Preliminary Investigation of Potential Phase I Surface Water Treatment Plant along West Fork San Jacinto River

San Jacinto River Authority

BROWN & GAY ENGINEERS, INC.

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Montgomery County
Alternative Water Supply Program

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Executive Summary

The Lone Star Groundwater Conservation District's (LSGCD) adopted District Regulatory Plan (Phase IIA) requires the overall groundwater use in Montgomery County to be reduced to 64,000 acre feet per year (afpy) by January 1, 2015. The San Jacinto River Authority (SJRA) responded to the need for the most cost-effective countywide plan through an extensive effort in the development of a Joint Water Resource Assessment Plan (WRAP) Part II which was submitted on behalf of 198 of the Large Volume Groundwater Users in the county. The SJRA WRAP Part II included the location of a surface water treatment plant (WTP) adjacent to Lake Conroe with a treated surface water transmission line system extending from the plant to various delivery points.

The purpose of this study is to review the potential feasibility of locating the SJRA Phase I (2015) WTP downstream of Lake Conroe along the West Fork of the San Jacinto River Authority closer to the Phase I delivery points in The Woodlands and the City of Conroe.

For the purpose of this report, the raw water intake is assumed to be located on the east side of the West Fork approximately 0.8 miles upstream of its confluence with Lake Creek, and the WTP is located on the south side of Lake Creek approximately 1.4 miles upstream of its confluence with the West Fork. **Figure 1** shows the WTP and intake site. This potential site was first identified in the "Planning Level Study for Alternative Surface Water Pipeline Routing in Montgomery County," and as will be demonstrated from the findings and conclusions outlined in this report, these sites are representative of the conditions and issues related to this section of the West Fork of the San Jacinto River.

This investigation analyzes each of the major elements involved in developing a downriver WTP, including the diversion of raw water. Raw surface water must be diverted from the West Fork of the San Jacinto River to the WTP. A weir must be constructed in the river to develop a pool of adequate depth that will reduce stream velocity to the low level needed to settle suspended solids prior to treatment and provide the submergence necessary to ensure operation of the raw water pumps that will convey the water from the river to the WTP. It is anticipated that a weir of at least 10 feet in height is required for this purpose. The potential pool formed by the weir is shown in **Figure 3**. Both the pool and diversion would require permitting by TCEQ. The time required to prepare and submit the permit applications plus the time required to obtain the permits would be sufficiently lengthy as to adversely affect the SJRA's ability to meet the mandated compliance schedule.

The diversion of raw water from this section of the river will also require a water right permit from the Texas Commission on Environmental Quality (TCEQ). The construction of all facilities will require numerous permits, including a Section 404 permit from the US Army Corps of Engineers (USACOE). The Section 404 permitting process followed by the COE includes concurrence of the project by numerous resource and regulatory agencies including but not limited to the US Fish and Wildlife Service, the Texas Parks and Wildlife Department, and the Texas Historical Commission. Together these agencies review the project for potential impacts to wetlands, endangered/threatened species habitat, cultural/historical sites, and a variety of other issues. Since it is anticipated that the construction of facilities in and near the river will be of interest to these agencies, a preliminary environmental review of the area along the West Fork of the San Jacinto River was performed. This study included environmental review and field investigations to identify potential issues.

The results of these investigations are documented in "Baseline Investigation for Alternative Water Plant and Intake" (Baseline Investigation) prepared by Halff Associates, Inc., dated August 2009 and included as Appendix A to this report. In summary, the potential that jurisdictional wetlands exist in any project site along this section of the river is high and could significantly impact the ultimate cost, schedule and success of the project. Habitat of endangered/threatened species specifically that of the Red-Cockaded Woodpecker, may also exist in the area. The USACOE can only permit the least damaging, practicable project, perhaps indicating that regardless of other factors, if a WTP at Lake Conroe is practicable and less damaging, then it may be extremely difficult and costly, if not impossible, to permit a raw water intake and WTP along the West Fork of the San Jacinto River. There is also a potential to discover historically significant sites along the West Fork of the San Jacinto River that, if identified through a required archeological study, could delay the project or require its relocation. If a historically significant site is discovered during construction, progress of the project would be delayed until the site could be adequately investigated and documented.

The costs developed for this report are consistent with the approach used to develop costs in the report, "Joint Water Resources Assessment Plan – Alternative Analysis" (Alternative Analysis). The major components of the Phase I system include: land acquisition of the WTP site, control buffer around the pool and water line easements, the weir and pool, raw water intake and pump station (with backup power), access road, the water treatment plant, ground storage tanks, booster pump station, and water lines.

The infrastructure associated with a Phase I WTP on the West Fork of the San Jacinto River results in an overall increase in cost compared to the preferred alternative developed for the WRAP Part II. The increases occur in the costs of improvements necessary to meet surface water demand in 2015 and 2025. There are no changes associated with infrastructure required for 2035 and 2045. The estimated total cost in future dollars for infrastructure in 2015 and 2025 is $519 million and $663 million, respectively. Most costs for the system based on a Phase I WTP along the West Fork of the San Jacinto River are identical to the system costs developed for the WRAP Part II Report. The primary differences occur in three components of the plans: the amount of land to be acquired, the raw water intake and pump station, and delaying the construction of approximately 40,000 feet (7.6 miles) of 54 inch diameter water line.

Table ES.1
Total Project Capital Costs
Future Dollars ($ millions)

	2015	2025	2035	2045	Total
WRAP Part II Report based on Phase I WTP at Lake Conroe	$480	$509	$712	$809	$2,510
Phase I WTP along the West Fork of the San Jacinto River all other Phases at Lake Conroe	$519	$663	$712	$809	$2,703
Change in Cost from WRAP Part II to Plan Based on First Phase WTP along the West Fork of the San Jacinto River	+ $39	+ $154	No Change	No Change	+ $193

It is anticipated that annual operation and maintenance costs will eventually increase with two geographically dispersed surface water treatment plants – one along the West Fork of the San Jacinto River and one at Lake Conroe – due to lost effectiveness of operating and maintaining one plant. Due to the evaporation and seepage of raw water while conveying it along the West Fork of the San Jacinto River and spillage over the weir, a portion of the effective yield of Lake Conroe will be lost. This will require the schedule of development of additional water supplies for the region to be shortened which will ultimately increase the raw water costs to the region. Power costs will also increase due to additional energy required to pump treated surface water uphill from the plant site to delivery points in Conroe. These costs, along with the costs of the environmental studies, permitting, and mitigation described above, are not included in the costs for the WTP along the West Fork outlined in Table ES.1 and would make this proposed site even less cost-effective.

In summary, constructing the Phase I WTP along the West Fork of the San Jacinto River increases the program costs by approximately $39 million in 2015 and by approximately $154 million in 2025 with no reduction in costs in 2035 or 2045. In addition the permits required for impoundment of water, diversion of water, and construction may not be obtainable and at the very least would delay construction and jeopardize compliance with the mandated conversion schedule of January 1, 2015.

Section 1
Introduction

1.1 Background

The San Jacinto River Authority (SJRA) Joint Water Resource Assessment Plan (WRAP) Part II Report documents important milestones beginning with creation of the Lone Star Groundwater Conservation District (LSGCD) by the Texas Legislature in 2001 through the development and submission of the Joint WRAP Part II Report. In summary, those milestones include:

1. Texas Legislature (2001) creates the LSGCD.
2. The LSGCD studies confirm that water levels in major aquifers in Montgomery County are rapidly declining.
3. Computer modeling of future reliance on groundwater predicts continued declines and new problem areas where water levels are not currently of concern.
4. The LSGCD establishes a preliminary estimate of 64,000 afpy as the sustainable yield for the aquifer in Montgomery County
5. In 2003, the LSGCD adopts (DRP Phase I) the 64,000 afpy estimate for the purposes of its Groundwater Management Plan (GMP).
6. In 2005, the Texas Water Development Board (TWDB) completed a project using the Northern Gulf Coast Aquifer Groundwater Availability Model (GAM) to study the aquifer. Results suggest that actual recharge may be significantly less than 64,000 afpy.
7. In 2006, the LSGCD contracted with the US Geological Survey (USGS) for a three-year study of the recharge rate. Preliminary results of that study are expected in late 2009.
8. On February 12, 2008, the LSGCD adopted regulations (DRP Phase II(A)) requiring certain groundwater users to develop a Water Resources Assessment Plan (WRAP) assessing future water needs and describing how alternative water supplies may be acquired to meet future demands and reduce groundwater in Montgomery County to 64,000 afpy by January 2015. WRAPs are composed of two major parts; Part I of the WRAP includes information about current and projected water demands; identification of current water supplies; and description of current well capacities. Part II includes identification of new water supply sources to meet projected water demands; description of infrastructure needed to deliver new supplies; timeline and cost estimate to develop new supplies; and a letter from the supplier confirming the availability of the new supplies. Multiple Large Volume Groundwater Users (LVGUs) may submit a Joint WRAP addressing plans to meet LSGCD requirements on behalf of all LVGUs that are part of the Joint WRAP.
9. The SJRA was joined by 198 of 201 LVGUs in Montgomery County and submitted a Joint WRAP Part I to the LSGCD in August 2008.

10. The SJRA was joined by 198 of 201 LVGUs in Montgomery County and submitted a Joint WRAP Part II to the LSGCD in February 2009.
11. LSGCD issued Draft Phase II (B) rules in August 2009.

1.2 Purpose and Approach

The purpose of this study is to investigate the feasibility of placing the Phase I water treatment plant (WTP) downstream of Lake Conroe in close proximity to the initial points of delivery of treated surface water in The Woodlands and Conroe. The Phase I WTP along the West Fork of the San Jacinto River would be of the same capacity as the Phase I WTP proposed in the Joint WRAP Part II Report (26,885 afpy/ 24 mgd). As discussed in the Joint WRAP Part II Report, a joint approach to surface water conversion is more cost-effective because it over-converts large concentrations of groundwater use for the benefit of all users, especially small, remote, users to which it would be cost-prohibitive to convey surface water. An important key to early phases of this approach is replacing a large portion of the groundwater used by The Woodlands, the City of Conroe and other large users of groundwater.

The intent of the potential Phase I WTP along the West Fork of the San Jacinto River is to supply water demand beginning in 2015 closer to the Phase I demand. This period represents the first phase of development of the larger plan described in the Joint WRAP Part II Report. For the purposes of this study, a potential Phase I WTP along the West Fork of the San Jacinto River was investigated. The potential site was first identified in the “Planning Level Study for Alternative Surface Water Pipeline Routing in Montgomery County” (Planning Level Study, May 2008). The current study did not attempt to identify other candidate sites and, based on review of aerial imagery, parcel data, and other information, it is considered representative of any site located along the West Fork of the San Jacinto River generally near The Woodlands.

Regardless of other specifics about the site, it is critical that the facilities be located near the West Fork San Jacinto River (West Fork) because the West Fork is SJRA’s means of conveying flows downstream of Lake Conroe. The specific site included in this study is located on the south side of Lake Creek approximately 1.4 miles upstream of its confluence with the West Fork. Existing access is by FM 1488, Old Conroe Road, and Park Avenue.

The raw water intake is on the east side of the West Fork approximately 0.8 miles upstream of its confluence with Lake Creek. **Figure 1** shows the WTP and intake sites.

Subsequent sections of this report address the major elements of a plan to incorporate the Phase I WTP along the West Fork of the San Jacinto River as the first phase in the larger plan documented in the Joint WRAP Part II Report. Those elements include:

1. Surface Water Required.
2. Environmental Factors.
3. Schedule Impacts.
4. Infrastructure: including the pool, weir, intake, pump station, raw water pipeline and WTP.
5. Capital costs.
6. O & M costs.

The final costs of these elements are incorporated into the estimate of total costs for the surface water conversion program and are compared with the costs developed in the Joint WRAP Part II Report.

Section 2
Surface Water Required

As previously stated, the Phase I WTP along the West Fork of the San Jacinto River will have the same capacity as the Phase I WTP proposed in the Joint WRAP Part II Report. The estimated quantity of surface water required during the planning period to 2045 was established in the Joint WRAP Part II Report. The following table, **Table 2.1,** is based on Table 4.1 of the Joint WRAP Part II Report.

Table 2.1
Surface Water Required (afpy)

	2015	2025	2035	2045
Estimated Treated Surface Water Required	19,730	40,838	62,823	89,446
Average Treated Surface Water Delivered	20,164	60,492	80,656	100,000
Proposed Surface Water Treatment Capacity (12 mgd modules)	26,885	80,656	107,541	134,426

LSGCD Phase II (A) Rules allow for growth in water demand to be met by groundwater, therefore, the first phase WTP capacity is based on the 2015 requirement for 20,164 acre-feet/year (afpy) or 18.0 million gallons per day (mgd) of surface water. The WRAP Part II Report also established the goal of supplying up to 80% of annual demand of those receiving surface water. For participants to receive 80% of their annual demand requires that surface water be virtually 100% of water used during low demand months of the year and that surface water be supplied at a maximum rate of approximately 125% of the average day water demand during high demand months.

For greater flexibility and to provide greater assurance of the ability to meet the groundwater reduction requirements, future studies will investigate the added cost to provide an additional treatment train and extend the distribution system to connect to more water plants. These steps provide redundancy in the event that a treatment train must be out of service or a water plant is unable to receive and distribute surface water.

Section 3
Environmental and Water Rights Considerations

Avoidance, minimization and mitigation of environmental impacts will be a key factor to cost and schedule impacts of a raw water intake and WTP sited along the West Fork of the San Jacinto River. The potential is high that wetlands are located along the West Fork regardless of the specific location. In addition to issues related to potential waters of the US (wetlands), threatened and endangered species habitat, cultural resources, and hazardous materials are also issues that could be critical.

For the purposes of this study, additional environmental review was conducted including field investigations to identify potential environmental issues. The results of these investigations are documented in “Baseline Investigation for Alternative Water Plant and Intake” (Baseline Investigation) prepared by Halff Associates, Inc., dated August 2009 and included as Appendix A to this report.

While all the environmental factors are important to the ultimate cost, schedule and success of the project, the potential that jurisdictional wetlands exist is especially critical for reasons including:

- Cost impacts:
  - Need to employ trenchless methods rather than open-cut construction to avoid/minimize impacts.
  - Need to mitigate at an unknown ratio of purchased acres to impacted acres.
- Schedule impacts:
  - Additional time to delineate wetlands.
  - Additional time in the review and approval/permit process including a period for public comment.
  - Additional time in construction if the contractor’s activities are restricted and progress is slowed.

The adage “avoid, minimize, mitigate” is important when considering environmental factors in the design of construction projects. Therefore, the approach adopted for the purposes of this report is to avoid both the environmental impacts with their unknown mitigation costs and potential impacts on the schedule.

Other important results of the Baseline Investigation include the potential presence of several endangered/threatened species including a number of migratory bird species, but especially the red-cockaded woodpecker indigenous to the area.

The U.S. Army Corps of Engineers (USACOE) is the agency responsible for issuing a Section 404 permit for the project. The USACOE will coordinate comments and concerns regarding a variety of environmental issues with U.S. Fish and Wildlife, Texas Parks and Wildlife, Texas

Historical Commission, Texas Commission on Environmental Quality (TCEQ), etc. Representatives of the SJRA, Halff, and Brown & Gay Engineers, Inc. (BGE) visited with USACOE's Galveston District project managers on July 23, 2009 to discuss the WTP along the West Fork of the San Jacinto River. Two important outcomes of that meeting include:

1. Once an application for an individual permit under Section 404 is submitted, the project could require one to three years to review and approve.
2. The COE can only permit the least damaging, practicable project.

The second point is critical because it appears to indicate that regardless of other factors, including cost, if a WTP at Lake Conroe is practicable and less damaging, then it may be impossible to permit a raw water intake and WTP along the West Fork of the San Jacinto River.

In addition, a WTP along the West Fork of the San Jacinto River will require an impoundment on the West Fork of the San Jacinto River with diversion from the impoundment to the WTP. The impoundment will require permitting by TCEQ as well as the diversion. The cost of this permitting process has not been considered in this analysis. The required time for preparing and submitting the application plus the time required to obtain the permits may be sufficiently lengthy as to adversely affect meeting the required compliance schedule.

Finally, the USACOE also indicated that a potential exists to discover historically significant sites, for example, Native American campsites, along the West Fork San Jacinto River. The potential is unknown because no major development or construction along this segment of the river has occurred. There is the potential that significant research would be required to confirm that there are no issues. If a historically significant site (or sites) were discovered, progress of the project would be delayed until the site could be adequately investigated and documented.

Section 4
Infrastructure

4.1 Weir and Pool

A weir and pool are recommended for two reasons explained below. The term “weir”, rather than “dam”, is used for consistency with the Baseline Investigation report because the US Army Corps of Engineers (USACOE) recognize that only the US Congress can authorize construction of a dam. Nevertheless, the Texas Commission on Environmental Quality (TCEQ) will permit the proposed structure as a dam. In addition, as previously described in Section 3, SJRA will have to acquire a new water right to store and divert water at the potential site. Potential costs and delays associated with acquiring these rights have not been investigated as a part of this study.

A weir and pool are recommended first because a pool provides the volume necessary to reduce stream velocity to the low level needed to settle suspended solids. Removal of suspended solids is important to reduce the maintenance required and increase the life of the raw water pumping equipment. In addition, removal of suspended solids is important to maximize efficiency of other treatment process and the final quality of the finished water. Second, a pool provides the submergence necessary to ensure efficient pump operation with minimal potential for cavitation to occur. The need for adequate depth in the pool to ensure sufficient submergence for proper pump operation is discussed in greater detail in the following section, “Raw Water Intake and Pump Station.

For the purposes of this study, the proposed weir would maintain a pool at approximately elevation 117 feet. The channel bottom is approximately elevation 107 feet, making the height of the weir at least 10 feet. With a proposed top width of 20 feet, an upstream slope of 3 (horizontal) to 1 (vertical), and downstream slope of 4:1, the weir will be 90 feet wide at its base and will require approximately 3,500 cubic yards of earth and concrete to construct. The location of the weir is illustrated in **Figure 1** and the potential pool is shown in **Figure 3**.

Operation of the pool and intake pump station will have to be coordinated with operations at Lake Conroe to ensure adequate releases without overtopping the weir. Releases at Lake Conroe will have to allow for conveyance losses that are assumed to be at least 5% along this relatively short section of the West Fork. The pool created at elevation 117 feet will inundate approximately 44 acres that will be cleared of existing trees before the pool is filled.

4.2 Raw Water Intake and Pump Station

Due to the high potential for wetlands discussed in Section 3, it is assumed that the raw water line from the raw water pump station to the forebay of the WTP will be constructed using trenchless methods. For the purposes of this report, tunnel construction is assumed, however, horizontal directional drilling (HDD) should be considered during future preliminary engineering.

Tunnel construction will require a large pit or shaft on each end of the proposed tunnel to conduct tunneling operations. The need for the shaft fits naturally with caisson construction of the raw water pump station. The walls of the pump station could be constructed and serve as the support for the shaft during tunneling operations. Once tunneling is complete, construction of the raw water pump station would resume.

River intake pump stations are subjected to the sediment loads, floatable trash, and other debris carried by the flow. Therefore, appropriately designed trash racks and screens are critical as well as a design that allows for easy maintenance of those screens to remove accumulated sediment and debris.

Another critical aspect of pump station design is ensuring adequate depth of water or submergence over the pump impeller. Adequate submergence is essential to avoid operation of the pumps under low suction head that can allow the formation of vapor cavities (cavitation) as the pressure drops below the vapor pressure of the water being pumped (i.e., the water boils at low pressure). Cavitation causes both inefficient operation (work is performed to move a volume not filled with water) and physical damage to impellers and other metal surfaces as the vapor cavity moves to a region of higher pressure and implodes on metal surfaces. Studies show that cavitation begins well before the standard industry measure detects or confirms that cavitation is occurring. Therefore, pump station designs should always follow Hydraulic Institute (HI) standards regarding submergence. If pump capacity exceeds 5,000 gallons per minute (gpm), HI standards recommend a physical model study to prove the design concept.

The raw water intake and pump station should be sized for approximately 28 mgd to ensure the production of 22.5 mgd of finished water after allowing for evaporation and losses in the treatment processes.

4.3 Water Treatment Plant Facilities

For the purpose of this report, the water treatment plant is assumed to be located along the West Fork of the San Jacinto River as shown in **Figure 1**. Much of the following discussion regarding potential treatment processes is similar to discussion in the Joint WRAP Part II Report and has been modified based on the different conditions expected for a river intake compared to a lake intake. Final process selection is only possible after additional study including the potential to form various disinfection byproducts based on the source water quality and different disinfectants. Until additional quality and treatability studies are performed, utilization of demonstrated, multi-barrier technology in the form of conventional treatment processes is assumed. In addition, assuming conventional treatment at this time, results in conservatively large plant site requirements for current planning. For the purpose of estimating the quantity of water required to be delivered to the WTP in order to produce a given quantity of finished water, the following losses are assumed:

- At least 5% of water originating at Lake Conroe will be lost to evaporation and seepage before reaching the raw water intake,
- Up to 15% of water delivered to the forebay of the WTP will be lost to evaporation and in various byproducts of the treatment processes.

The following paragraphs provide a basic description of conventional treatment unit processes including flocculation, sedimentation, filtration, and disinfection.

Presedimentation

A water treatment plant located at Lake Conroe would not require presedimentation because the lake serves to settle out the majority of suspended solids. In contrast however, with the water treatment plant intake located on the West Fork, presedimentation is recommended to settle out solids suspended in the stream flow and to achieve higher finished water quality.

Flocculation

Following pre-sedimentation, the flocculation process binds fine suspended solids to a chemical floc and precipitates some dissolved compounds sometimes present in raw surface waters. Various chemicals selected for their ability to perform these functions will be thoroughly mixed with the raw water stream before continuing to the flocculation zone where gentle mixing continues. Selection of the proper chemicals and chemical dose is essential to remove organic matter in order to minimize the potential formation of undesirable disinfection byproducts.

Sedimentation

Precipitates and flocculated particles settle out of the slowly flowing stream in large basins. Traditional sedimentation employs large basins and gravity to settle sediments to the bottom of the basin. High rate sedimentation processes employ additional mechanical and/or physical methods to enhance sedimentation and, therefore, employ smaller basins than traditional sedimentation. Following sedimentation, the clarified water is filtered, but may also be disinfected before being filtered.

Filtration

After additional study, later preliminary design will select a conservative filter loading rate to ensure that the filters operate effectively to meet more stringent water quality regulations. Filtered water continues to a clearwell designed to provide sufficient detention time for the disinfection process.

Disinfection

Primary disinfection is critical to inactivate organic matter that has not been removed in previous treatment processes. The disinfectant must not be allowed to combine with organic matter to form significant disinfection byproducts. For this reason, chlorine is usually avoided as the disinfectant and chloramine is frequently chosen for its lower potential to form undesirable byproducts. An alternative disinfectant, chlorine dioxide, could be generated on site for use in this application. Still, it is assumed that chloramine will be used to provide disinfectant residual in the distribution system.

Advanced Treatment

As future regulations require treated water to meet more stringent standards of quality, 'advanced' treatment in addition to conventional treatment may be required. Advanced treatment may use a membrane process to provide additional solids removal or add disinfection using ultraviolet radiation or ozone.

In addition to the processes described above, treatment plant operations will require supporting facilities including laboratory testing facilities and office space, lockers and restrooms for staff. Lab facilities will allow staff to perform the chemical analyses necessary to optimize the treatment process, test, and report water quality. In addition, space will be required for tool and parts storage as well as working area to conduct routine maintenance. Costs for these supporting facilities are included in Region H estimates for water treatment plant capital costs.

Ground Storage Tanks

The "Planning Level Study for Alternative Surface Water Pipeline Routing in Montgomery County" (Planning Level Study, May 2008) indicates preliminary plans for four 3.5 million gallon ground storage tanks (GSTs) to provide eight hours storage for a final treatment plant capacity of 42 mgd. The comparable eight hours storage is approximately 8 million gallons (Mgal) for the first phase surface water requirements. The cost of ground storage is based on providing four, 2 Mgal GSTs.

High Service Pump Station

The high service pump station will pump treated water stored in the GSTs to the transmission/distribution system piping for delivery to Participants' water plants. The high service pump station should be sized for approximately 22.5 mgd to meet the surface water demand requirements of the 2015 first phase.

4.4 Access for Construction and Maintenance

Construction and future maintenance of the raw water pump station, intake structure, and weir will require access to the north/east bank of the West Fork to be extended from existing Old Magnolia Road/Sgt. Ed Holcomb Blvd. The proposed access is approximately 2,900 feet and is illustrated on **Figure 1**.

4.5 Other Facilities

Other major components such as treatment units, storage tanks, and high service pump station may be designed, bid and constructed as separate projects. The following discussion is primarily concerned with the capacity required for these components so they are addressed generally or as a whole rather than individually.

Ground storage tanks for treated water are assumed to be constructed of steel or prestressed concrete at ground level. For purposes of this report, four 2 million gallon storage tanks are assumed at the potential water treatment plant. This assumption is consistent with the space available and the layout presented in the Planning Level Study.

A booster pump station will deliver water to the existing water plants in Conroe and The Woodlands. Pump station costs are influenced by many factors including the type, size and number of pumps, structural design of facilities, complexity of electrical, instrumentation and control systems, and site conditions among others. All of these must be addressed in detail in future investigations. A booster pump station located on the West Fork of the San Jacinto River downstream of the Lake Conroe dam will use more energy than a pump station located at the Lake Conroe dam. A booster pump station located at the dam would only have to overcome approximately 95 feet of elevation to supply water to the City of Conroe's Water Plant 14, whereas a pump station located downstream on the West Fork will have to overcome an elevation difference of 145 feet and pump a greater distance to Water Plant 14.

Table 4.1 quantifies the estimated conveyance and treatment losses and the maximum rate at which water must be released from Lake Conroe to meet the desired goal of replacing 80% of annual water demand in Conroe and The Woodlands with surface water. As mentioned previously, for greater flexibility and to provide greater assurance of the ability to meet the groundwater reduction requirements, future studies will investigate the added cost to provide an additional treatment train and extend the distribution system to connect to more water plants. These steps provide redundancy in the event that a treatment train must be out of service or a water plant is unable to receive and distribute surface water.

For the purpose of estimating costs for this report, no standby treatment modules or capacity were assumed. Instead it is assumed that groundwater pumpage would be increased during periods in which process trains are taken out of service for maintenance, repair or other temporary periods. Treatment plant costs are based on the total capacity constructed and not on the capacity of individual treatment modules or trains.

Table 4.1
Required Operational Capacities (mgd)

Item	Description	2015
1	Treated Surface Water Required (mgd)	18.00
2	Rate to provide 80% of annual volume (mgd)	22.50
3	Conveyance Losses (5% of total)	1.41
4	Treatment Losses (15% of total)	4.22
5	Required Releases from Lake Conroe (mgd)	28.13

It should be noted that the conveyance losses contribute to using the available yield of Lake Conroe sooner than would occur if the treatment plant were located at Lake Conroe.

4.6 Water Transmission System

The process of evaluating alternative surface water systems was described in the "Joint Water Resources Assessment Plan – Alternative Analysis" (Alternative Analysis), February 2009. Costs were applied to each alternative and the present worth of future annual costs including debt service, purchased water, and operation and maintenance were determined. The alternative with the lowest present worth, T2C1W1, was selected as the preferred alternative and its costs are the basis for comparison with changes in costs associated with the potential WTP along the West Fork of the San Jacinto River.

Figure 1 indicates the changes to transmission mains in the WRAP Part II report and the addition of new transmission mains necessary to incorporate the Lake Creek WTP into the preferred transmission system. In summary, the changes and additions include:

1. Construction of approximately 21,300 feet of 54 inch water line planned for construction in 2015 (Phase I) is replaced by:
    a. 15,900 feet of 54 inch water line in 2015 (Phase I), and
    b. 9,900 feet of 54 inch water line in 2025 (future phase).
2. Construction of approximately 23,500 feet of 54 inch water line in 2015 (Phase I) is delayed until 2025 (future phase).
3. Construction of approximately 14,000 feet of 36 inch water line in 2015 (Phase I) is delayed until 2025 (future phase).
4. Approximately 6,000 feet of 42 inch raw and treated water lines are added to the plan in 2015 (Phase I).
5. Approximately 6,600 feet of 24 inch water line are added to the plan in 2015 (Phase I).
6. Approximately 19,400 feet of 10 inch water line are upsized to 24 inch to the plan in 2015 (Phase I).

Note that all changes between the plan presented in the WRAP II Report and this report are limited to construction in 2015 (Phase I) and 2025. There are no changes to future 2035 and 2045 phases.

Section 5
WTP Facilities' Costs

The report, "Joint Water Resources Assessment Plan – Alternative Analysis" (Alternative Analysis), February 2009, describes the approach to determine the cost of surface water facilities based on bid tabulations to determine appropriate unit prices and through the use of Region H cost tables. The costs used for this report are consistent with that approach and the following paragraphs summarize selected results and expand on discussion in that study.

5.1 Weir and Pool

Significant costs for the weir are in the geotechnical investigation and subsequent construction of the weir. The primary costs for the pool are the costs associated with land acquisition and preparation of the inundated area. Costs include boundary surveying, legal costs, property cost to acquire the land followed by topographic surveying, permitting, and clearing and grubbing of the area.

5.2 Raw Water Intake and Pump Station

The raw water intake is grouped with the raw water pump station because both functions often are performed by the same physical structure. Region H estimates that the total cost for the water intake adds approximately 20 percent to the construction cost of the pump station. Of that 20 percent, approximately 10 percent is related to the structure and the remaining 10 percent is for mechanical equipment including trash rack and rack cleaning equipment as well as other screens.

In addition, backup or emergency power is provided for critical water system components to ensure that facilities remain operational in the event of a loss of normal power. In some cases a second electric power transmission supply is brought on site, but most often in an emergency, power is produced using a standby generator. Backup power is estimated to add 35 percent to the overall cost of pump station construction.

The raw water pipe is assumed to be built using tunnel construction. The basis for the estimated construction cost is the unit price established for other water lines of the same size (see **Table 5.1**). However, due to the sensitivity of the overlying wetlands, possible historic sites, potential habitat for threatened and endangered species, unknown geological conditions, greater depth and probability of groundwater occurrence with the associated need for increased dewatering capability, and the long length of tunnel required, the unit price was increased 50% to $2,000 per L.F. to account for these factors.

The raw water intake and pump station should be sized for approximately 28 mgd to ensure the production of 22.5 mgd of finished water after allowing for evaporation and losses in the treatment processes. Based on Region H cost tables and recommendations regarding cost of the intake and providing backup power to the pump station, the estimated cost of these facilities is approximately $6 million. This does not include the cost of land which is accounted for with the pool and control buffer discussed in a later section.

5.3 Cost of Water Treatment Plant Facilities

Water treatment infrastructure includes several major components that are often designed, bid and constructed as separate projects. The approach to develop preliminary costs for these components is described in the following sections regarding raw water intake and pump station, the water treatment plant, storage tanks for treated water, and high service pump station to distribute treated water. Cost estimates are based on the work of Region H Water Planning Group, which are appropriate for the current level of study.

Until treatability studies of Lake Conroe surface water are performed and finished water quality is defined, it is assumed that the proposed water treatment plant will utilize conventional treatment processes. The primary processes in conventional treatment include flocculation, sedimentation, filtration, and disinfection. Proposed facilities on the site will be laid out in a way that provides flexibility by allowing the addition of other processes once their need is determined based on the timing and direction of future planning.

Future treatability studies and finished water quality criteria will determine whether additional ‘advanced’ treatment is required to ensure compliance with Stage 2 Disinfection Byproducts Rule (DBP2) and Long Term 2 Enhanced Surface Water Treatment Rule (LT2) water quality regulations. Advanced treatment might include other forms of disinfection such as ozonation or ultraviolet (UV) radiation and may include membrane filtration to achieve greater solids removal.

5.4 Access for Construction and Maintenance

Significant costs for all weather access to the weir, intake and raw water pump station site include the necessary property costs and construction of approximately 2,900 feet of asphalt pavement. Costs associated with land acquisition include boundary surveying, legal costs, and property cost to acquire the land followed by topographic surveying, permitting costs, clearing, and construction of the roadway.

5.5 Other Facilities

Finished Water Storage

Cost estimates for ground storage tanks for treated water assume that tanks will be constructed of steel or prestressed concrete at ground level. Estimates are based on the work of Region H, which includes construction costs that vary from approximately $0.78/gallon of capacity for a 1 million gallon tank to $0.35/gallon of capacity for a 10 million gallon tank. These costs were also compared with tank costs in recent construction projects of SJRA, WHCRWA and NHCRWA. For the purposes of this report, four 2 million gallon storage tanks are assumed at the potential water treatment plant.

High Service Pump Station

Following the finished water ground storage tanks, a booster pump station will be necessary to deliver water at adequate pressure to water plants in Conroe and The Woodlands. Pump station cost ultimately depends on many factors including the type, size, and number of pumps; structural design of building; complexity of electrical, instrumentation, and disinfection control systems; and site conditions, among others. All of these must be addressed in detail in future investigations.

For the purposes of this report, the work of Region H is used. Region H estimates of pump station costs are based on station horsepower and, therefore, require assumptions regarding design flow rate and pump head requirements. A booster pump station located on the West Fork of the San Jacinto River downstream of the Lake Conroe dam will use more energy than a pump station located at the Lake Conroe dam. A booster pump station located at the dam would only have to overcome approximately 95 feet of elevation to supply water to the City of Conroe's Water Plant 14. However, a pump station located downstream on the West Fork will have to overcome an elevation difference of 145 feet and pump a greater distance to Water Plant 14 and the cost to do so will be greater.

The proposed high service pump station is also proposed to have backup power. Again, 35 percent of pump station construction cost is added to account for the cost of backup power. These pump station cost estimates were also compared with pump station costs in recent construction projects of SJRA, WHCRWA and NHCRWA.

5.6 Water Transmission System

5.6.1 Capital Costs

<u>Transmission Mains</u>

The development of unit costs for the construction of large diameter water transmission mains is described in the Alternative Analysis. Unit costs were based on analysis of bidding information for 35 water line projects bid between 2001 and 2008. The size of pipe in the projects varied from less than 12 inches to 60 inches in diameter. Project information was provided by the North Harris County Regional Water Authority, West Harris County Regional Water Authority, and the City of Houston. The Engineering News Record Construction Cost Index (ENR CCI) was used to adjust the bid tab data for each project to October 2008 dollars based on when the projects were bid.

Projects were categorized as "Urban" or "Rural" construction based on quantities of pavement, curb, construction exits, clearing & grubbing, fence replacement, inlet protection, use of sod to restore residential areas, utility relocations, and traffic control. Categorizing projects as "Urban" or "Rural" allows the costs developed to be compared with the unit costs developed by the Texas Water Development Board Region H (Region H). Aerial photography and GIS mapping were used to determine the level of development along the preferred alternative. Sections of pipe in developed areas were considered to have higher costs associated with construction in urban areas. Conversely, pipelines in minimally developed areas were assumed to have lower costs associated with simpler construction in rural areas.

Unit costs for rural and urban construction are summarized in **Table 5.1**. In addition, **Table 5.1** provides estimated costs for trenchless construction. As with the rural and urban construction methods, costs for trenchless construction were determined from existing bid tabs.

Table 5.1
Unit Costs for Water Line Construction

Pipe Diameter Inches	Cost/LF ($)		
	Open Cut		Trenchless
	Rural	Urban	
8	95	95	225
10	115	125	290
12	130	155	350
16	165	210	475
20	200	270	595
24	240	330	720
30	290	415	905
36	345	500	1,095
42	400	590	1,280
48	450	675	1,465
54	505	765	1,650
60	560	850	1,835
66	615	940	2,025

Pipe unit costs do not include 'soft' costs associated with planning, design, permitting, bidding and financing projects such as program management, engineering, surveying, geotechnical studies, construction management, materials testing and contingency, financial, and legal costs. Soft costs related to planning and construction are estimated as 30 percent of construction costs and this value is added to the cost of intake structure and treatment plant construction including ground storage. Financial and legal costs are estimated as a percentage of estimated bond sales. A contingency of 35% is placed on costs associated with WTP planning and construction. For transmission mains, the contingency is reduced to 25% because water line projects are less complex and have less uncertainty associated with them than WTP construction. Again, 30% of the estimated construction is added to account for the soft costs associated with their planning and construction.

<u>Water Line Easements</u>

As for previous studies, transmission mains are assumed to be constructed in easements adjacent to existing rights-of-way. Easements are assumed to be 20 feet for pipe up to 36 inches in diameter and 30 feet for larger pipe. Permanent easement widths for all transmission mains not adjacent to existing rights-of-way or other easements are assumed to be 30 feet. Twenty feet for easements is adequate for the majority of locations where the proposed water lines will be adjacent either to public right-of-way or to other corridors such as gas/petrochemical or electric power transmission facilities.

An additional 10 to 20 feet of temporary construction easement may be acquired where beneficial. Easement costs were estimated based on available land values from the Montgomery County Appraisal District (MCAD) and by using GIS to identify potentially affected parcels along each corridor. To be conservative, because the parcel data is incomplete and to allow for acquisition of temporary construction easements, the weighted average value was increased by 25% and rounded to the nearest $0.05 per square foot ($/sf). In addition, if the estimate was less than $0.25 per square foot ($10,900/acre), then a minimum value of $0.25/sf was used.

In addition to the value of the land, there is significant cost associated with the acquisition process, such as title acquisition, engineering and legal support, boundary surveys, offer and negotiation activities, recording fees, and, on occasion, the condemnation process. A value of $8,000/parcel for easement acquisition was adopted for the purpose of this study. The estimated number of parcels should be considered very preliminary because the number of parcels in a 1,000 feet buffer is expected to overestimate the number of parcels, however, the incomplete nature of the MCAD parcel data is expected to underestimate the number of parcels.

5.6.2 Annual Costs

Annual Operation and Maintenance (O&M) costs include:

- Debt service,
- Reserve funds (e.g., debt service reserve, operating reserve)
- Operating costs for the treatment plant (e.g., chemicals, power), and an operator to oversee daily operations,
- Maintenance of water treatment plant and transmission mains and their repair,
- Purchased water (including reservation fees)
- Program management
- Engineering, legal, and financial support

Debt service is determined based on the amount of the bond sale(s) (including legal, financial advisor and other fees) required to fund the total project cost including construction and soft costs. Based on a review of the operation of this potential Phase I WTP along the West Fork of the San Jacinto River it was determined that the annual costs of operation and maintenance would be similar to, though higher than, the annual operation and maintenance costs for the Phase I plan presented in the Joint WRAP Part II Report. The higher costs are primarily due to two factors: 1) the additional maintenance associated with the raw water intake and pump station, and 2) the greater pumping cost to pump treated water back to water plants in the City of Conroe.

Section 6
Comparison of Program Costs

The proposed infrastructure described in Section 4 and the Costs described in Section 5 result in an overall increase in cost compared to the preferred alternative developed for the WRAP Part II. The increases occur in the costs of improvements necessary to meet surface water demand in 2015 and 2025. There are no changes associated with infrastructure required for 2035 and 2045.

Operating and maintenance costs for a plan developed around a Phase I WTP on the West Fork of the San Jacinto River with a WTP at Lake Conroe are expected to exceed the costs of a WTP at Lake Conroe alone. The three primary additional costs of this plan are: 1) raw water lost in conveyance along the West Fork of the San Jacinto River (conveyance losses), 2) additional pumping costs due to the much lower elevation of the West Fork WTP compared to a WTP at Lake Conroe and water plants in the City of Conroe, and 3) increased costs associated with the operation of two WTPs rather than one.

The estimated total cost in future dollars for infrastructure in 2015 and 2025 is $520 million and $663 million, respectively.

Table 6.1
Total Project Capital Costs
Future Dollars ($ millions)

	2015	2025	2035	2045	Total
WRAP Part II Report based on WTP at Lake Conroe	$480	$509	$712	$809	$2,510
Estimated Costs based on First-Phase WTP along the West Fork of the San Jacinto River and Future WTP Capacity at Lake Conroe	$519	$663	$712	$809	$2,703
Change in Cost from WRAP Part II to Plan Based on First Phase WTP along the West Fork of the San Jacinto River	+ $39	+ $154	No Change	No Change	+ $193

Most costs for the system based on a Phase I WTP along the West Fork of the San Jacinto River are identical to the system costs developed for the WRAP Part II Report. The cost of the WTP, the single largest cost, is assumed to be essentially the same construction cost whether at Lake Conroe or along the West Fork of the San Jacinto River. The differences occur in three components of the plans; the amount of land to be acquired, the raw water intake and pump station, and delaying the construction of approximately 40,000 feet (7.6 miles) of 54 inch diameter water line.

In the WRAP Part II Report, water line easements plus about 40 acres for the proposed WTP site are proposed to be acquired. In contrast, the Phase I WTP along the West Fork of the San Jacinto River delays the purchase of approximately 25 acres of water easements, but potentially requires more than 1,500 acres to be purchased. This includes approximately 1,100 acres for the pool necessary at the raw water intake and control buffer surrounding the pool and another 400 acres for the WTP site, raw and treated water lines, and the access required to the east side of the West Fork. The additional 1,500 acres required for the Phase I WTP along the West Fork of the San Jacinto River far exceeds the savings in 2015 for approximately 25 acres of easements that may be acquired later.

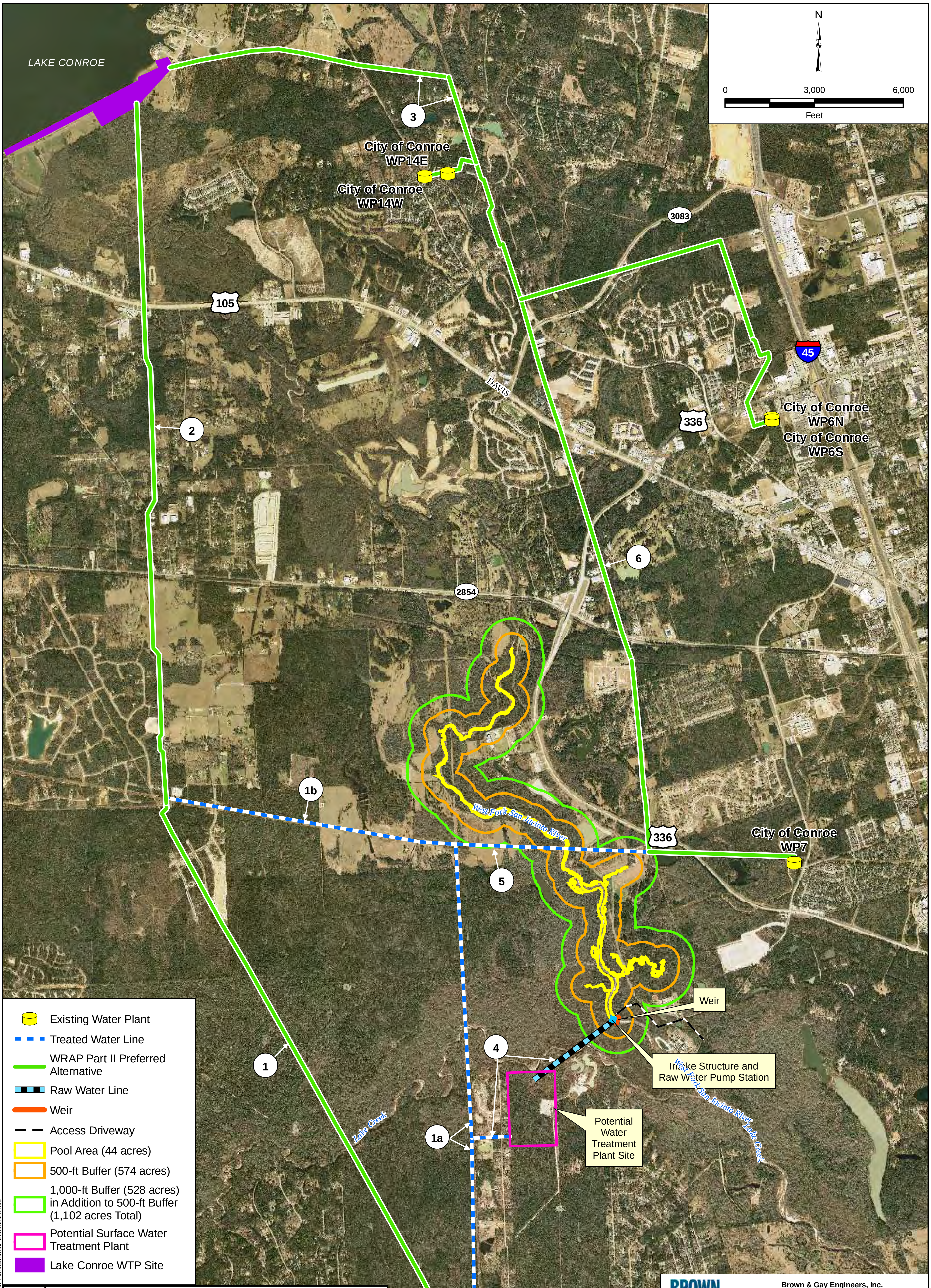
The second and third components of a Phase I WTP along the West Fork of the San Jacinto River that account for the large increase in 2025 are the raw water intake and pump station, and delaying construction of approximately 40,000 feet of 54 inch water line. Both result in additional cost compared to the plan developed for the WRAP Part II Report because they are built later in time at greater cost due to inflation.

The raw water intake and pump station are affected by inflation. The river intake and pump station for a WTP along the West Fork of the San Jacinto River is estimated to cost less than one-third of the cost of the facilities anticipated to be constructed at Lake Conroe. However, even after adjusting for the reduced capacity of the intake and pump station facilities needed at Lake Conroe, the effect of delaying construction by ten years increases the overall cost by 35% after inflation.

Much of the savings of delaying the construction of the 54 inch water line in 2015 is offset by construction of approximately 12,000 feet of 42 inch raw water and treated water lines specific ally for the WTP along the West Fork of the San Jacinto River. The offset is even greater when the unit cost of construction is considered. Because of the presence of wetlands along the 3,600 feet of raw water line, tunnel construction is estimated to cost more than $2,000 per foot or about four times the per foot cost of the 54 inch water line by open cut construction.

Section 7
Conclusions

Constructing the Phase I WTP along the West Fork of the San Jacinto River increases the program costs by at approximately $39 million in 2015 and by approximately $154 million in 2025 with no reduction in costs in 2035 or 2045. In addition the permitting required for impoundment of water, diversion of water and construction may not be obtainable and at the very least could delay the construction and jeopardize compliance with the regulated conversion schedule of January 1, 2015.



1	2015 - 54-inch water line replaced in plan by 1a and 1b
1a	54-inch water line
1b	54-inch water line
2	2025 (was 2015) - 54-inch waterline postponed 10 years
3	2025 (was 2015) - 36-inch water line postponed 10 years
4	2015 - 42-inch water lines added to plan
5	2015 - 24-inch water line added to plan
6	2015 - 24-inch water line (was 10-inch)

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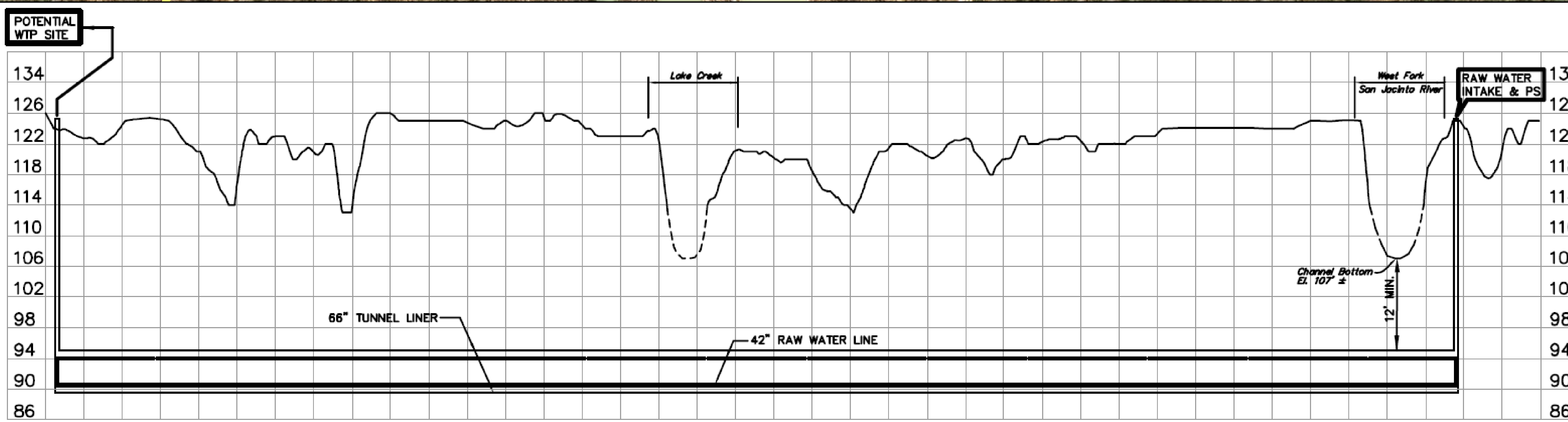
Potential Surface Water Treatment Plant at Lake Creek

Date: September 2009 | Proj No: SJR10-61 | Figure: 1



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Potential Raw Water Line

Date: August 2009	Proj. No: SJR10-61	Figure: 2

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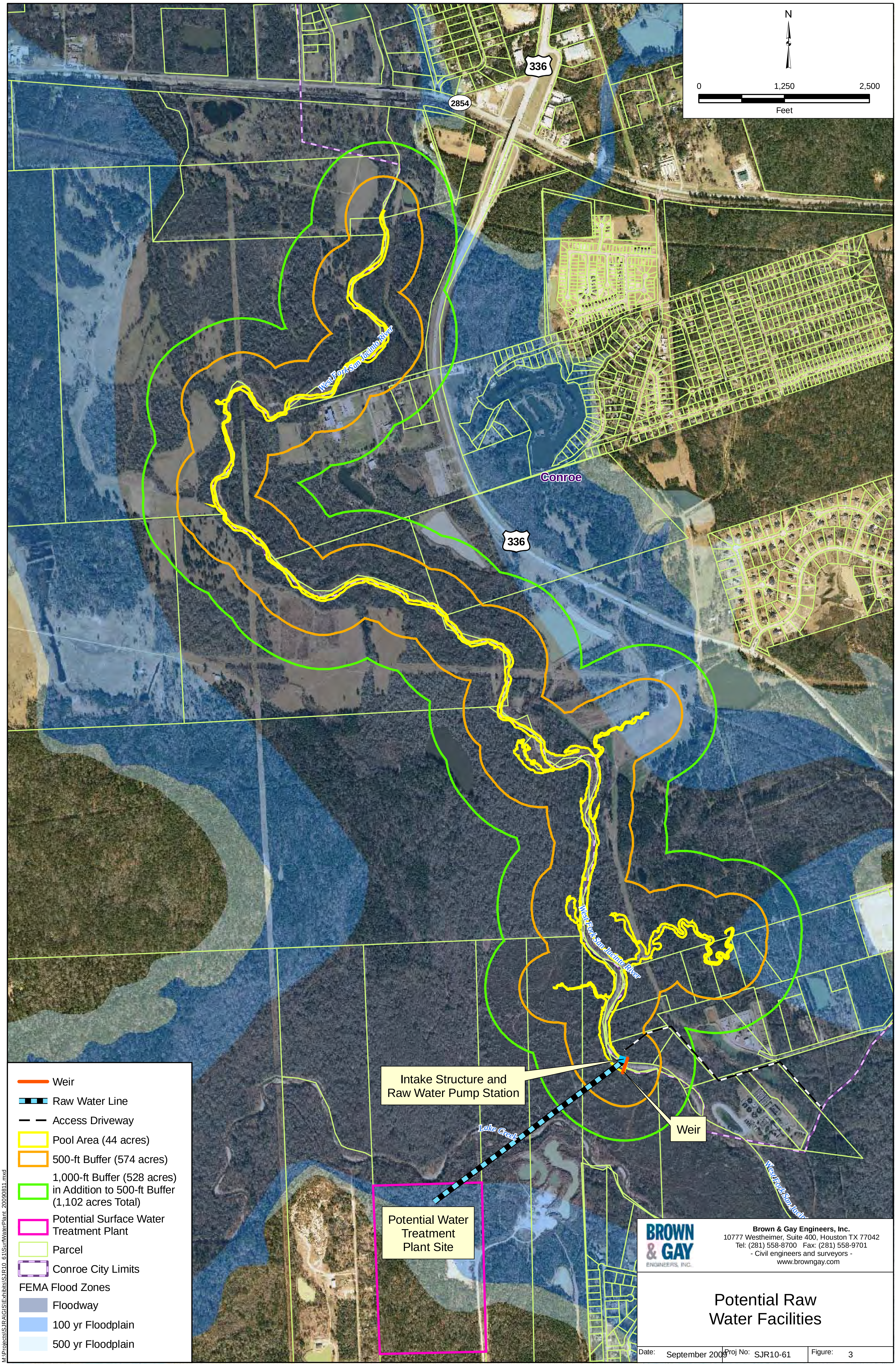

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APPENDIX

A

BASELINE INVESTIGATION

Conducted for:
Alternative Water Treatment Plant and Intake
Montgomery County Alternative Water Supply Project

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1.0 INTRODUCTION

The Lone Star Groundwater Conservation District (LSGCD), in its Phase IIA District Regulatory Plan, is requiring county-wide groundwater consumption to be at or below 64,000 acre-foot per year (ac-ft/yr) by the year 2015. In Montgomery County, it was decided in order to achieve this goal it will require a large-scale conversion from groundwater to surface water.

In May 2008, TCB/AECOM completed a planning level study (*Planning Level Study for Alternative Surface Water Pipeline Routing in Montgomery County*) for the LSGCD and San Jacinto River Authority (SJRA) as a follow-up to their *Regulatory Study and Facilities Implementation Plan for Lone Star Groundwater District and San Jacinto River Authority* (June 2006) building upon the concept of distributing treated Lake Conroe water to the high-demand areas of Montgomery County to meet the LSGCD regulatory goal of reducing groundwater withdrawal. Within the study, a single-plant option and a dual plant option and corresponding transmission alignment corridors were identified. Each option was generally reviewed based on water demands on the system, environmental and historical impacts, right-of-way requirements, existing utilities, and other factors. The single-plant option and corresponding transmission alignment corridor was selected as the preferred option based on long-term cost effectiveness.

The SJRA developed and submitted a Water Resources Assessment Plan (WRAP) – Part II in February 2009. The WRAP – Part II evaluated a water treatment plant site and intake on the Lake Conroe dam with corresponding transmission corridors radiating from the plant site. Halff Associates (Halff) has been retained by Brown & Gay Engineers, Inc. to further evaluate the alternative raw water intake along the West Fork San Jacinto River and a water treatment plant site north of the Woodlands (**Attachment A, Figure 1**).

Using previously acquired information, a base map indicating the location of the floodplain, National Wetland Inventory (NWI) map features, and the known location of hazardous material and cultural resources sites was prepared prior to field investigations (**Attachment A, Figure 2**). Field investigations were conducted over a day and half by qualified personnel from Halff Associates (Halff) in July 2008. Based on this background information and field investigations, the following baseline investigation evaluates the alternative water treatment plant site under environmental constraints including waters of the United States, threatened and endangered species, cultural resources, and hazardous materials. This report also includes results from a meeting with the United States Army Corps of Engineers (USACE) Galveston District on July 23, 2009 regarding potential Section 404 permitting scenarios for the proposed project.

The alternative water treatment plant site, selected by the TCB/AECOM study during investigations for the dual plant option, is located south of Lake Creek, with the raw water intake located along the West Fork San Jacinto River, upstream of the Conroe Wastewater Treatment Plant (the "project"). To capture a significant enough amount of water to enter the system, a weir would be necessary within the West Fork San Jacinto River to create a collection pool. The weir would be constructed across the West Fork San Jacinto River approximately 90 feet wide at the base, 20 feet wide at the top, and require approximately 3,500 cubic yards of fill. The proposed weir would maintain the collection pool at approximately 117 mean feet above sea level (msl), and the collection pool would be approximately 44 acres in size. The collection pool would flood the West Fork San Jacinto River approximately 20,000 linear feet upstream, as well as adjacent uplands, tributaries, and wetlands to the 117 msl elevation. To fill the collection pool, SJRA would be required to release water from Lake Conroe. A raw water intake structure would be located within the pool near the weir. A raw water intake line would connect the raw water intake to the water treatment plant, located along Lake Creek. To avoid impacts to the floodplain, the water treatment plant could be constructed within the same tract and shifted south, located completely out of the floodplain, and the impacts of this were considered as well. However, for the purposes of this report, the study area includes the proposed alternative water treatment plant site as shown, the raw water intake and weir location, the raw water intake line, and a 1000-foot buffer (500 feet on either side) surrounding the intake and intake line. At the time of the field investigation, the extent of the collection pool was not known, and therefore this area was not investigated.

2.0 WATERS OF THE UNITED STATES

In response to growing potential for degradation of the national waters, Congress enacted The Federal Water Pollution Control Act Amendments of 1972, which was later amended in 1977. These amendments are commonly referred to as the Clean Water Act (CWA), and give the Environmental Protection Agency (EPA) the authority to establish the basic structure for regulating the discharge of pollutants into the waters of the United States. Section 404 of the

CWA authorizes the Secretary of the Army to issue permits for the discharge of dredged or fill material into waters of the United States.

The United States Army Corps of Engineers (USACE) has established a list of criteria within 33 Code of Federal Regulations (CFR) 328 to assist in the identification of "waters of the United States." The USACE also has the discretion to determine on a case-by-case basis whether or not a particular waterbody is a "water of the United States." Limits of USACE jurisdiction extend to the ordinary high water mark (OHWM), and adjacent wetlands when present. According to USACE, the OHWM is properly measured at the line on the shore created by the normal fluctuations of water. It is indicated by physical characteristics such as a natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area. Wetlands often extend beyond the OHWM, and therefore, are separately delineated in accordance with the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region* (Environmental Laboratory, October 2008).

Prior to field investigations, topographic maps, soil surveys, floodplain maps, and NWI maps were reviewed and a base map was prepared indicating the location of the floodplain, NWI, and stream features (**Attachment A, Figure 2**). The raw water intake structure and raw water intake line are located almost entirely within the 100-year floodplain and what is indicated on the NWI map as a freshwater forested/shrub wetland (PFO1A). The northeast portion of the water treatment plant site, as proposed in the May 2008 report, is located within the 100-year floodplain and small areas of freshwater forested/shrub wetland (PFO1A) are indicated within the site. During field investigations, the West Fork San Jacinto River was observed at the proposed raw water intake and weir location, as well as 500 feet upstream and downstream of the proposed location. The average width at the OHWM of the West Fork of the San Jacinto River within the study area varied from 100 to 120 feet (**Attachment A, Figure 3**). Wetland determination data points were taken on either side of the West Fork San Jacinto River to determine if adjacent wetlands were present. Wetland determination data sheets have been included in **Attachment B**. Photographs taken during field investigations have been included in **Attachment C**. While no wetlands were identified at these data points, the potential is very high for forested wetlands anywhere along the river that will hold water for longer than the standard flood duration based on the present vegetation. This would include areas within the study area that were not observed because of site access restrictions.

The width of the OHWM of Lake Creek, within the study area, is estimated to be approximately 90-100 feet, and like the West Fork San Jacinto River, Lake Creek is heavily wooded on either side. While Halff was not able to investigate the banks of Lake Creek at the study area crossing due to restricted access, observations immediately downstream of the crossing are consistent with this estimation. Review of aerial photographs and topographic maps have also indicated that in addition to Lake Creek, several tributaries and wetlands may be present within the study area. Along the northern bank of Lake Creek, prior to the crossing, a tributary is indicated flowing into Lake Creek that would be located within the study area. On the south bank of Lake Creek, immediately after the crossing, there is what appears to be a creek braid, overflow channel, or potential wetland area that is inundated on the aerial photograph. Prior to where the intake line meets the proposed water treatment plant site, another area appears inundated on the aerial photograph, which may be another drainage feature or potential wetland area. Lastly, where the water treatment plant site is currently proposed, another inundated area, observed on the aerial photograph, is located in the northeast corner of the site. These features are noted in **Attachment A, Figure 3**. If the water treatment plant were moved out of the floodplain, the water intake line would most likely still cross this area to reach the water treatment plant.

Federal regulations (33 CFR Section 328.3(a)) note that waters of the United States include navigable waters; intrastate rivers, streams, wetlands, and various other types waters; and impoundments, tributaries, and wetlands adjacent to previously defined waters. In response to a recent Supreme Court decision (Rapanos v. U.S., 547 *S. Ct.* 715 [2006]) addressing the limits of federal jurisdiction, the USACE and Environmental Protection Agency (EPA) have issued further guidance, and require additional documentation to support jurisdiction. Under the Rapanos guidance, the West Fork San Jacinto River and Lake Creek would remain waters of the United States and under the jurisdiction of the USACE. Onsite field investigations would have to confirm the presence of the features located adjacent to Lake Creek prior to determining if they would be considered waters of the United States under Rapanos.

3.0 THREATENED AND ENDANGERED SPECIES

The Endangered Species Act (ESA) of 1973 was enacted to "conserve threatened and endangered species and the ecosystems on which those species depend." The United States Fish and Wildlife Service (USFWS) has legislative authority to list and monitor the status of species whose populations are considered imperiled. Regulations supporting this Act are codified and regularly updated in 50 CFR Section 17. Endangered species legislation passed in Texas in 1973 (amended in 1981, 1985, and 1987) and subsequent 1975 and 1981 revisions to the Texas Parks and Wildlife Code established a state regulatory vehicle for the management and protection of threatened and endangered species. Chapters 67 and 68 (the 1975 revisions) of the code authorize the Texas Parks and Wildlife Department (TPWD) to formulate lists of threatened and endangered fish and wildlife species and to regulate the taking or possession of the species.

Federally- and state-listed threatened and endangered species for Montgomery County were obtained from available USFWS and TPWD sources, and are presented in **Table 1**. These species and their associated habitats were examined to assess the potential for occurrence within the study area.

TABLE 1 - THREATENED AND ENDANGERED SPECIES LISTED FOR MONTGOMERY COUNTY AND POTENTIAL FOR OCCURRENCE

Species	Federal Status	State Status	Potential to Occur in Study Area
American Peregrine Falcon *(Falco peregrinus anatum)*	---	E	Yes (Potential migrant)
Arctic Peregrine Falcon *(Falco peregrinus tundrius)*	---	T	Yes (Potential migrant)
Bald Eagle (*Haliaeetus leucocephalus)*	DM	T	Yes
Piping Plover *(Charadrius melodus)*	LT	T	Unlikely (Potential migrant)
Red-cockaded Woodpecker (*Picoides borealis*)	LE	E	Yes
White-faced Ibis (*Plegadis chihi)*	---	T	Yes (Potential migrant)
Wood Stork (*Mycteria americana*)	---	T	Yes (Potential migrant)
Creek chubsucker (*Erimyzon oblongus*)	---	T	Unlikely

Species	Federal Status	State Status	Potential to Occur in Study Area
Paddlefish (*Polyodon spathula*)	---	T	Unlikely
Louisiana black bear (*Ursus americanus luteolus*)	---	T	Unlikely (Extirpated)
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	---	T	Unlikely
Red wolf (*Canis rufus*)	---	E	Unlikely (Extirpated)
Alligator snapping turtle *(Macrochelys temminckii)*	---	T	Yes
Louisiana Pine Snake (*Pituophis ruthveni*)	---	T	Unlikely
Texas Horned Lizard *(Phrynosoma cornutum)*	---	T	Unlikely
Timber/Canebrake Rattlesnake *(Crotalus horridus)*	---	T	Yes
Key: DM – De-listed, Recovered, Being Monitored First Five Years; E,T – State Listed as Endangered, Threatened; LE, LT – Federally Listed as Endangered, Threatened			

Unlikely to Occur within Study Area

It is unlikely that several of the species listed in **Table 1** would occur within the study area, however they cannot be completely ruled out. The Louisiana black bear (*Ursus americanus luteolus*) and the red wolf (*Canis rufus*) are both considered locally extinct. However, suitable habitat that was historically utilized by both species is located within the study area. The creek chubsucker (*Erimyzon oblongus*) and paddlefish (*Polyodon spathula*) are aquatic species that are also not likely to be found within the study area. Outside of impoundments with access to spawning sites, the paddlefish prefers the slow moving water of large rivers or reservoirs, usually in water deeper than four feet. Neither the West Fork San Jacinto River nor Lake Creek would be considered deep enough to support the paddlefish within the project area. The creek chubsucker prefers highly vegetated headwaters and clear streams with a moderate current. As they are very sensitive to siltation, they are typically not found in rivers and creeks subject to siltation. Based on field investigations Lake Creek is subject to heavy siltation, and neither Lake Creek nor the West Fork San Jacinto River provide ample vegetation with the stream channel, therefore the creek chubsucker is not expected to be found within the study area. For the Texas horned lizard *(Phrynosoma cornutum)* preferred habitat is not found within the study area. Montgomery County represents the far western edge of the distribution range for both the Louisiana pine snake (*Pituophis ruthveni*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*); both are more likely to be found further east. According to USFWS, no verifiable sightings have been recorded to support that the Louisianan pine snake still occurs within Montgomery County (www.fws.gov). It is unlikely that either species would be found within the study area, even with the presence of suitable habitat. Furthermore, for the Louisiana pine snake, pocket gophers (*Geomys breviceps*) are an essential part of their habitat; pocket gopher mounds were not observed during site investigations, and are not expected within the study area based on its location within the floodplain.

Potential Migrants for the Study Area

Protected or otherwise sensitive birds of potential occurrence within the study area consist largely of migratory species. These include the Arctic and American peregrine falcons (*Falco peregrinus tundrius; anatum*), piping plover *(Charadrius melodus),* white-faced ibis (*Plegadis chihi*), and wood stork (*Mycteria americana*). These species may utilize the area primarily as a travel corridor, where various habitats are used for resting and feeding stops. Some of the more important migratory habitats within the study area include landscape edges such as the Lake Creek and West Fork San Jacinto shoreline and tall trees for roosting. Preferred feeding and stopover habitat for the Arctic and American peregrine falcon, the white-faced ibis, and the wood stork is provided by the study area. While suitable stopover and feeding habitat is not present for the piping plover, although unlikely, they may still occur within with study area as it is within their migratory path to the Gulf Coast. These species are also subject to protection by the Migratory Bird Treaty Act.

Year-Round Residents for the Study Area

The study area provides suitable habitat for the remaining species listed in **Table 1**, which include the bald eagle (*Haliaeetus leucocephalus*), the red-cockaded woodpecker (*Picoides borealis*), the alligator snapping turtle (*Macrochelys temminckii*), and the timber rattlesnake (*Crotalus horridus*). The ecological requirements, and known localities of each species potentially occurring in the study area are presented below.

The bald eagle is listed by the TPWD to be threatened and has been de-listed by the USFWS. Although this species has been removed from the federal endangered and threatened species list, it still receives federal protection under provisions of the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. In Texas, bald eagles breed along the Gulf coast and on major inland lakes and rivers. Many also spend the winter in these habitats. The study area is located within an area of Texas known for bald eagle nesting, with known nest locations within miles of the study area. Field investigations confirm that suitable habitat for the bald eagle is provided by the study area. Although no bald eagles were observed during field investigations, there is a potential for the bald eagles to occur within the study area.

The red-cockaded woodpecker (RCW) is listed as endangered by both the USFWS and TPWD. Essential habitat for the RCW consists of open pine forests with widely-spaced mature trees. Within Montgomery County, suitable habitat is generally restricted to loblolly and short-leaf pine forests. Discussions with local biologists indicate three known populations of RCW within Montgomery County, which occur at Sam Houston National Forest, WG Jones State Forest, and Cook's Branch Conservancy. There are no other known populations of the RCW within Montgomery County, though potential habitat is present throughout the county. Based on aerial photography and limited field investigations along the property boundary, it appears that suitable habitat may be present where the water treatment plant would be proposed for construction if it were moved outside of the floodplain. Furthermore, known RCW nest sites are located within 2 miles of the site within the WG Jones State Forest, increasing the likelihood that the RCW may occur within this area. Therefore, a potential exists for the RCW to occur within the study area, and/or the areas immediately adjacent to it.

The alligator snapping turtle is listed as threatened in Montgomery County by TPWD but is not federally listed. Habitat consists of slow-moving, deep water of rivers, sloughs, oxbows, and canals or lakes associated with rivers, which also includes swamps, bayous, and ponds near rivers, and shallow creeks that are tributaries to occupied rivers; this sometimes includes swift upland streams. Usually they occur in water with a mud bottom and some aquatic vegetation but may use sand-bottomed creeks. The West Fork San Jacinto River, Lake Creek, and forested wetlands adjacent to Lake Creek would provide suitable habitat for the alligator snapping turtle. Therefore, there is a potential for the alligator snapping turtle to occur within the study area.

The timber/canebrake rattlesnake is listed as threatened in Montgomery County by TPWD but is not federally listed. The distribution of the timber/canebrake rattlesnake stretches from the East Coast westward into Texas, and as far north as New England. In the southern portions of its range, this species prefers to make its den in somewhat swampy, wetland habitats. Forested areas located near permanent water sources are also utilized, as fallen debris from trees can act as refugia for the rattlesnake. The timber/canebrake rattlesnake is a shy animal that prefers to live in areas with high amounts of cover and available refuge. The home range of this species is large, at times encompassing in excess of 100 acres. Within the study area, forested areas within the floodplain would provide suitable habitat for the timber/canebrake rattlesnake. Therefore, there is a potential for the timber/canebrake rattlesnake to occur within the study area.

4.0 CULTURAL RESOURCES

The Antiquities Code of Texas (TAC, Title 9, Chapter 191, Subchapters A-F, Texas Natural Resources Code, amended 1997) provides for the protection of historic buildings and archaeological sites on public land or under the jurisdiction of a public agency. The Texas Historical Commission (THC) is authorized to ensure compliance under the Antiquities Code of Texas. The THC is also responsible for ensuring compliance with the National Historic Preservation Act (NHPA) of 1966, as amended - (16 USC 470, P.L. 95-515). Section 106 of the NHPA requires that agencies take significant cultural resources into consideration before issuing any permits, licenses or funds.

Significant cultural resources include historic and archeological properties that are on or eligible for listing in the National Register of Historic Places (NRHP), or listing as a State Archeological Landmark (SAL). Both the Texas Antiquities Code and the NHPA use the criteria of the NRHP to determine site significance. Unless they are exceptionally important, historic resources must be at least 50 years old to be considered to be significant, although surveys may not evaluate properties for significance. Archeological resources include physical evidence of prehistoric and/or historic activity.

4.1 Historic Resources

A review of the Texas Historic Sites Atlas (THSA) was conducted to determine if NRHP properties, Texas Historical Markers, neighborhood historic building survey sites, cemeteries, or historic saw mills lie within the study area. There are no previously-recorded historic properties within the study area.

4.2 Archeological Resources

The Texas Historical Commission's Archeological Sites Atlas and the site files of the University of Texas, Texas Archeological Research Laboratory were examined to determine the location of recorded archeological sites. These data sources indicate that archeological surveys have been conducted near the study area and have identified an archeological site (MQ62) approximately 1,500 feet northeast of the proposed raw water intake structure (**Attachment A, Figure 2**); no sites were located within the study area.

5.0 HAZARDOUS MATERIALS

A review of selected federal and state regulatory databases was conducted to determine the potential for encountering hazardous materials and substances within the study area. The databases obtained and evaluated were consistent with the standards of the American Society of Testing Materials (ASTM) *E 1527-05 Standard Practice for Environmental Assessments: Phase I Environmental Site Assessment Process*. The database was acquired from Environmental Data Resources, Inc. (EDR). The regulatory listings are limited and include only those sites that are currently registered or are known to the regulatory agencies to be contaminated or in the process of evaluation for potential contamination.

The proposed water treatment plant site is located on a tract of land that was identified within the regulatory database review as having a documented enforcement issue with the Environmental Protection Agency (EPA). The details of this enforcement issue were not included in the database report. Further research on the EPA Enforcement and Compliance History Online (ECHO) site did not produce any information on the site as well. Further research with the EPA would be required to locate the files pertaining to this site. Two sites were identified west of the proposed water treatment plant site along Park Avenue (**Attachment A, Figure 2**). The two marked sites are for the same facility, which is a solid waste landfill, permitted in 2003. While the landfill site drains towards Lake Creek, and not towards the study area, the close vicinity of the landfill (500 feet) may pose a risk to the water treatment plant site.

6.0 SECTION 404 PERMITTING

Under Section 404 of the CWA, the USACE utilizes Individual Permits to authorize the discharge of dredge or fill material into waters of the United States that will result in more than a minimal adverse impact. Based on an analysis of proposed impacts associated with the raw water intake structure, weir, and collection pool, Halff believes that the project would require authorization from the USACE under a Section 404 individual permit. Additional impacts may occur as a result of the raw water intake line and water treatment plant construction based on the location of each facility and the construction methods used. All components of the system, including the water transmission pipeline system, may be lumped together and permitted as a single project under the individual permit. While boring/tunneling the raw water intake line under the floodplains of the West Fork San Jacinto River and Lake Creek may prevent impacts to waters of the United States, primarily forested wetlands, costs associated with this could make the project impractical from a financial standpoint. Similarly, moving the water treatment plant site out of the floodplains of the West Fork San Jacinto River and Lake Creek would prevent impacts to the floodplain and could reduce impacts to waters of the United States, however this may impact suitable nesting and foraging habitat for the federally- and state- listed endangered red-cockaded woodpecker.

The typical Individual Permit process includes:

1) pre-application meeting,
2) submittal of permit application and mitigation plan, which may include Section 401 water quality certification analysis,
3) USACE review (which may require modification to the permit application),
4) project goes out on 30-day public notice, which includes notification to adjacent landowners, the Texas Historical Commission, the Texas Commission on Environmental Quality (which may also consist of Section 401 Water Quality Certification review), the Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the Texas Parks and Wildlife Department,
5) based on number of comments, potential public hearing,
6) response to all public and agency comments is prepared and submitted to USACE,
7) review of responses by the USACE (which could include another round of modifications to the permit application), and

8) decision document is prepared by the USACE to issue the permit, issue the permit with conditions, or deny the permit.

The USACE may not issue a permit under Section 404 if the proposal does not meet the 404(b)(1) guidelines, which states that the USACE may only issue a permit for the least environmentally damaging practicable alternative. Practicability includes cost, existing technology, and logistics.

All comments presented by the agencies and the public during the public notice period must be addressed to the satisfaction of the USACE. Based on background information, field investigations, the proposed design of the project, and past experience, the following are potential agency and public comments and concerns that may be presented during the public notice period that would have to be addressed (**Table 2**).

TABLE 2 – POTENTIAL AGENCY/PUBLIC COMMENTS AND CONCERNS

Agency	Potential Comments/Concerns
U.S. Army Corps of Engineers	Size, type, location, and nature of impact within the West Fork San Jacinto River; converting this section of river from free-flowing water to an impounded, open water area; area of flooding created by impoundment; impact to river flow; impacts to forested wetlands; proposed mitigation; alternatives analysis; analysis as to whether or not this is the least damaging, practicable alternative.
Environmental Protection Agency	Loss of forested wetlands; affects of converting a section of the West Fork San Jacinto River to open water; area of flooding created by impoundment; analysis as to whether or not this is the least damaging, practicable alternative.
U.S. Fish and Wildlife Service	Impeding fish and other aquatic species movement; conversion of habitat from free-flowing water to open water within the West Fork San Jacinto River; impact to river flow; forested wetland impacts; potential loss of suitable habitat for threatened or endangered species; prevention of fish and other aquatic species impingement on intake structure; area of flooding created by impoundment.
Texas Parks and Wildlife Department	Impeding fish and other aquatic species movement; conversion of habitat from free-flowing water to open water within the West Fork San Jacinto River; impact to river flow; forested wetland impacts; potential loss of suitable habitat for threatened or endangered species; prevention of fish and other aquatic species impingement on intake structure; area of flooding created by impoundment.
Texas Commission on Environmental Quality	Water storage permits; dam construction permits; loss of forested wetlands and impacts on water quality; impact of structure within the West Fork San Jacinto River on water quality; impact on river flow; Section 401 Water Quality certification.
Texas Historical Commission	Will require cultural resources investigation along both West Fork San Jacinto River and Lake Creek where excavation and potential flooding will occur; potential impact to cultural resources from flooding or construction of intake structure.
Public	Concerns associated with their close vicinity to water treatment plant; loss of wildlife habitat adjacent to their property; loss of property due to flooding.

The USACE may not issue a permit that does not comply with Section 401 of the Clean Water Act, the Endangered Species Act, and the National Historic Preservation Act, among other state and federal laws. Therefore, clearance from the appropriate agencies must be provided to the USACE if the project would impact one of these resources. Since known archeological resource sites are located within close vicinity of the study area, a full archeological resource survey would be recommended and most likely required within the study area and the entire area of flooding. An in-depth habitat study for red-cockaded woodpeckers would potentially be required for the water treatment plant site and the surrounding area. If threatened or endangered species, or cultural resources were to be impacted, coordination with the proper agencies must be complete prior to the issuance of the individual permit.

7.0 USACE MEETING

On July 23, 2009 individuals from Halff Associates, Brown & Gay Engineers, and the San Jacinto River Authority met with two project managers from the USACE Galveston District Regulatory Group to discuss the proposed water treatment plant and intake alternative under Section 404 permitting. Project details were explained to the USACE and potential permitting scenarios and timelines were discussed.

The various components of the water treatment plant, intake line, and eventual water transmission pipeline system could be permitted separately. However, since each project component is dependant on each other, the USACE would view this as one complete project and permit the entire project under an individual permit. They would still consider evaluating each water transmission pipeline crossing separately and not cumulatively. The USACE Galveston District does not consider the West Fork San Jacinto River, within the project area as historically navigable, therefore additional authorization of the project under Section 10 of the Rivers and Harbors Act would not be necessary.

The permitting process would go as follows, a jurisdictional determination would be submitted to the USACE Galveston District Compliance Group for verification and approval; this would take approximately 6 to 8 months. Submitting the jurisdictional determination for verification prior to submitting the individual permit application would assist in moving the process along. Once impacts to waters of the United States have been determined, an individual permit application would be prepared and submitted to the USACE Galveston District Regulatory Group. For USACE Galveston District project managers, in order for a individual permit application to be complete it should include the following information: all pertinent information regarding the project, project details, the total amount and description of waters of the United States within the project area, the total amount and description of impacts to waters of the United States, a statement regarding any potential impacts to threatened or endangered species and cultural resources, an alternatives analysis, and description of the mitigation plan. Once reviewed and revised (if needed) for completeness, the USACE would put the project out on a 30-day public notice and commenting period. If there was enough public involvement generated by the public notice, a public hearing may be deemed necessary, which could add an additional 60 days to the permitting process. Additional state and federal agencies (previously mentioned in **Table 2**) would also provide comments to the USACE at this time. Once all comments from the agencies and the public are addressed to the satisfaction of the USACE, a decision will be made to issue the permit. Overall, the USACE Galveston District project managers expect that once submitted, the project could take in excess of 1½ years to authorize as proposed.

As previously noted in this document, the USACE must permit the least damaging, practicable alternative. The Lake Conroe water treatment plant and intake would be a considered an alternative to this project, if it were selected. Therefore, the USACE project managers would compare costs and impacts associated with both alternatives, as well as public interest, in deciding the least damaging, practicable alternative. In considering alternatives, the USACE could permit the water treatment plant and water transmission pipeline system from Lake Conroe under nationwide permits, making it the least damaging alternative. However, the USACE would still consider practicability, which includes the cost of building the water treatment plant on the dam or farther downstream, and the cost of additional pipeline if the water treatment plant were built on the dam. Furthermore, public interest is considered, and whether there is enough public objection over one alternative or the other. Potentially, the water treatment plant site and intake along the West Fork San Jacinto and Lake Creek may not be the least damaging, practicable alternative.

The San Jacinto River Authority mentioned potential mitigation banks in the area that may used for the proposed project, including one located along Cypress Creek. The USACE believes that they do have a signed Memorandum of Agreement (MOA) to operate and sell credits and that we would need to contact them in order to see how they determine impacts scores and mitigation bank credits.

8.0 SUMMARY

The alternative water treatment plant and intake location along the West Fork San Jacinto River and Lake Creek was evaluated under environmental constraints and discussed with the USACE Galveston District under potential Section 404 permitting scenarios and timelines. The average width at the OHWMs of the West Fork of the San Jacinto River and Lake Creek, within the study area, varied from 100 to 120 feet and 90 to 100 feet, respectively. Both the West Fork San Jacinto River and Lake Creek were heavily wooded on either side. The potential is very high for forested wetlands anywhere along both features that will hold water for longer than the standard flood duration. Aerial photographs note the potential presence of forested wetlands south of Lake Creek, within the study area. All waters of the United States identified within the study area, if impacted, would be subject to Section 404 of the Clean Water Act permitting.

The study area provides suitable habitat for the bald eagle, the red-cockaded woodpecker, the alligator snapping turtle, and the timber rattlesnake; these listed species are potential year-round residents. Listed migratory species that may be present during certain times of the year include the Arctic and American peregrine falcons, piping plover, white-faced ibis, and wood stork. Further onsite investigations would be required to confirm or deny the presence of year-round species within the study area, to determine if an impact to listed species would be made by the proposed project.

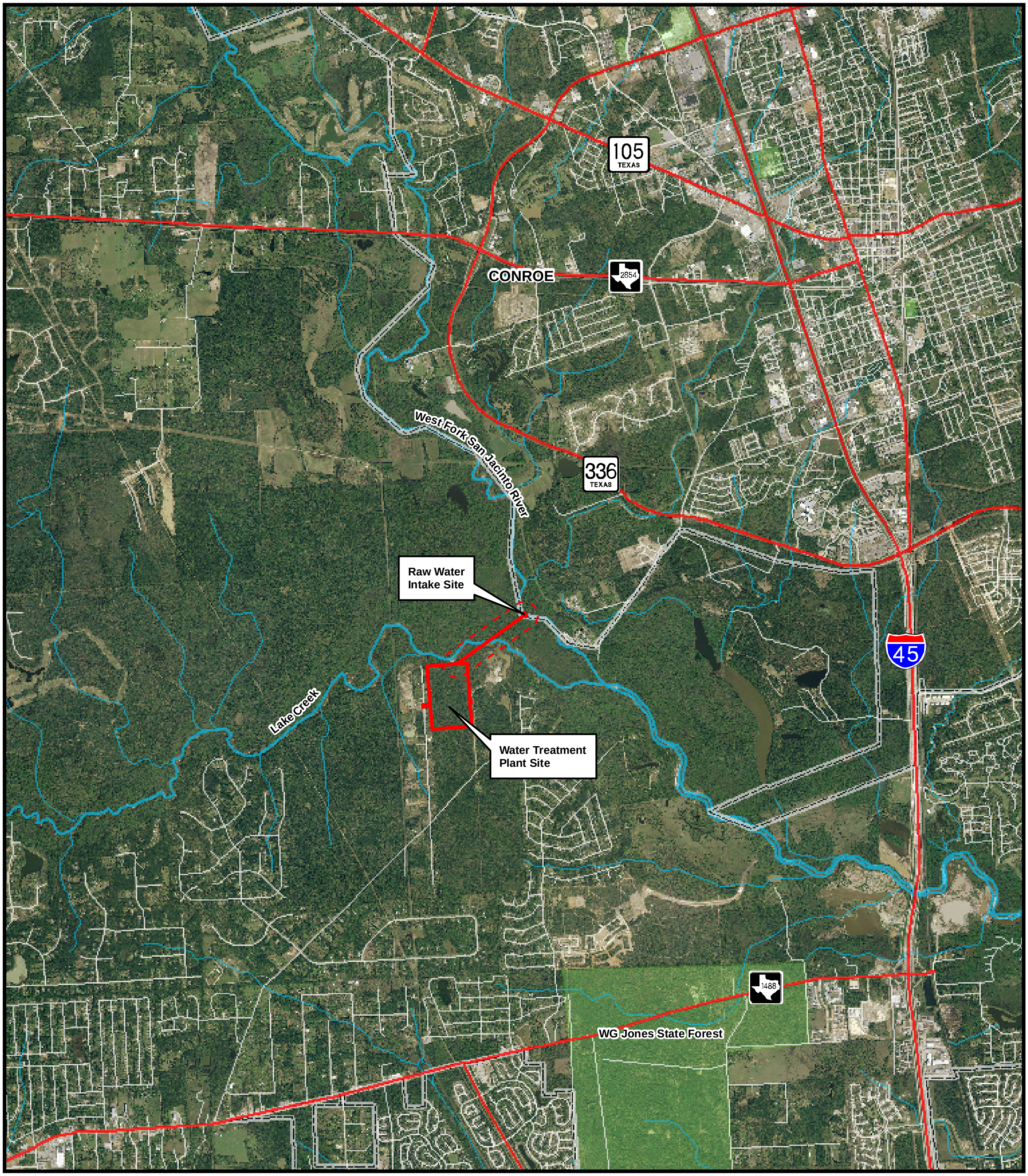
While no cultural resource sites are located within the study area, a known site is located adjacent to it, and it is likely that other sites would be located along the West Fork San Jacinto River. Cultural resource surveys would be required to determine if any previously unknown sites are located within the study area and would be impacted by the proposed project.

The water treatment plant site is currently located within a tract of land that is under an EPA enforcement action, the details of which are currently unknown. A permitted landfill is located approximately 500 feet west of the water treatment plant site. While the landfill site drains towards Lake Creek, and not towards the study area, the close vicinity of the landfill may pose a risk to the water treatment plant site. At this time, no details can be found regarding the enforcement action within EPA online databases, and further research would be required to gain information on the site. Based on the type and nature of the enforcement action, the site may be restricted for development and/or sale.

Conversations with the USACE Galveston District Regulatory Group confirms that the project, as proposed, would be permitted under a Section 404 individual permit. Based on the nature of the project and the potential impacts, authorization may take more than 1½ years to obtain. Furthermore, the USACE must permit the least damaging, practicable alternative. With the alternatives locations available, such as the Lake Conroe dam, the USACE must decide if this alternative would meet those qualifications and may decide that this project is not the least damaging, practicable alternative.

Proposed construction of a water treatment plant and intake along the West Fork San Jacinto River and Lake Creek may provide to be problematic based on present EPA enforcement actions on the water treatment plant site that may limit site development, potential presence of threatened and endangered species habitat, and practicability from a Section 404 permitting standpoint.

Attachment A
Figures



Map Features

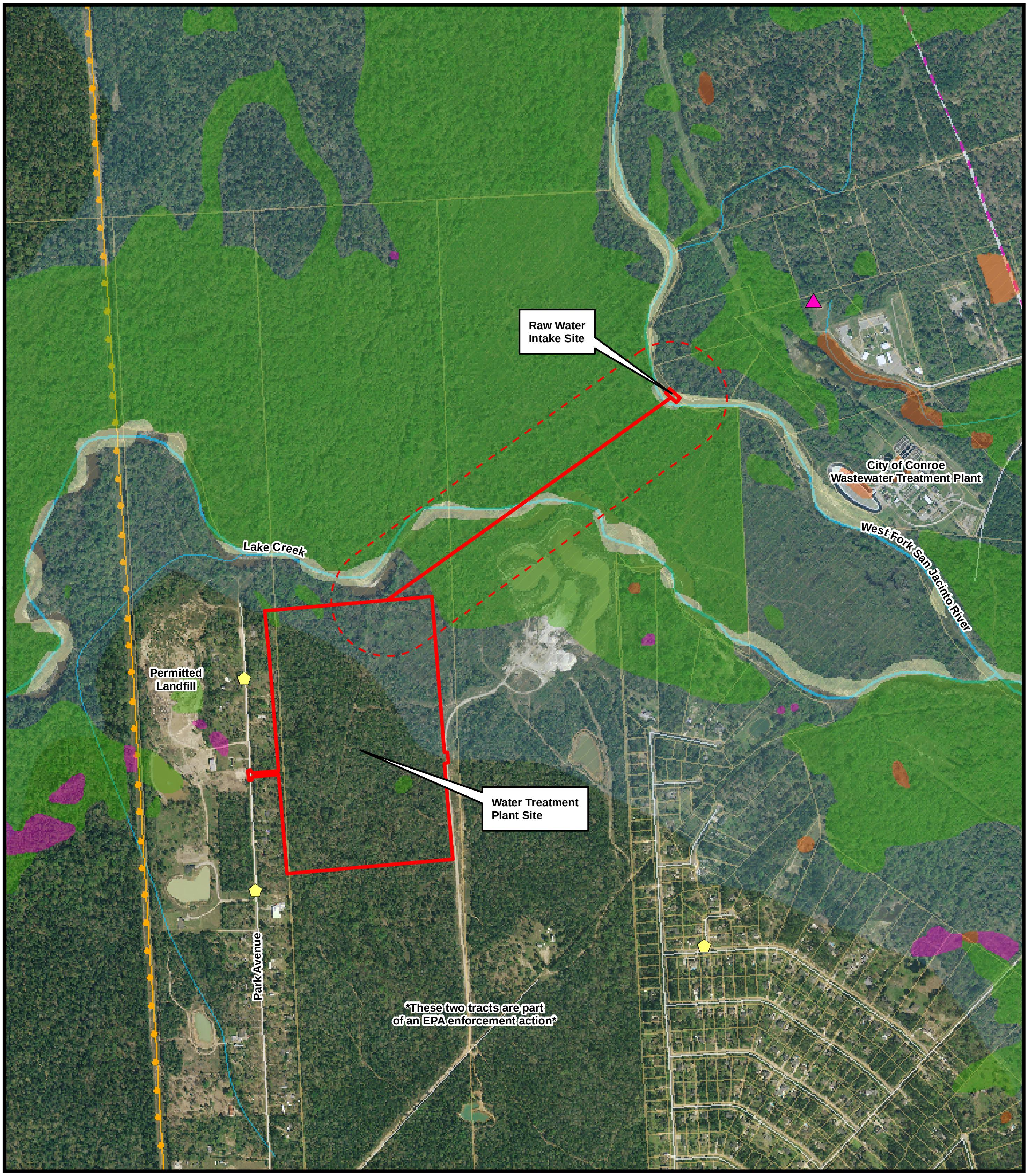
City Limit
Raw Water Intake Line
Water Treatment Plant Site
500-Foot Buffer
Minor Stream
Major Stream
Lake
Park

All locations are approximate.
Map Created: July, 2009
Aerial Flown: March 2007

0 2,500 5,000 10,000
SCALE IN FEET

Montgomery County
Alternative Water Supply Project
Alternative Water Treatment Plant and Intake
Figure 1 - Location Map

HALFF



Map Features

- Raw Water Intake Line
- Water Treatment Plant Site
- 500-Foot Buffer
- Haz-Mat Site
- Archaeological Site
- Transmission Line
- Parcel Boundary
- Minor Stream
- Major Stream
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Riverine
- 100 Yr Floodplain

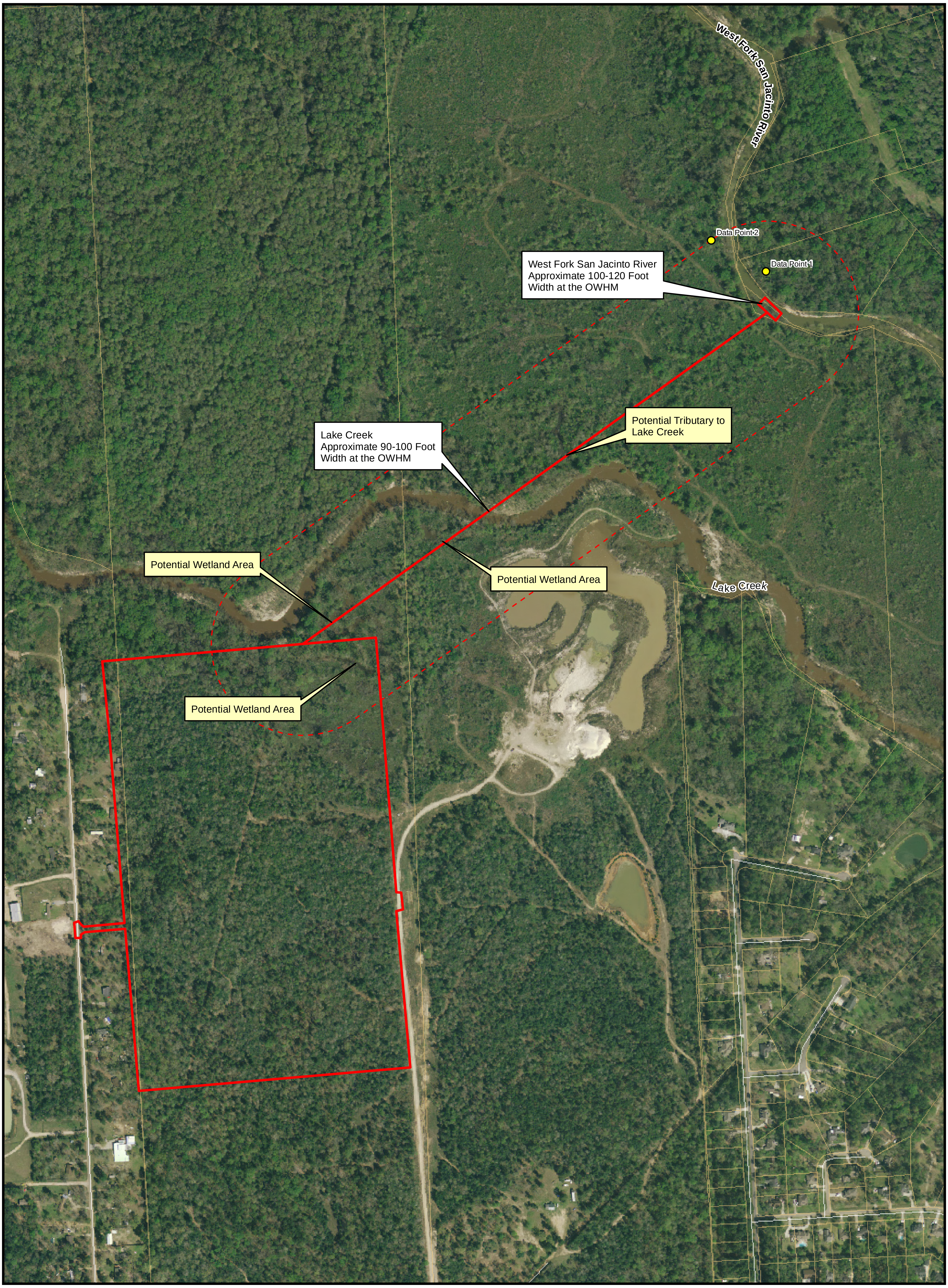
All locations are approximate. Map Created: July, 2009. Aerial Flown: March 2007.

0 600 1,200 2,400
SCALE IN FEET

Montgomery County
Alternative Water Supply Project

Alternative Water Treatment Plant and Intake
Figure 2 - Base Map

HALFF



Map Features

- Parcel Boundary
- Raw Water Intake Line
- Water Treatment Plant Site
- 500-Foot Buffer

All locations are approximate.
Map Created: July, 2009
Aerial Flown: March 2007

0 250 500 1,000
SCALE IN FEET

Montgomery County
Alternative Water Supply Project

Alternative Water Treatment Plant and Intake
Figure 3 - Potential Waters of the U.S.

HALFF

Attachment B

Wetland Determination Data Sheets

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Alternative WTP and Intake Site City/County: Conroe, Montgomery Sampling Date: 7/13/2009

Applicant/Owner: San Jacinto River Authority State: TX Sampling Point: 1

Investigator(s): M. Claycamp, B. Vacek Section, Township, Range: ______

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): Convex Slope (%): < 5

Subregion (LRR): LRR T Lat: 30 16.54 °N Long: 95 30.12 °W Datum: NAD 1983 UTM Zone 14

Soil Map Unit Name: Bruno loamy fine sand NWI classification: None

Are climatic/hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No X	**Is the Sampled Area within a Wetland?**	Yes ____	No X
Hydric Soil Present?	Yes ____	No X			
No Wetland Hydrology Present?	Yes ____	No X			

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
__ Saturation (A3)
__ Water Marks (B1)
__ Sediment Deposits (B2)
__ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Water-Stained Leaves (S4)
__ Aquatic Fauna (S5)
__ Marl Deposits (B15)
__ Hydrogen Sulfide Odor (C1)
__ Oxidized Rhizospheres (C3)
__ Presence of Reduced Iron (C4)
__ Recent Iron Reduction in Tilled Soils (C6)
__ Thin Muck Surface (C7)
__ Other

Secondary Indicators (minimum of two required:

__ Surface Soil Cracks
__ Sparsely Vegetated Concave Surface (A9)
__ Drainage Patterns (B10)
__ Moss Trim Lines (B16)
__ Dry-Season Water Table (C2)
__ Crayfish Burrows (C8)
__ Saturation visible on Aerial Imagery (C9)
X Geomorphic Position (D2)
__ Shallow Aquitard (D3)
__ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ______

Water Table Present? Yes ____ No X Depth (inches): ______

Saturation Present? (includes capillary fringe) Yes ____ No X Depth (inches): ______

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous in sections), if available:

Remarks:

Located within 100-year floodplain.

VEGETATION - Use scientific names of plants.

Tree Stratum (Plot size: ____)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus nigra*	40	Yes	NL
2. *Celtis laevigata*	20	Yes	FAC
3. *Carya texana*	20	Yes	NL*
4.			
5.			
6.			
7.			
	80	= Total Cover	
Sapling Stratum (Plot size: ____)			
1. *Ilex vomitoria*	20	Yes	FAC-
2.			
3.			
4.			
5.			
6.			
7.			
	20	= Total Cover	
Shrub Stratum (Plot size: ____)			
1. *Sabal minor*	40	Yes	FACW
2. *Ilex vomitoria*	20	Yes	FAC-
3. *Prunus serotina*	60	Yes	FACU
4. *Ligustrum sinense*	20	Yes	UPL
5.			
6.			
7.			
	140	= Total Cover	
Herb Stratum (Plot size: ____)			
1. *Lirope sp.*	10	Yes	NL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11			
12.			
	10	= Total Cover	
Woody Vine Stratum (Plot size: ____)			
1. *Cocculus carolinus*	10	Yes	FACU
2.			
3.			
4.			
5.			
	10	= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 10 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 0 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	40	x 2 = 80
FAC species	100	x 3 = 300
FACU species	70	x 4 = 280
UPL species	50	x 5 = 250
Column Totals:	260 (A)	910 (B)

Prevalence Index = B/A = 3.5

Hydrophytic Vegetation Indicators:

____ Dominance Test is >50%

____ Prevalence Index is ≤3.0[1]

____ Morphological Adaptations[1] (Provide Supporting data in Remarks or on a separate sheet)

____ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size. Includes woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ____ No X

Remarks: (If observed, list morphological adaptations below).

*Species that are not listed (NL) in the wetland plant indicator status list are considered upland (UPL).

SOIL

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	10 YR 5/3	100	None				Sandy loam	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ Organic Bodies (A6) **(LRR P, T, U)**
__ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
__ Muck Presence (A8) **(LRR U)**
__ 1 cm Muck (A9) **(LRR P, T)**
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Coast Prairie Redox (A16) **(MLRA 150A)**
__ Sandy Mucky Mineral (S1) **(LRR O, S)**
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Dark Surface (S8) **(LRR P, S, T, U)**

__ Polyvalue Below Surface (S8) **(LRR S, T, U)**
__ Thin Dark Surface (S9) **(LRR S, T, U)**
__ Loamy Mucky Mineral (F1) **(LRR O)**
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)
__ Marl (F10) (LRR U)
__ Depleted Ochric (F11) **(MLRA 151)**
__ Iron-Manganese Masses (F12) **(LRR O, P, T)**
__ Umbric Surface (F13) **(LRR P, T, U)**
__ Delta Ochric (F17) **(MLRA 151)**
__ Reduced Vertic (F18) **(MLRA, 150A, 150B)**
__ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
__ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

__ 1 cm Muck (A9) (**LRR O**)
__ 2 CM Muck (A10) **(LRR S)**
__ Reduced Vertic (F18) **(outside MLRA 150A,B)**
__ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
__ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
__ Red Parent Material (TF2)
__ Very Shallow Dark Surface (TF12) **(LRR T, U)**
__ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________________

Depth (inches): ______________________

Hydric Soil Present? Yes ____ No X

Remarks:

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Alternative WTP and Intake Site City/County: Conroe, Montgomery Sampling Date: 7/13/2009

Applicant/Owner: San Jacinto River Authority State: TX Sampling Point: 2

Investigator(s): M. Claycamp, B. Vacek Section, Township, Range: ____

Landform (hillslope, terrace, etc.): Terrace Local relief (concave, convex, none): Convex Slope (%): < 5

Subregion (LRR): LRR T Lat: 30 16.57 °N Long: 95 30.18 °W Datum: NAD 1983 UTM Zone 14

Soil Map Unit Name: Tuscumbia clay, frequently flooded NWI classification: PFO1A

Are climatic/hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____	Is the Sampled Area within a Wetland?	Yes ____	No X
Hydric Soil Present?	Yes ____	No X			
No Wetland Hydrology Present?	Yes ____	No X			

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Water-Stained Leaves (S4)
- __ Aquatic Fauna (S5)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron Reduction in Tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other

Secondary Indicators (minimum of two required):

- __ Surface Soil Cracks
- __ Sparsely Vegetated Concave Surface (A9)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ____ No X Depth (inches): ________

Water Table Present? Yes ____ No X Depth (inches): ________

Saturation Present? Yes ____ No X Depth (inches): ________

(includes capillary fringe)

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous in sections), if available:

Remarks:

Located within 100-year floodplain.

VEGETATION - Use scientific names of plants.

Tree Stratum (Plot size: ____________)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Quercus nigra*	25	Yes	FAC+
2.			
3.			
4.			
5.			
6.			
7.			
	25	= Total Cover	

Sapling Stratum (Plot size: ________________)			
1. *Ulmus alata*	15	Yes	FACU
2. *Ilex vomitoria*	15	Yes	FAC-
3. *Quercus nigra*	10	Yes	FAC+
4.			
5.			
6.			
7.			
	35	= Total Cover	

Shrub Stratum (Plot size: ___________)			
1. *Sabal minor*	75	Yes	FACW
2. *Phyllostachys aurea*	10	No	NL*
3.			
4.			
5.			
6.			
7.			
	85	= Total Cover	

Herb Stratum (Plot size: ____________)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11			
12.			
		= Total Cover	

Woody Vine Stratum (Plot size: ________)			
1.			
2.			
3.			
4.			
5.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC	4	(A)
Total Number of Dominant Species Across All Strata:	5	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	80	(A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	________	x 1 = ________
FACW species	________	x 2 = ________
FAC species	________	x 3 = ________
FACU species	________	x 4 = ________
UPL species	________	x 5 = ________
Column Totals:	________ (A)	________ (B)

Prevalence Index = B/A = ____________

Hydrophytic Vegetation Indicators:

X Dominance Test is >50%

____ Prevalence Index is ≤3.0[1]

____ Morphological Adaptations[1] (Provide Supporting data in Remarks or on a separate sheet)

____ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling - Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb - All herbaceous (non-woody) plants, including herbaceous vines, regardless of size. Includes woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine - All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes X________ No __________

Remarks: (If observed, list morphological adaptations below).

*Species that are not listed (NL) in the wetland plant indicator status list are considered upland (UPL).

SOIL

Sampling Point: 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	10 YR 3/2		None				Clay loam	
4-12	10 YR 5/2		None				Sandy clay loam	

[1] Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ Organic Bodies (A6) **(LRR P, T, U)**
__ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
__ Muck Presence (A8) **(LRR U)**
__ 1 cm Muck (A9) **(LRR P, T)**
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Coast Prairie Redox (A16) **(MLRA 150A)**
__ Sandy Mucky Mineral (S1) **(LRR O, S)**
__ Sandy Gleyed Matrix (S4)
__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Dark Surface (S8) **(LRR P, S, T, U)**

__ Polyvalue Below Surface (S8) **(LRR S, T, U)**
__ Thin Dark Surface (S9) **(LRR S, T, U)**
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__ Loamy Gleyed Matrix (F2)
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__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)
__ Marl (F10) (LRR U)
__ Depleted Ochric (F11) **(MLRA 151)**
__ Iron-Manganese Masses (F12) **(LRR O, P, T)**
__ Umbric Surface (F13) **(LRR P, T, U)**
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__ Red Parent Material (TF2)
__ Very Shallow Dark Surface (TF12) **(LRR T, U)**
__ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______________

Depth (inches): ______________

Hydric Soil Present? Yes ____ **No** X

Remarks:

Attachment C

Photographs

Photograph 1: Photo looking downstream along West Fork San Jacinto River at raw water intake location (July 2009).

Photograph 4: View of vegetation located at Data Point 1 (July 2009).

Photograph 2: Photo looking upstream along West Fork San Jacinto River; photo taken immediately upstream of raw water intake location (July 2009).

Photograph 5: View of vegetation and habitat located at Data Point 2 (July 2009).

Photograph 3: View of western banks of the West Fork San Jacinto River at raw water intake location (July 2009).

Photograph 6: Photo looking upstream along Lake Creek; photo taken approximately 3,000 feet downstream of crossing (July 2009).