zone on the east side of the river that excludes picnic tables, pop-up tents, shelters and portable grills. The riparian restoration efforts continue to increase the amount of riverside buffers from upper Sewell Park to IH 35.
12. Overall Interpretation Plan. A master plan for location and type of all HCP signage is under development to ensure an aesthetic and effective effort. The plan shows the type and location for signage in and along the river corridor, as listed below.
    - (5) English riparian
    - (2) Spanish riparian
    - (1) Invasive Removal
    - (1) WQPP
    - (7) Bank access point kiosks
    - (1) Edwards Aquifer
    - (1) Archaeological sign at Ramon Lucio
    - (12) HCP background/all-project signs distributed along all riparian fences

13. Stencil on rented tubes. Applied stencils rubbed off over time so this action was eliminated. The video loop at City Park and signage while tube renters are queuing will replace this action. This video loop is being developed by Challenge SMTX; a program under development by the City and University to reduce litter in the San Marcos River watershed.
14. Reduce turbidity through watershed management strategies. This action is fully covered as discussed in Section 1.2.17 (Water Quality Protection Plan).
15. Partnership between the City and University. The Conservation Crew monitors both City and University property and is supported by City Park Rangers and University Police. A pre-recreation season meeting is held with University and City law enforcement to ensure a cohesive approach to recreation management. Additionally, the Habitat Conservation Plan Manager is funded equally by University and City to ensure a unified approach.

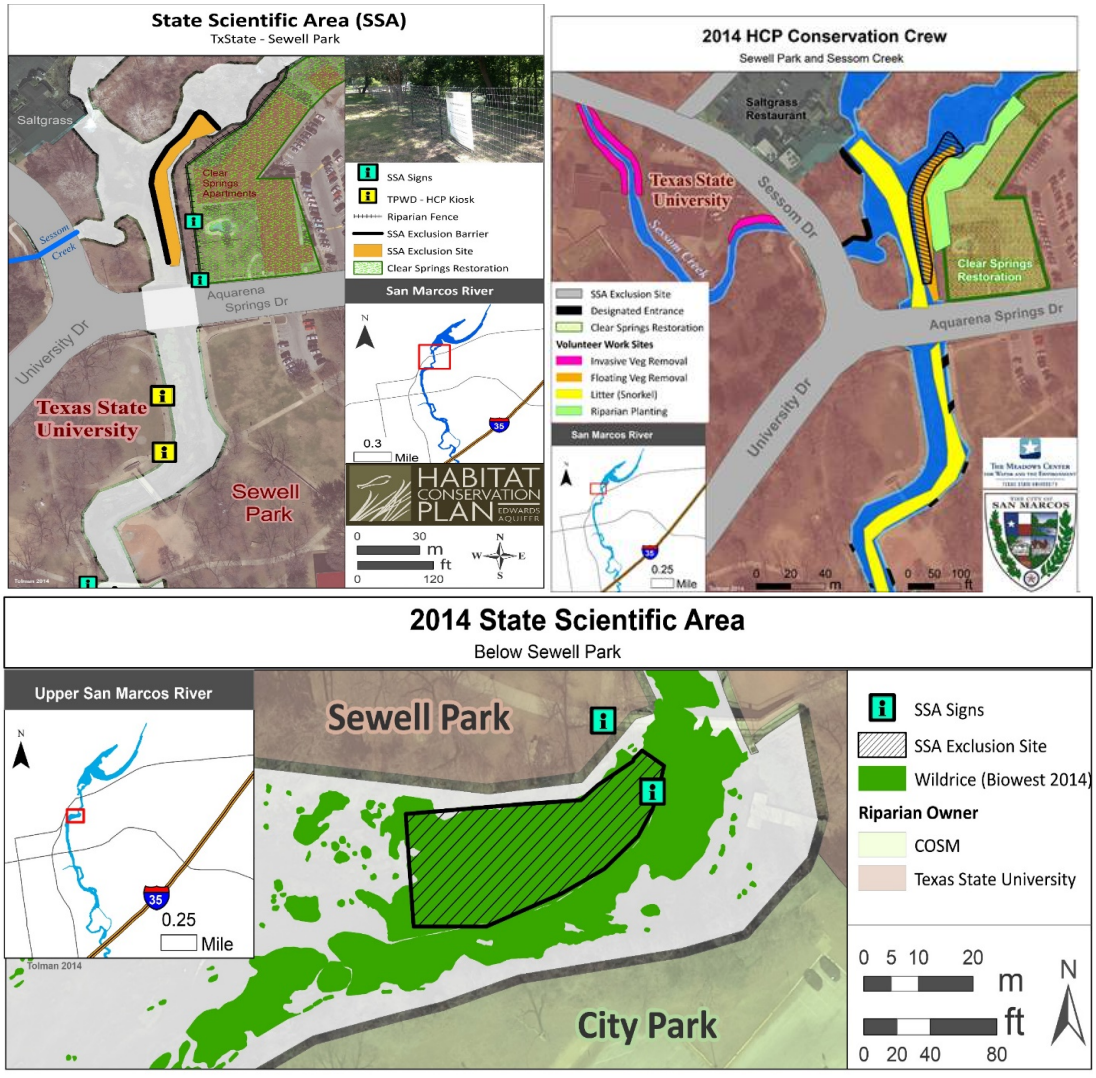


Figure 3.3-4. Location of Texas wild-rice enclosures, fencing and signage along the San Marcos River

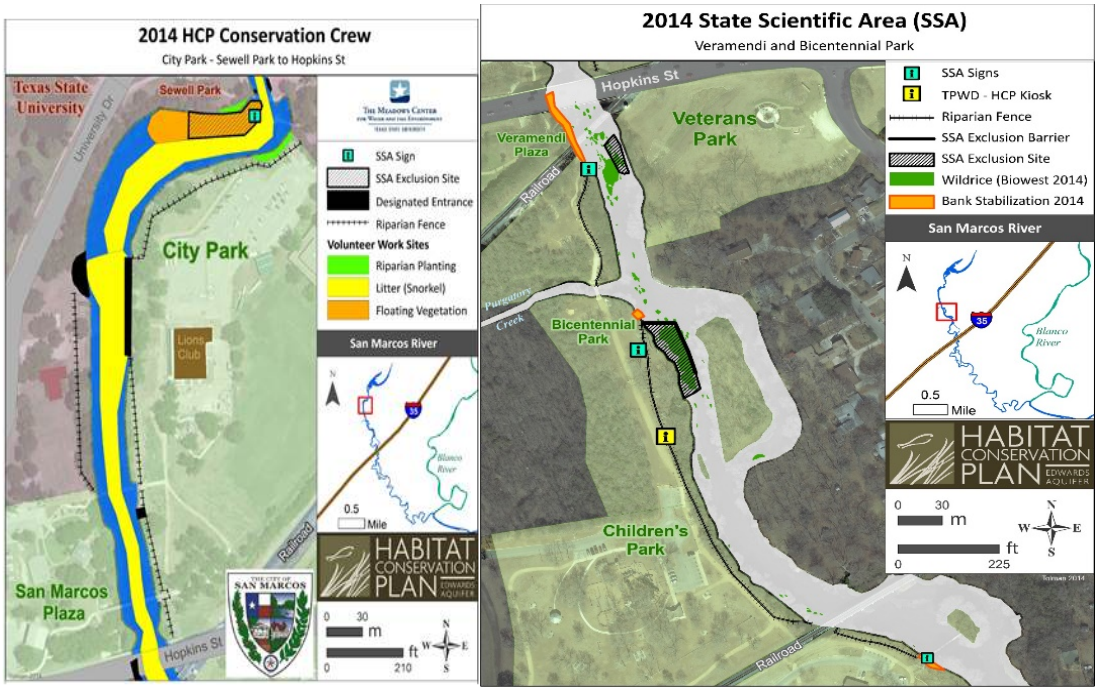


Figure 3.3-4 (contd). Location of Texas wild-rice enclosures, fencing and signage along the San Marcos River

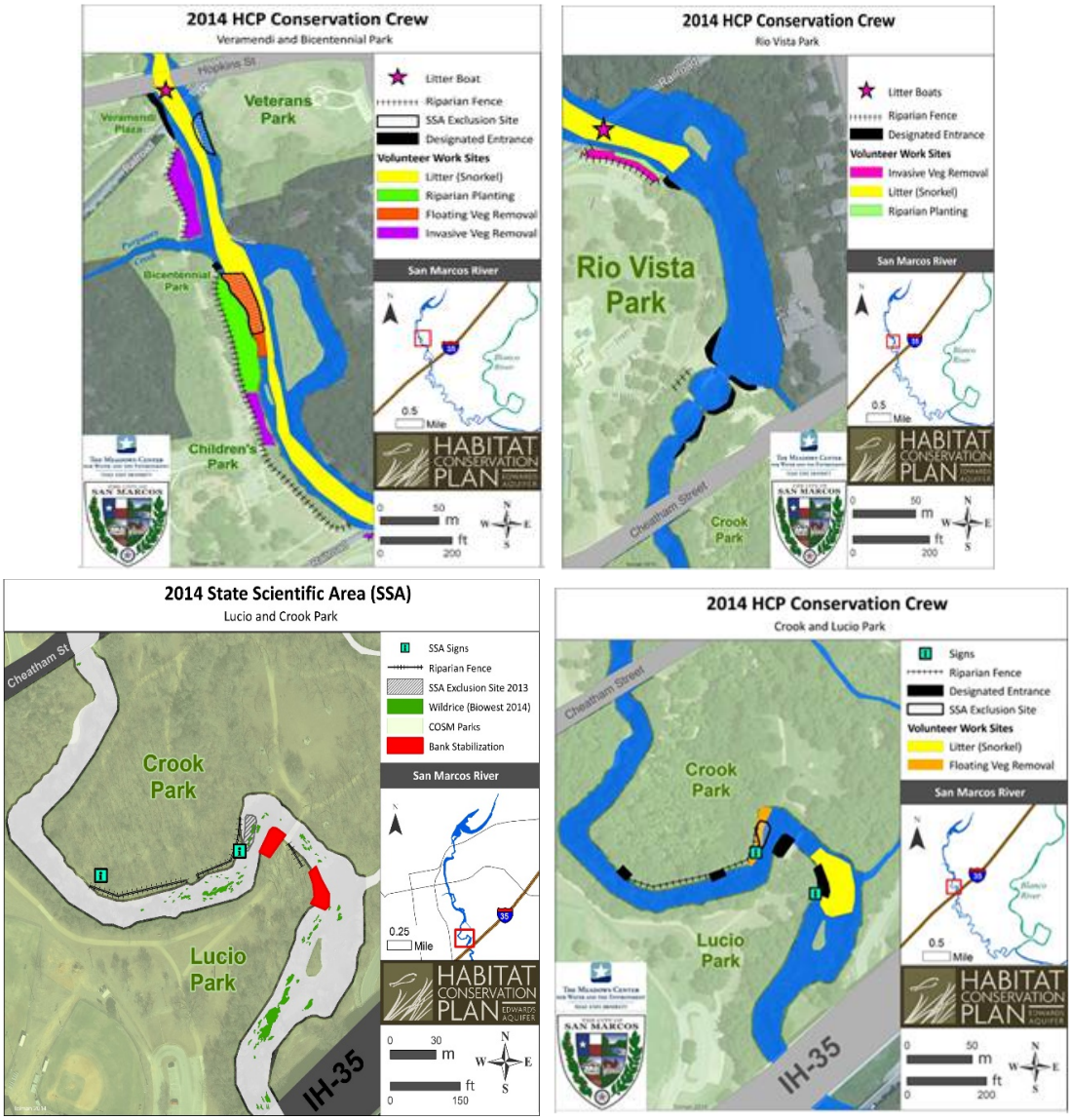


Figure 3.3-4 (contd). Location of Texas wild-rice enclosures, fencing and signage along the San Marcos River

Modifications Due to Drought Conditions:

The drought continues to cause lower flow rates in the San Marcos River, which results in increased accumulation of floating vegetation on Texas wild-rice stands and litter on the substrate. Therefore, removal of vegetation mats from Texas wild-rice stands as well as litter removal frequency increased as flows decreased to minimize potential impacts.

Proposed Activities for 2015:

In 2015, the COSM will continue to implement education programs targeting river users about sustainable river use and the listed species. Texas State will continue to gather information on recreational use of the

river and potential impacts of those activities on the ecosystem. The CC, a paid group of individuals responsible for educating the public, informing authorities of destructive behavior, and conducting miscellaneous clean-up of the system, will be present from Memorial Day to Labor Day. Specifically, additional litter boats will be added for the consumptive public and EAHCP Manager/CC/interns will increase time spent on riparian maintenance in an effort to keep up with the growing riparian buffer.

3.3.3 Management of Aquatic Vegetation and Litter below Sewell Park (EAHCP §5.3.3)

Obligations:

The COSM will dislodge floating vegetation mats on the river's surface to facilitate their movement downstream. The City will additionally remove inorganic litter regularly during the recreation season.

2014 Compliance Actions:

Pristine Texas Rivers Inc. (PTR) removes inorganic litter from upper Sewell Park to City Park, and from Rio Vista to Stokes Island. PTR uses SCUBA equipment to remove underwater litter from the substrate and surface (**Figure 3.3-5** through **Figure 3.3-7**).

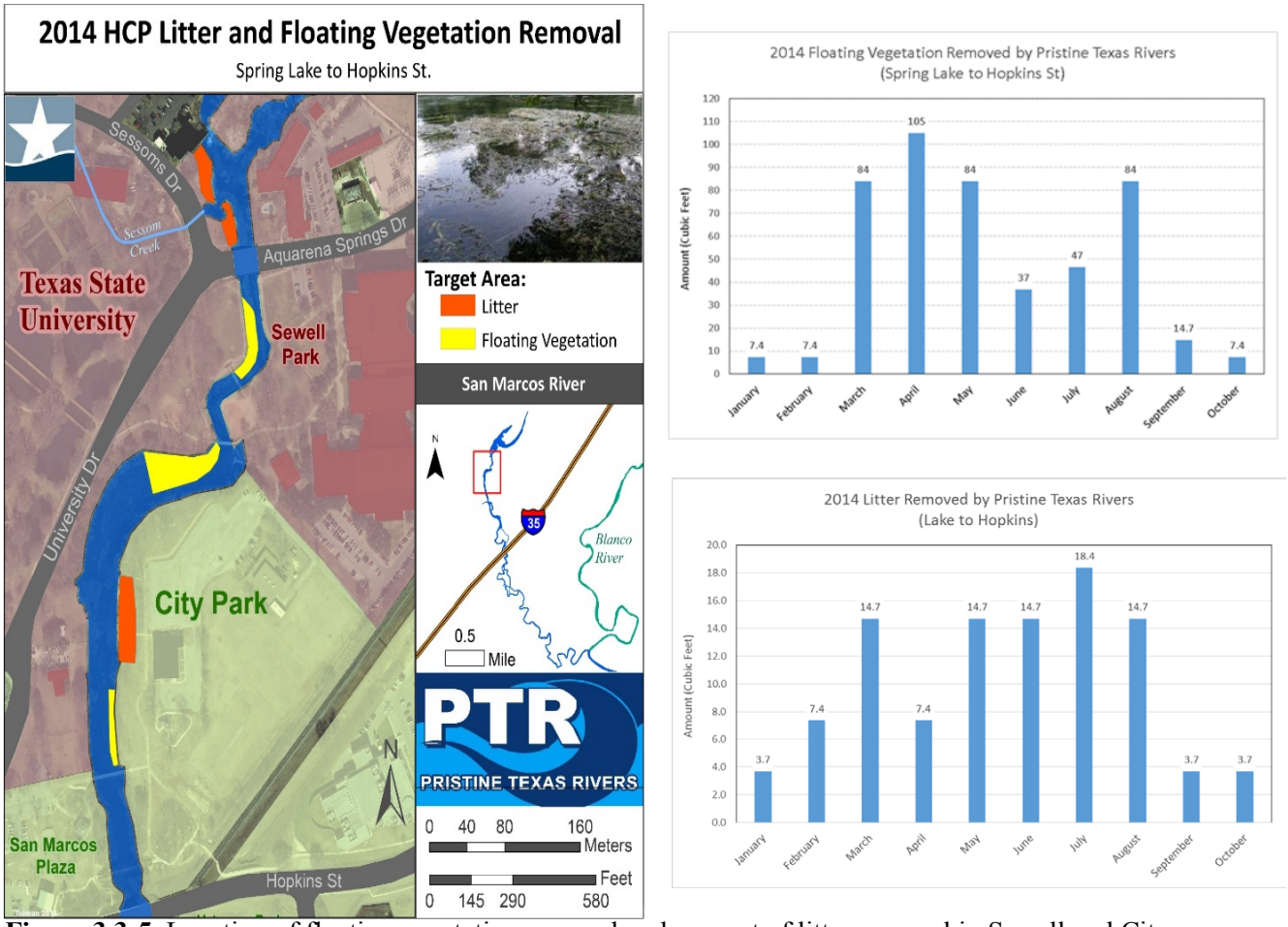
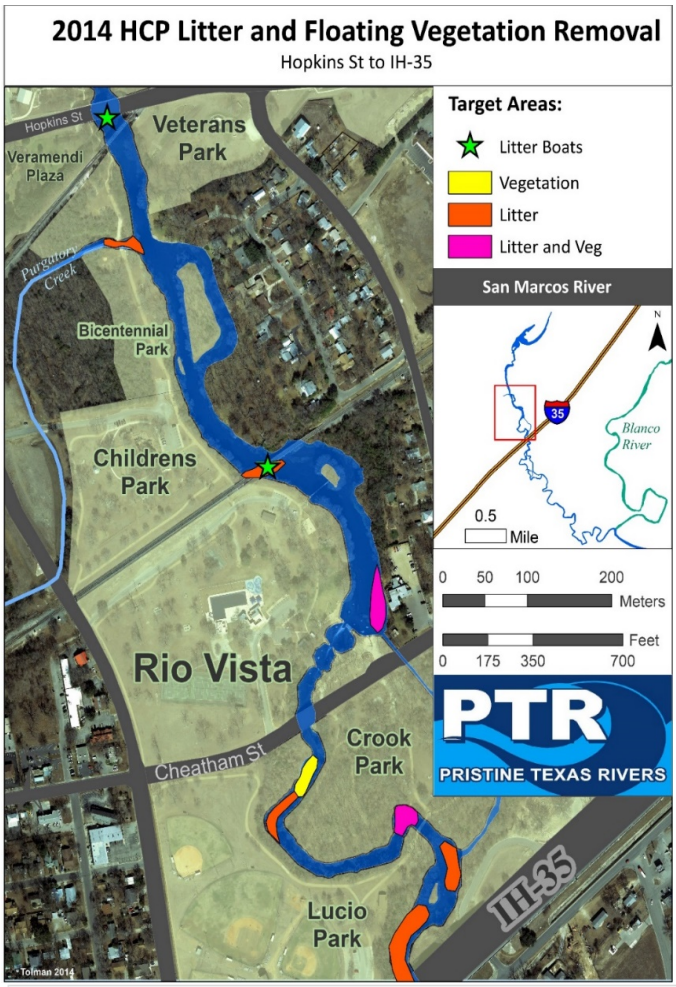
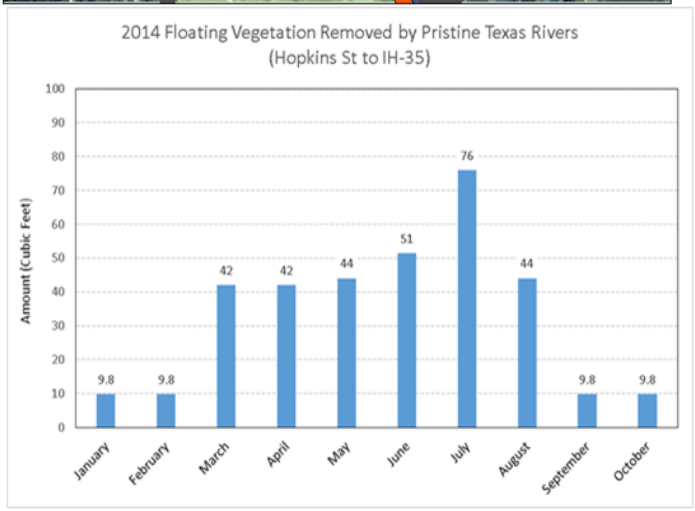


Figure 3.3-5. Location of floating vegetation removal and amount of litter removal in Sewell and City parks


2014 HCP Litter and Floating Vegetation Removal
Hopkins St to IH-35
Hopkins St
Veterans Park
Veramendi Plaza
Purgatory Creek
Bicentennial Park
Childrens Park
Rio Vista
Cheatham St
Crook Park
Lucio Park
IH-35
Target Areas:
Litter Boats
Vegetation
Litter
Litter and Veg
San Marcos River
N
35
Blanco River
0.5
Mile
0 50 100 200
Meters
Feet
0 175 350 700
PTR
PRISTINE TEXAS RIVERS
Tolman 2014


2014 Floating Vegetation Removed by Pristine Texas Rivers
(Hopkins St to IH-35)
Amount (Cubic Feet)
100
90
80
70
60
50
40
30
20
10
0
9.8
9.8
42
42
44
51
76
44
9.8
9.8
January
February
March
April
May
June
July
August
September
October

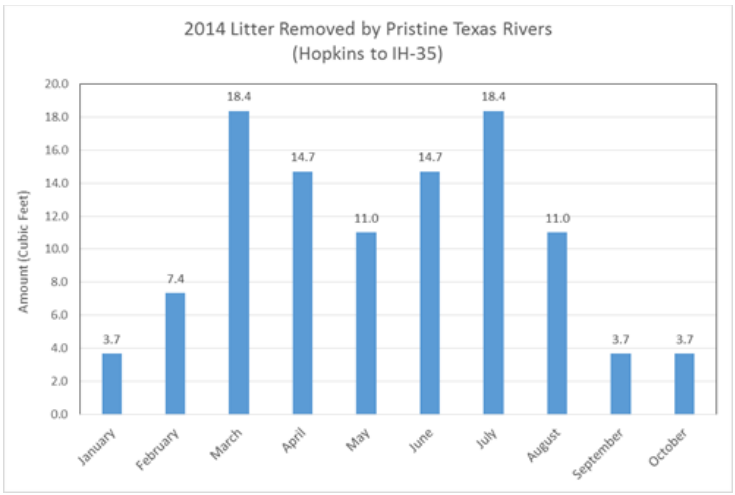


Figure 3.3-6. Location and amount of litter and floating vegetation removal along with litter boat stations

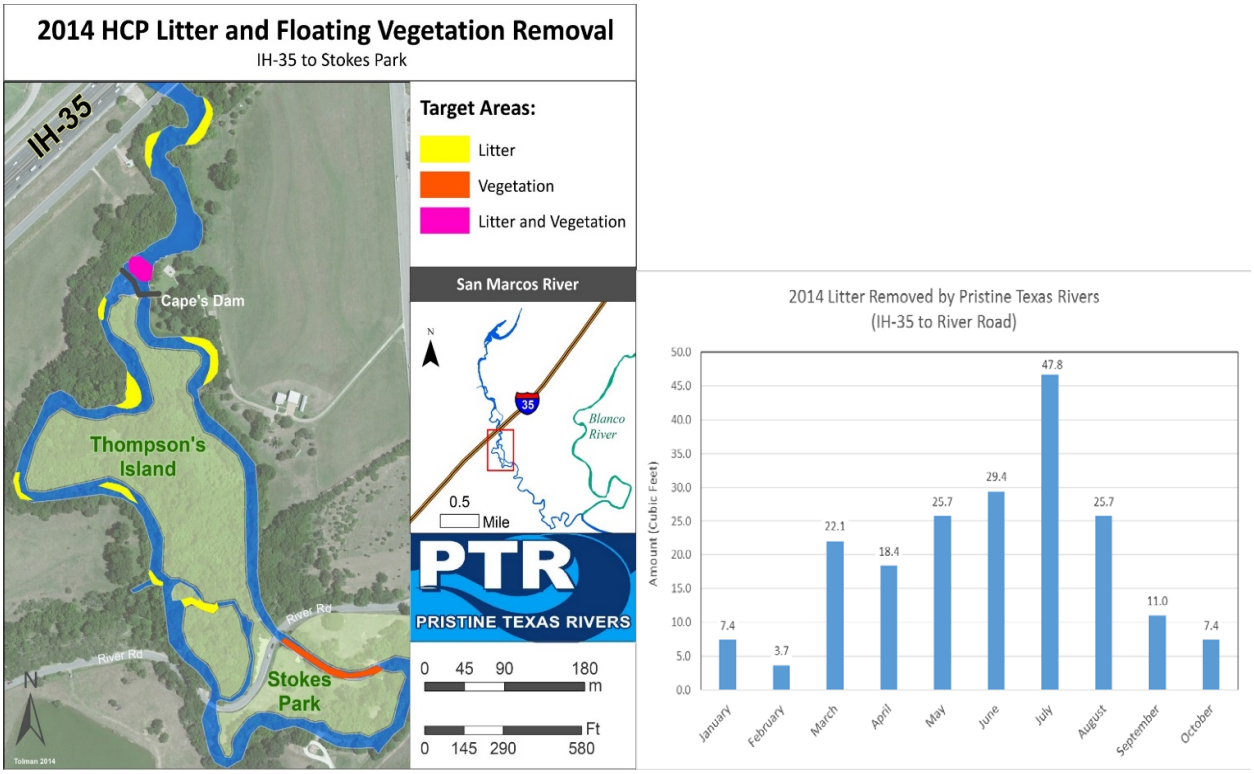


Figure 3.3-7. Location and amount of litter and floating vegetation removal below IH-35

PTR has identified litter "hot spots" and tracks them throughout the year. They also walk the four San Marcos River tributaries (**Figure 3.3-8**) and collect litter in mesh bags. The monthly totals of litter removed exhibit the importance of focusing on areas downstream of IH-35 and the tributaries. Due to the low amounts of litter collected in Spring Lake during the first year of implementation (2013), this location will be accomplished by the University as needed under the Spring Lake Management Plan.

PTR consistently collected large debris primarily from the tributaries. The large debris included tires, road cones, PVC, and metal building materials. By July, PTR had reduced recent depositions of litter in the river, and older deposits were becoming visible, mostly below Rio Vista Falls. They continue to uncover more old debris with every pass.

Modifications Due to Drought Conditions:

PTR increased time spent removing floating mats, particularly from Texas wild-rice stands because floating mats accumulated more quickly on plant stands as flows decreased. Similarly, litter removal increased because low flow facilitated litter collection.

Additionally, due to increased accumulation of vegetation mats on stands of Texas wild-rice, both the Conservation Crew and MCWE personnel spent time removing mats from the system.

Proposed Activities for 2015:

In 2015, the City of San Marcos will continue to implement floating vegetation mat and litter removal consistent with protocols established in the EAHCP and in the 2015 Work Plan.

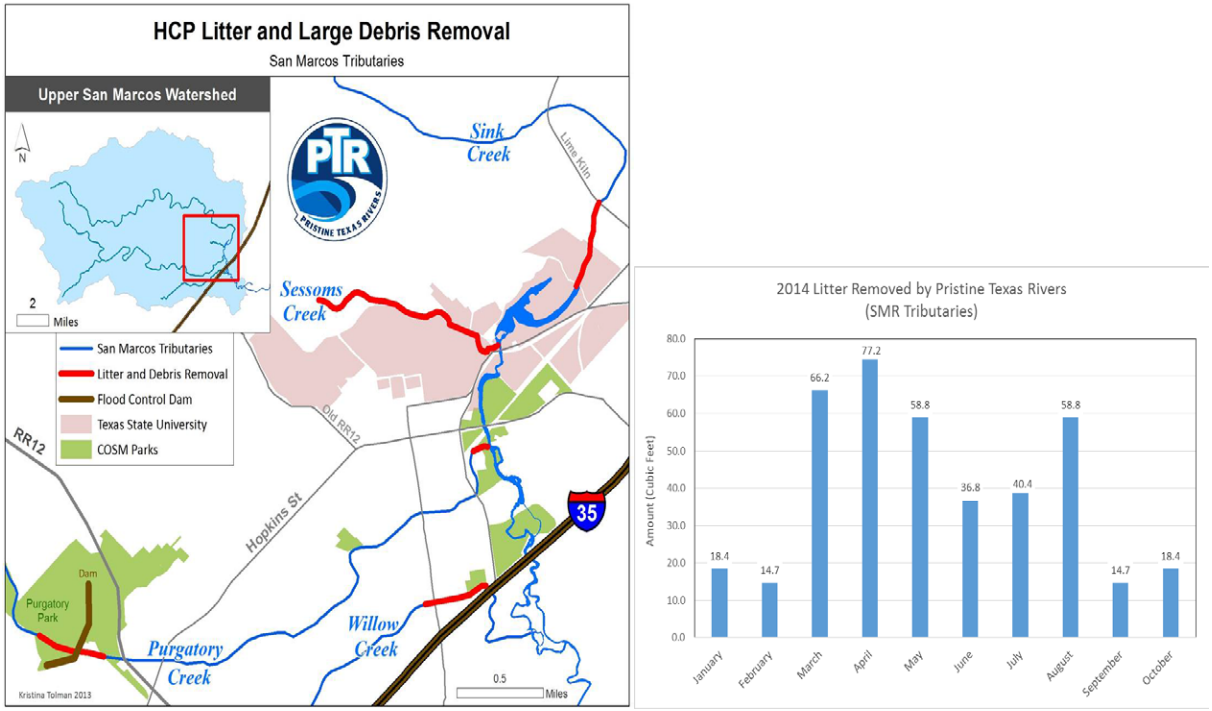


Figure 3.3-8. Areas of the San Marcos River tributaries and amount of litter removed

3.3.4 Prohibition of Hazardous Materials Transport across the San Marcos River and its Tributaries (EAHCP §5.3.4)

Obligations:

The COSM will coordinate with TxDOT to designate routes for the transportation of hazardous materials that will minimize the potential for impacts to the San Marcos River and its tributaries.

2014 Compliance Actions:

The City initiated the following TxDOT process in 2013 to designate Wonder World Drive from IH-35 to RR12 as a HAZMAT Route (**Figure 3.3-9**). This process is based on the document titled *Traffic Operations Manual*, Chapter 5 Regulatory Signs, Section 7 Non-Radioactive Hazardous Materials Routing. The City is working with Ben Englehardt from TxDOT. Further action is pending awaiting an internal decision on the smaller designated roads to deliver goods to vendors. City of San Marcos GIS has developed a more comprehensive map that is under review by City staff.

Figure 3.3-9. Proposed HAZMAT route

Authority

Rules for NRHM routing are contained in the Texas Administrative Code (TAC) under Title 43, Sections 25.101–25.104. These rules authorize a political subdivision of a state to establish NRHM route designations consistent with the federal regulations (Title 49, Code of Federal Regulations, Part 397, Subpart C). As the state routing agency, TxDOT is required to approve all new NRHM routing designations or revisions to existing routing designations. A city or political subdivision cannot simply pass an ordinance to establish an NRHM route. In establishing or revising an NRHM route, a political subdivision must comply with both federal and state regulations for NRHM routing (49 CFR, Part 397, Subpart C, and 43 TAC, Sections 25.101–25.104).

Financial Responsibility

The City is responsible for all costs of NRHM route development, including proposal preparation, public hearings, signs, sign supports, sign installation, and sign maintenance. The TxDOT local district office should obtain or amend any agreements as appropriate.

The following steps outline the process of establishing or revising an NRHM route.

Step 1: Initial Contact (Accomplished – Ben Engelhardt)

A political subdivision considering the establishment of an NRHM route must contact the local TxDOT district office and any other political subdivisions within a 25-mile radius of any point along the proposed route. The political subdivision must consult with the district office and other affected political subdivisions during the process of determining the best NRHM route. Coordination with the Texas Department of Public Safety (DPS) and the local emergency planning council or committee is encouraged. The district office is encouraged to contact TRF for assistance with the procedures.

Step 2: Route Analysis and Proposal (Pending – The major route is Wonder World Drive from Hunter Road to RR12, but identified smaller roads and hazmat facilities, such as gas stations, are under internal review.)

The political subdivision must develop a route proposal. The written proposal must address all of the federal standards and factors listed in 49 CFR Section 397.71(b). The political subdivision must use the most current version of the United States Department of Transportation (USDOT) publication entitled Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials or an equivalent routing analysis tool to develop the route proposal. If an equivalent routing analysis tool is used, the political subdivision must include in its route proposal a written explanation of how the tool is equivalent to the USDOT standards.

Step 3: Local Public Hearing

The political subdivision must hold at least one public hearing on the proposed NRHM routing designation. Public hearings may take the form of a city council or commissioner's court meeting and must conform to

all applicable state laws governing public meetings, including the Texas Open Meetings Act, Government Code, Chapter 551. Public notification of the hearing must comply with the following criteria:

- The public must be given 30 days prior notice of the hearing through publication in at least two newspapers of general circulation in the affected area, one of which is a newspaper with statewide circulation.
- The notice must contain a complete description of the proposed route, including the location, route name, highway number if the route is on the state highway system, and beginning and ending points of the route. The notice must also provide the date, time, and location of the public hearing.
- The notice must initiate a 30-day public comment period and inform the public where to send written comments.

Step 4: Proposal Submission

After performing the analysis and conducting a local public hearing, the political subdivision must submit eight copies of the NRHM route designation proposal and one original color map of the proposed NRHM route to TRF for approval.

Step 5: Proposal Review

TxDOT Public Hearing. TRF will provide the public with notice through publication in the Texas Register and a 30-day period in which to comment. TRF will also conduct a public hearing to receive additional comments on the proposed NRHM routing designation. TRF will publish a notice satisfying the criteria described in Step 3 above. The notice must be published in two newspapers of general circulation in the affected area. The public hearing must be held in Austin, Texas. The public hearing must be conducted before the executive director or the designee of the executive director.

Step 6: Authorization and Approval

If TxDOT determines that a route has met all of the criteria for approval, TRF will submit the proposed NRHM routing designation to the TxDOT executive director for approval. Upon approval by the TxDOT executive director, TRF will notify the political subdivision in writing that the proposed routing designation is authorized, and will issue appropriate notice to the Federal Highway Administration and the Texas DPS.

Step 7: Route Designation and Signing Designation

Upon receipt of a letter of approval from TxDOT, the political subdivision must designate the NRHM route by ordinance, resolution, rule, regulation, or other official order. The political subdivision must forward a copy of the order to TRF within 30 days of receipt of the letter of approval.

Step 8. Signing

After passage of the order, the political subdivision must submit the proposed sign and installation locations of the NRHM route designation to the local TxDOT district office for approval. All signs must conform to

the latest version of the Texas Manual on Uniform Traffic Control Devices (see "Route Signing Guidelines" below). The local TxDOT district office should submit the proposed signing schematic to TRF for review. The political subdivision must coordinate sign installations with the local TxDOT district office prior to placement.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

The COSM in 2015 will finalize the hazmat route internally, then coordinate with TxDOT for approval and the implementation of approved hazardous material route restrictions and appropriate signage.

3.3.5 Reduction of Non-Native Species Introduction (EAHCP §5.3.5)

Obligations:

The COSM will partner with Texas State and other groups to establish an education campaign targeted at reducing the introduction of non-native species into the river system. The COSM will also provide opportunities for people to dispose of unwanted aquatic animals and plants to deter aquarium dumps into the river system.

2014 Compliance Actions:

The following outline to reduce aquaria dumping was developed based on data gathered in 2013 through pet store visits and meetings with Residential Life at Texas State. This plan will be implemented by Atlas Environmental, CC, and student interns.

Purpose: To increase public awareness regarding the harms of releasing non-native fish into the San Marcos River.

- Flyer(s)
- State the harms of releasing non-native fish into our river
- Advertise at donation centers
- Advertise through:
- Local pet stores
- Local schools
- Texas State campus
- On social media websites
- Newspapers
- Donation Centers
- A convenient location to drop off any unwanted fish
- San Marcos Nature Center 430 Riverside Dr. San Marcos, TX

- Earth Angel Pet Supply 1254 W Hopkins St. San Marcos, TX
- Educational Booth for Events
- Informing the public of the harm of releasing non-native fish into the San Marcos River through educational booths
- Advertise donation center
- Educate public at events such as River Awareness Day and Texas Wild Rice Festival

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

The COSM, in partnership with Texas State and contractors, will implement the plan described above.

3.3.6 Sediment Removal below Sewell Park (EAHCP §5.3.6)

Obligations:

The COSM will remove sediment from areas along the river between City Park and IH-35. Sediment removal efforts will specifically target potential Texas wild-rice habitat.

2014 Compliance Actions:

A three-inch hydrosuction hose was used to remove accumulations of fine sediment within the San Marcos River. Divers were trained on equipment operations, diving safety protocols, and recognition of all stages of listed species from larval to adult prior to any sediment removal. Before dredging, vegetation was removed and the area was fanned to encourage fountain darters and other biota to move out of the area. Additional details regarding fountain darters and the potential for "take" are discussed in Section 5.0 of this report. Sediment was removed using a three-inch suction hose with a 0.25-inch strainer on the end. Removed sediment was pumped into a settling area or catchment pit that was surrounded by sediment fence and sediment noodles to prevent sediment runoff.

Texas State continued to remove fine sediment in the San Marcos River at two locations, just upstream of City Park and at the confluence with Purgatory Creek (**Figure 3.3-10** and **Figure 3.3-11**). Approximately $77m^2$ (i.e., $20m^3$) of fine sediment was removed in the San Marcos River from November 2013 – February 2014 (**Table 3.3-2**). Dredging did not occur after February due to the delayed arrival of new equipment, onset of the recreation season, and flows below 120 cfs.

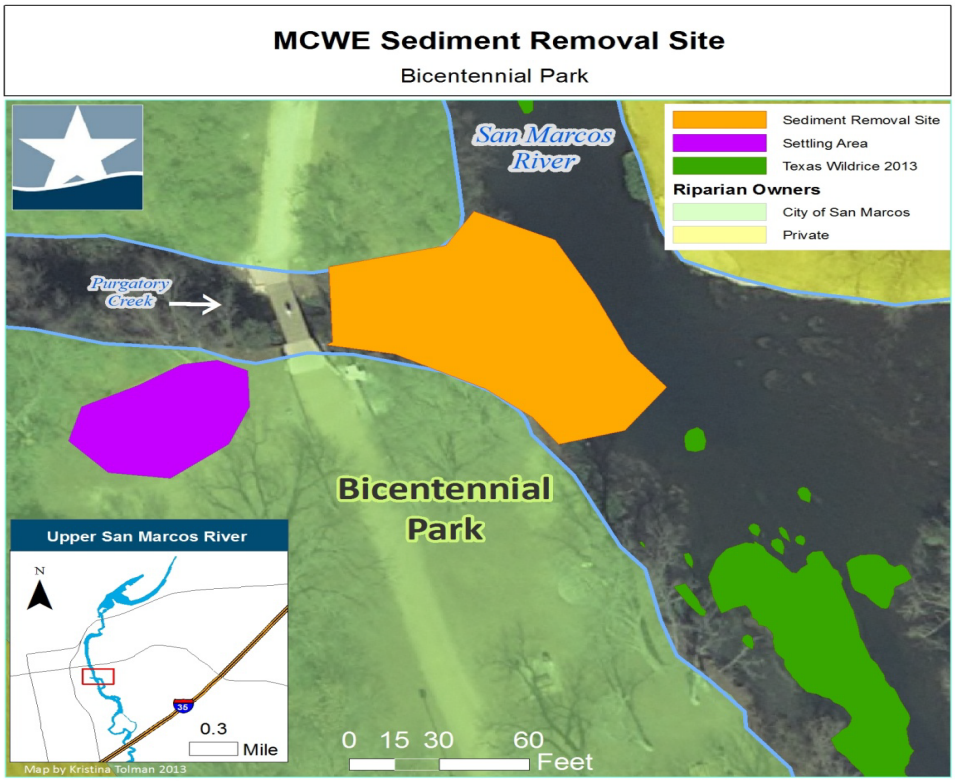


Figure 3.3-10. Sediment removal and discharge sites at Bicentennial Park

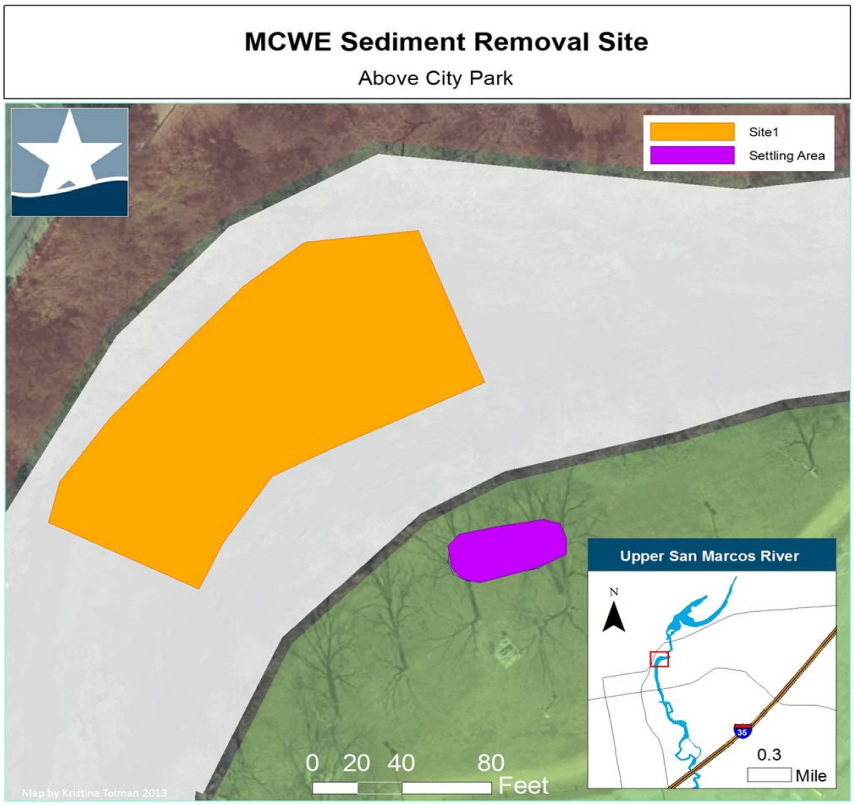


Figure 3.3-11. Sediment removal and discharge sites at City Park

Table 3.3-2. Monthly estimates for fine sediment removed (m^2 and m^3) in the San Marcos River

Month	Sediment Removed	
	m^2	m^3
November 2013	10	3
December 2013	47	10
January 2014	19	6
February 2014	1	1
Total	**77**	**20**

After dredging activities at the confluence of Purgatory Creek, Texas wild-rice was planted in the newly exposed substrate. **Figure 3.3-12** illustrates the growth of Texas wild-rice from initial planting in February 2014 to August 2014.

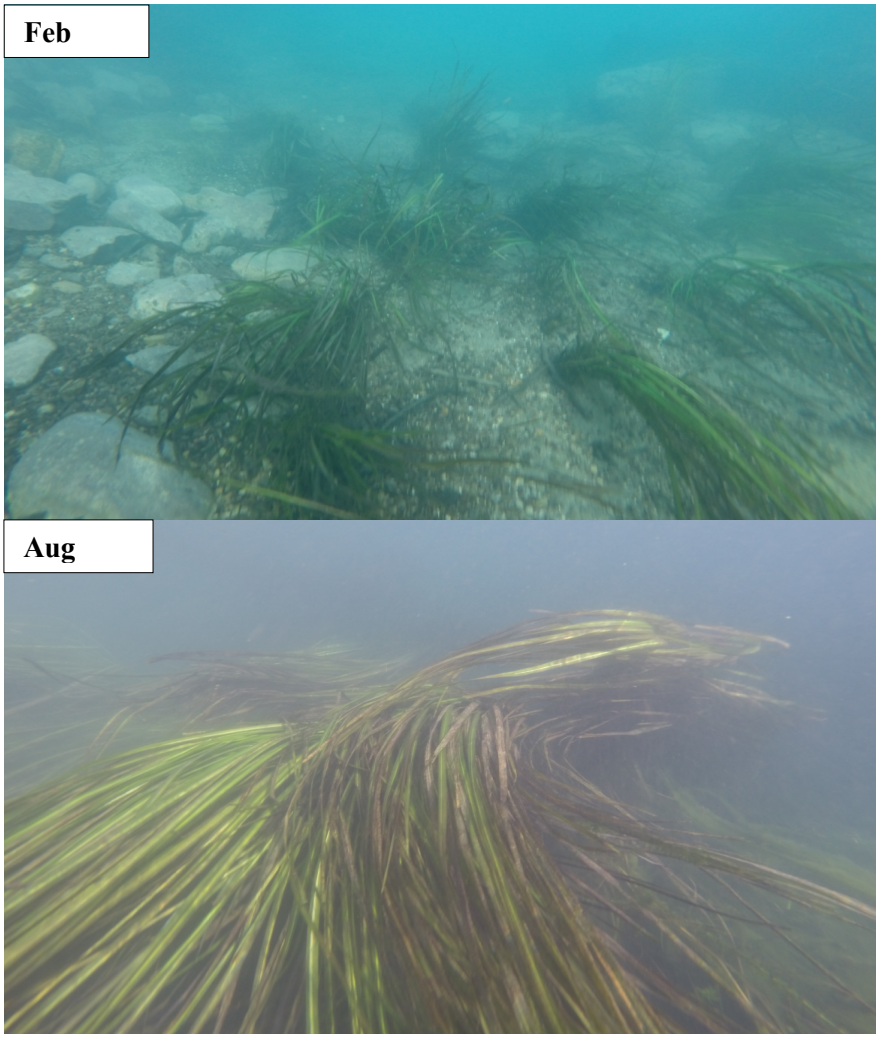


Figure 3.3-12. Texas wild-rice planted in February 2014 after dredging activities at the confluence of Purgatory Creek and growth observed by August 2014

Modifications Due to Drought Conditions:

Dredging ceased in August after San Marcos River flows dropped and remained below 120 cfs.

Proposed Activities for 2015:

In 2015, the COSM will remove a total of approximately 1,000 m^2 of fine sediment from the river bottom.

3.3.7 Designation of Permanent Access Points and Bank Stabilization (EAHCP §5.3.7)

Obligations:

The COSM will stabilize banks in City Park, at the Hopkins Street underpass, Bicentennial Park, Rio Vista Park, Ramon Lucio Park, and at the Cheatham Street underpass (**Figure 3.3-13** through **Figure 3.3-18**). Bank stabilization will be conducted using stone terraces and native vegetation along the riparian zone. The COSM will incorporate permanent access points to facilitate river entrance by recreationists that is more protective to the species and their habitats.

2014 Compliance Actions:

The remaining six proposed bank stabilization/access points were completed (**Figure 3.3-14** through **Figure 3.3-18**). All sites are constructed of natural rock and are strategically placed to offer the public several points of access while eliminating public access between these sites.

Figure 3.3-13. Natural rock was used to build bank stabilization/access points. This is the first of seven access points; called Dog Beach and located across from City Park

Figure 3.3-14. Extended access from Hopkins Street bridge to Hopkins RR bridge

Figure 3.3-15. Fishing access at Bicentennial Park

Figure 3.3-16. Access to existing concrete bridge at Rio Vista Park

Figure 3.3-17. Upper access point at Ramon Lucio Park prior to modifications due to undermined lower level of rock.

Figure 3.3-18. Lower Ramon Lucio Park access point

All bank stabilization/access points were heavily eroded areas that experienced intense use by the public through river access. This strategy of providing access points and enhancing riparian zones provides a balance between recreation and maintaining a healthy riparian buffer and river bank.

Immediately prior to construction, the area of disturbance within the river was surveyed for the presence of any biota. During construction, a 12-foot mulch log was staked in place along the line of open soil to prevent runoff of sediment and immediately upon completion of construction all open soil was covered with an erosion blanket.

One of the access points (Ramon Lucio) was undermined during spring of 2014 and during the summer two limestone blocks rolled off into the river. As a result, a team of City and TPWD personnel surveyed all the access points and made recommendations for changes to strengthen the access points. These changes are under design by Recreation, Engineering and Planning to be implemented in 2015.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

The COSM will begin modifying the existing access points in accordance with the approved design specifications.

3.3.8 Control of Non-Native Plant Species (EAHCP §5.3.8)

Obligations:

The COSM will partner with Texas State to develop and implement a non-native plant removal program reaching from Spring Lake downstream to the city boundary. Aquatic, littoral, and riparian non-native plant species will be removed and replaced with native species. The riparian zone will be replanted to cover 15 meters in width where possible. The City will install fencing to protect the new plantings while they mature. For aquatic removal and planting, divers removed non-native plants during sediment removal from the riverbed. Divers focus particularly on *H. verticillata*. All removed non-natives will be bagged and disposed of in accordance with state laws.

2014 Compliance Actions:

Non-native Aquatic Plant Removal

Non-native aquatic vegetation removal focused on *H. verticillata, H. polysperma,* and *Nasturtium officinale*, as these species were the most actively invasive. Prior to non-native vegetation removal, the area was fanned to minimize incidental take of fountain darters and other native species. Details regarding possible "take" of fountain darters is discussed in Section 5.0 of this report. The non-native aquatic vegetation was removed, shaken and bagged for disposal at the City of San Marcos or Spring Lake composting facility. MCWE's progress for non-native vegetation removal was tracked with polygons containing the date, species removed, estimated area (m^2) and percent removed. A composite map depicting the routine maintenance required to remove large areas of non-native aquatic vegetation was generated using weekly polygons. The map illustrating the degree of effort was created by overlaying all the weekly polygons, rasterizing the spatial units, assigning a value of one for the treated area, and combining the layers with a raster calculator. As a result, the layers capture the degree of overlap between 89 work sites and identify areas that required repeated removal efforts.

Denuded areas were targeted for Texas wild-rice or selected native aquatic species planting based on habitat preferences for each native species. Texas wild-rice and native species were obtained from the USFWS SMARC or from raceways located at the FAB. Initial efforts for restoration of Texas wild-rice or native vegetation were targeted at planting approximately 20 percent of the surface area restored. MCWE planting efforts was tracked with polygons containing the date, number of individuals, estimated area (m^2), and estimated density planted (individuals/m^2). A map illustrating planting location and planted densities was generated using weekly polygons. Aquatic vegetation was mapped using Trimble GPS units in work areas prior to non-native vegetation removal and native planting to assess changes in the vegetation community through time.

An estimated 2,649 m^2 of non-native aquatic vegetation was removed in the San Marcos River downstream of Sewell Park to IH-35 November 2013 – November 2014 among areas worked by MCWE staff (**Table 3.3-3**). The non-native vegetation species removed were *H. verticillata (*Estimated Area ~965 m^2*), H. polysperma* (~537 m^2*), Hydrilla/Hygrophila* mix (~445 m^2) and *Nasturtium officinale* (~523 m^2*).* **Figure 3.3-19** illustrates the degree of effort for non-native aquatic vegetation removal by MCWE staff in the San

Marcos River for 2014. An average work site ranged in scale from concentrated removal of 100 percent *H. polysperma* within a small area of 5 m^2 to removing mixed stands of *Hygrophila* and *Hydrilla* in 5 percent of a large work site that covered 939 m^2 but with a total removal of 47 m^2. The largest removal effort occurred during the week of February 12, 2014 when 50 percent, or 123 m^2, of *Hygrophila polysperma* within a 247 m^2 work site were removed.

Table 3.3-3. Estimated area removed (m^2) of Non-Native Vegetation Species by Date in the San Marcos downstream of Sewell Park to I35 (December 2013 – November 2014)

Species	Date	Area Removed (m^2)
Hydrilla verticillata	12/17/2013	6.99
	2/12/2014	23.25
	2/21/2014	80.03
	2/28/2014	38.17
	3/10/2014	11.20
	3/10/2014	7.46
	3/11/2014	37.36
	3/21/2014	62.82
	4/2/2014	33.70
	4/9/2014	45.06
	4/11/2014	40.24
	4/16/2014	19.16
	4/18/2014	42.95
	4/21/2014	50.81
	4/23/2014	27.41
	4/28/2014	52.67
	4/30/2014	30.33
	5/2/2014	33.09
	6/2/2014	11.94
	6/3/2014	45.39
	6/5/2014	21.61
	6/5/2014	17.36
	6/19/2014	24.80
	6/25/2014	20.39
	6/26/2014	38.66
	6/30/2014	19.47
	7/9/2014	9.12
	7/17/2014	17.83
	7/23/2014	10.85
	7/24/2014	16.83
	7/29/2014	6.10
	7/31/2014	5.18
	8/5/2014	11.15
	8/6/2014	3.16
	8/7/2014	19.45
	11/4/2014	12.48

Table 3.3-3. Estimated area removed (m^2) of Non-Native Vegetation Species by Date in the San Marcos downstream of Sewell Park to I35 (December 2013 – November 2014)

Species	Date	Area Removed (m^2)
	11/10/2014	10.07
Hydrilla verticillata total		**964.55**
Hydrilla/Hygrophila mix	12/10/2013	25.24
	12/13/2013	29.75
	12/16/2013	41.65
Hydrilla/Hygrophila mix	12/18/2013	18.27
	1/7/2014	28.81
	1/8/2014	60.74
	1/13/2014	40.36
	2/19/2014	46.97
	3/7/2014	31.27
	6/16/2014	66.13
	7/1/2014	39.81
	8/7/2014	3.90
	11/4/2014	11.84
Hydrilla/Hygrophila mix total		**444.74**
Hygrophila polysperma	12/17/2013	3.19
	1/10/2014	25.93
	2/12/2014	123.48
	2/14/2014	14.57
	2/19/2014	75.51
	2/21/2014	25.24
	4/16/2014	50.73
	4/23/2014	5.23
	6/17/2014	121.65
	6/25/2014	18.08
	6/27/2014	33.17
	7/17/2014	28.89
	7/29/2014	7.64
	8/5/2014	3.31
Hygrophila polysperma total		**536.63**
Nasturtium officinale	2/24/2014	104.96
	3/19/2014	54.42
	4/11/2014	62.72
	4/14/2014	43.76
	11/3/2014	40.32
	11/4/2014	99.49
	11/7/2014	48.84
	11/10/2014	68.22
Nasturtium officinale total		**522.74**
Total estimated area removed of non-native vegetation		**2,469.00**

Based upon GPS polygon locations, estimated loss of non-native vegetation observed from April 2013 – November 2014 was 1,120 m^2 in the San Marcos River downstream of Spring Lake Dam through Sewell Park (**Table 3.3-4**). Changes in vegetation outside of the areas worked were not included since differences observed could not be attributed to EAHCP work. Estimated totals for non-native vegetation species removed were *Hygrophila polysperma* (~682 m^2) and *Hydrilla verticillata* (~491 m^2). A slight increase in *Nasturtium officinale* (53 m^2) was observed, which was attributed to low flow conditions and the inability to remove non-native vegetation from July – October 2014 when flows dropped below 120 cfs.

Table 3.3-4. Difference in area (m^2) of Non-Native Vegetation Species in the San Marcos River downstream of Sewell Park Prior to (April 2013) and After (November 2014) Removal Activities

Species	April 2013	November 2014	Total Difference
Hydrilla verticillata	1,392	901	-491
Hygrophilia polysperma	1,395	713	-682
Nasturtium officinale	22	75	53
Total	**2,809**	**1,689**	**-1,120**

Twenty-six fountain darters were collected during non-native aquatic vegetation removal and returned to the river. Additional details regarding potential "take" of fountain darters are provided in Section 5.0 of this report. Another species of interest collected and returned to the river during non-native aquatic removal were two American eels. During its lifetime, the American eel undergoes several physical phases as well as changes in where it lives. Some scientists consider the highly adaptive American eel to have the broadest diversity of habitats of any fish species in the world and has long been considered the only catadromous fish in North America. Other species collected and returned to the river included crayfish, sunfish species, and mosquito fish (**Table 3.3-5Table 3.3-5.** Animal Species Collected and Returned to the San Marcos River During Non-Native Vegetation Removal (Dec 2013 – Nov 2014)).

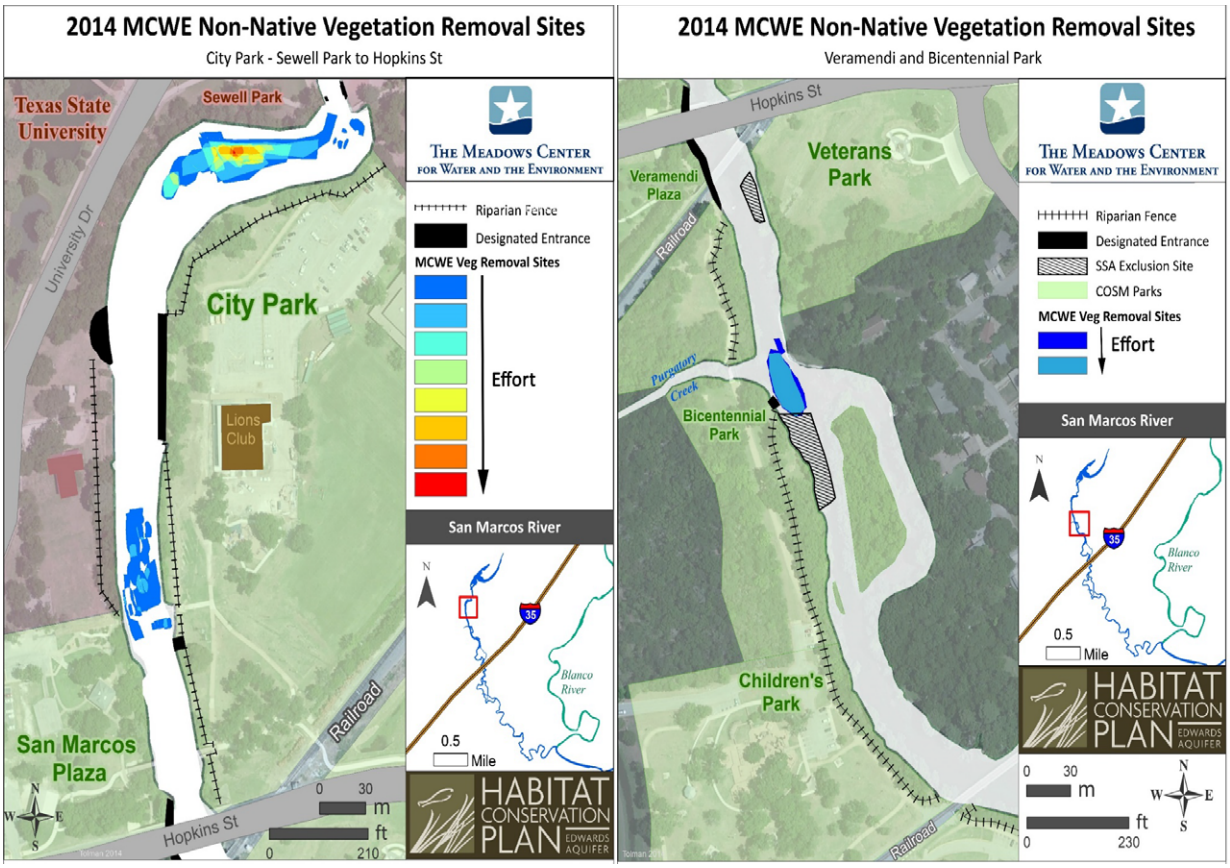


Figure 3.3-19. Vegetation removal effort by MCWE staff for removing non-native vegetation in the San Marcos River downstream of Sewell Park. Red spots indicate the areas of highest effort (i.e. hotspots) needed for continued non-native removal

Table 3.3-5. Animal Species Collected and Returned to the San Marcos River During Non-Native Vegetation Removal (Dec 2013 – Nov 2014)

Species	Month										
	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Aug-14	Oct-14	Nov-14	Total
***Lepomis sp.* (sunfishes)**	**1**	**1**	**7**	**12**	**21**	**15**	**8**	**5**	**-**	**2**	**72**
Etheostoma fonticola (fountain darter	-	-	-	3	-	4	14	3	2	-	**26**
Gambusia sp. (mosquito fish)	-	-	-	-	21	25	29	8	-	-	**83**
Oreochromis aurea (tilapia)	-	-	-	-	-	-	-	-	-	-	**0**
Ameiurus sp. (bullhead catfish)	-	-	1	1	-	10	1	4	-	-	**17**
Poecilia sp. (mollies)	-	-	-	-	-	-	1	-	-	2	**3**
Micropterus salmoides (largemouth bass)	-	-	-	-	-	5	2	-	-	-	**7**
Ambloplites rupestris (rockbass)	-	-	-	-	1	-	5	-	-	-	**6**
*Anguilla rostrata (*American Eel)	-	-	-	-	-	2	-	-	-	-	**2**
Astyanax mexicanus (Mexican tetra)	-	-	-	1	2	-	-	-	-	-	**3**

Table 3.3-5. Animal Species Collected and Returned to the San Marcos River During Non-Native Vegetation Removal (Dec 2013 – Nov 2014)

Species	Month										
	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Aug-14	Oct-14	Nov-14	Total
Notropis amabilis (Texas Shiner)	-	-	6	-	7	-	-	-	-	-	**13**
Cambaridae (crayfish)	22	10	47	32	105	200	138	15	-	25	**594**
Testudinata (Turtle)	-	1	3	1	-	-	-	-	-	-	**5**
Natantia (Freshwater Shrimp)	2	-	-	-	-	-	-	-	-	-	**2**

Table 3.3-6 denotes the number of each native vegetation species planted once an area was denuded of non-native vegetation. An estimated number of native species planted in the San Marcos River downstream of Sewell Park was 17,413 individuals from November 2013 – November 2014. The greatest number of individuals planted was Texas wild-rice (9,120) followed by *Lugwigia repens* (5,523), *Heteranthera dubia* (1,664), and S*agittaria platyphylla* (955). Other native species planted were *Potamogeton illinoensis* and *Hydrocotyle umbellata*. Estimated area planted with native species was 2,037 m^2 in the San Marcos River downstream of Sewell Park within areas removed of non-native vegetation. **Figure 3.3-20** through **Figure 3.3-22** illustrates planting density (plants/m^2) as well as planting location of Texas wild-rice and other native species in the San Marcos River downstream of Sewell Park.

Table 3.3-6. Number of Each Native Vegetation Species Planted Monthly in the San Marcos River Downstream of Sewell Park (December 2013 – November 2014)

Species	Date	N	Area planted (m^2)	Density Planted
Heteranthera dubia	12/12/2013	63	5.27	11.95
	2/24/2014	171	8.36	20.46
	3/10/2014	188	14.63	12.85
	4/4/2014	72	5.81	12.38
	4/9/2014	60	2.45	24.44
	4/9/2014	136	2.41	56.45
	4/16/2014	58	4.43	13.08
	6/6/2014	257	13.81	18.61
	6/19/2014	167	6.63	25.20
	6/30/2014	63	3.40	18.53
	7/1/2014	28	7.73	3.62
	7/9/2014	40	0.60	66.97
	7/29/2014	165	6.76	24.39
	7/30/2014	35	2.70	12.96
	7/31/2014	55	2.85	19.29
	8/6/2014	106	2.58	41.02
Heteranthera dubia total		**1,664**	**90.00**	-
Hydrocotyle	12/19/2013	**27**	**10.07**	-
Ludwigia repens	12/2/2013	84	8.96	9.38
	12/12/2013	200	4.74	42.21
	12/12/2013	200	25.78	7.76
	12/16/2013	208	19.61	10.61

Table 3.3-6. Number of Each Native Vegetation Species Planted Monthly in the San Marcos River Downstream of Sewell Park (December 2013 – November 2014)

Species	Date	N	Area planted (m^2)	Density Planted
	12/19/2013	88	14.27	6.17
	1/15/2014	167	26.41	6.32
	2/14/2014	113	2.27	49.85
	2/14/2014	113	2.89	39.14
	2/14/2014	113	6.69	16.89
	2/24/2014	264	7.96	33.17
	3/10/2014	909	18.83	48.28
	4/4/2014	468	12.49	37.48
	4/9/2014	106	1.53	69.08
	4/9/2014	162	3.99	40.56
	4/16/2014	298	24.34	12.24
	4/23/2014	203	9.60	21.15
	6/4/2014	428	28.69	14.92
	6/6/2014	36	18.71	1.92
	6/19/2014	148	5.55	26.69
	6/26/2014	72	1.41	51.18
	6/27/2014	40	1.39	28.87
	6/30/2014	239	1.51	158.57
	7/1/2014	52	4.65	11.19
	7/15/2014	12	2.38	5.04
	7/16/2014	380	9.80	38.76
	7/24/2014	114	3.91	29.16
	7/31/2014	126	1.87	67.25
	8/5/2014	180	4.81	37.40
Ludwigia repens total		**5,523**	**275.00**	-
Potamogeton illinoensis	12/19/2013	**124**	**24.88**	-
Sagittaria platyphylla	11/19/2013	104	30.98	3.36
	12/2/2013	40	12.35	3.24
	12/17/2013	60	11.02	5.44
	1/15/2014	108	125.23	0.86
	1/15/2014	66	23.13	2.85
	2/3/2014	25	53.67	0.47
	2/14/2014	21	8.34	2.52
	2/21/2014	57	15.22	3.74
	2/24/2014	87	15.90	5.47
	2/28/2014	108	14.16	7.63
	6/30/2014	71	6.21	11.43
	7/29/2014	18	4.23	4.25
	8/7/2014	97	7.32	13.25
	8/7/2014	93	4.06	22.90
Sagittaria platyphylla total		**955**	**332.00**	-
Zizania texana	12/2/2013	420	21.16	19.85
	12/12/2013	128	20.64	6.20

Table 3.3-6. Number of Each Native Vegetation Species Planted Monthly in the San Marcos River Downstream of Sewell Park (December 2013 – November 2014)

Species	Date	N	Area planted (m^2)	Density Planted
	12/16/2013	276	25.98	10.62
	12/17/2013	294	39.36	7.47
	12/19/2013	269	6.68	40.27
	12/19/2013	56	25.23	2.22
	1/10/2014	176	275.87	0.64
	1/15/2014	108	197.80	0.55
	2/3/2014	100	177.86	0.56
	2/14/2014	269	15.94	16.87
	2/21/2014	472	47.47	9.94
	3/19/2014	77	9.42	8.18
	3/19/2014	195	6.74	28.92
	4/4/2014	148	7.83	18.90
	4/4/2014	240	6.20	38.74
	4/9/2014	160	4.28	37.40
	4/9/2014	160	6.88	23.24
	4/23/2014	94	35.13	2.68
	4/28/2014	148	15.97	9.27
	5/30/2014	328	14.12	23.22
	6/2/2014	332	87.89	3.78
	6/18/2014	312	26.11	11.95
	6/26/2014	117	16.53	7.08
	6/26/2014	117	19.50	6.00
	6/26/2014	117	4.65	25.16
	6/27/2014	112	23.49	4.77
	6/30/2014	275	16.73	16.44
	7/1/2014	252	35.75	7.05
	7/9/2014	112	3.07	36.44
	7/9/2014	112	1.66	67.56
	7/15/2014	140	15.88	8.81
	7/16/2014	336	22.90	14.67
	7/17/2014	92	11.74	7.84
	7/23/2014	264	6.36	41.52
	7/24/2014	116	7.55	15.37
	7/29/2014	124	4.09	30.35
	7/30/2014	236	6.91	34.17
	7/30/2014	484	9.86	49.09
	7/31/2014	392	5.46	71.84
	8/6/2014	700	5.70	122.77
	11/4/2014	260	11.91	21.83
Zizania texana total		**9,120**	**1,304.31**	
Native species planting totals		**17,413**	**2,036.53**	

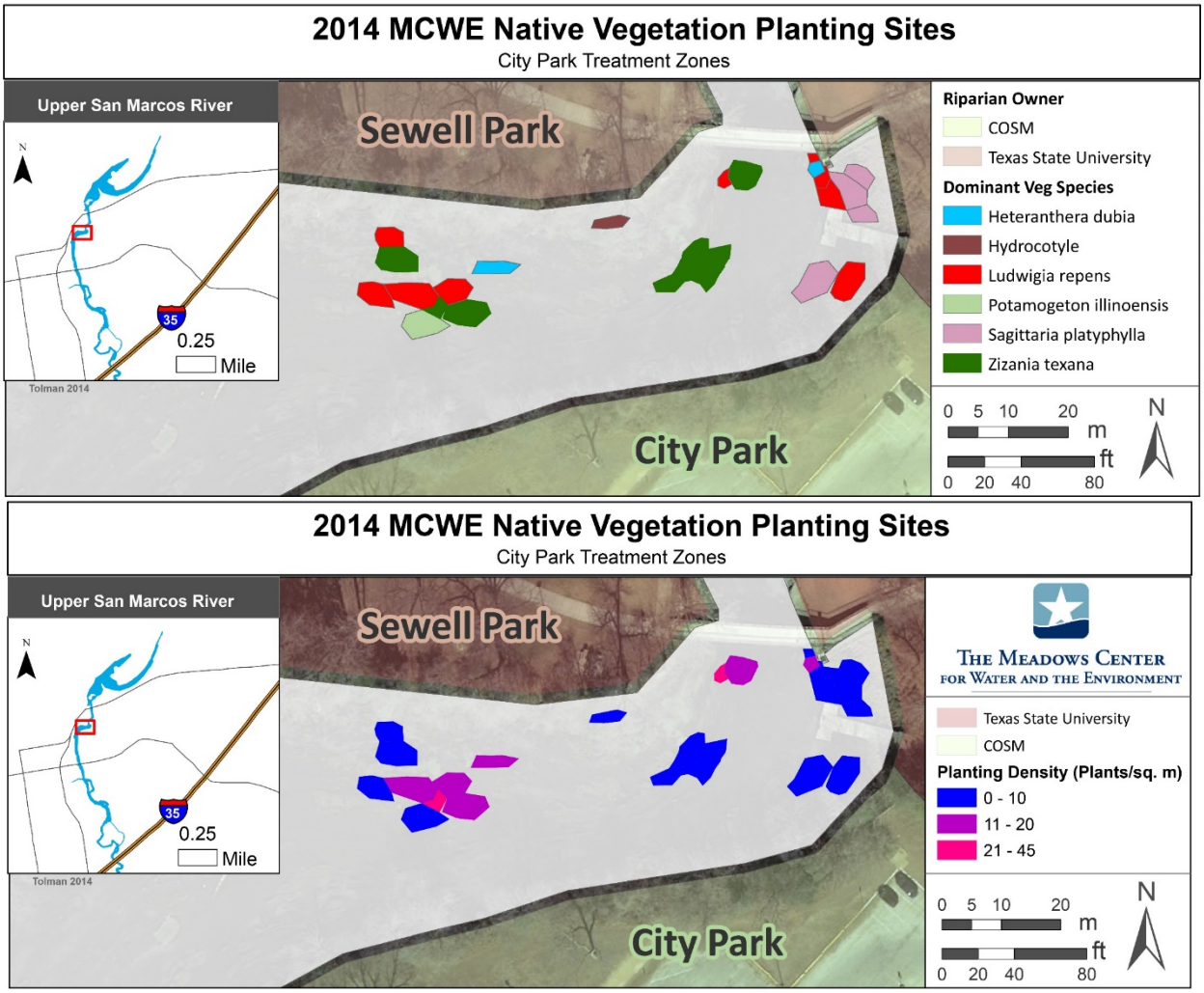


Figure 3.3-20. 2014 MCWE planting locations (top) and planted densities (bottom) of Texas wild-rice and other native species just downstream of Sewell Park

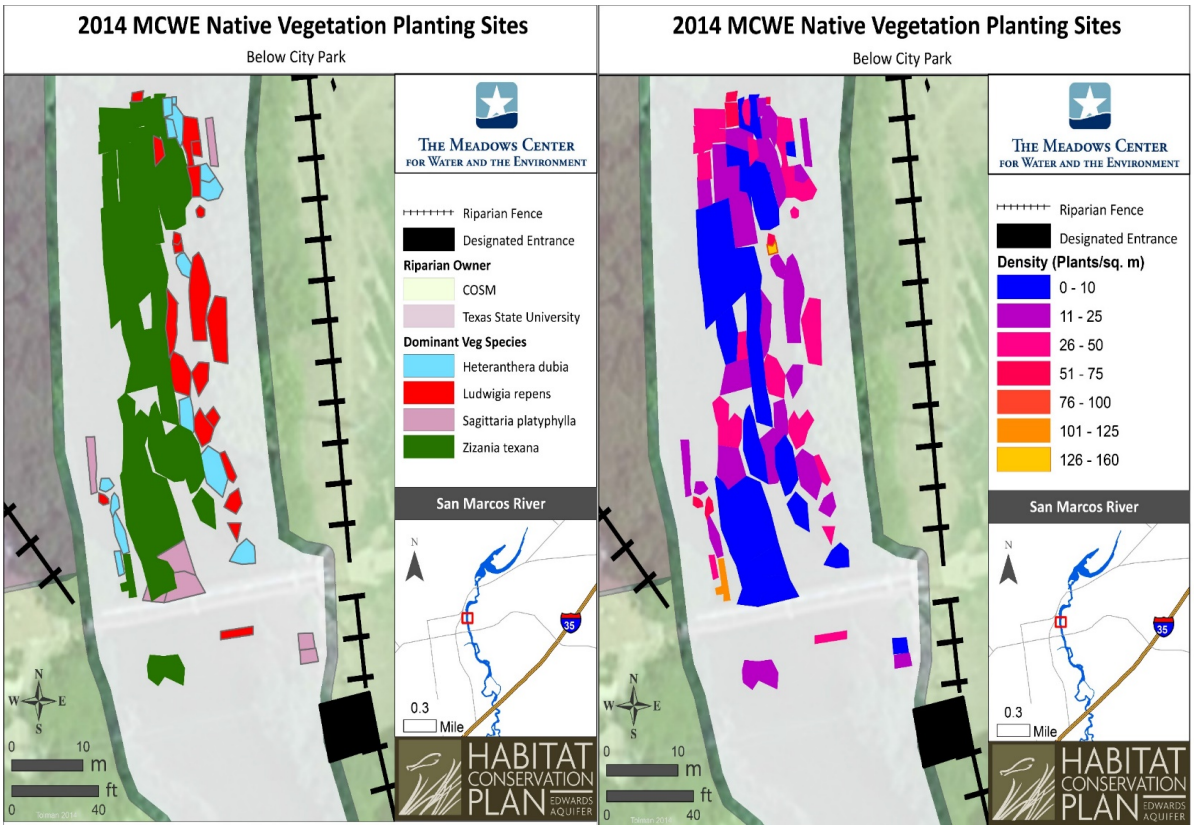


Figure 3.3-21. 2014 MCWE planting locations (left) and planted densities (right) of Texas wild-rice and other native species just downstream of City Park

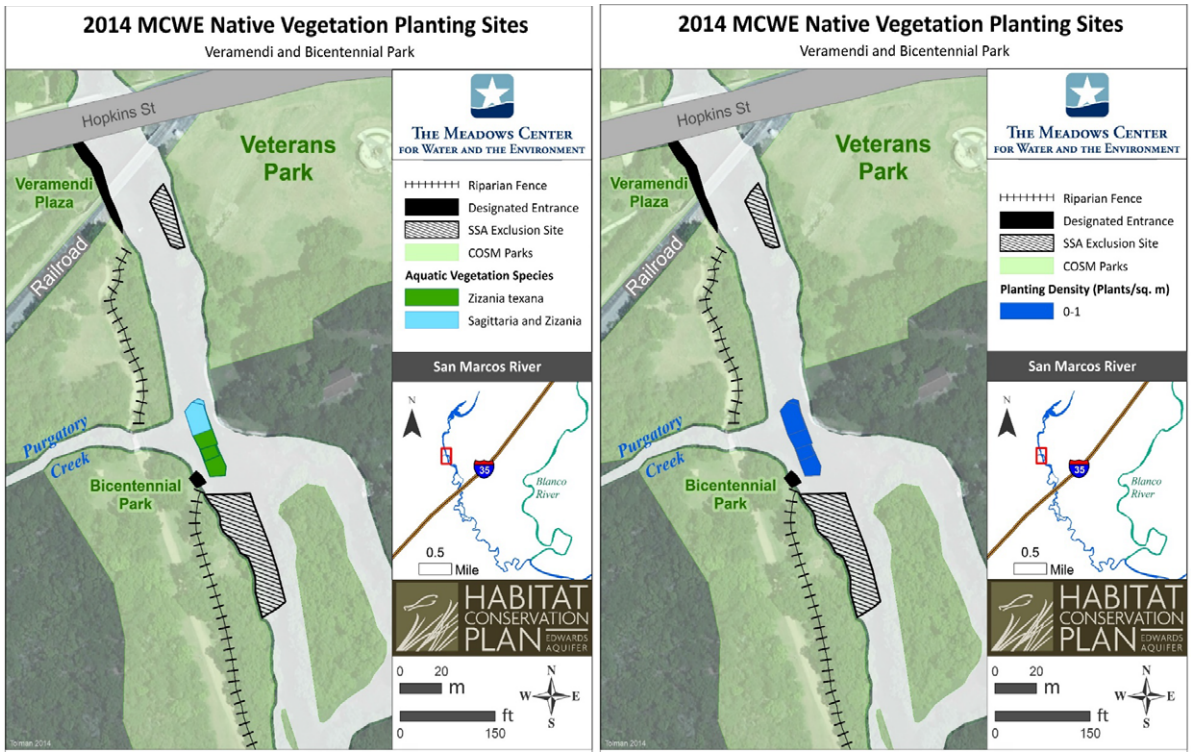


Figure 3.3-22. 2014 MCWE planting locations (left) and planted densities (right) of Texas wild-rice and other native species at the confluence of Purgatory Creek and the San Marcos River

Based upon GPS polygon locations, net area gain in native aquatic vegetation was 236 m^2 since April 2013 (i.e., prior to EAHCP activities) and November 2014 in the San Marcos River downstream of Sewell Park (**Table 3.3-7**). Changes in native vegetation outside of the areas worked were not included since differences observed could not be attributed to work by the MCWE team. Among native species, *Zizania texana* increased the most (891 m^2) followed by *Heteranthera dubia* (79 m^2), *Sagittaria platyphylla* (58 m^2), *Ludwigia repens* (41 m^2) (**Table 3.3-7** and **Figure 3.3-23** and **Figure 3.3-24**). A loss in area was observed for native species, *Potamogeton illinoensis* and *Cabomba* sp. Among planted native vegetation species, pondweed constituted only less than 1 percent of total effort and *Cabomba* sp. was even less than that. For these two species, primarily non-native vegetation surrounding them was removed which allowed them to expand.

Table 3.3-7. Difference in Area (m^2) of Native Vegetation Species in the San Marcos River below Sewell Park Prior to (April 2013) and Post (November 2014) Non-Native Vegetation Removal and Native Planting Activities

Species	April 2013	November 2014	Difference
Zizania texana	691	1,582	891
Ludwiga repens	0	41	41
Sagittaria platyphylla	320	378	58
Potamogeton illinoensis	975	282	-693
Cabomba caroliniana	154	15	-139
Heteranthera dubia	0	79	79
Hydrocotyle	1.5	3.5	2
Total	**2,141.5**	**2,380.5**	**239**

Non-native Littoral Plant Removal

In 2014, removal efforts continued at Spring Lake and downstream along both banks to the Cheatham Street/Crook Park area. Removal consisted of both new treatments and "mopping up" as shown in **Figure 3.3-25** and **Figure 3.3-26**.

EBR uses Aquaneat (glyphosate-based herbicide) for elephant ears and other non-native plants encountered in the littoral zone (10.25 oz per gallon maximum). This herbicide is mixed with Aqua King Plus Surfactant (1 oz per gallon) and Turf Mark Blue, Blue Dye. On the upland tree, shrub stumps and root buttresses, EBR uses Relegate **(**Triclopyr-based herbicide) at 10 oz per gallon. This is mixed with glyphosate (10.25 oz per gallon maximum), and Drexel Surf Ac 820 Surfactant (1 oz per gallon) and Turf Mark Blue, Blue Dye. Chemicals are applied with a one gallon pump-up sprayer set on a steady stream for a more precise target hit which minimizes leaching and non-target plant damage. Woody plants are scarred up with a machete to expose more of the cambium layer and treated with an herbicide mix.

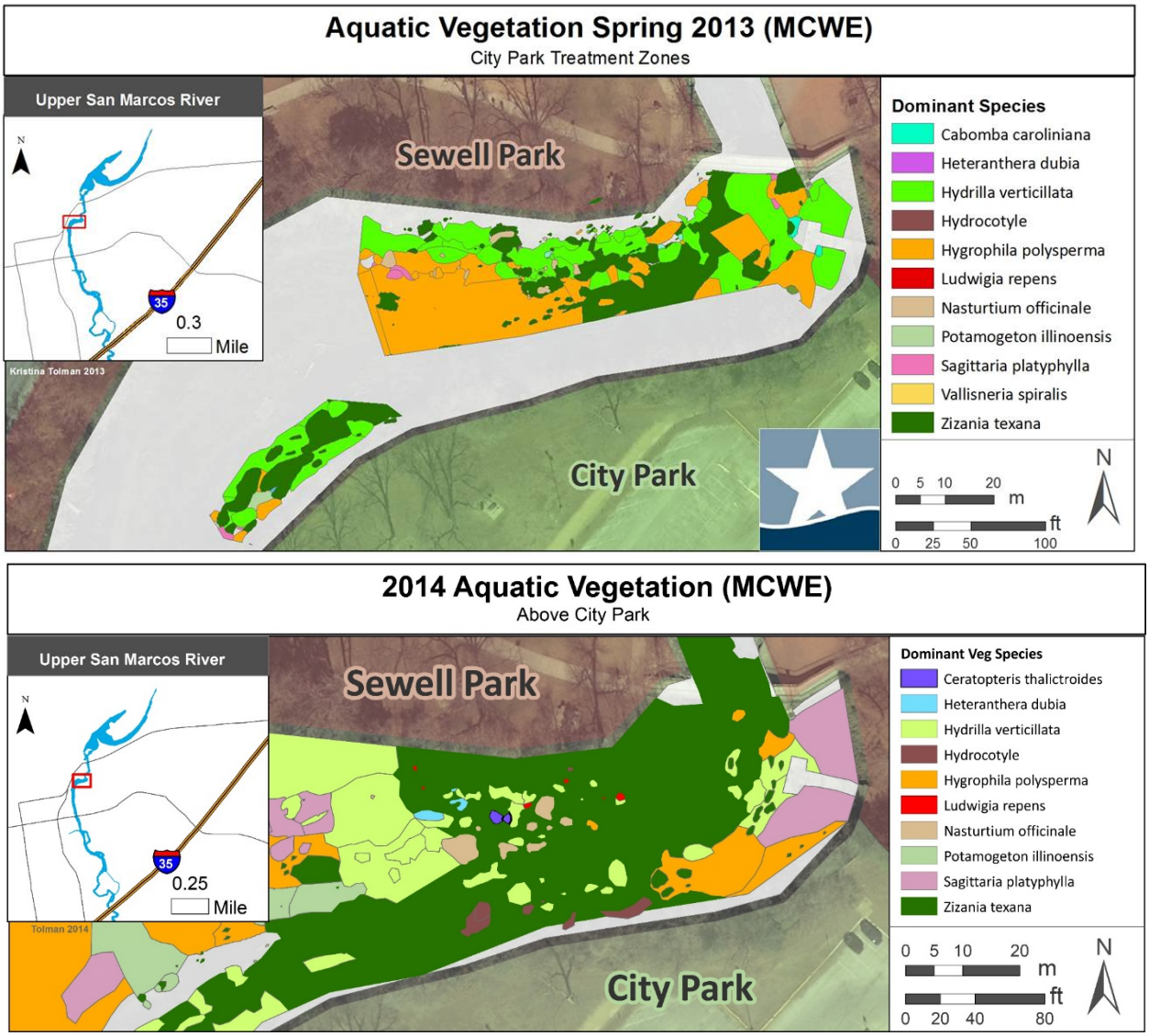


Figure 3.3-23. Vegetation changes observed from Spring 2013 to Fall 2014 in non-native removal and native planting areas in the San Marcos River downstream of Sewell Park

Figure 3.3-24. Vegetation changes observed from Spring 2013 to Fall 2014 in non-native removal and native planting areas in the San Marcos River downstream of Sewell Park

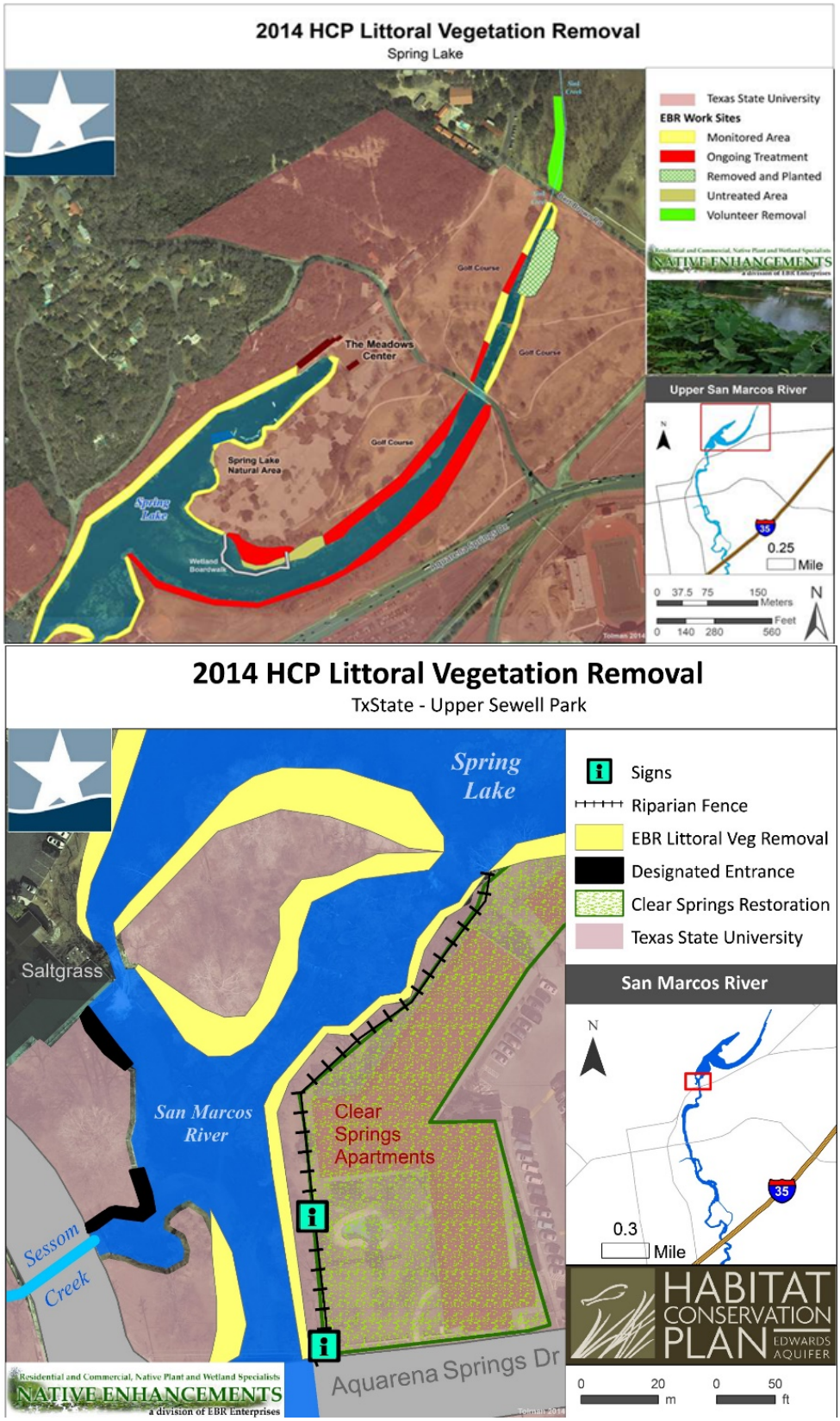


Figure 3.3-25. Areas of removal and replanting at Spring Lake and upper Sewell Park

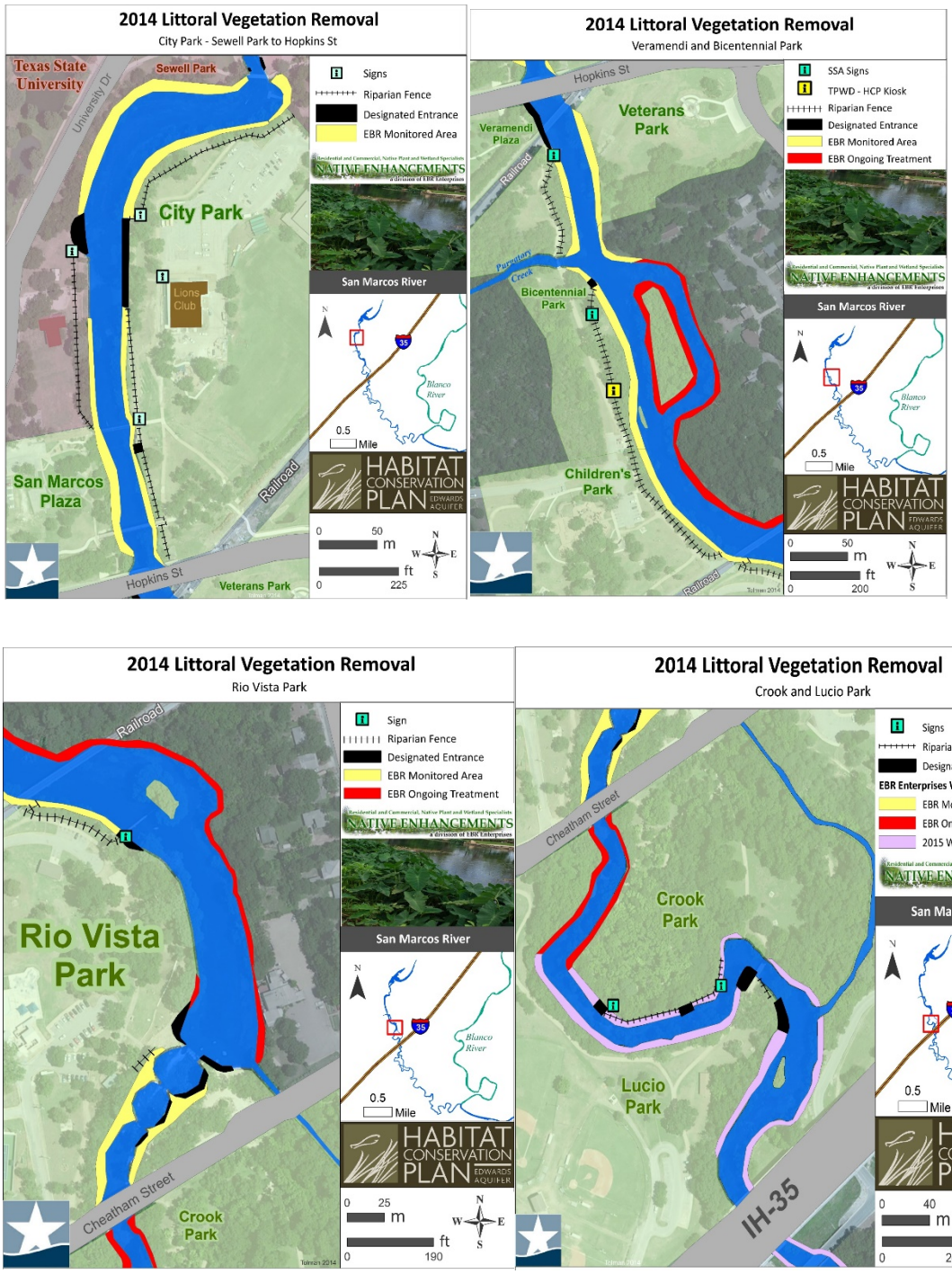


Figure 3.3-26. Treated areas from City Park to IH-35

EBR worked an average of three days each week to remove non-natives and replant treated areas (**Table 3.3-8** and **Table 3.3-9**). The majority of the work zone (Bert Brown Road to Cheatham Street) is now under maintenance, meaning most of the original elephant ears and other non-native invasive vegetation has been removed and regrowth is under control.

Table 3.3-8. Non-Native Species (less than 4 inches dbh) Removed from the Littoral Zone of the San Marcos River

Common Name	Scientific Name
Arrowhead vine	*Syngonium podophyllum*
Chinaberry tree	*Melia azedarach*
Chinese tallow	*Triadica sebifera*
Chinese privet	*Ligustrum sinense*
Elephant ear	*Colocasia esculenta*
Japanese honeysuckle	*Lonicera japonica*
Ligustrum	*Ligustrum japonicum* and/or *Ligustrum lucidum*
Nandina	*Nandina domestica*
Umbrella sedge	*Cyperus alternifolius*
Water hyacinth	*Eichhornia crassipes*
Yellow iris	*Iris pseudacorus*

Table 3.3-9. Native Species Planted in the Littoral Zone of the San Marcos River

Common Name	Scientific Name
American beautyberry	*Callicarpa Americana*
Bald cypress	*Taxodium distichum*
Bear grass	*Nolina lindheimeriana*
Buttonbush	*Cephalanthus occidentalis*
Chili pequin	*Capsicum annuum var. aviculare*
Coralbean	*Erythrina herbacea*
Eastern Red Cedar	*Juniperus virginiana*
Elbow Bush	*Forestiera pubescens*
Eve's necklace	*Styphnolobium affine*
Gum bumelia	*Sideroxylon lanuginosum*
Inland sea oats	*Chasmanthium latifolium*
Palmetto	*Sabal minor*
Pigeonberry	*Rivina humilis*
Rockrose	*Pavonia lasiopetala*
Roughleaf dogwood	*Cornus drummondii*
Texas lantana	*Lantana urticoides (horrida)*
Texas mountain laurel	*Sophora secundiflora*
Texas sage	*Leucophyllum frutescens*
Texas stool	*Dasylirion texanum*
Turk's cap	*Malvaviscus drummondii*
Yaupon	*Ilex vomitoria*

Modifications Due to Drought Conditions:

Non-native littoral removal and native plantings were delayed until the rainy season (October) to avoid the need for weekly watering. October proved to be relatively dry, and the City had to scramble to provide irrigation. Consequently, a larger percentage of riparian plants were lost than in 2013 (20 percent). Conversely, a larger amount of elephant ears were exposed due to the drought and easier to treat due to lower river levels. EBR focused on invasive trees and establishing buffer zones.

Proposed Activities for 2015:

In 2015, the COSM will remove 3,000 m^2 of non-native plant material. Stands of elephant ears already treated will continue to be weeded for regrowth, and removal will continue to IH-35 and native littorals will be planted in their place. In 2015, this effort will be extended to Stokes Park. Elephant ear coverage becomes more spotty downstream of IH-35.

3.3.9 Control of Harmful Non-Native and Predator Species (EAHCP §5.3.9)

Obligations:

The COSM, in partnership with Texas State, will implement a non-native species control program that targets the suckermouth catfish (*Hypostomus plecostomus*), Mozambique Tilapia (*Oreochromis mossambicus*) the sailfin catfish (*Pterygoplichthys disjunctivus*), the Red-rimmed melania (*Melanoides tuberculate*), and the giant ramshorn snail *(Marisa cornuarietis)*. The COSM will conduct annual monitoring and maintenance activities to ensure continued control of the invasive population within the San Marcos system.

2014 Compliance Actions:

Tilapia

During the months of March through June, while tilapia are spawning, Atlas Environmental focused efforts on Spring Lake using gill nets, seine nets, bows, and pole spears. Tilapia were also captured in areas downstream of Spring Lake and were targeted along with suckermouth catfish from July to February. While pole spears were predominately used to capture tilapia, bow fishing proved the most successful method during spawning season (March-June). **Figures 3.3-27** and **3.3-28** show the locations and number of tilapia captured over time in the San Marcos River.

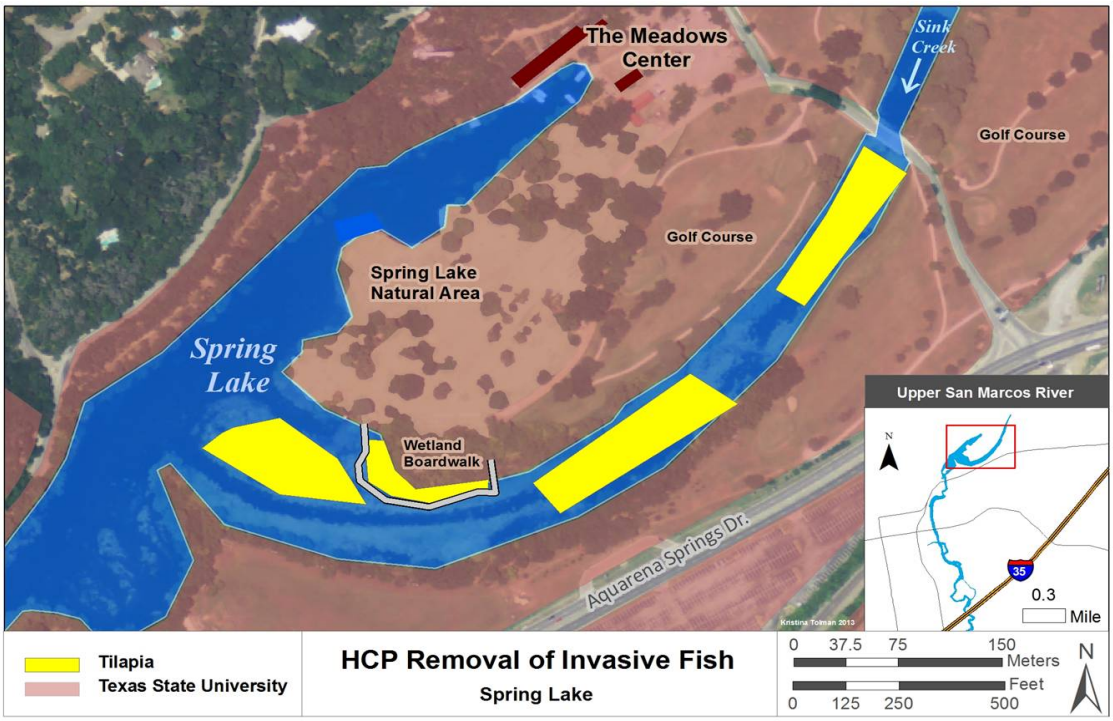


Figure 3.3-27. Area of Tilapia removal in Spring Lake

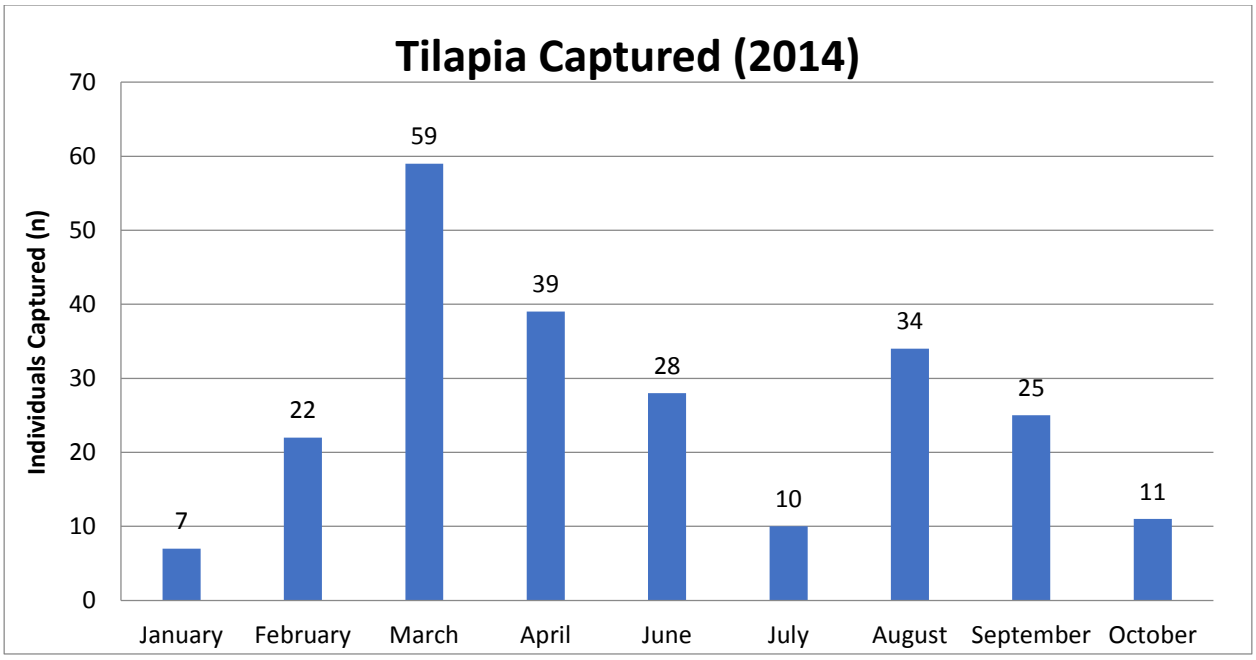


Figure 3.3-28. Number of individual Tilapia captured from January to October 2014

Suckermouth catfish

Suckermouth catfish were captured from Spring Lake to IH-35 using pole spears and hand collection while snorkeling. Suckermouth catfish are speared at both night and day, but during the recreation season Atlas dives only at night due to the constant turbidity of the water during the day. **Figure 3.3-29** and **Figure 3.3-30** shows the number and locations of suckermouth catfish captures over time in the San Marcos River.

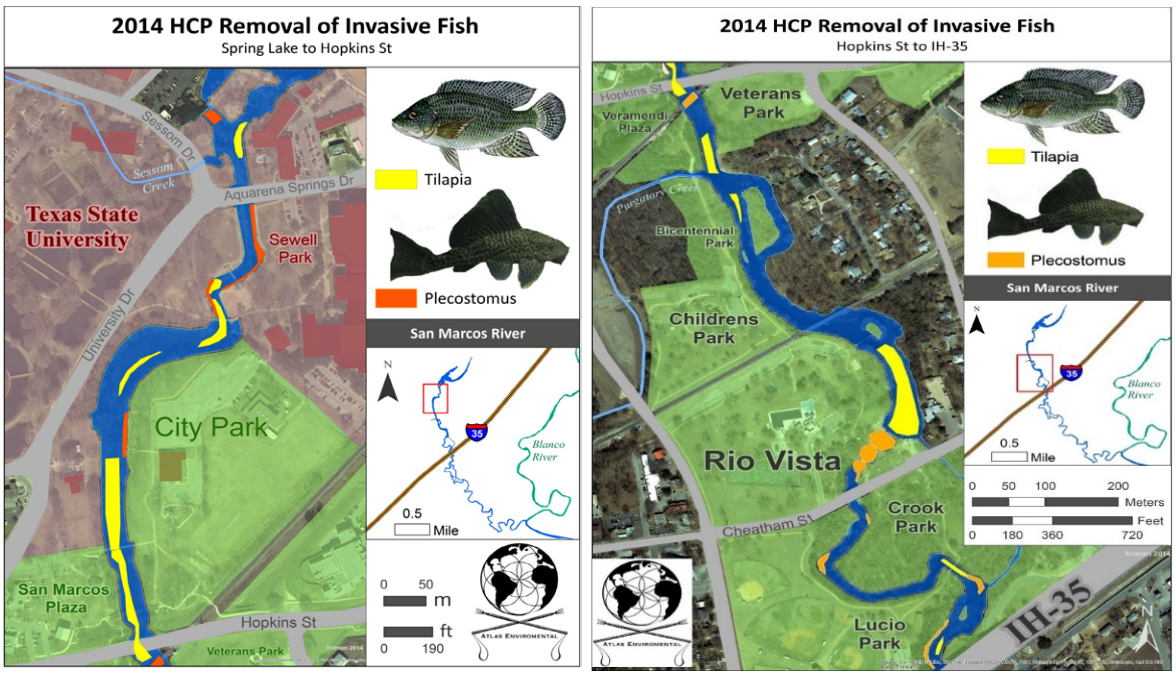


Figure 3.3-29. Treatment areas for suckermouth catfish and Tilapia from Spring Lake Dam to IH-35

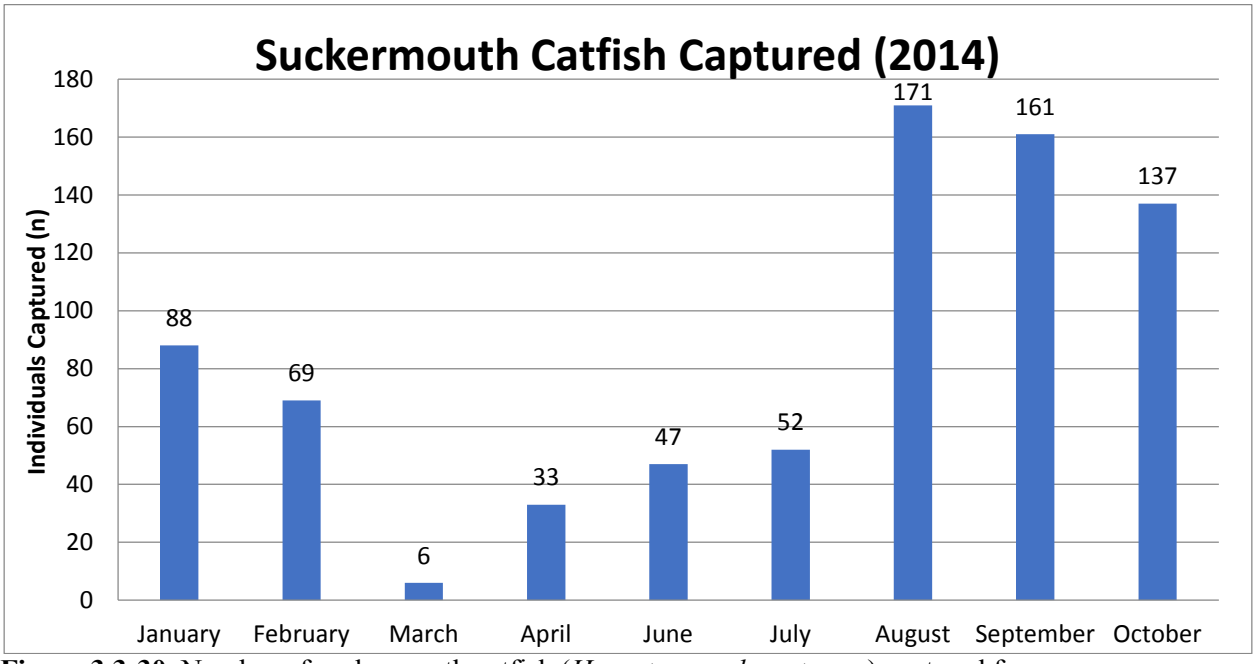


Figure 3.3-30. Number of suckermouth catfish (*Hypostomus plecostomus*) captured from January to October 2014

Red-Rimmed Melania and Giant Ramshorn Snail Removal

Early in 2013, Atlas built traps to capture snails in areas of highest concentrations both during the day and at night. However, traps were not as successful or selective as hand-picking snails. Atlas now works areas of large concentrations by hand collection and primarily in Spring Lake and by Clear Springs Apartments.

Atlas participated in the EAHCP's public outreach efforts using brochures and posters to inform on the impacts of dumping aquaria into rivers. These have been distributed at local pet stores, schools, San Marcos Nature Center and the University. Atlas also set up educational booth to increase public awareness of non-native invasive fish at the annual Texas wild-rice Festival. With recent permission from the San Marcos Park Rangers, Atlas programmed a week-long pole spear tournament this December to give the community the opportunity to take part in the EAHCP by removing non-native invasive fish.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, the COSM will continue to refine their population estimates for non-native species targeted for removal. Regular removal of the tilapia, suckermouth catfish, and snails will continue. Monthly maps showing changes in non-native populations will be generated. Quarterly tournaments will be proposed to the City to increase the removal quantities.

3.3.10 Native Riparian Habitat Restoration (EAHCP §5.7.1)

Obligations:

The COSM will restore riparian habitats with native species on city property from City Park to IH-35. The COSM will establish a program for private landowners to implement riparian restoration on their properties with the opportunity for reimbursement of plant acquisition costs if program criteria are met.

2014 Compliance Actions:

Heritage Tree Care (HTC) accomplished non-native tree, shrub and vine removal and native replanting in Upper Sewell, City and Veteran's Parks throughout the spring and autumn of 2014. Plant removal was performed with chainsaws and hand tools. Stumps were treated with painted Glyphosate plus (41 percent).A second removal pass was accomplished in October to capture the regrowth (about 5 percent). Erosion control and soil protection practices placed all the straight branches and trunks on contour as well and produced mulch on site to fill between the contour logs. In City Park, the logs from the site were not sufficient, so HTC supplemented erosion control with 1,550 linear ft of mulch logs and 265 cubic yards of hardwood mulch. This had the advantage of creating new germination areas from catching silt and seed in mulch logs and allowed existing seed bank to germinate under the protective layer of mulch (combined with irrigation). Species removed were Japanese and Chinese privet (*Ligustrum japonicum* and *L. sinense*), chinaberry (*Melia azedarach*), white mulberry (*Morus alba*), Chinese tallow (*Triadica sebifera*), and Japanese honeysuckle (*Lonicera japonica*). The canopy removed ranged from 20 percentto 80 percent depending on the site. New invasive seedlings were removed in October, mostly by hand-digging or simply pulling.

Most plantings were performed in March-April 2014 and October 2014 to take advantage of spring and fall rains. Most plantings were sourced from Texas Madrone Nursery, Native Texas Nursery and Far South. Due to drought conditions, supplemental watering was required and completed with a combination of temporary irrigation system drawing from 2,500-gallon rain tanks filled with city water when river water was not allowed to be pumped due to TCEQ drought restrictions. Hand-watering with a spray rig was performed when needed due to spray irrigation restrictions and for deep watering efficiency. HTC selected spray irrigation instead of drip to allow the entire reclaimed riparian area to start filling in from existing seed stock beyond our plantings.

HTC's monthly maintenance consisted of spray irrigation periodic removal of Johnson grass which smothered smaller plantings. Hand-removal was selected to prevent mass use of herbicides. Weekly hand watering and weeding were the bulk of the maintenance required.

Across all sites, a five- to ten-foot buffer zone of access-prohibitive trees, shrubs and vines was planted along the length of the planting zone. This buffer zone of plants was fenced in by the City to protect it from trampling. Species were selected as recommended by local plant experts, the USDA, USFWS, TPWD and the TCEQ for riparian restoration projects. The existing plant species composition is very diverse, which will assist the riparian restoration. **Figures 3.3-31** and **3.3-32** depict locations of riparian restoration. **Table 3.3-10** provides a list of species planted at Upper Sewell and Veteran's City Parks.

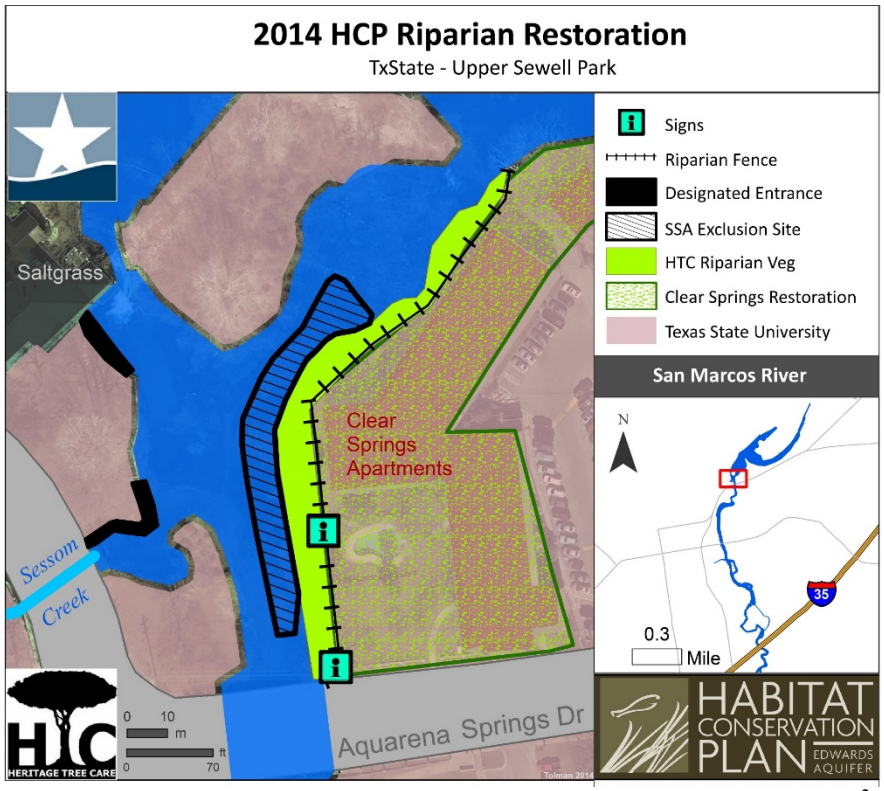


Figure 3.3-31. New riparian restoration at Upper Sewell Park site (967 m^2)

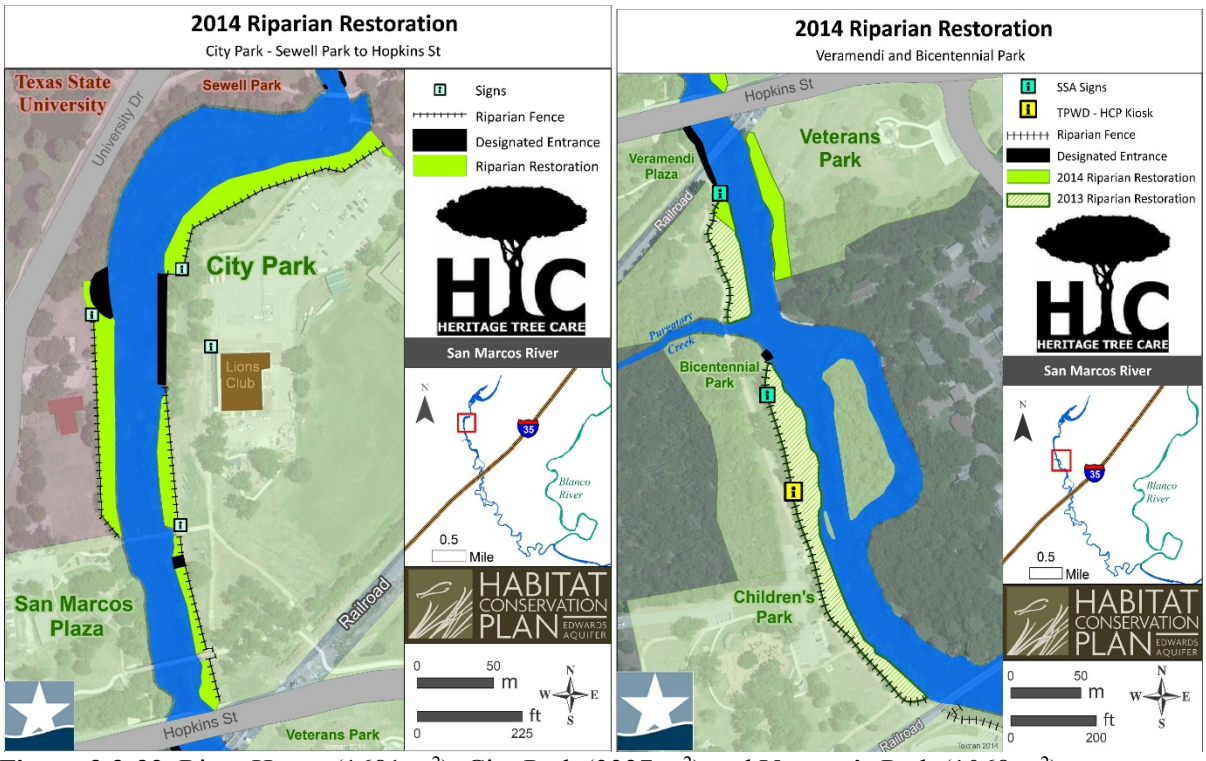


Figure 3.3-32. River House (1681 m^2), City Park (3327 m^2) and Veteran's Park (1068 m^2) are new restoration sites and maintenance sites at Veramendi and Bicentennial (480 m^2)

Table 3.3-10. List of species planted at Upper Sewell, Veteran's City Parks

Common name	Species	size (gal)	quantity
Amorpha	*Amporpha* sp.	1	64
Arizona walnut	*Juglans major*	1	10
Aromatic sumac	*Rhus aromatic*	1	34
Beautyberry	*Calicarpa americana*	5	15
Carolina buckthorn	*Frangula caroliniana*	1	20
Juniper (Cedar)	*Juniperus* sp.	1	34
Cedar Elm	*Ulmus crassifolia*	1	34
Cedar Elm	*Ulmus crassifolia*	5	20
Condalia	*Condalia hookerii*	5	5
Coral Bean	*Erythrina herbacea*	1	34
Dwarf Wax Myrtle	*Myrica cerifera*	1	34
Dwarf palmetto	*Sabal minor*	5	10
Elbow Bush	*Forestiera pubescens*	1	34
Evergreenn Sumac	*Rhus virens*	5	36
Fragrant Mimosa (catclaw)	*Mimosa borealis*	0.25	75
Fragrant Mimosa (catclaw)	*Mimosa borealis*	1	68
Fragrant Sumac	*Rhus aromatica*	1	34
Fragrant Sumac	*Rhus aromatica*	5	10
Golden Ball Lead Tree	*Leucaena retusa*	1	34
Gum Bumelia	*Bumelia lanuginosa*	5	16
Kidney wood	*Eysenhardtia texana*	1	34
Lacey Oak	*Quercus laceyi*	1	34
Lacey Oak	*Quercus laceyi*	5	10
Central Texas live oak	*Quercus fusiformis*	1	39
Mesquite	*Prosopis glandulosa*	1	34
Mexican Buckeye	*Ungnadia speciosa*	5	44
Mexican Buckeye	*Ungnadia speciosa*	1	15
Mexican Plum	*Prunus mexicana*	5	44
Texas Muhly Grass	*Muhlenbergii capillaris*	5	20
Possum Haw	*Ilex decidua*	5	17
Red Buckeye	*Aesculus pavia*	5	16
Red Mulberry	*Morus Rubra*	1	5
Red Oak	*Quercus buckleii*	1	5
Rough Leaf Dogwood	*Cornus drummondii*	5	16
Soapberry	*Sapindus drummondii*	1	39
Southern sugar Maple	*Acer barbatum*	5	5
Swamp Bay	*Persea palustris*	5	16
Sycamore	*Platinus occidentalis*	5	10
Texas Buckeye	*Aesculus glabra*	5	16

Table 3.3-10. List of species planted at Upper Sewell, Veteran's City Parks

Common name	Species	size (gal)	quantity
Texas Mountain Laurel	*Sophora secundiflora*	1	34
Texas Redbud	*Cercis canadensis*	1	54
Texas Redbud	*Cercis canadensis*	5	10
Texas Wisteria	*Wisteria frutescens*	5	1
Vasey Oak	*Quercus pungens var. vaseyana*	5	35
Walnut	*Juglans* sp.	1	34
White Brush	*Aloysia*	1	34
White Brush	*Aloysia*	5	5
Buckley's yucca	*Yucca constricta*	1	34

Modifications Due to Drought Conditions:

Low rainfall conditions in combination with planting in April demanded an intense irrigation program throughout the summer. This condition continued on through the autumn resulting in a higher loss of plants in 2014.

Proposed Activities for 2015:

In 2015, the COSM will focus on invasive removal due to continuing drought conditions and the difficulty of watering new plantings. Restoration efforts will be evaluated for 2016.

3.3.11 Septic System Registration and Permitting Program (EAHCP §5.7.3)

Obligations:

The COSM will establish a registration, evaluation, and permitting program for aerobic and anaerobic septic systems.

2014 Compliance Actions:

As of January 1, 2015, the San Marcos Environmental Health Department had registration records for 595 septic systems within City jurisdiction. Since January 1, 2014, four new septic systems were added into service. The total number of septic systems on December 4, 2014 was 599. These systems have been permitted and evaluated to prevent subsurface pollutant loadings into the Edwards Aquifer or San Marcos River.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

The COSM will continue to implement their septic system registration and permitting program. This program includes the required connection to municipal sewer lines according to city ordinance Section 86.152.

3.3.12 Minimizing Impacts of Contaminated Runoff (EAHCP §5.7.4)

Obligations:

The COSM will excavate and stabilize two areas for the construction of two sedimentation ponds (one in Veramendi Park and one alongside Hopkins Street) in the vicinity of the San Marcos River. As the ponds are designed, they will be considered through the Adaptive Management Process. Implementation will include erosion minimization measures and construction will be closely monitored for potential impacts to the river system. Once completed, the COSM will regularly monitor these ponds, and remove and properly dispose of accumulated sediments off-site.

2014 Compliance Actions:

The EAHCP calls for the design and construction of two water quality BMPs located at Veramendi and Hopkins Street bridge, to capture stormwater runoff before it enters the San Marcos River. John Gleason LLC intended to complete conceptual designs, but funding was required for the completion of the WQPP.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

Design plans for the two sedimentation ponds described in the EAHCP will be completed and presented to the Science Committee for review. The COSM will conduct water quality sampling prior to, and after installation of the sedimentation ponds to monitor their effects.

3.3.13 Management of Household Hazardous Wastes (EAHCP §5.7.5)

Obligations:

The COSM will continue and expand its existing household hazardous waste program. This program will include opportunities for collection locations available to the general public.

2014 Compliance Actions:

As part of the EAHCP, the COSM operates a household hazardous waste (HHW) collection program. This program is available free of charge for all San Marcos and Hays County residents. Residents are able to drop off household chemicals and paint that are hazardous for the environment. This facility also operates a reuse program for items that are new or in good condition. Labor for the facility is contracted to Green

Guy Recycling. HHW is open to the public every Tuesday and Friday, from 12:00 PM to 3:30 PM. It is located at 630 E. Hopkins, San Marcos, TX 78666.

HHW serves communities throughout Hays County, which is home to large sections of the San Marcos River Watershed, and the Edwards Aquifer Contributing and Recharge Zones. This program offers an environmentally safe alternative to improper disposal of hazardous waste in the municipal waste stream and illegal dumping. Proper disposal and recycling decreases the risk of pollution to the local water resources. **Figure 3.3-33** depicts 2014 HHW Participants.

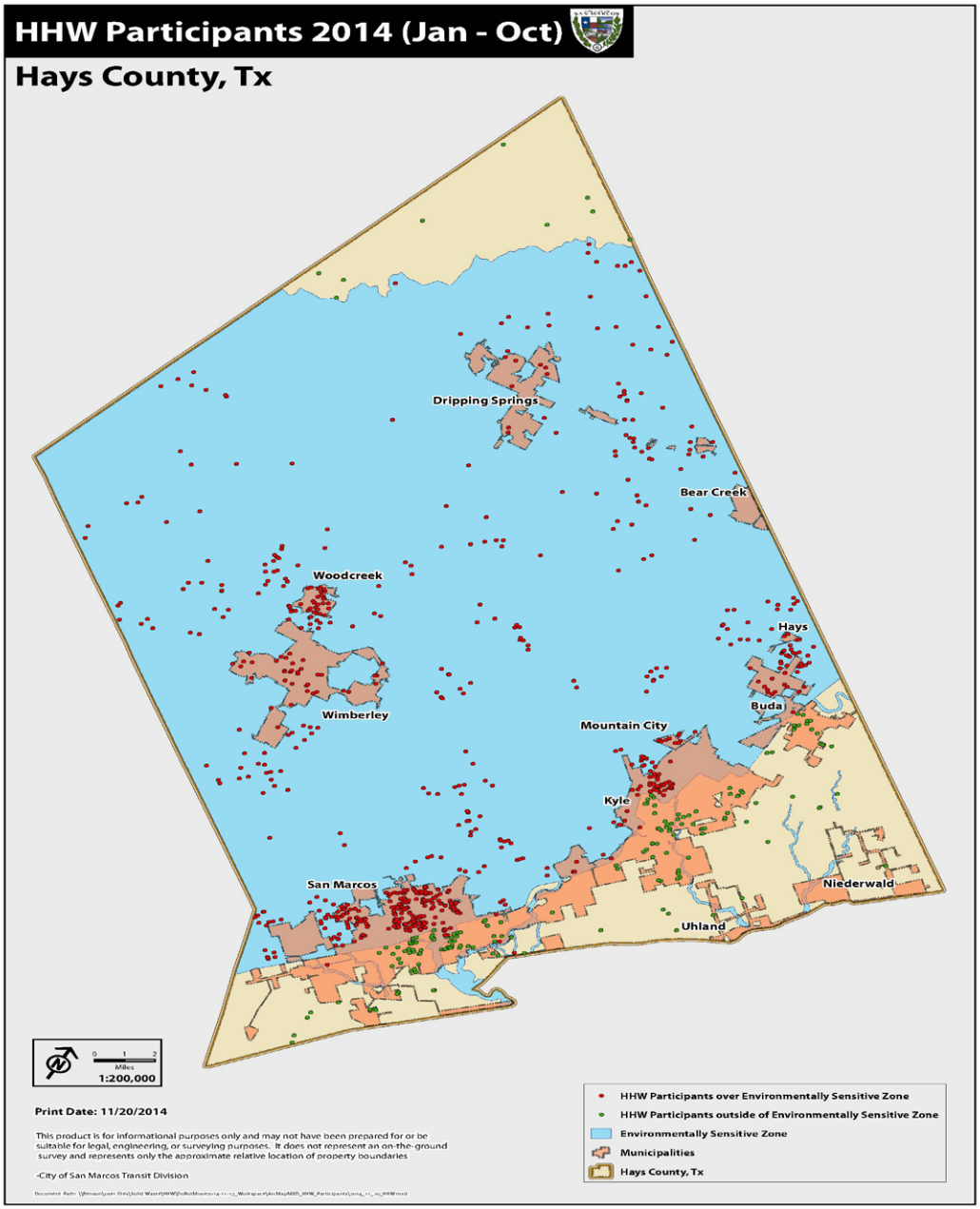


Figure 3.3-33. Locations of HHW Participants 2014

Drop Off Center Participation

The primary function of the HHW program is the drop off center. Here, residents drive into the unloading area, where they are met by an HHW worker. The participants remain in their vehicle as the worker unloads the containers onto a cart. Each participant fills out a survey and provides their address. From these surveys, monthly participation rates are tracked from each community.

The monthly drop off center participation rates are shown in **Figure 3.3-34**. Though participation is steady throughout the year, the summer months are the busiest. The average number of participants for 2014 is 122 per month.

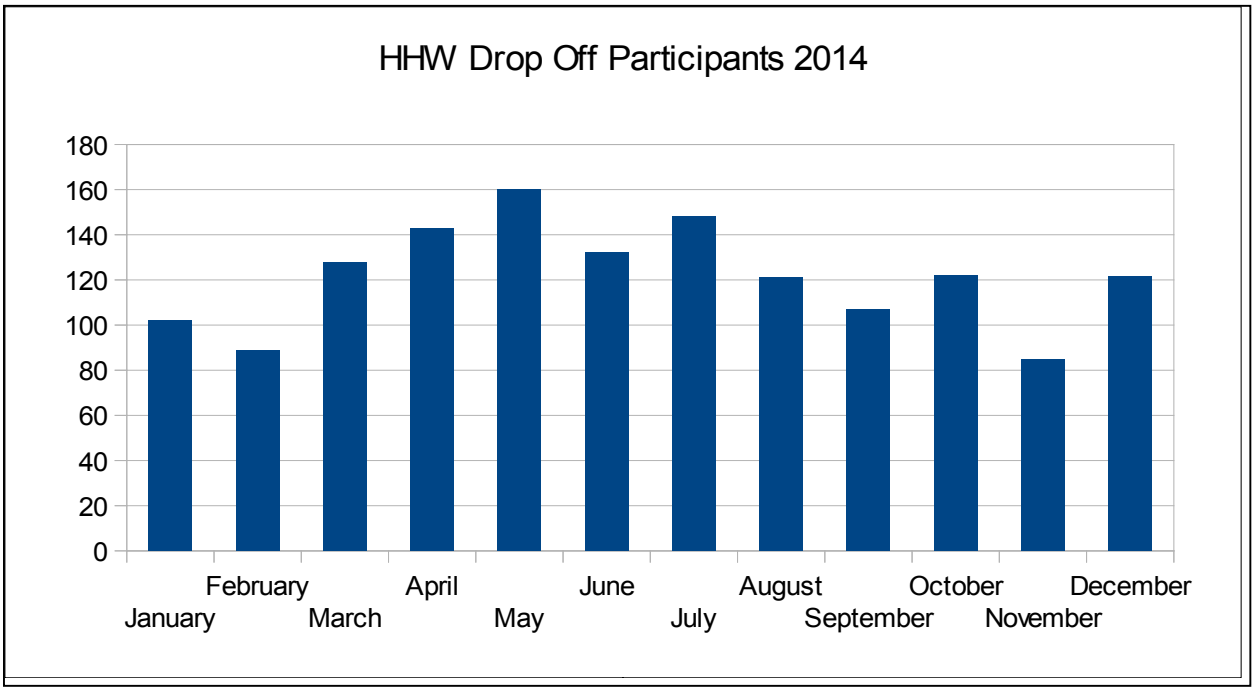


Figure 3.3-34. HHW Drop Off Participants 2014

While the HHW program serves many communities, the majority of the participants come from areas that are environmentally sensitive for the San Marcos River (**Figure 3.3-35**).

Reuse Program Participation

The reuse program is a cost-saving addition to the drop off center. When chemicals are unloaded, the worker segregates new and slightly used containers that are ready for use. These items are taken to the reuse building and are sorted on shelves. This building is open to the public during regular operating hours. Separating the reuse items saves on disposal costs, encourages public support, and reduces the demand for new chemical products. Reuse participants fill out a form documenting the materials they pick up. This form explains that unused items are to be returned to HHW and not thrown into the regular waste stream.

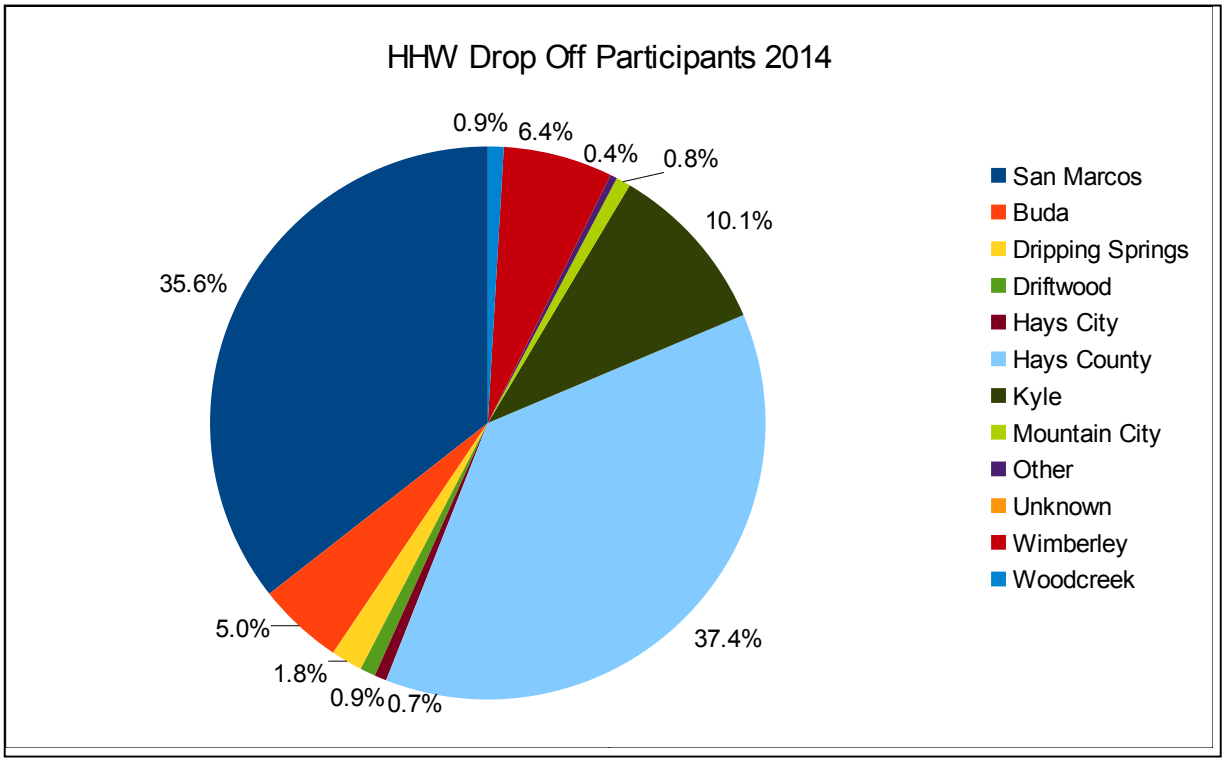


Figure 3.3-35. 2014 Drop Off Center Participants by Community

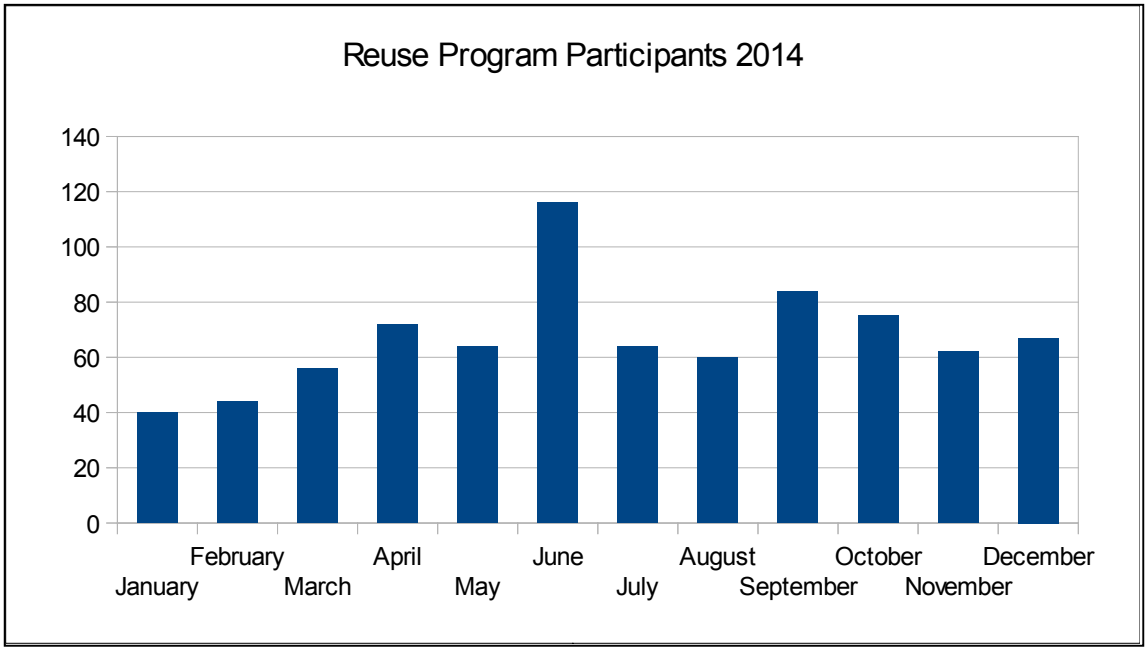


Figure 3.3-36. Reuse Program Participants 2014

The monthly totals range from 40 participants in January to 116 participants in June (**Figure 3.3-36**). The monthly average is 67 participants. The reuse program is very popular among residents. This community service allows residents to save money and help improve the sustainability of the local environment.

The annual outreach goal for HHW is 1,400 total participants. This goal was exceeded by 76 percent with an annual total of 2,462 participants. The popularity of the reuse program and increased exposure through public outreach contributed to the program's success.

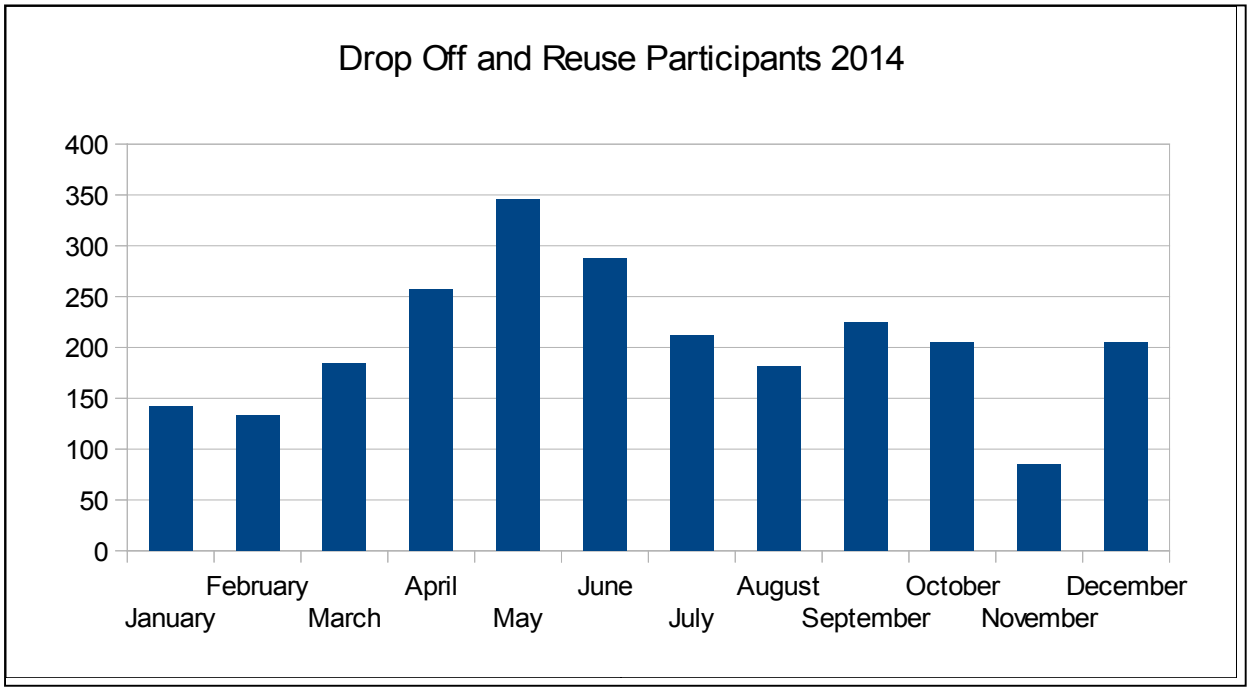


Figure 3.3-37. Drop Off and Reuse Participants 2014

Total participation rates remain steady throughout the year; however, May was an exceptional month with 346 participants (**Figure 3.3-37**). The average is 205 participants per month. The drop off center surveys indicate that the City website and word of mouth contribute to the steady program participation.

The Chemicals

The household hazardous materials accepted by HHW include a wide-range of common chemicals and waste products (**Table 3.3-11**). After the waste was unloaded from the vehicle, the material was sorted by community and weighed. Each item was sorted based on chemical type. Oil based and latex paint, liquid flammables, used motor oil, cooking oil, and anti-freeze were bulked into 55-gallon drums. Bulking these materials reduces the cost of disposal. The remaining chemicals were sorted into either 55 gallon drums or lined gaylord boxes. Each container was stored in a chemical building or under cover until they were shipped to recycling facilities and a chemical landfill.

Table 3.3-11. A complete list of materials accepted at HHW

Materials Accepted
Latex Paint
Oil Based Paint
Flammable Liquids and Solids
Pesticides

Table 3.3-11. A complete list of materials accepted at HHW

Materials Accepted
Liquid and Solid "9's"
Acids
Bases
Oxidizers
Aerosol
Oil and Oil Filters
Anti-Freeze
Cook Oil
CFL's
Fluorescent Bulbs
Mercury Vapor Bulbs
Batteries
Propane
Expandable Foam
Smoke Detectors and Thermostats
Unknown Materials

HHW collected approximately 81,714 kilograms of household hazardous waste in 2014 (**Figure 3.3-38**). Without this program, much of this waste would have been improperly disposed of in the municipal waste stream or illegally dumped.

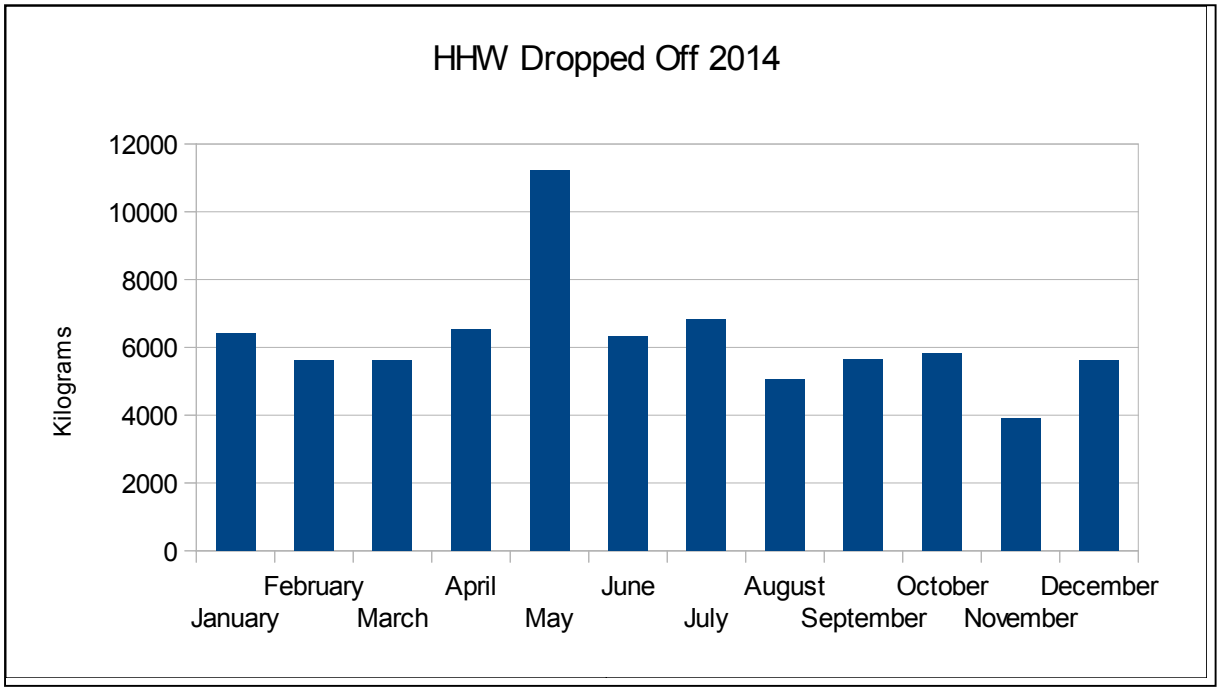


Figure 3.3-38. HHW Drop Off Weights 2014

Monthly figures range from 3,902 kilograms in November to 11,222 kilograms in May. Drop off weights for 2014 averaged 5,606 kilograms per month.

The amount of household hazardous waste diverted from the waste stream and distributed by the Reuse Program totaled 7,157 kilograms (**Figure 3.3-39**). Not only does this save on costs, it also decreases the demand for new products. The program helps with both material reuse and waste reduction.

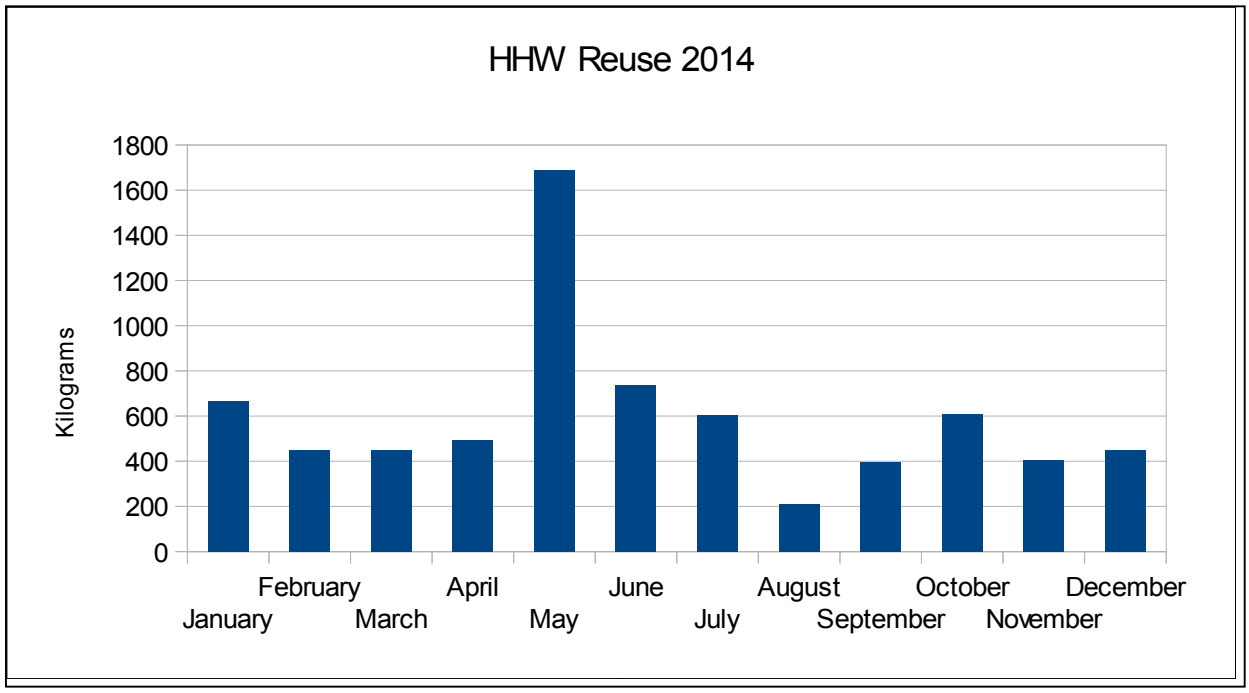


Figure 3.3-39. HHW Reuse Weights 2014

The average amount reused was 451 kilograms per month. During the month of May, 1,690 kilograms of waste was diverted for reuse. The weight of May material can be attributed to the mobile event in Driftwood. The amount of waste collected from the reuse program remains steady throughout the year.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, the HHW/recycle program will hold a spring event in northern Hays County. This outreach will increase disposal costs as northern Hays County has not had a drop off event in four years. EAHCP funding will shift to help cover these costs. The City will continue to promote the HHW facility in the surrounding communities.

3.3.14 Impervious Cover and Water Quality Protection (EAHCP §5.7.6)

Obligations:

The COSM will establish a program to protect water quality and reduce the impact of impervious cover. Target programs will be identified consistent with the recommendations of the LID/Water Quality Work Group Report developed during the EARIP and included as Appendix Q to the EAHCP.

The San Marcos Water Quality Protection Plan (WQPP) is a locally-developed approach for compliance with the ESA in San Marcos, Texas. The intent of the WQPP is to provide a holistic, integrated approach for Texas State and the COSM in regards to water quality concerns associated with impervious cover and urban development. In addition to protecting habitat for endangered species, the WQPP will help the entities serve the needs of their growing populations and promote responsible economic development, good public infrastructure, and preserve open space.

2014 Compliance Actions:

The following services were performed in support of the 2014 Water Quality Protection Plan during this period.

- Completed the 2014 WQPP report. This included separating the executive summaries for the two entities (COSMand Texas State). Additional content has been added and reorganized to separate recommendations for each entity throughout the report.
- The Meadows Center for Water and the Environment completed their watershed characterization and HSPF/BASINS modeling work as it pertains to the WQPP.
- Completed initial revisions to the COSM Land Development Code ("low-hanging fruit") including procedures for meeting current City standards (which are different from those of the TCEQ) in the Edwards Aquifer Recharge Zone.
- Conducted site visits and provided consulting services for the following potential water quality retrofits:
    - Potential transformation of the City-owned Schulle Creek detention pond into a water quality pond that manages the neighborhood litter problem as well as other non-point source pollution
    - Responded to comments from the City staff and Park Rangers on the City Park parking lot stormwater retrofit project; revised design based on input
    - Site visit and assessment of the Glade & Recycling Center stormwater impacts on the University campus
- Presented WQPP recommendations to various stakeholders and decision-makers. Solicited feedback and revised the recommendations accordingly. Opportunities for meaningful interaction included the following:
    - Multiple presentations to the City DREAM team allowing in-depth review of the three major elements of the WQPP including revised land development regulations, operational and programmatic elements, and potential stormwater retrofits on City property
    - Discussions regarding the potential for integrating stormwater treatment into Code and Criteria that apply to the downtown SmartCode T5 and T6 transects

- Code SMTX: met with Dover-Kohl and City staff regarding Chapter 5 of the Land Development Code; revised WQPP recommendations
- Presentation to the Core Committee of the San Marcos Watershed Initiative regarding WQPP-recommended BMPs
- Multiple presentations and discussions with COSM CIP and Planning Department staff regarding proposed WQPP stormwater management performance standards and regulations
- Presentations to key stakeholders including the City Manager, City Council, Greater San Marcos Partnership and the Home Builders Association regarding basic WQPP recommendations
- Assessment of the potential impact of WQPP recommended performance standards on three specific development projects proposed in the COSM
- Participation in the COSM Code Rodeo which solicited input from citizens and Think Tank committee members in regards to environmental concerns
- Multiple presentations and discussions with the Texas State staff regarding WQPP recommendations and their effect on the Campus Master Plan and construction standards

- Completed the transformation of a downtown water quality retrofit pond from the originally-designed wet pond into a biofiltration pond. This included revisions to the contract documents, guidance for the COSM client, and contractor oversight.
- Met with Hays County staff regarding potential collaboration on a City Land Conservation program
- Reviewed and commented on the following documents and projects for the City of San Marcos:
  - Proposed Blanco Riverwalk development (undergoing site permit review)
  - COSM MS4 Stormwater Management Plan
  - La Cima Planned Development Agreement

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, the COSM and Texas State will continue implementation of the WQPP, including participation from all jurisdictional watershed areas that directly or indirectly impact the Covered Species. The COSM will continue development of an educational program to accompany the roll-out of the Protection Plan. Once adopted by both COSM and Texas State, the WQPP will be implemented.

3.3.15 Challenges Observed and Identified Solutions

In 2014, the COSM experienced the following challenges:

- Public impact on the eastern spillway is causing high disturbance of the San Marcos salamander habitat (USFWS has noted significantly decreased numbers after recreational season). TPWD will not allow closure of this spillway, so a solution is difficult.
- To be compliant with the TPWD ruling, the SSAs should not be erected until flows drop below 120 cfs. However, the structures have provided needed protection to vulnerable Texas wild-rice stands

during the recreational season thus it is best for the species to erect them immediately prior to Memorial Day (start of the season). City staff will begin meetings with the TPWD to see what can be done about remaining in compliance with TPWD rules.

- Avoiding damage to Texas wild-rice is difficult while removing floating vegetation mats. Pristine Texas Rivers developed an effective method of raking the stands in a downstream direction to minimize physical damage. Pristine Texas Rivers also began lifting and removing the floating vegetation so it did not simply float downstream and re-gather on other Texas wild-rice stands. This action needs to be observed during 2015 to ensure it is efficient and delivering the least impact to Texas wild-rice.
- For sediment removal, the EAHCP identifies the use of a 0.25-inch strainer on the suction pump. However, at this small of diameter, the strainer became clogged very quickly and slowed the dredging process. The use of a 1.0-inch strainer to increase dredging efficiency was proposed for approval. This request has been granted by the USFWS.
- Determining the most efficient, cost-effective, and practical method in collecting fine sediment once it is dredged from the river. Initially tried a reusable Geo Tube bag but this method was not efficient because we quickly filled the bag and the Geo Tube bag did not retain the fine sediment. The next method tried was to dredge the fine sediment into a large storage tank. However, this method ended with similar results with the tank filling up very quickly. City staff determined that using a settling area or catchment pit was the most effective and efficient method to collect the sediment once it is dredged from the river. However, it has space limitations. Options are under consideration. This is still relevant as little silt removal occurred in 2014 due to flows below 120 cfs.
- The removal of elephant ear left behind a bare bank which was sometimes used as access by recreationists thus causing bank damage. In 2014, these areas will be fenced and heavily planted with larger species such as Mexican buckeye, red buckeye, and rice cutgrass *(Leersia oryzoides)*. This solution did not work as these small areas close to the river could not be fenced and all plantings were trampled. No more small plantings will be undertaken until most of the larger riparian treatment areas require less maintenance.
- After the first year, the City is responsible for the restored riparian areas. This responsibility falls upon one full-time position which does not have time available for maintenance. No solution in sight at this time.

3.4 Texas State

Texas State is responsible for the following minimization and mitigation measures under the EAHCP:

- Texas wild-rice Enhancement and Restoration (§ 5.4.1)
- Management of Recreation in Key Areas (§ 5.4.2)
- Management of Vegetation (§ 5.4.3)
- Sediment Removal in Spring Lake and Sewell Park (§ 5.4.4)
- Diversion of Surface Water (§ 5.4.5)
- Sessom Creek Sand Bar Removal (§ 5.4.6)
- Diving Classes in Spring Lake (§ 5.4.7)

- Research Programs in Spring Lake (§ 5.4.8)
- Management of Golf Course and Grounds (§ 5.4.9)
- Boating in Spring Lake and Sewell Park (§ 5.4.10)
- Reduction of Non-Native Species Introduction (§ 5.4.11)
- Control of Non-Native Plant Species (§ 5.4.12)
- Control of Harmful Non-Native and Predator Species (§ 5.4.13)

All measures have been implemented according to the reviewed and approved 2014 Work Plans. Implementation of these measures has been accomplished in partnership with the COSM, as specified in the EAHCP. Modifications due to drought conditions are discussed in the subsections below. Texas State extended its EAHCP obligations in partnership with the COSM to maintain consistency in implementation of EAHCP measures that jointly affect the listed species and their habitats in the San Marcos River.

3.4.1 Texas wild-rice Enhancement and Restoration (EAHCP §5.4.1)

Obligations:

Texas State, in partnership with the COSM, will identify optimal habitat areas for Texas wild-rice and target those areas for restoration. Restoration will involve the removal of non-native plant species, propagation of new wild-rice plants, and continued monitoring of the new stands. The City will use modeling results from Texas State and TPWD to determine appropriate sites for restoration to ensure the best possible success rate.

2014 Compliance Actions:

Non-native aquatic vegetation was removed in areas suggested as optimal Texas wild-rice habitat, based on modeling results from Hardy et al. 2010. Non-native vegetation was also removed in mixed stands of Texas wild-rice, and the original Texas wild-rice stand was monitored for expansion. Similarly, for Texas wild-rice stands occupying optimal areas with adjacent non-native vegetation, the non-native vegetation was removed. Non-native vegetation was fanned to displace fountain darters prior to uprooting the vegetation. After removal, all non-native vegetation was sorted and any fountain darters (or other native species) were salvaged and returned to the river. The non-native vegetation was disposed at the COSM composting facility. Denuded areas were planted with Texas wild-rice obtained from the USFWS SMARC or from raceways located at the FAB, Texas State campus.

An estimated total number of Texas wild-rice planted within the San Marcos River from November 2013 through December 2013 (not reported in Annual Report 2013) in the San Marcos River from Spring Lake Dam downstream through Sewell Park was 343 individuals that covered 20 to 50 percent of the denuded area. The estimated area planted with Texas wild-rice was 33.59 m^2 (**Table 3.4-1**). **Figure 3.4-1** illustrates planting density (plants/m2), as well as planting location of Texas wild-rice and other native species in the San Marcos River at Sewell Park.

The estimated net gain of Texas wild-rice area from April 2013 through November 2014 determined by mapped polygons was 170 m^2 within areas denuded of non-native vegetation followed with Texas wild-rice planting in the San Marcos River at Sewell Park (**Figure 3.4-1**).

Table 3.4-1. Estimated number (N), area planted (m^2), and density planted of *Zizania texana* planted by date in the San Marcos River from Spring Lake Dam through Sewell Park (November 2013 – December 2014)

Species	Date	N	Area planted (m^2)	Density Planted
Zizania texana	11/20/2013	174	10.58	16.44
	12/8/2013	169	8.06	20.97
***Zizania texana* planting totals**		**343**	**18.64**	-

Modifications Due to Drought Conditions:

Texas State ceased Texas wild-rice planting from August 2014 to October 2014 due to river flows dropping below 120 cfs. In October 2014, a clarification of Condition M of the ITP from USFWS permitted MCWE to conduct maintenance in previously restored areas.

Proposed Activities for 2015:

In 2015, Texas State will continue to maintain existing Texas wild-rice stands and plant stands in areas where new habitat has been created through sediment removal and aquatic vegetation restoration. The 2015 goal is to add 1,100 m^2 of additional Texas wild-rice to the system.

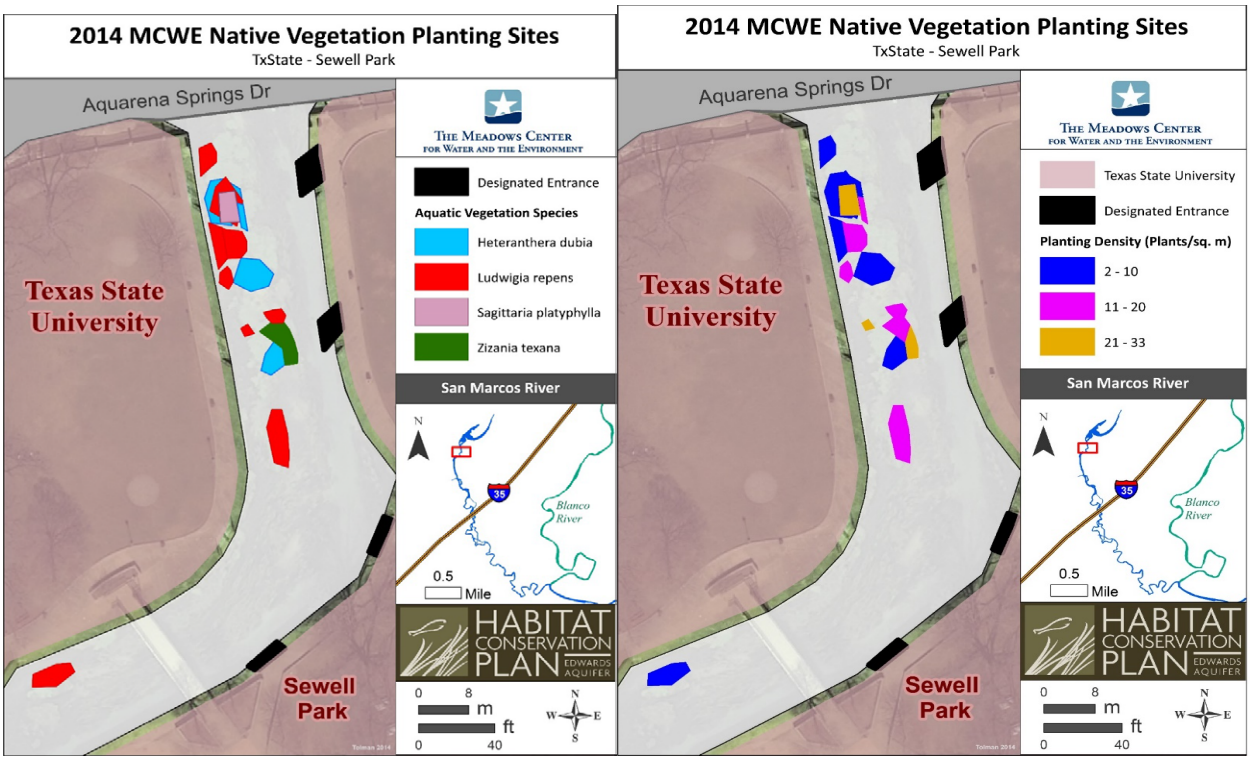


Figure 3.4-1. 2014 MCWE planted densities (left) and planting locations (right) of Texas wild-rice and other native species in Sewell Park

Management of Recreation in Key Areas (EAHCP §5.4.2)

Obligations:

Texas State will work with the COSM to implement recreation restrictions in Spring Lake and the San Marcos River within the jurisdiction of the University. Texas State will incorporate permanent access points along the east and west banks of the San Marcos River to direct recreationists. Texas State will additionally develop kiosks to educate the public regarding recreation restrictions within their property limits.

2014 Compliance Actions:

- Access control: Working in collaboration with the COSM, the eastern shoreline below the eastern spillway of Spring Lake adjacent to the Clear Springs Apartments downstream to Aquarena Springs Drive bridge was fenced to block access to the river and was targeted for riparian vegetation restoration. An access point is being designed at the Aquarena Springs Drive bridge that avoids the Texas wild-rice stands in this section of the river. Access on the western shoreline upstream of the Aquarena Springs Drive bridge was enhanced by the bank stabilization project completed by Texas State in May.
- State Scientific Areas: During 2012, the TPWD designated the segment of the river from the Spring Lake Dam to the San Marcos wastewater treatment plant as the San Marcos River State Scientific Area (SSA). The SSA designation established state regulations prohibiting uprooting of Texas wild-rice within the designated segment. TPWD authorized the placement of physical barriers

around vulnerable stands of Texas wild-rice when flows within the designated segment are 120 cfs or lower, to help people avoid the plant while recreating in the river (**Figure 3.4-2**). Barriers were deployed around select stands of Texas wild-rice at Bicentennial Park, the eastern spillway by Clear Springs Apartments, downstream of the Hopkins Street railroad bridge and across from the Texas State Outdoor Recreation Center boat dock. The Texas wild-rice stand across from the Ramon Lucio access point was also roped off, but it failed multiple times, so it was removed. Efforts by the Conservation Crew (CC) to educate people about the SSA and the four exclusion areas along with signage on the barriers furthered public awareness.

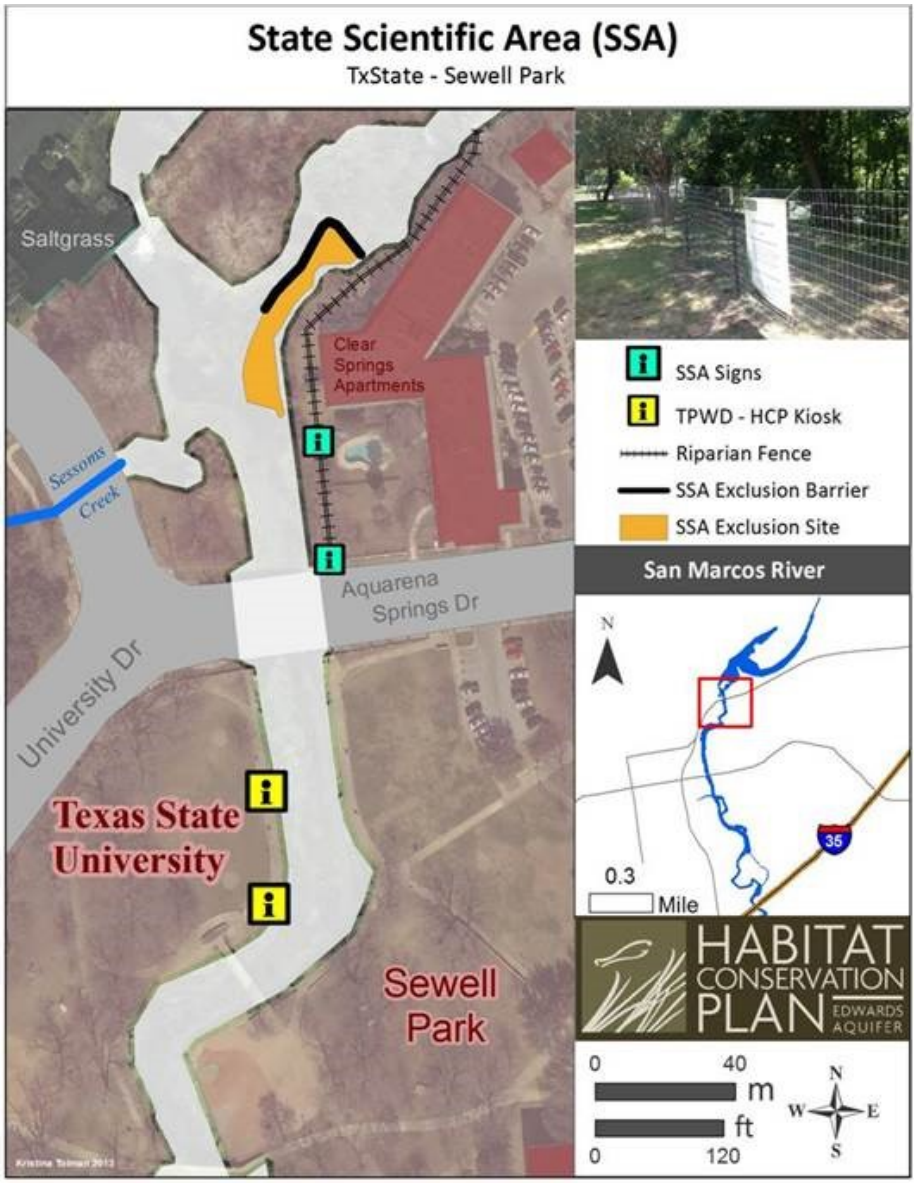


Figure 3.4-2. Location of exclusion zones and TPWD-HCP Kiosk in the San Marcos River from Spring Lake Dam downstream through Sewell Park

- Signage: In 2013, two kiosks were constructed to display signs produced by the TPWD in Sewell Park (**Figure 3.4-2**). Additionally, signs were placed at multiple locations on the SSA barriers, which was critical because people in the river cannot see the signs on the banks. The TPWD is currently working to produce Spanish language versions of these signs for existing and future kiosks. In 2014, CC replaced one of the weathered kiosk signs and removed the other kiosk entirely at Sewell Park. A new kiosk will be constructed.
- CC: This work team was developed to educate the public about the EAHCP, but their primary focus is on Texas wild-rice stands in high recreation areas. The team was composed of twelve university students paid by both EAHCP funds and City funds. They began work on May 21 with an orientation at the SMARC. On May 23, the CC began working Wednesday-Sunday, and worked through the Labor Day weekend. Four crewmembers worked in teams of two each day from 11:00 AM – 7:00 PM, with two crewmembers kayaking the river and two crewmembers walking the banks in an effort to maximize river user contact. Duties performed by the crew included:
    - Interacting with people using the river and riverside parks to help increase public knowledge about Texas wild-rice. CC pointed out Texas wild-rice stands, presented actions river users could take to help protect Texas wild-rice and discussed other San Marcos River listed species and park rules.
    - Clearing vegetation mats from surface of Texas Wild Rice stands. These mats accumulate quickly and degrade the plant stand. This is particularly important during low flows when the stands are exposed.
    - Emptying litter boats. During the recreation season, boats are tied under the two railroad bridges. The crew emptied these boats four times a week.
    - Monitoring SSA exclusion sites. The EAHCP 2014 Work Plan designated four areas within the SSA to be areas of recreation exclusion. These areas required frequent monitoring for structure maintenance and cleaning of floating vegetation mats.
    - Pick up litter along and in the river. This was a continual effort that enabled the EAHCP litter contractor to spend more time in the tributaries, which are heavily littered.
    - All projects and tasks were used as "public education opportunities."
- Establishment of a recreational baseline: MCWE took video at hourly intervals at four locations along the river from Sewell Park to Rio Vista Falls to obtain a baseline of recreational use. These data are being summarized and correlated with turbidity and other water quality readings from these sections of the river.
- EAHCP Section 5.3.2.1 for the COSM was coordinated with Texas State and action was taken on the following tasks:
    - Education - Signage – kiosks and fence signs were maintained at upper Sewell Park and Sewell Park. TPWD, the City, and the University are working on Spanish translations of their signs. The EAA sign template is used as the background for most of the signs.
    - Partnership between the City and University. The CC monitors both City and University property and is supported by City Park Rangers and University Police. A pre-recreation season meeting is held with University and City law enforcement to ensure a cohesive approach to recreation management. Additionally, the COSM Habitat Conservation Plan Manager is funded equally by the University and the City to ensure a unified approach.

Modifications Due to Drought Conditions:

The drought caused lower flow rates in the San Marcos River which resulted in increased accumulation of floating vegetation on Texas wild-rice stands and litter on the substrate. Therefore, removal of vegetation mats from Texas wild-rice stands as well as litter removal frequency increased as flows decreased to minimize potential impacts.

Proposed Activities for 2015:

Texas State will continue to implement education programs targeting river users about sustainable river use and the listed species. The University will gather information on recreational use of the river and potential impacts of those activities on the ecosystem. The CC, a paid group of individuals responsible for educating the public, informing authorities of destructive behavior, and conducting miscellaneous clean-up of the system will be present from Memorial Day to Labor Day.

3.4.2 Management of Vegetation (EAHCP §5.4.3)

Obligations:

Texas State will utilize hand-cutting and a harvester boat to manage aquatic vegetation in Spring Lake. Related activities include:

- Weekly, floating vegetative mats will be dislodged in five springs; each spring will be addressed every two-three weeks.
- Floating vegetation mats will be dislodged more frequently in the summer.
- Floating vegetation mats will be dislodged from Texas wild-rice stands weekly.
- Algae will be removed regularly in the summer.
- Accumulated sediments around spring orifices will be removed within a 1.5-meter buffer radius.
- From 1.5 to 3.0 meters from spring orifices, vegetation will be sheared to a height of 30 centimeters (cm) and from 3.0 to 6.0 meters from the orifice, vegetation will be sheared to a height of one meter.
- Fifteen to twenty boatloads of plant material will be removed by the harvester boat monthly; including weekly removal from designated zones one, two, and three (Figure 5.2 in the EAHCP).
- Removed vegetation will be inspected for aquatic species which will be returned to the river system immediately.
- Vegetation mats will be removed from zones four and five (Figure 5.2 in the EAHCP) on an as-needed basis.
- University employees or others working with and around Texas wild-rice will be trained by TPWD to recognize and protect the plant while doing work in the San Marcos system.
- All vegetation removal activities on Texas State property will be managed by a full-time staff person responsible for operating the harvester boat, manually removing floating vegetative mats, and ensuring all staff and volunteers involved in vegetation removal are familiar with the aquatic ecosystem and able to recognize listed species.

2014 Compliance Actions:

Management of Submerged and Floating Aquatic Vegetation in Spring Lake

- Spring Orifice Maintenance: Texas State personnel at the MCWE in conjunction with qualified Diving for Science volunteers removed accumulated sediment where necessary from target springs in Spring Lake by finning the substrate away. In addition, aquatic vegetation was removed from an approximately 1.5 meter radius of each target spring with a machete. The aquatic vegetation within the next 1.5 meter radius area around each target spring was cut to a height of 30 cm and the cut material allowed to flow downstream with the current. Aquatic vegetation within the next three-meter radius of target springs was sheared to height of one-meter and cut vegetation allowed to drift downstream. **Table 3.4-2** provides a summary of work conducted for this EAHCP measure.

Table 3.4-2. Aquatic Vegetation Maintenance Activities within Spring Lake in 2014

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Totals
Aquatic Maintenance (approxiate dives)	15	15	15	15	15	25	25	10	15	15	20	10	**195**
Aquatic Maintenance Dive Hours (average 1.15 hrs/dive)	18.75	18.75	18.75	18.75	18.75	31.25	31.25	12.5	18.75	18.75	25	12.5	**243.75**
Diving for Science Volunteers	65	75	60	43	60	72	82	68	56	108	143	58	**890**
D4S Dive Hours (average 1.15 hrs/dive)	81.25	93.75	75	53.75	75	90	102.5	85	70	135	178.75	72.5	**1,112.5**

- Harvester Boat: Maintenance of submerged and floating aquatic vegetation followed the protocols outlined in the EAHCP (Section 5.4.3.1) and the approved Spring Lake Management Plan. The harvesting schedule targets three cuts per week, typically Monday, Wednesday, and Friday mornings. Scheduled harvesting of each zone rotates in order to allow each zone adequate recovery time and ensure that a specific zone is not over cut. This results in each zone being cut two or three times a month. The estimated aquatic vegetation harvest is approximately 10 to 12 cubic yards/per cutting. The total estimated harvest is approximately 1,112.5 cubic yards for the year.

Management of Aquatic Vegetation below Spring Lake Dam to City Park

Texas State collaborated with the COSM to control aquatic vegetation mats entrained on Texas wild-rice stands below Spring Lake Dam to the end of Sewell Park. Aquatic vegetation removal was conducted by Pristine Texas Rivers, Inc. (PTR) by pushing floating mats downstream, as specified in the EAHCP. In

addition, personnel at the Meadows Center for Water and Environment and members of the COSM CC supplemented vegetation removal during low flows.

Modifications Due to Drought Conditions:

Increased frequency of aquatic vegetation removal activities.

Proposed Activities for 2015:

In 2015, Texas State will continue to implement floating vegetation mat and litter removal consistent with protocols established in the EAHCP and in the initial 2013 Work Plan.

3.4.3 Sediment Removal in Spring Lake and Sewell Park (EAHCP §5.4.4)

Obligations:

Texas State will remove accumulated sediments from Texas wild-rice habitat in Spring Lake and from Spring Lake Dam to City Park. Sediments will be removed using hydrosuction. Protective measures including finning, controlled use of the vacuum hose, and clear boundaries for divers will limit any impacts to the species.

2014 Compliance Actions:

No dredging occurred in the San Marcos River in Spring Lake through Sewell Park during 2014.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, Texas State does not have any areas proposed for sediment removal with the exception of sediment at the confluence of Sessom Creek.

3.4.4 Diversion of Surface Water (EAHCP §5.4.5)

Obligations:

Texas State will reduce the amount of surface water diverted from the San Marcos River in accordance with the following conditions:

- Reduce diversion by two cfs when the USGS gauge at University Bridge reads 80 cfs (reduction made below Spring Lake Dam).
- Reduce diversion by an additional two cfs (total two cfs) when the USGS gauge at University Bridge reads 60 cfs (reduction made in Spring Lake).
- Reduce diversion by all but one cfs when the USGS gauge at University Bridge reads 49 cfs (reduction made in the Sewell Park reach).

- Cease all surface water diversions when the USGS gauge at University Bridge reads 45 cfs.

The University will additionally use, maintain, and monitor 0.25-inch mesh screen covers at the intake for the surface water diversion.

2014 Compliance Actions:

Texas State did not reduce permitted pumping in 2014 to EAHCP requirements, since total San Marcos River flows did not reach trigger points (i.e., < 80 cfs). Texas State did, however, continue to voluntarily suspend pumping from the San Marcos River at Sewell Park (Certificate 18-3866). The total volume of surface water diversions from Spring Lake was 38 ac-ft/yr for 2014 and below the permitted 100 ac-ft/yr. Maximum instantaneous diversion rates did not exceed the permitted amount of 1.33 cfs.

Texas State continued to use a 0.25-inch mesh screen to cover the intake for surface water diversions. The mesh screen prevents the suctioning of fountain darters and other protected biota into the diversion pumps. The screens were routinely inspected and cleaned as part of regular operations. No fountain darters were observed when the screens were cleaned.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, Texas State will reduce or cease the diversion of surface water as required by flow conditions and described in the EAHCP.

3.4.5 Sessom Creek Sand Bar Removal (EAHCP §5.4.6)

Obligations:

Texas State, in partnership with the COSM, completed a study to determine the most appropriate technique for removal of the Sessom Creek Sand Bar. The modeling results and removal method recommendation was reviewed by the Science Committee and approved by the Implementing Committee. In addition, external to EAHCP measures, Texas State stabilized the Sessom Creek confluence (**Figure 3.4-3**)

2014 Compliance Actions:

The Adaptive Hydraulics Modeling System (version 4.31, Berger et al. 2013) was utilized to model existing conditions and three alternative scenarios that ranged from full sediment bar removal versus differential channel configurations. The report recommended removal using backhoe and was approved by the Science Committee and the Implementing Committee. Low flows precluded removal of sediments from the river.

Figure 3.4-3. External to EAHCP measures, Texas State stabilized the Sessom Creek confluence in 2014

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

Removal of the gravel bar at the Sessom Creek confluence when flows in the San Marcos are greater than 120 cfs.

3.4.6 Diving Classes in Spring Lake (EAHCP §5.4.7)

Obligations:

Every diver participating in the Texas State Diving for Science Program will need to show an understanding of the listed species found in Spring Lake and their habitats, as well as the laws and regulations relevant to those species. Divers must exhibit good buoyancy control, have the ability to avoid contact with listed species and critical habitat, and maintain a distance from the lake bottom.

No more than 16 trained divers may be present in Spring Lake at any time. Texas State will conduct training for check-out dives and SCUBA classes no more than three times per day, and classes will include a maximum of twelve students per class.

2014 Compliance Actions:

MCWE updated the Spring Lake Management Plan to reflect all the requirements under the EAHCP and ITP. This includes the following EAHCP measures:

- Diving for Science Program (§5.4.7.1)
- Texas State Continuing Education (§5.4.2)
- Texas State SCUBA Classes (§5.4.7.3)

The revised plan implements the EAHCP requirements with the following restrictions:

- Diving for Science Program – No more than 16 volunteer divers/day and $\leq$ 8 at one time
- Texas State Continuing Education – 12 divers/class; $\leq$ 3 classes/day; restricted to the Dive Training Area
- Texas State SCUBA Classes – 12 students/class; $\leq$ 3 classes/day; restricted to the Dive Training Area

The revised Spring Lake Management Plan was submitted and approved by the President's Cabinet in 2012. As part of this effort, MCWE implemented a Diving Program Control Board that reviews all diving activities within Spring Lake to ensure they comply with the Spring Lake Management Plan and the EAHCP. These efforts also include the development of the Spring Lake Dive Accident Management Plan and revised Diving for Science program, which has implemented a more rigorous training program that includes expanded training and orientation on the endangered species. Diving activities in Spring Lake are summarized in **Table 3.4-3**.

Table 3.4-3. Diving Activities in Spring Lake in 2014

Activity FY 2014	January	February	March	April	May	June	July	August	September	October	November	December	Reporting Period Totals
Aquatic Maintenance (approxiate dives)	15	15	15	15	15	25	25	10	15	15	20	10	**195**
TXST Student Dives	0	0	9	170	0	0	0	0	8	36	189	65	**477**
Public Divers	0	0	275	200	277	271	218	279	101	142	143	116	**2022**
Volunteer Divers	65	75	60	43	60	72	82	68	56	108	143	58	**890**
SCI Student Dives	0	13	20	11	8	0	0	0	28	28	28	7	**143**
SCI Class Dives	0	32	24	32	8	0	0	0	0	20	20	17	**153**
Research Dives	20	4	23	4	12	5	4	11	4	6	18	1	**112**
External Dives (EAA, FWS, etc.)	8	8	2	2	7	4	0	4	3	3	4	0	**45**
New volunteers	0	0	10	0	0	0	0	0	20	34	4	12	**80**
Wounded Warriors (groups not individual #'s)	2	2	0	2	2	0	0	1	0	0	2	0	**11**
Totals	**110**	**149**	**438**	**479**	**389**	**377**	**329**	**373**	**235**	**392**	**571**	**286**	**4,128**

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, Texas State will implement their diving class program consistent with the protocols identified in the EAHCP.

3.4.7 Research Programs in Spring Lake (EAHCP §5.4.8)

Obligations:

No research will be conducted in Spring Lake without prior review and approval by the MCWE to assess impacts to the covered species. Where take cannot be avoided, Texas State will provide education to researchers regarding the species and their habitats. Independent researchers may need to obtain individual permits from the USFWS.

2014 Compliance Actions:

The Chief Science Officer at the MCWE chairs the Spring Lake Environmental Committee, which oversees all access to Spring Lake. To this end, MCWE developed an online access request form (http://www.aquarena.txstate.edu/Diving-for-Science/Access.html). Each request is reviewed by the eight-member committee, and if a vertebrate animal is the target of research the Institutional Animal Care and

Use Committee is also consulted for approval. In the event that the proposed research involves diving, the application and methods are reviewed by the Spring Lake Diving Control Board and if necessary, Scientific Diving training is required prior to access. **Table 3.4-4** summarizes the research/access activities in Spring Lake.

Table 3.4-4. Research and/or Access Activities on Spring Lake in 2014

Approved Research Activities FY 2014					
Researcher	**Department /Agency**	**Duration**		**Description**	**Impact +/-**
Maria Rocha	Indigenous Cultures Institute	1/18/2014	1/19/2014	Overnight Native American church Ceremony at the Headwaters	Minimal
Thomas Hardy	Biology_ MCWE	1/20/2014	1/31/2014	Filming underwater from barge with a boom camera; Take underwater video from the barge	Minimal
Jerry Cochran	Texas Water Safari	6/13/2014	6/14/2014	260 mile non stop canoe race starting on Spring Lake and finishing in Seadrift Texas	Minimal
William Terry	Biology_ Wildlife Ecology	3/10/2014	5/12/2014	Population Monitoring of Golden-cheeked Warblers	Minimal
Daniel Sharp	Private Study	2/24/2014	2/28/2014	Access Denied; Requested lake access for recreational snorkeling	N/A
Jacob Bilbo	Biology_ MCWE	3/15/2014	5/15/2014	Growth rates of invasive plant species	Minimal
Thomas Simpson	Biology_ Science and Engineering	3/1/2014	4/30/2014	Visual observation of beaver activity from bank or by canoe. Some nighttime surveys may be required.	Minimal
Todd Ahlman	Anthropology-CAS Texas State	1/27/2014	11/31/2014	Archaeological excavation; Data Recovery Proposal Crooks Park at Spring Lake	Moderate
Benjamin Hutchins	Texas Parks and Wildlife Department	3/21/2014	5/31/2014	Identification and monitoring of snail species; visual searches, hand collection, leaf litter searching hillside above Spring Lake	Minimal
William Beckers	Texas A&M Forest Service	3/21/2014	8/31/2014	Sticky trap hung in ash tree to capture Emerald Ash Borers	Minimal
Scott Gallagher	Flying FishViews Inc	4/15/2014	4/18/2014	Development of river/stream mapping techniques for public website;panoramic camera node, u/w cameras, hummingbird side looking sonar, HI9828 Water Quality Multi-meter	Minimal
Caitlin Gabor	Biology	4/24/2014	4/24/2014	Field Educational exercise; conducted annually; dip net to show students the mollies but all will be put back. No other invasive work will be performed	Minimal
Joseph Risse	Texas A&M Corpus Christi_ Research	4/15/2014	4/19/2014	Access Denied; Requested staff diver and lake access; no methodology or intent was provided	N/A
Frederick Hanselmann	MCWE_ Office of Sponsored Programs	4/23/2014	4/25/2014	Installation of Platform lift to assist ADA divers conducting dive training from the Center for the Intrepid.	Minimal
Kristin Kibling	OFPDC_ Texas State Facilities	5/15/2014	6/15/2014	Construction of ADA Upgrades Approved by OFPDC and Office of Disability Services; Boat Docks and Ticket Kiosk	Minimal

Table 3.4-4. Research and/or Access Activities on Spring Lake in 2014

Approved Research Activities FY 2014					
Researcher	**Department /Agency**	**Duration**		**Description**	**Impact +/-**
Pete Diaz	SM Aquatic Resource Center_ USFWS	5/28/2014	7/3/2014	Passive water sampler deployment; deploy one of the passive water samplers at the lower end of Spring Lake by the Salt Grass outflow.	Minimal
Andrew Johnston	Halff Associates, Inc	6/27/2014	6/27/2015	Halff Associates (Austin, TX) is under contract with Texas State to prepare a response to the most recent TCEQ Dam Safety Inspection Report.	Minimal
Stephen Harding	College of Science Biology	7/21/2014	8/31/2015	Collecting feces of piscivorous birds (mainly herons); attempt to establish artificial infections of trematodes in lab-reared snails.	Minimal
Don Steen	Parking Services	10/20/2014	10/20/2014	Stripping of 26 parking spaces in the Bus Turn around Loop	Minimal

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, Texas State will implement their research program consistent with the protocols identified in the EAHCP.

3.4.8 Management of Golf Course and Grounds (EAHCP §5.4.9)

Obligations:

Texas State will develop and implement a Golf Course Management Plan, including an Integrated Pest Management Plan (IPMP). These plans will consider the appropriate application of environmentally sensitive chemicals to reduce negative impacts to neighboring ecosystems. Any significant changes in the management protocol will be addressed through the Adaptive Management Process.

2014 Compliance Actions:

The MCWE in collaboration with the COSM completed a revised golf course management plan that includes a draft Integrated Pest Management Plan. The revisions follow the guidelines outlined in both the EAHCP (§5.4.9) and the Spring Lake Management Plan. Golf course operations followed the IPMP.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, Texas State will continue to implement its Golf Course Management Plan and IPMP and make updates to improve the quality of the Plan.

3.4.9 Boating in Spring Lake and Sewell Park (EAHCP §5.4.10)

Obligations:

Boating at Spring Lake will be restricted to areas treated with the harvester, operators will enter and exit boats at designated access points, and all boats will follow USFWS standards for proper cleaning.

2014 Compliance Actions:

The Spring Lake Management Plan was modified to ensure consistency with the EAHCP measures outlined in EAHCP (§5.4.10) for activities in Spring Lake. This included limiting canoe/kayak classes to no more than two classes per day with a maximum duration of one hour and limited to 20 students in ten canoes. In addition, the glass-bottom boats are restricted to areas in Spring Lake that are mowed for aquatic vegetation control. Boat access into Spring Lake must follow the USFWS decontamination process as outlined in the Spring Lake Management Plan and only enter at specific controlled locations that minimize potential impacts to listed species or their habitats. A total of 7,526 glass-bottom boat tours and 802 glass-bottom kayaks were conducted in 2014.

Canoeing/kayak classes in Sewell Park were limited to the region between Sewell Park and Rio Visa Dam as specified in the EAHCP. Access to the river was confined to the floating boat dock adjacent to the recreation center downstream of the walking bridge in Sewell Park. No more than three classes/day with a maximum of 20 students in ten canoes are permitted and not to exceed two hours in duration.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, Texas State will implement the boating program in Spring Lake and Sewell Park consistent with the protocols identified in the EAHCP.

3.4.10 Reduction of Non-Native Species Introduction (EAHCP §5.4.11)

Obligations:

Texas State will develop an education program and alternative disposal options to deter aquarium dumps into Spring Lake and the San Marcos River. The Texas State will work closely with the COSM in completing this measure.

2014 Compliance Actions:

Texas State collaborated with the COSM in looking for a suitable location for a pond that would function as a drop-off location for unwanted fish and other aquaria species that students no longer want. The University expects this to be operational for the 2015-16 school year.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

Texas State, in partnership with the COSM,will continue to provide educational information to local pet shops and commercial retailers that sell aquatic species.

3.4.11 Control of Non-Native Plant Species (EAHCP §5.4.12)

Obligations:

Texas State, in partnership with the COSM, will develop a non-native plant species removal program within university boundaries.

2014 Compliance Actions:

Non-native aquatic vegetation removal focused on *Hydrilla verticillata, Hygrophila polysperma,* and *Nasturtium officinale* as these species are the most actively invasive. Prior to non-native vegetation removal, the area was fanned to minimize incidental take of fountain darters and other native species. The non-native aquatic vegetation was removed, shaken, native aquatic species salvaged and returned to the river (including egg masses) and then bagged for disposal at the COSM or Spring Lake compositing facility. MCWE's progress for non-native vegetation removal was tracked with polygons containing the date, species removed, estimated area (m^2) and percent removed. A composite map depicting the routine maintenance required to remove large areas of non-native aquatic vegetation was generated using weekly polygons. The map illustrating the degree of effort was created by overlaying all the weekly polygons, rasterizing the spatial units, assigning a value of one for the treated area, and combining the layers with raster calculator. As a result, the layers capture the degree of overlap between 89 work sites and identify areas that required repeated removal efforts.

Denuded areas were targeted for Texas wild-rice or selected native aquatic species planting based on habitat preferences for each native species. Texas wild-rice and native species were obtained from the SMARC or from raceways located at the Freeman Aquatic Building, Texas State campus. Initial efforts for restoration of Texas wild-rice or native vegetation were targeted at planting approximately 20 percent of the surface area restored. MCWE planting efforts was tracked with polygons containing the date, number of individuals, estimated area (m2), and estimated density planted (individuals/m^2). A map illustrating planting location and planted densities was generated using weekly polygons. Aquatic vegetation was mapped using

Trimble GPS units in work areas prior to non-native vegetation removal and native planting to assess changes in the vegetation community through time.

An estimated 314 m^2 of non-native aquatic vegetation was removed in the San Marcos River from Spring Lake Dam downstream through Sewell Park from January 2014 to November 2014 among areas worked by Texas State staff (**Table 3.4-5**). The non-native vegetation species removed were *Hygrophila polysperma* (Estimated Area ~146 m^2), *Nasturtium officinale* (~89 m^2), *Hydrilla/Hygrophila* mix (~42 m^2), and *Hydrilla verticillata* (~37 m^2). **Figure 3.4-4** illustrates the degree of effort for non-native aquatic vegetation removal by MCWE staff in the San Marcos River for 2014. An average work site ranged in scale from concentrated removal of 100 percent *Hygrophila polysperma* within a small area of 5 m^2 to removing mixed stands of *Hygrophila* and *Hydrilla* in 5 percent of a large work site that covered 939 m^2 but with a total removal of 47 m^2. The largest removal effort occurred during the week of February 12, 2014 when 50 percent, or 123 m^2, of *Hygrophila polysperma* within a 247 m^2 work site were removed.

Table 3.4-5. Estimated area removed (m^2) of Non-Native Vegetation Species by Date in the San Marcos from Spring Lake Dam through Sewell Park (January – November 2014)

Species	Date	Area removed (m^2)
Hydrilla verticillata	1/9/2014	2.31
	6/9/2014	24.04
	8/4/2014	10.18
Hydrilla verticillata total		**36.53**
Hydrilla/Hygrophila mix	2/10/2014	0.76
	2/10/2014	11.34
	6/9/2014	29.54
Hydrilla/Hygrophila mix total		**41.64**
Hygrophila polysperma	1/9/2014	30.85
	3/11/2014	44.46
	6/10/2014	6.51
	8/4/2014	14.14
	10/10/2014	12.04
	10/16/2014	15.51
	10/20/2014	18.10
	10/24/2014	4.84
Hygrophila polysperma total		**146.45**
Nasturtium officinale	8/4/2014	15.20
	10/24/2014	74.24
Nasturtium officinale total		**89.44**
Total Area Non-native Aquatic Plants Removed		**314.06**

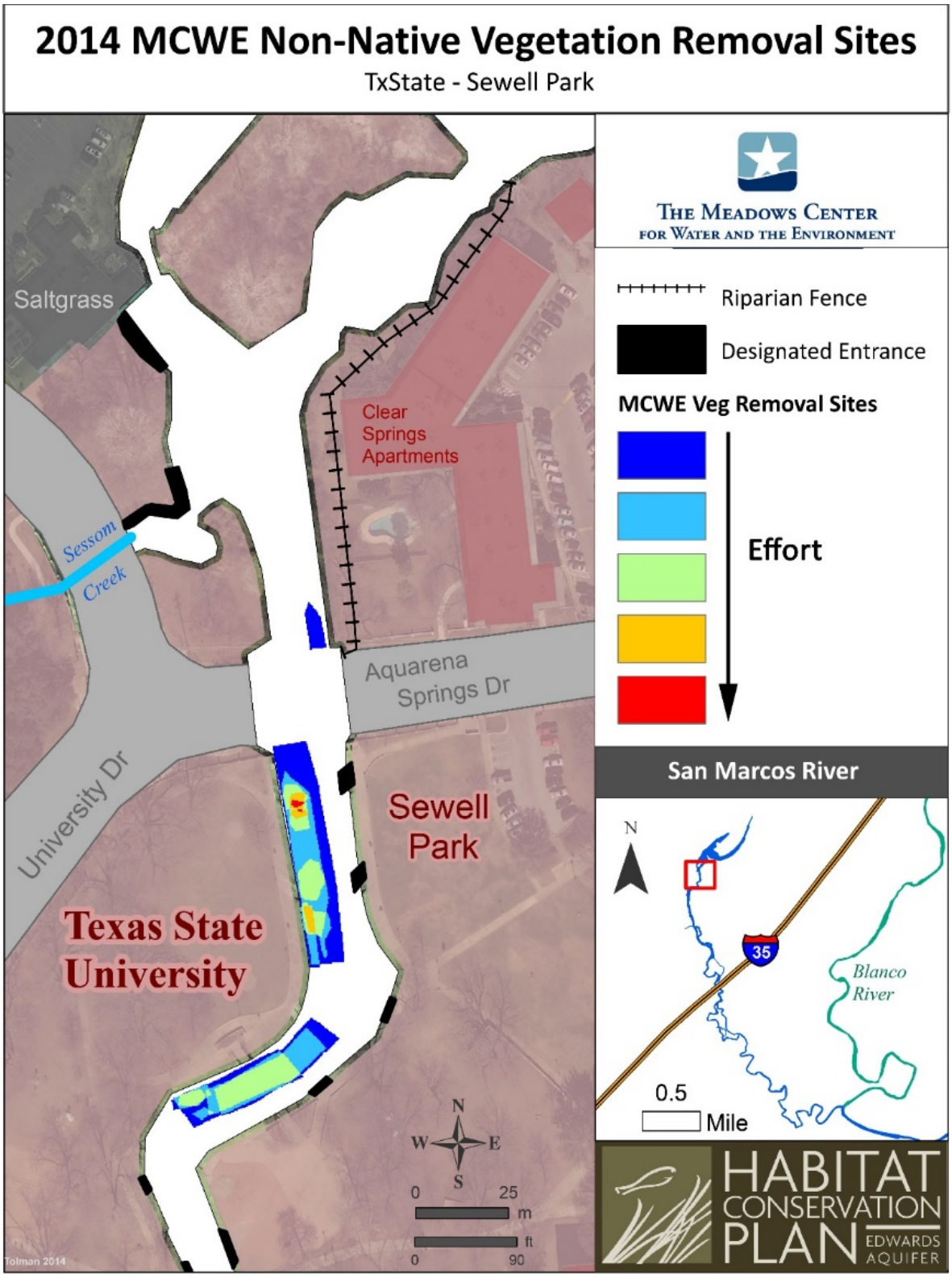


Figure 3.4-4. Vegetation removal effort by MCWE staff for removing non-native vegetation in the San Marcos River from Spring Lake Dam downstream through Sewell Park. Red spots indicate the areas of highest effort (i.e, hotspots) needed for continued non-native removal

Based upon GPS polygon locations, estimated net loss of non-native vegetation observed from April 2013 to November 2014 was 121 m^2 in the San Marcos River downstream of Spring Lake Dam through Sewell Park (**Table 3.4-6**). Changes in vegetation outside of the areas worked were not included because differences observed could not be attributed to our work. Estimated totals for non-native vegetation species removed were *Hygrophila polysperma* (~75 m^2), *Nasturtium officinale* (~32 m^2), and *Hydrilla verticillata* (~14 m^2).

Table 3.4-6. Difference in area (m^2) of Non-Native Vegetation Species in the San Marcos River in Sewell Park Prior to (April 2013) and after year one (November 2013) and year two (November 2014) of Removal Activities

Species	April 2013	November 2013	November 2014	Total Difference
Hydrilla verticillata	97	13	83	-14
Hygrophilia polysperma	287	122	212	-75
Nasturtium officinale	32	0	0	-32
Totals	**416**	**135**	**295**	**-121**

Twenty-six fountain darters were captured during non-native aquatic vegetation removal and returned to the river. Another species of interest captured and returned to the river during non-native aquatic removal were two American eels. Other species captured and released included crayfish, sunfish species, and mosquito fish (**Table 3.4-7**).

Table 3.4-7. Animal Species Collected and Returned to the San Marcos River During Non-Native Vegetation Removal (December 2013 – November 2014)

Species	Month										
	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Aug-14	Oct-14	Nov-14	**Total**
Lepomis sp. (sunfishes)	1	1	7	12	21	15	8	5	-	2	**72**
Etheostoma fonticola (fountain darter)	-	-	-	3	-	4	14	3	2	-	**26**
Gambusia sp. (mosquito fish)	-	-	-	-	21	25	29	8	-	-	**83**
Oreochromis aurea (tilapia)	-	-	-	-	-	-	-	-	-	-	**0**
Ameiurus sp. (bullhead catfish)	-	-	1	1	-	10	1	4	-	-	**17**
Poecilia sp. (mollies)	-	-	-	-	-	-	1	-	-	2	**3**
Micropterus salmoides (largemouth bass)	-	-	-	-	-	5	2	-	-	-	**7**
Ambloplites rupestris (rockbass)	-	-	-	-	1	-	5	-	-	-	**6**
Anguilla rostrata (American Eel)	-	-	-	-	-	2	-	-	-	-	**2**
Astyanax mexicanus (Mexican tetra)	-	-	-	1	2	-	-	-	-	-	**3**
Notropis amabilis (Texas Shiner)	-	-	6	-	7	-	-	-	-	-	**13**
Cambaridae (crayfish)	22	10	47	32	105	200	138	15	-	25	**594**
Testudinata (Turtle)	-	1	3	1	-	-	-	-	-	-	**5**
Natantia (Freshwater Shrimp)	2	-	-	-	-	-	-	-	-	-	**2**

Table 3.4-8 denotes the number of each native vegetation species planted once an area was denuded of non-native vegetation in the San Marcos River from Spring Lake Dam through Sewell Park. The greatest number of individuals planted were *Lugwigia repens* (1,184) followed by *Heteranthera dubia* (522), *Sagittaria platyphylla* (351), and Texas wild-rice (343). Estimated area planted with native species was 236 m^2 in the San Marcos River within areas removed of non-native vegetation. **Figure 3.4-5** illustrates planting density (plants/ m^2) as well as planting location of Texas wild-rice and other native species in the San Marcos River at Sewell Park.

Table 3.4-8. Number of Each Native Vegetation Species Planted Monthly in the San Marcos River from Spring Lake Dam through Sewell Park (Nov 2013 – Oct 2014)

Species	Date	N	Area planted (m^2)	Density Planted
Heteranthera dubia	11/20/2013	62	25.52	2.43
	3/17/2014	135	14.32	9.42
	6/12/2014	280	37.46	7.47
	10/24/2014	45	3.93	11.45
Heteranthera dubia total		**522**	**81.23**	-
Ludwigia repens	11/20/2013	81	5.65	14.35
	11/20/2013	81	5.95	13.62
	12/8/2013	245	15.17	16.15
	3/17/2014	372	24.77	15.02
	6/11/2014	75	18.09	4.15
	6/12/2014	96	25.73	3.73
	10/24/2014	78	10.58	7.37
	10/24/2014	78	2.42	32.26
	10/24/2014	78	12.34	6.32
Ludwigia repens total		**1,184**	**121.70**	-
Sagittaria platyphylla	10/24/2014	351	14.94	23.49
Zizania texana	11/20/2013	174	10.58	16.44
	12/8/2013	169	8.06	20.97
Zizana texana total		**343**	**33.59**	-
Native species planting totals		**2,400**	**235.53**	-

Based upon GPS polygon locations, net area gain in native aquatic vegetation was 253 m^2 from April 2013 (i.e., prior to EAHCP activities) through November 2014 in the San Marcos River at Sewell Park (**Figure 3.4-6**). Changes in native vegetation outside of the areas worked were not included, because differences observed could not be attributed to MCWE's work. Among native species, *Zizania texana* increased the most (170 m^2) followed by *Heteranthera dubia* (72 m^2) *Ludwigia repens* (32 m^2), *Sagittaria platyphylla* (17 m^2), and *Hydrocotyle* (7 m^2). Although large areas of *Ludwigia repens* and *Heteranthera dubia* were routinely planted, they were often a subdominant species. Therefore, *Ludwigia* locations are not visible on the **Figure 3.4-6**, but the increase in these two species was accounted for within **Table 3.4-9**. A small loss in area was observed for two native species (*Potamogeton illinoensis* and *Cabomba caroliniana*),

which we attribute to multiple factors including potential recreation effects and competition with non-native species under low flow conditions. River flows dropped below 120 cfs in July, so we were unable to conduct non-native removal maintenance July 2014 – October 2014. Additionally, these two species were the lowest number of individuals planted following non-native aquatic vegetation removal.

Table 3.4-9. Difference in area (m^2) of Native Vegetation Species Prior to Non-Native Vegetation Removal and Native Planting Activities (April 2013), after year 1 (November 2013), and year 2 (November 2014) in the San Marcos River from Spring Lake Dam through Sewell Park

Species	April 2013	November 2013	November 2014	Total Difference
Zizania texana	714	776	884	170
Ludwigia repens	0	15	32	32
Sagittaria platyphylla	21	32	38	17
Potamogeton illinoensis	212	101	194	-18
Cabomba caroliniana	32	52	5	-27
Hydrocotyle	0	8	7	7
Heteranthera dubia	0	0	72	72
Totals	**979**	**984**	**1,232**	**253**

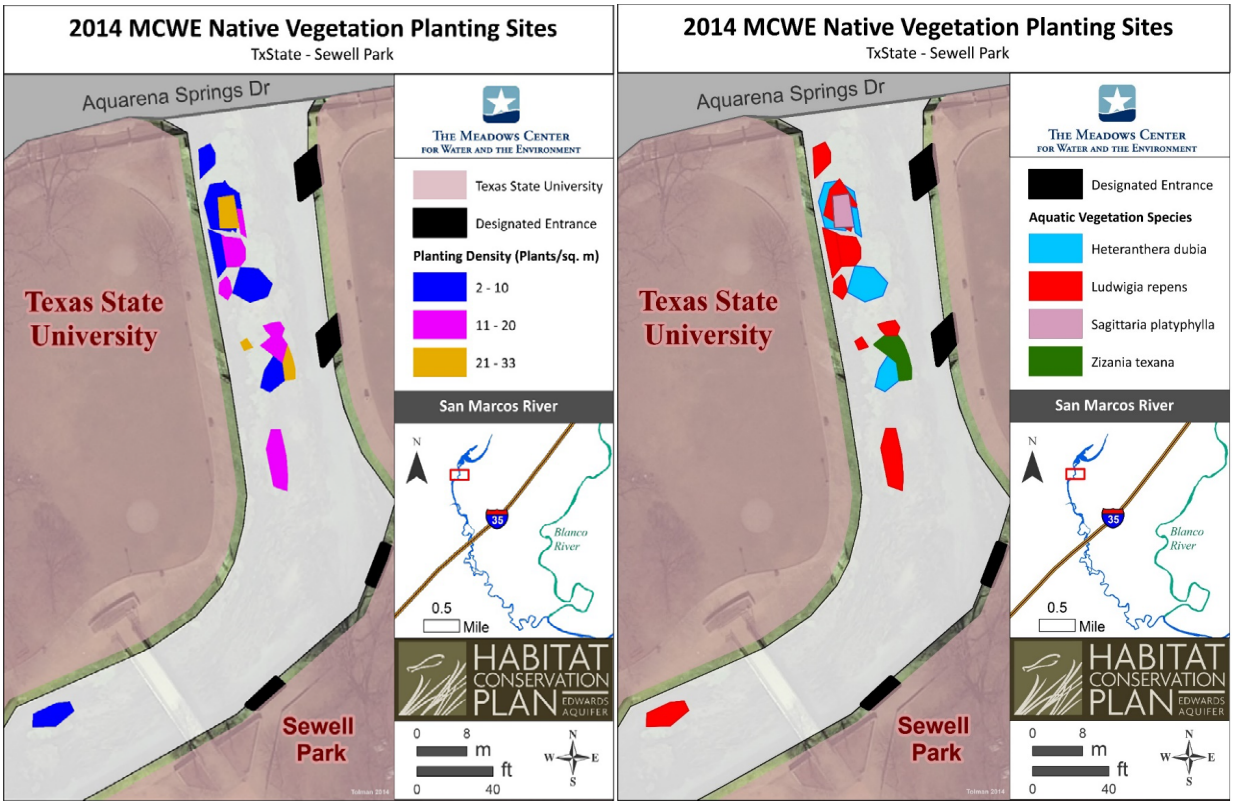


Figure 3.4-5. 2014 MCWE planted densities (left) and planting locations (right) of Texas wild-rice and other native species in Sewell Park

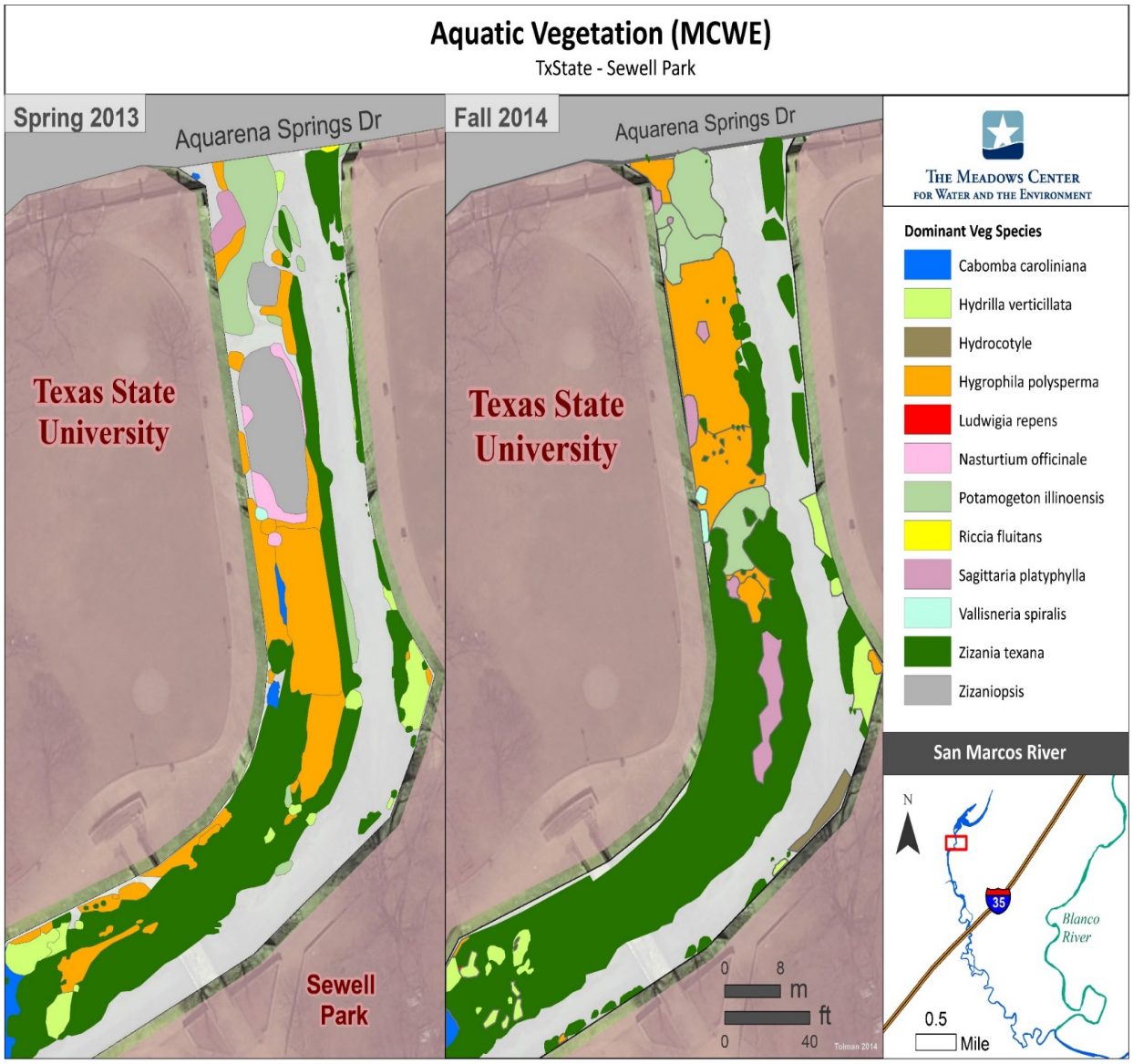


Figure 3.4-6. Vegetation polygons illustrating changes as a result of removal and planting from Spring 2013 to Fall 2014

Modifications Due to Drought Conditions:

Texas State staff ceased non-native aquatic removal and native aquatic planting from July 2014 to October 2014 due to river flows dropping below 120 cfs. In October 2014, a clarification to Condition M from USFWS permitted MCWE to conduct maintenance in previously worked areas.

Proposed Activities for 2015:

In 2015, Texas State will remove 3,000 m^2 of non-native plant material. Additional elephant ears will be removed, and native littorals will be planted in their place.

3.4.12 Control of Harmful Non-Native and Predator Species (EAHCP §5.4.13)

Obligations:

Texas State, in partnership with the COSM, will develop a non-native and predator species removal program within University boundaries.

2014 Compliance Actions:

Texas State collaborated with the COSM to undertake control of harmful non-native and predatory species in Spring Lake and the San Marcos River upstream of City Park.

Tilapia

Atlas targeted tilapia in Spring Lake twice each month using gill nets, seine nets and pole spears, but also captured tilapia in areas downstream of Spring Lake during *Plecostomus* removal (**Figure 3.3-28** through **Figure 3.3-30**).

Tilapia concentrations were viewed from a barge before entering the water. Pole spears were predominately used; gill and seine nets were most successful downstream of vegetation mats close to banks. A fence was used to channel tilapia into live traps, but this method was not as successful and was thus discontinued. The number of tilapia captured was highest in August and September.

Modifications Due to Drought Conditions:

There were no modifications to this program due to drought conditions.

Proposed Activities for 2015:

In 2015, Texas State will refine their population estimates for non-native species targeted for removal. Removal techniques will be refined and regular removal of the suckermouth catfish and tilapia will occur. Monthly maps showing changes in non-native populations will be generated.

3.4.13 Challenges Observed and Identified Solutions

In 2014, Texas State experienced the following challenges:

The San Marcos River dropped below 120 cfs in August 2014 and has remained below the 120 cfs threshold to perform certain EAHCP activities.

For sediment removal, the EAHCP identifies the use of a 0.25-inch strainer on the suction pump. The USFWS has approved the removal of the strainer in future dredging activities.

3.5 San Antonio Water System

The SAWS is one of the largest water and wastewater systems in the United States and serves most of Bexar County, as well as portions of three adjacent counties. The municipally-owned utility serves a customer base of over 1.6 million customers that grows an additional two percent each year, as San Antonio is one of the fastest growing cities in the country. SAWS' Twin Oaks ASR Project in southern Bexar County is a key conservation measure for the EAHCP. This conservation measure uses the injection and storage of EAA-issued Edwards Aquifer groundwater withdrawal permits leased by the EAA. Under certain conditions more fully described in the EAHCP and the ASR contract entered into with the EAA, this water is recovered from storage to serve SAWS customers during certain drought conditions as specified in the contract. The day-to-day operation of the ASR is managed by SAWS. A 12-person Regional Advisory Group composed of diverse stakeholders meets to advise SAWS on the implementation of the conservation measure.

The EAHCP broadly outlines how SAWS, with the assistance of the Regional Advisory Group, will describe in the Annual Report the storage and recovery activities (EAHCP page 5-38) associated with the SAWS ASR Project.

SAWS is responsible for the following minimization and mitigation measures under the EAHCP:

- Use of the SAWS ASR for Springflow Protection (EAHCP §5.5.1 and §5.5.2)
- Phase II Expanded Use of the SAWS ASR and Water Resources Integration Program Pipeline (EAHCP §5.5.2)

3.5.1 Use of the SAWS ASR for Springflow Protection (EAHCP §5.5.1 and §5.5.2)

Obligations:

SAWS will utilize the Twin Oaks ASR Facility as a springflow protection measure during times of certain extreme drought. When the level of well J-17 is less than 630 ft-msl and the ten-year rolling recharge to the Aquifer is less than or equal to 500,000 ac-ft/yr, SAWS may return water from the ASR facility to its distribution system. Additionally, when these conditions are met, SAWS will forbear making withdrawals from the Aquifer from designated wells on the northeast side of its service area equivalent to certain forbearance schedules prescribed in the ASR contract.

SAWS will make every effort to simulate the return patterns identified in modeling by HDR during the development of the EAHCP; however, the EAHCP recognizes that future droughts may not exactly mimic the drought of record, so flexibility will be afforded SAWS.

Section 5.5.2 of the EAHCP includes a discussion on the use of the SAWS Water Resources Integration Program as the Phase II presumptive action for the EAHCP. To date, Phase II is not yet effective and has not yet been discussed by the committees of the EAHCP, so it is not discussed at length in this report.

2014 Compliance Actions:

In 2013, an Interlocal Contract (IC) was developed between the EAA and SAWS during a seven-month period. The IC translates the conceptual elements of SAWS ASR commitment in Section 5.5.1 of the EAHCP into measurable activities related to both parties' responsibilities.

SAWS is also responsible for organizing and facilitating an ASR Advisory Group. The IC also required formation of a Staff Work Group. This subject will also be discussed further in this document.

Under the IC, SAWS is required to credit to the EAA as being in storage any permitted Edwards Aquifer water for which it receives a Notice of Availability (NOA) from the EAA by certain dates detailed further in the IC, or based on metered recharge for NOAs received by SAWS after certain dates. The initial NOA was issued by the EAA in 2014, on January 8th, for 6,080.757 ac-ft, though this amount was reduced by critical period cutbacks. A total of 4,031 ac-ft was then credited to the EAA as being in storage in 2014.

Modifications Due to Drought Conditions:

No modifications to the use of SAWS' ASR due to drought conditions occurred in 2014. Trigger levels were not reached during this time period, so SAWS ASR use for EAHCP springflow protection was not implemented.

Proposed Activities for 2015:

In 2015, SAWS will continue to manage the ASR program as described in the EAHCP and consistent with the terms identified in the IC with the EAA.

3.5.1.1 SAWS ASR Advisory Committee

Per the requirement on pages 5-39 of the EAHCP, a 12-person Regional Advisory Group consisting of four representatives of SAWS, the EAHCP Program Manager, and one representative each from the EAA, an EAA permit holder for irrigation purposes, a representative of small municipal pumpers, a representative of the spring cities, an environmental representative (including TPWD), a representative of industrial aquifer users, and downstream interests, will provide advice to SAWS regarding the implementation of the program.

The EAHCP and SAWS ASR IC provide for continued dialog and interaction. Under the IC, SAWS has the responsibility for facilitating two groups. The first is SAWS Aquifer Storage and Recovery Regional Advisory Group as described in the EAHCP and immediately above. The second is a Staff Work Group whose membership and general descriptions are described in the IC. These groups each met in compliance with EAHCP and IC. The SAWS Aquifer Storage and Recovery Regional Advisory Group met quarterly subsequent to the approval of the EAHCP (on March 25, 2014, May 28, 2014, September 11, 2014, and December 8, 2014). Topics of these meetings included:

- 1st Quarter – presentations by SAWS and the EAA on drought outlook and SAWS production statistics.

- 2nd Quarter - presentations on historic recharge and recharge triggers as it relates to the ASR in the EAHCP, drought and aquifer level forecasts by SAWS and the EAA, and selected SAWS production statistics.
- 3rd Quarter - discussion of El Niño development, aquifer level and drought outlooks, and SAWS production activities.
- 4th Quarter - presentations by SAWS and the EAA on drought outlook and SAWS production statistics.

3.5.1.2 Status of SAWS ASR Lease Acquisition

The EAA will acquire 50,000 ac-ft of Edwards Aquifer permitted water through leases and options for use in the SAWS ASR program. Acquisition will be accomplished in three tiers (**Table 3.5-1**).

Table 3.5-1. SAWS ASR Lease and Structure Option as Identified in the EAHCP

Tier	Acre-feet	Description
I	16,667	Leased for immediate storage in the ASR
II	16,667	Acquired as options; exercised when the 10-year rolling recharge for the previous year falls below 572,000 ac-ft/yr
III	16,667	Acquired as options; exercised when the 10-year rolling recharge for the previous year falls below 472,000 ac-ft/yr

The total amount of water acquired through December 2013 was 4,718.995 ac-ft; 2,669.036 ac-ft was enrolled for lease terms starting in 2013, and 2,049.959 ac-ft was enrolled for lease terms starting in 2014.

EAA has contracted with the SARA to be its leasing agent for ASR leases. The total amount of water acquired through December 2014 was 6,202.142 ae-ft; and from this total, 4,310.426 ae-ft was enrolled from prior-year roll-over leases, and 1,891.716 ae-ft was acquired during the year (**Table 3.5-2**).

Table 3.5-2. EAA ASR Acquired Leases in 2014

Lease Term	Total Acre-feet Acquired in 2014	Percent of Total Tier I Target
15 years	2,252.205	13.5%
10 years	492.664	3.0%
7 years	683.445	4.1%
5 years	35.000	0.2%
3 years	1,327.000	8.0%
1 year	1,411.828	8.5%
Total Confirmed	6,202.142	37.2%

The ASR leasing program satisfied 37.2 percent of its enrollment goal for Tier 1 in 2014. Enrollment is ongoing and the program will continue to be adjusted to respond to the dynamics of the market. In 2015, SARA will continue to work with the EAA staff to encourage and increase participation in the Program, and new enrollment options will be introduced.

3.5.1.3 EAA Notices of Availability to SAWS

Of the total 6,202.142 ac-ft acquired in 2014, EAA made available 4,031 ac-ft, withholding 36.02 percent to meet expected Critical Period Monitoring (CPM) permit reductions (**Table 3.5-3**). The EAA issued nine NOAs to SAWS during the months ASR leases were accepted by the EAA board of directors. Five NOAs were issued to SAWS authorizing 5,728.257 ac-ft for injection into the ASR (92.4 percentof leases) before June 30, 2014, and four NOAs were issued to SAWS authorizing 473.885 ac-ft for injection into the ASR (7.6 percent of leases) after June 30, 2014. EAA must account for expected CPM permit reductions for the San Antonio Pool in making groundwater available to SAWS for injection into the ASR facility, and EAA withheld pumping rights to cover a maximum 36 percent reduction for 2014.

Table 3.5-3. SAWS ASR NOAs in 2014

NOA #	Date Effective (through December 31, 2014)	Total Acre-feet Acquired	Total Acre-feet Authorized
2014 NOA #1	January 9, 2014	4,310.426	3,017.298
2014 NOA #2	March 12, 2014	481.569	337.098
2014 NOA #3	April 9, 2014	75.500	0.000
2014 NOA #4	May 14, 2014	163.014	0.000
2014 NOA #5	June 13, 2014	697.748	370.000
2014 NOA #6	August 13, 2014	5.000	3.250
2014 NOA #7	September 10, 2014	265.000	110.000
2014 NOA #8	October 15, 2014	35.566	22.762
2014 NOA #9	November 13, 2014	168.319	107.724
2014 NOA #10	December 18, 2014	0.000	63.360
	Total:	**6,202.142**	**4,031.492***

*EAA withheld pumping rights to cover a maximum 36% reduction for 2014.

3.5.2 Challenges Observed and Identified Solutions

Four primary master recharge meters have been chosen to provide accounting of water storage to the degree specified by the IC. These meters on SAWS transmission infrastructure account for ASR flows proximal to SAWS primary production facilities that are delivering recharge water to Twin Oaks ASR facilities. SAWS can accomplish accounting sufficient for the IC using two of the existing meter locations and the existing Panametric meters (a brand of electromagnetic meters made by GE) identified in the IC. Data collected in 2014 verifies flows being accounted for EAA credited regional storage activities and was collected through Artesia Flowmeter – 1 and Seale Flowmeter – 2. SAWS investigated the use of electromagnetic insertion meters, as discussed in the 2013 annual report. Because of the lack of manufacturers support for and SAWS confidence in the new equipment, SAWS will continue to record and reflect storage of EAA ASR leases water made available through NOAs through Artesia Flowmeter – 1 and Seale Flowmeter – 2, as described above.

The SAWS Twin Oaks ASR facility is gated, fenced, and patrolled, and SAWS is unaware of any unauthorized activities by the public at the ASR.

SAWS ASR use for EAHCP springflow protection was not implemented.

3.6 Texas Parks and Wildlife Department

The TPWD serves as the state agency with primary responsibility for conserving, protecting and enhancing the state's fish and wildlife resources. In this role, TPWD has the authority to establish state "scientific areas" for the purposes of education, scientific research, and preservation of flora and fauna of scientific or educational value (TPW Code § 81.501). To minimize the impacts of recreation, TPWD has created a two-mile segment of the public waters of the San Marcos River as a SSA in the San Marcos Springs ecosystem (30 TAC 57.910).

In order to protect existing and restored fountain darter habitat, TPWD will pursue creation of state scientific areas in the Comal Springs ecosystem. The goal of the regulations will be to minimize impacts to habitat from recreation activities.

3.6.1 State Scientific Areas (EAHCP §5.6.1)

Obligations:

The TPWD will pursue the establishment of a SSA in the San Marcos Springs ecosystem for expanded protection of Texas wild-rice within a two-mile segment (**Figure 3.6-1**). TPWD will pursue an inter-local agreement with the COSM and Texas State regarding enforcement of the SSA.

Figure 3.6-1. Biologist removing detritus from area of Texas wild-rice

To protect extensive aquatic and riparian restoration, TPWD, in coordination with the CONB, will pursue a SSA within the Old Channel of the Comal River. Once a SSA is established, TPWD will pursue an inter-local agreement with the CONB regarding enforcement of the area.

2014 Compliance Actions:

The EAHCP requires that TPWD create SSAs in the San Marcos and Comal River. TPWD has the authority to establish state "scientific areas" for the purposes of education, scientific research, and preservation of flora and fauna of scientific or educational value (TPW Code § 81.501). To minimize the impacts of recreation, TPWD created a two-mile segment of the public waters of the San Marcos River as a SSA in the San Marcos Springs ecosystem (30 TAC 57.910). This scientific area is designed to protect Texas wild-rice by restricting recreation in these areas during flow conditions below 120 cfs. The rule makes it unlawful for any person (1) to move, deface, alter, or destroy any sign, buoy, boom or other such marking delineating the boundaries of the area; (2) uproot Texas wild-rice within the area; and (3) enter an area that is marked. The regulations are intended to preserve at least 1,000 m^2 of Texas wild-rice (**Appendix J**).

In cooperation with the COSM and Texas State, signs and information kiosks were designed, produced and installed during the summer of 2013. The purpose of the signs and information kiosks is to educate the public about protecting the San Marcos River and its endangered inhabitants, especially during prime recreational season. TPWD is currently working to produce Spanish language versions of the signs and kiosks. TPWD also created and distributed a news release to inform the public about the San Marcos River SSA.

Modifications Due to Drought Conditions:

When the flows within the San Marcos River SSA are 120 cfs or less, physical barriers may be placed within the State Scientific Area to help recreational users avoid vulnerable stands of Texas wild-rice while enjoying the river and to protect areas where habitat has been restored. Flows in the San Marcos River were below 120 cfs during the summer of 2014. In June the decision was made by the COSM, in consultation with TPWD and Texas State, to deploy barriers to protect six stands of Texas wild-rice.

Proposed Activities for 2015:

In 2015, TPWD will work to expand their public education efforts to include signage in Spanish. In addition, TPWD will pursue an inter-local agreement with the COSM and Texas State regarding enforcement of the SSA.

3.6.2 Challenges Observed and Identified Solutions

TPWD did not complete the effort to expand public education efforts by translating signage into Spanish during 2014 due to a staff retirement. Efforts will be made to complete the project by working with other staff.

4.0 ADAPTIVE MANAGEMENT PROCESS ACTIVITIES FOR 2014

Article 7 of the Funding and Management Agreement outlines the procedural steps and responsibilities of the Permittees for making Adaptive Management Process (AMP) decisions. It also identifies three different AMP decisions the Permittees may make – Routine, Nonroutine and Strategic AMP decisions.

Routine decisions are decisions involving ongoing, day-to day matters related to the management and administration of existing Conservation Measures that do not require an amendment to the ITP. Nonroutine AMP decisions are decisions relating to existing Conservation Measures that do require an amendment to the ITP.

Strategic AMP decisions are decisions that relate to the selection of Phase II Conservation Measures and are to be implemented by the Permittees in Phase II. While strategic AMP decisions will not be made until 2018, in 2014, the Permittees continued to implement the monitoring, research and modeling activities to support those decisions. Those activities are summarized in Section 3.1 of this Annual Report. Additionally, the EAA entered into a contract with the National Academy of Sciences (NAS) to establish an independent Science Review Panel that will advise the EAHCP on its monitoring, research and modeling activities. In 2014, NAS met four times and expects to deliver its first set of recommendations in early 2015.

The Permittees have implemented adaptive management in the form of Permittees learning from implementation experiences and then modifying annual workplans the following year. However, no formal adaptive management processes, as defined by the Funding and Management agreement, were initiated in 2014.

4.1 Routine Decisions

In 2014, the Permittees made the following routine AMP decisions.

- Changing the methodology for sediment removal in the San Marcos River system – EAHCP Sections 5.3.6 and 5.4.4.
- Changing the methodology for sediment removal in the San Marcos River system – EAHCP Section 5.4.6.

4.2 Nonroutine Decisions

With authorization from the Permittees, the Program Manager submitted a Minor Administrative Amendment letter to the USFWS (dated December 4, 2014), seeking acceptance to amend the language of both the EAHCP, Section 5.1.1 and the ITP, Condition K to allow the EAA to develop a Refugia Program with contractors other than the Service. The Permittees made this decision because the EAA reached an impasse in their negotiations with the Service to establish a fully-functioning Refugia Program.

5.0 2014 ANNUAL TAKE ESTIMATES

The EAHCP Incidental Take Permit (ITP) requires a Net Disturbance and Incidental Take assessment to be conducted at the conclusion of each year for incorporation into the ITP Annual Report. Requirement M (1a and 2a) of the ITP specifically addresses minimization and mitigation activities associated with the HCP.

This requirement stipulates that over the course of any given year no more than 10 percent of a Covered Species occupied habitat can be affected by HCP mitigation and restoration activities. Following quantification of net disturbance specific to these activities, incidental take was calculated for the disturbed areas. However, that is only part of the overall incidental take assessment. Incidental take associated with implementation of all other applicable HCP covered activities was then characterized and quantified to the degree practical. For a more detailed description of methodologies and species specific results please refer to the Item M Net Disturbance (**Appendix K, Section 1**) and Incidental Take (**Appendix K, Section 2**) assessments of this technical memorandum. As in 2013, all 2014 assessments were performed in accordance with ITP requirements.

Prior to the original assessment in 2013, specific discussions were held with professionals from the USFWS Austin Ecological Services (ES) office to establish the appropriate definition and description of "occupied" habitat and seek guidance on methodologies for calculating incidental take. Following the USFWS review of the EAA 2013 ITP Annual Report, a meeting was held on October 1, 2014 with professionals from the USFWS Austin ES, EAA, and BIO-WEST. The purpose of the meeting was to receive feedback from the USFWS on the net disturbance and incidental take assessments conducted for 2013. Based on those conversations, it was determined that only one change was needed to the methodology moving forward. This change involved the inclusion of Texas wild-rice as fountain darter occupied habitat in 2014. Although Texas wild-rice has not been routinely sampled for fountain darters over time as to not disturb this federally-listed plant, darters have been visually documented within Texas wild-rice. In 2013, the decision was made not to include Texas wild-rice as occupied fountain darter habitat on the basis it lacked routine sampling. However, upon review of the EAA 2013 ITP Annual Report, USFWS Austin ES made a formal recommendation for Texas wild-rice to be included as occupied habitat for the fountain darter in the 2014 assessment and all subsequent evaluations. As such, this slight adjustment was made to the methodology and approved by both the HCP Science Committee on November 12th as well as the HCP Implementing Committee on November 20th.

Discussions with USFWS Austin ES at the October 1, 2014 meeting also confirmed that annual incidental take should be based on the condition of the system going into the next year and not be cumulative with incidental take reported for 2013 for areas that had not recovered prior to 2014. This USFWS Austin ES comment was adhered to and that approach built into the 2014 assessment described in Section 2.

Table 5.0-1 provides an overview of net disturbance percentages and a summary of incidental take for 2014. As shown in **Table 5.0-1**, only the fountain darter in the Comal System had a net disturbance when considering the project footprint for HCP mitigation and restoration activities overlaid on occupied habitat. The net disturbance was 2.1 percent of the total occupied habitat for the fountain darter. As shown in **Table 5.0-1**, there were no project footprints that overlapped with any of the occupied habitat for the endangered Comal invertebrates. In the San Marcos system, both the fountain darter and San Marcos salamander had a net disturbance per this assessment. The fountain darter had 4.0 percent of its total occupied habitat disturbed whereas the San Marcos salamander amount was lower at 1.4 percent. For the Texas blind salamander and Comal Springs riffle beetle, there were no activities conducted in 2014 that directly impacted any of the orifices where collections have routinely been made over the years. In summary, the 10 percent disturbance rule (Item M [a]) was in compliance for 2014.

A continued evaluation of **Table 5.0-1** shows that based on the characterization of drought in the incidental take assessment for the Comal system, conditions experienced during 2014 went beyond an average year as described in the Biological Opinion. As expected, conditions on the Comal system exceeded those observed in 2013 particularly with respect to the surface dwelling organisms (Comal Springs riffle beetle and fountain darter). The primary cause for this increase was low total system discharge which resulted in expanded amounts of exposed surface habitat within Comal Springs riffle beetle occupied habitat and loss of habitat and elevated water temperatures relative to the fountain darter in the Upper Spring Run reach. For the San Marcos system, incidental take went down in 2014 because the system did not experience as severe of drought related impacts as the previous year.

When examining 2014 impacts, conditions are nowhere near those characterized in the Biological Opinion DOR-like scenario. As such, we are confident the incidental take numbers summarized in **Table 5.0-1** and documented in this memorandum continue to justify the data sets used and methodologies employed in 2014 relative to performing an incidental take assessment within the context of the Biological Opinion. It is understood that adjustments to data sets and/or methodologies may be employed based on feedback from the USFWS, HCP Science Committee, HCP participants, or others as deemed appropriate by the EARIP.

Table 5.0-1 Summary of Impacted Habitat (m2) and Net Disturbance and Incidental Take for HCP Covered Species compared against ITP Maximum Permit Amounts.

COVERED SPECIES PER SYSTEM	HCP Mitigation / Restoration		HCP Measures / Drought	Combined Impacted Habitat 2014 TOTAL (m^2)	INCIDENTAL TAKE		2014 INCIDENTAL TAKE TOTAL	ITP Maximum Permit Amount	2013 INCIDENTAL TAKE TOTAL	ITP Permit Maximum - (combined Year 1 and Year 2 Incidental Take)
	IMPACTED HABITAT (m^2)	NET Disturbance % OF TOTAL Occupied Habitat	IMPACTED HABITAT (m^2)		HCP Mitigation / Restoration	HCP Measures / Drought				
COMAL SYSTEM										
Fountain Darter	1,995	2.1%	2,484	**4,479**	2,993	20,067	**23,060**	797,000	10,482	763,459
Comal Springs Riffle Beetle	0	0.0%	237	**237**	0	1,564	**1,564**	11,179	681	8,933
Comal Springs Dryopid Beetle	0	0.0%	18	**18**	0	2	**2**	1,543	13	1,528
Peck's Cave Amphipod	0	0.0%	79	**79**	0	82	**82**	18,224	81	18,060
SAN MARCOS SYSTEM										
Fountain Darter	4,567	4.1%	3,372	**7,939**	6,851	5,058	**11,909**	549,129	16,698 +15*	520,508
San Marcos Salamander	30	1.4%	131	**161**	89	393	**482**	263,857	1,053	262,323
Texas Blind Salamander	0	0.0%	0	**0**	0	0	**0**	10	0	10
Comal Springs Riffle Beetle	0	0.0%	0	**0**	0	0	**0**	n/a	0	n/a

6.0 RECOMMENDATIONS MOVING FORWARD

The Permittees are now in the second year of implementing the EAHCP. With over 21 months of experience, the Permittees have gained practical insights and realized many challenges regarding implementation of the EAHCP. Based upon this knowledge and experience, the Permittees offer the following recommendations as priorities for 2015.

6.1 Aquifer Storage and Recovery (Condition L.5.b.i of the ITP, and EAHCP §5.5.1 and §5.5.2)

As discussed in Section 3.5, the ASR mitigation measure is based on the EAA leasing a total of 50,000 ac-ft of EAA groundwater rights in three 16,666 ac-ft tiers, and transferring use of those rights to SAWS for storage and use during severe drought. To date, a limited number of EAA permit holders have participated in the program, with the EAA enrolling only 6,202 ac-ft in the program, meeting 37.2 percent of the goal for Tier 1 in 2014. Because of this limited participation, the Implementing and Stakeholder committees developed recommendations for improving the program's offerings and participation. These recommendations will be implemented in 2015. Depending upon the success of these new program elements, the ASR minimization measure may require further discussion and evaluation in 2015 to achieve the program's goals.

6.2 Refugia (Conditions L.1.b and K of the ITP, and EAHCP §5.1.1 and §6.3.4)

Pursuant to Condition K of the ITP and Sections 5.1.1 and 6.3.4 of the EAHCP, the EAA began contract negotiations with the USFWS to develop and maintain long-term refugia facilities for the Covered Species. In 2014, these negotiations stopped with no agreement because of issues related to whether advance payment to the USFWS is possible and of issues related to who would retain ownership of any new buildings or other infrastructure constructed. The EAA is seeking legal clarification on these matters. Until these matters are resolved and to keep moving this initiative forward to comply with the ITP and EAHCP, the EAA is simultaneously pursuing three separate initiatives: 1) negotiating with USFWS for a long-term refugia contract; 2) issuing an RFQ/RFP for a long-term refugia contract; and 3) developing interim short-term refugia efforts for implementation until a long-term contract is established. Depending upon resolution of the payment issues and contract negotiations with USFWS, the future direction of this program may require additional discussion and decision-making in 2015.

6.3 New Braunfels Springs System: Bank Stabilization Project in the Old Channel

As a mitigation measure against further sedimentation in the Comal River, and potentially reversing the habitat restoration effort, the Bank Stabilization Project will provide an engineered solution to an eroded bank along the Old Channel and is a priority for the City of New Braunfels. In May 2014, the CONB completed the project's final designs but due to low flows throughout the remainder of the year, the project was postponed. If flows stabilize at or above 160 cfs in 2015, the City of New Braunfels will put the project out for bid and begin construction. Considering the long delay on this project, all state and federal permits will be checked for accuracy before any work activity commences. Once construction begins, there will be continuous communication with all local, state and federal agencies, so that full compliance will be achieved over the life of the project.

6.4 San Marcos Springs System: Water Quality Protection Plan

The WQPP is a locally developed approach for compliance with the Endangered Species Act in San Marcos, Texas will be a priority for the COSM and Texas State. The intent of the WQPP is to provide a holistic, integrated approach in regards to water quality concerns associated with impervious cover and urban development. In addition to protecting habitat for endangered species, the WQPP will help the Permittees serve the needs of their growing populations and promote responsible economic development, good public infrastructure, and preserve open space. As the WQPP is rolled-out, the COSM will develop an educational program.

6.5 National Academy of Sciences Report

In December 2013, the Implementing Committee approved a contract with the NAS to create an independent Science Review Panel (SRP). The role of the SRP is to provide ongoing review and comments on the modeling, studies, and data collection and analyses performed in support of the EAHCP. The SRP met four times in 2014, and is scheduled to release their first report in February 2015. Depending upon the recommendations in this report, the SRP may identify new, or adjustments to existing, research initiatives that may require consideration of additional or new funding. Table 7.1 of the EAHCP does not include funding for the implementation of SRP's recommendations.

6.6 Frequent Communication with the USFWS

Because of the significance of the Edwards Aquifer and the EAHCP to this region, implementation of the EAHCP requires frequent and open communication between and among the USFWS, Permittees, Stakeholders and all interested parties. In addition, however, the continued and prolonged drought creates an opportunity to encourage more and frequent communication to prepare for and respond to conditions as they develop. Frequent communication, especially informal communications, with the USFWS will be necessary for successful implementation.

7.0 LITERATURE REVIEW

The following list of articles and reports represent a review of literature related to the protected species, aquatic features, and management actions associated with the EAHCP and the EARIP. This review includes journal articles, study reports, and theses and dissertations published or approved during 2013 and 2014. The literature search was accomplished by conducting online searches of the JSTOR digital library, Google Scholar, Texas State Dissertations and Theses, and the EAA document library.

Literature from 2013

Alarie, Y., J. R. Gibson, and K. B. Miller. 2013. Descriptions of larvae of the North American endemic stygobiontic *Ereboporus naturaconservatus* Miller, Gibson & Alarie and *Haideoporus texanus* Young & Longley (Coleoptera: Dytiscidae). Tijdschrift voor Entomolgie 156:1–10.

This journal article describes second- and third-instar larval characteristics of the Texas cave diving beetle based on morphometry and chaetotaxy.

Behen, K. P. K. 2013. Influence of Connectivity and Habitat Heterogeneity on Fishes in the Upper San Marcos River, Texas. Thesis, Texas State University, San Marcos, Texas, USA.

This thesis examined abundance and habitat distribution of fishes within five reaches of the Upper San Marcos River between Spring Lake and its confluence with the Blanco River. The spring-associated fishes encountered during the study included the endangered fountain darter. The study found that fish distribution was largely dependent on predictable fish habitat associations.

Bendik, N. F., J. M. Meik, A. G. Gluesenkamp, C. E. Roelke, and P. T. Chippindale. 2013. Biogeography, phylogeny, and morphological evolution of central Texas cave and spring salamanders. BMC Evolutionary Biology 13:201. [http://www.biomedcentral.com/1471-2148/13/201]

This journal article describes phylogenetic analysis based on mitochondrial DNA from central Texas cave and spring salamanders, including the threatened San Marcos salamander and the endangered Texas Blind Salamander. In addition, head morphology and pigmentation characteristics were also examined and compared across habitat and geographic locations.

Bendik, N. F. and A. G. Gluesenkamp. 2013. Body length shrinkage in an endangered amphibian is associated with drought. Journal of Zoology 290:35–41.

This journal article documents reversible shrinkage in body length and tail width in the Jollyville Plateau salamander, as identified during mark-recapture studies performed before and after an exceptional drought in 2008.

Cantu, V., T. M. Brandt, and T. L. Arsuffi. 2013. An evaluation of three sampling methods to monitor a digenetic trematode *Centrocestus formosanus* in a spring-fed ecosystem. Parasitology 140:814–820.

This journal article compares three sampling methods (using wild-caught fish, using cage reared fish, and cercariometry) to sample for a trematode that is a concern due to its negative effects on the endangered fountain darter. The authors recommended cercariometry, a method where water is filtered for the trematode larval cercariae, because it is less expensive and showed similar trends to caged-fish results.

Dammeyer, N. T., C. T. Phillips, and T. H. Bonner. 2013. Site fidelity and movement of *Etheostoma fonticola* with implications to endangered species management. Transaction of the American Fisheries Society 142:1049–1057.

This journal article describes the results of a mark-recapture study of fountain darter populations within the old channel reach at the headwaters of the Comal River below Landa Lake. According to the study, the fountain darter shows site fidelity to areas with low-growing aquatic vegetation and movement of individuals is more frequently upstream, is usually toward low-growing vegetation, is somewhat seasonal, and occurs frequently among larger fish.

Epp, K., J. 2013. Threat sensitivity in the San Marcos Salamander: effects of predator diet and prey experience. Behaviour 150:617–634.

This journal article describes behavioral responsiveness of San Marcos salamanders to predatory threats based on previous experience with predators and chemical diet cues from predators. According to the study, lab-reared (inexperienced) salamanders showed reduced activity in response to predator chemical cues, whereas wild-caught (experienced) salamanders showed less of an avoidance response to predator chemical stimuli.

Ethridge, J. Z., J. R. Gibson, and C. C. Nice. 2013. Cryptic diversity within and amongst spring-associated *Stygobromus* amphipods. Zoological Journal of the Linnean Society 167:227–242.

This journal article describes a phylogenetic study of several Texas Stygobromus species, including the endangered Peck's cave amphipod. The study demonstrated that based on genetic information, Edwards Plateau Stygobromus *species are a complex, genetically diverse group with more diversity than previously recognized.*

Fenolio, D. B., M. L. Niemiller, M. G. Levy, and B. Martinez. 2013. Conservation status of the Georgia Blind Salamander (*Eurycea wallacei*) from the Floridan Aquifer of Florida and Georgia. IRCP Reptiles and Amphibians 20:97–111.

This journal article describes the Georgia Blind Salamander, a stygobitic salamander that lives in the Floridan Aquifer system. In addition to life history and survey information, the article discusses conservation actions and plans to establish a captive colony.

Hooge, J. 2013. Underwater geoarcheology at Spring Lake, San Marcos, Texas. Thesis, Texas State University, San Marcos, Texas, USA.

This thesis research examined sediment core samples in order to understand the geoarcheological properties of Spring Lake and the stratigraphic context of inundated alluvial deposits.

Hutchins, B. T., R. U. Tovar, and B. F. Schwartz. 2013. New records of stygobionts from the Edwards Aquifer of central Texas. Speleobiology Notes 5:14–18.

This journal article presents new occurrence records for four stygobiotic invertebrates from four sites associated with the Edwards Aquifer. The records consisted of an amphipod from Diversion Spring, an amphipod from Sessom Creek Spring, an isopod from Ruiz Well, and a flatworm from Deep Hole Spring.

Mahler, B. J. and R. Bourgeais. 2013. Dissolved oxygen fluctuations in karst springflow and implications for endemic species: Barton Springs, Edwards aquifer, Texas, USA. Journal of Hydrology 505:291–298.

This journal article describes fluctuation of dissolved oxygen concentrations over a six year period at Barton Springs as a function of flow rate and water temperature variation, as well as storm-term storm events. The study discussed dissolved oxygen concentrations as they relate to Barton Springs Salamander mortality. The authors also hypothesized that low dissolved oxygen events from reduced spring discharge or higher groundwater temperatures could result from increased groundwater withdrawals or decreased recharge and climate change.

Miller, K., A. Jean, Y. Alarie, N. Hardy, and R. Gibson. 2013. Phylogenetic placement of North American subterranean diving beetles (Insecta: Coleoptera: Dytiscidae). Arthropod Systematics & Phylogeny 71:75–90.

This journal article describes a phylogenetic analysis of Dytiscid diving beetles, with an emphasis on three groundwater-adapted species from Texas: the Texas cave diving beetle (from Comal Springs), a beetle from San Felipe Springs, and a beetle from Caroline Springs (Independence Creek). The study used both molecular data and adult morphological features.

Mora, M. A., W. E. Grant, L. Wilkins, and H. Wang. 2013. Simulated effects of reduced springflow from the Edwards Aquifer on population size of the fountain darter (*Etheostoma fonticola*). Ecological Modelling 250:235–243.

This journal article describes an age- and sex-structured population model for the fountain darter that was used to predict population dynamics under scenarios of reduced springflows. The study's simulations indicated that low springflows, such as those associated with the 2011 drought, would not have a noticeable effect on population dynamics. The modeling also identified springflow thresholds that could affect minimum annual population levels for the species.

Ryan, T. A., A. N. Kohl, D. J. Soucek, T. S. Smith, T. M. Brandt, T. H. Bonner, and D. M. Cropek. 2013. Short-term effects of military fog oil on the Fountain Darter (*Etheostoma fonticola*). Archives of Environmental Contamination and Toxicology 65:790–797.

This journal article describes toxicity testing of military fog oil, a chemical used during military training to create obscurant smoke, on four life stages of the fountain darter in a laboratory setting. Different life stages in the chronic exposure tests showed varying sensitivity, depending on the form of the fog oil tested.

Veni, G. 2013. Impact of climate change on human and ecological use of karst groundwater resources: A case study from the southwestern USA. Pages 51–59 *in* NCKRI Symposium 3: Proceedings of the 20th National Cave and Karst Management Symposium. National Cave and Karst Research Institute, 4–8 November 2013, Carlsbad, New Mexico, USA.

This symposium article examines the potential impacts climate change on karst groundwater resources by discussing the San Solomon Springs system as a case study. The article also highlights water and ecosystem management activities that may be needed in response to these climate change impacts.

Literature from 2014

Barton Springs/Edwards Aquifer Conservation District. 2014. Draft habitat conservation plan for managed groundwater withdrawals from the Barton Springs Segment of the Edwards Aquifer, November 2014. Prepared by the Barton Springs/Edwards Aquifer Conservation District for the U.S. Fish and Wildlife Service, Austin, Texas, USA.

This November 2014 draft report is part of the proposed Habitat Conservation Plan (HCP) in support of an Incidental Take Permit (ITP) application to the USFWS for the Barton Springs Salamander and the Austin Blind Salamander. It outlines groundwater conservation activities that consider groundwater management strategies while minimizing impacts to federally listed endangered species that depend on the aquifer. The discussion also includes a comparison of the proposed EAHCP to the EAHCP and EARIP.

Bendik, N. F., B. N. Sissel, J. R. Fields, L. J. O'Donnell, and M. K. Sanders. 2014. Effect of urbanization on abundance of Jollyville Plateau Salamanders (*Eurycea tonkawae*). Herpetological Conservation and Biology 9:206–222.

This journal article summarizes population survey data for the threatened Jollyville Plateau Salamander and presents analysis of abundance and density trends correlated with development characteristics of the monitored sites where the Salamander is found. The study found that Salamander counts decreased with increasing residential development and Salamander densities were negatively correlated with residential development across the Salamander's range. The authors also discuss potential mechanisms that could link urbanization and salamander decline.

DeColo, S. L. 2014. Mating behavior and the effects of turbidity on preferences for size in the Fountain Darter, *Etheostoma fonticola*. Thesis, Texas State University, San Marcos, Texas, USA.

This thesis examines the effects of water turbidity on social behaviors, such as mate choice and association preferences, in the fountain darter. The study found that turbidity decreased female strength of preference for larger males and fountain darters spent less time associating with the opposite sex when their vision was reduced.

Holsinger, J. R. and L. Ansell. 2014. A new species of the subterranean amphipod genus *Stygobromus* (Amphipoda: Crangonyctidae) from two caves and a spring in western Maryland, USA with additional records of undescribed species from groundwater habitats in central Maryland. Zootaxa 3768:368–394.

This journal article describes a new species of karst amphipod from Maryland.

Huston, D. C. 2014. Invasive heterophyid trematodes and their native aquatic hosts in Texas. Thesis, Texas State University, San Marcos, Texas, USA.

This thesis discusses the life history of two exotic trematodes (Centrocestus formosanus and Haplorchis pumilio); examines the potential susceptibility of the San Marcos salamander to C. formosanus*; and looked for* H. pumilio metacercariae *infection in several endangered fishes, including the fountain darter. The study found that San Marcos salamander was not susceptible to* C. formosanus*, but wild-caught fountain darter specimens showed evidence of infection with* H. pumilio*.*

Huston, D. C., V. Cantu, and D. G. Huffman. 2014. Experimental exposure of adult San Marcos Salamanders and larval leopard frogs to the cercariae of *Centrocestus formosanus*. Journal of Parasitology 100:239–241.

This journal article describes the experimental exposure of San Marcos salamanders to an exotic trematode gill parasite. The study found that the San Marcos salamander did not show signs of metacercarial *infection, whereas leopard frog tadpoles and fountain darters were readily infected by the parasite.*

Mainali, K. P. 2014. Areas of endemism for rare fauna in karst regions of Hays County, Texas. Master's Report, University of Texas at Austin, Austin, Texas, USA.

This master's report uses statistical analysis techniques to analyze and predict areas of endemism for rare fauna in the karst regions of Hays County, Texas.

Pierce, B. A., K. D. McEntire, and A. E. Wall. 2014. Population size, movement, and reproduction of the Georgetown Salamander, *Eurycea naufragia*. Herpetological Conservation and Biology 9:137–145.

This journal article describes life history observations, population size estimates, and the findings of a mark-recapture study of the threatened Georgetown Salamander at two springs on the North San Gabriel River in Williamson County, Texas. Visual implant elastomers were injected to uniquely identify individual adult salamanders and follow their movements and life history over a two year period.

Serio, T. C. 2014. A preliminary investigation into the use of environmental DNA to detect the presence of rare *Eurycea* salamanders in the Devils River, Texas. Honors Thesis for a Bachelor of Science in Biology, Angelo State University, San Angelo, Texas, USA.

This undergraduate honors thesis examines the use of DNA analysis techniques to extract and amplify environmental DNA from freshwater as a potential method to detect presence of rare salamanders in the Devils River, Val Verde County, Texas. The results of the study were inconclusive.

Zara Environmental, LLC. 2014a. Literature review and proposed methodology for study to establish Comal Springs Riffle Beetle baseline population distribution and refine riffle beetle collection methods. Report dated 20 February 2014. Prepared for Edwards Aquifer Authority, San Antonio, Texas, USA. 13 pages.

This report includes a review of literature related to collection methods and rearing parameters for the Comal Springs riffle beetle, followed by proposed methods to study the population distribution of the beetle at Comal Springs. The report outlines the development of a refugium system and laboratory testing of proposed collection techniques, which would initially use a surrogate species before testing with collected Comal Springs riffle beetles. Testing of collection lures will be followed by proposed presence/absence sampling at Comal Springs.

Zara Environmental, LLC. 2014b. Proposed methodology to establish a Comal Springs Riffle Beetle baseline population estimate within the Comal Springs System. Report dated 24 March 2014. Prepared for Edwards Aquifer Authority, San Antonio, Texas, USA. 5 pages.

This report describes the proposed methods to estimate Comal Springs riffle beetle population distribution and abundance. The study would also correlate sampling results to measured habitat and site characteristics, such as spring characteristics, siltation, location, shade, and rainfall.

Zara Environmental, LLC. 2014c. Fauna of wells near the saline water line of the Edwards Aquifer, Texas. Report prepared on 1 September 2014 for Edwards Aquifer Authority, San Antonio, Texas, USA. 37 pages.

This report describes sampling results of stygobitic fauna from Edwards Aquifer wells near the saline water line, between 2008 and 2014. A number of sites yielded invertebrate fauna, including rare species, and evidence of the toothless blindcat was also collected from several new locations. Statistical analysis for correlation between faunal diversity and site factors was performed, but the researchers found no significant correlation of diversity with volume of water flow or other factors tested, such as distance from the saline water line, well depth, or temperature.

8.0 REFERENCES CITED

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