North Harris County Regional Water Authority

DESIGN MANUAL

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NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY DESIGN MANUAL

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Chapter 1

Program Concepts

1.1 INTRODUCTION

The North Harris County Regional Water Authority (the "Authority") was created by the 76th Texas Legislature in 1999 and confirmed by a special public election in 2000. The Authority's mission includes finding and assuring a long-term supply of quality drinking water at the lowest responsible cost. The Authority is also charged with promoting water conservation and maintaining regulatory compliance. This last assignment is paramount because the Harris- Galveston Subsidence District (the "HGSD") published its 1999 Regulatory Plan, updated in 2013, requiring the area to reduce groundwater withdrawals to not more than 20 percent of total water demand by the year 2035. Since no individual MUD or well owner had the ability to convert to surface water on their own, the Authority has become the single entity to negotiate for a secure, long-term supply of drinking water for all the municipal utility districts, small municipalities, and other permitted well owners within its boundaries. Perhaps the most critical task in achieving this goal is to develop and construct the infrastructure to bring that water to the political subdivisions within the boundaries of the Authority.

The Authority adapted a three phased approach ("Program") to meeting the HGSD mandates. Phase I entailed those infrastructure needs required to meet the HGSD 2010 mandate of 30% Alternative Water and is often referred to as the "2010 System". Phase II expands and continues to build upon the Phase I infrastructure and includes those additional infrastructure components to meet the 2025 mandate of 60% Alternative Water. Similarly Phase III is the planned infrastructure expansion to meet the HGSD 80% Alternative Water mandate for 2035.

The Authority has approved a contract to buy capacity in the raw water, treatment, and transmission system facilities owned by the City of Houston (City). The treated surface water source will be the Northeast Water Purification Plant (NEWPP). The NEWPP expansion project will provide an additional 113 million gallons per day of treated surface water in the year 2023.

The Authority's has successfully pursued and obtained funding for many projects from the Texas Water Development Board's State Water Infrastructure Fund for Texas (SWIFT). The SWIFT was created by Texas Legislature to provide affordable, ongoing state financial assistance for projects in the state water plan. Through the SWIFT, the Authority has been able to obtain low-interest loans.

1.2 PROGRAM CONCEPTS

The current concepts have been grouped under the broad headings of Administrative, Design, Construction, and Support Services.

1.2.1 Team Members

The Program Team consists of the Authority, the Program Manager, the Design Engineers, various Support Services Consultants, and other selected consultants. The roles of two of these team members, the Program

Manager and the Design Engineer, are discussed below.

The members of the Program Team share a common goal of providing the Authority with those improvements necessary to distribute the surface water supply. The Program places great demands on all members of the team to complete their assignments as scheduled and in compliance with the needs and requirements of the Program.

This Design Manual is intended to assist in the accomplishment of this mission. It is a "living" document subject to modification and refinement as the design definitions and developments continue to take shape. Users of these materials are encouraged to submit any suggestions or comments they may have to the Authority.

1.2.1.1 Program Manager Role

When assigned by the Authority, the Program Manager has an active and central interaction with all members of the team. The Program Manager will administer all aspects of the Design Engineers' work on behalf of the Authority, including the general management and administrative services necessary to assist the General Manager in coordinating and expediting the completion of the Program.

The Program of Improvements requires that multiple, separate design and construction projects be handled within schedule and cost constraints. Each individual project's scope of work will include detailed design and various supporting activities, which are necessary to accomplish a well-designed project. The successful performance of these services will enable the Authority to advertise and award construction contracts to complete the water system.

For projects funded by Texas Water Development Board (TWDB) the Authority or Program Manager will lead the coordination and approval of the design by TWDB.

The Program Manager will maintain effective control and overview of the engineering assignments through a comprehensive system of cost, schedule, and performance monitoring.

1.2.1.2 Design Engineer Role

The specific tasks to be performed by the Design Engineer are defined in the Design Engineer's authorized Scope of Service. These tasks will not be repeated here, but reference is made to that document. The principal role of the Design Engineer is defined as follows:

> "Prepare design drawings (Drawings) and Specifications covering this project and incorporate into the Bidding and Contract Documents. The Drawings and Specifications are to be prepared in accordance with Authority's Standard Specifications Sections, Details, and Contract Documents and shall incorporate design concepts and criteria, standard design, and graphic standards as provided or required by the Authority."

The development of detailed project plans and documents depends on the periodic submission of essential project data and information by the Design Engineers to the Authority. Standard design, document formats, monthly reports, design reviews, monthly invoices, and such similar requirements form a part of the administrative procedures the Design Engineer shall adhere to.

In carrying out these essential services, the Design Engineer shall coordinate their design efforts, drawings, and details with the Program Manager (when designated by the Authority); the Design Engineers involved in projects adjacent to or connecting to his project; and such public agencies, utility companies, and other parties as may be required to successfully complete the project. For TWDB funded projects, the Design Engineer will need to incorporate into the Contract Documents provisions required by TWDB.

1.2.2 Construction Documents

The Program contains multiple construction packages scheduled over multiple years. It is in the best interests of the Authority these packages present a uniform description of the proposed improvements. As a result, standard design format and graphic standards will be used throughout the construction documents. These are presented later in the Design Manual.

1.2.3 Quality Control

The quality control of the project is the responsibility of the Design Engineer. The Design Engineer shall establish a project specific quality management plan (QMP) to guide the engineer's efforts in meeting the quality required by the Authority.

Additionally, the Design Engineer shall designate a quality control reviewer(s) prior to beginning the design effort. This reviewer(s) shall be independent from the design team. Review shall be performed on the formal review documents submitted to the Authority. The quality control reviews may occur simultaneously with the 30% and 60% submittals but shall occur prior to the 95% submittals. A copy of the review comments generated by the quality control reviewer(s) shall be submitted to the Authority with the 95% submittal.

As part of the quality control, the Design Engineer is to walk the project at least twice. The first time, before the 30% Submittal, to verify accuracy of the survey and assess design requirements. The second time, just before the 95% Submittal, to verify the appropriateness of the design and identify changes to the site that may have occurred since the initial topographic survey and walk-through.

1.2.4 Utility and Pipeline Conflicts

The proposed water lines superimposed upon the existing infrastructure will encounter existing utility and pipeline conflicts. The Design Engineer is responsible for employing best practices, extra care, and the necessary effort to locate all existing utilities, pipelines and other obstructions which may impact the proposed water line construction. Where necessary, the Design Engineer will work with the Authority to request Level A Subsurface Utility Engineering ("SUE") (refer to Chapter 6), and other methods of field exploratory work to identify the location of utilities and pipelines. It is the responsibility of the Design Engineer to identify and resolve all potential conflicts during design.

A. The extent of conflicts during design may dictate the location or depth of the water line and shall be carefully coordinated. All efforts should be made to resolve utility conflicts in the most economical manner consistent with local best practices to avoid schedule impacts.

B. The Design Engineer is responsible for contacting the private utility companies and requesting they field locate their utilities within the rights-of-way of the proposed route. This private utility verification effort is to be accomplished prior to finalizing the base sheets (plan and profile) and the water line alignment (horizontal and vertical) along the proposed route.

C. If the pipeline company requires their line to be located by the use of SUE Level A, coordinate with the Authority for authorization (refer to Chapter 6).

1.3 REGULATORY COORDINATION AN APPROVALS

1.3.1 Coordination

The construction for the proposed Program will require extensive coordination with the following various regulatory agencies:

A. Public entities

B. Public utilities

C. Private utilities

1.3.2 Responsibilities

The Design Engineer is responsible for the following tasks:

A. Resolve the specifics of his design with the applicable agency.

B. Keep the Authority apprised of the status of the approval process involving pertinent agencies until such time as final approval is granted.

C. For projects designated to receive SWIFT funding, compliance with TWDB requirements by the Design Engineer is necessary for the Authority to obtain TWDB approval for construction documents.

Additionally, Section 27 of the Harris County RULES OF HARRIS COUNTY, INCLUDING THE HARRIS COUNTY TOLL ROAD AUTHORITY, A DIVISION OF HARRIS COUNTY, AND THE HARRIS COUNTY FLOOD CONTROL DISTRICT FOR THE CONSTRUCTION OF FACILITIES WITHIN HARRIS COUNTY AND THE HARRIS COUNTY FLOOD CONTROL DISTRICT RIGHTS-OF-WAY provides the requirements for seeking a variance for any utility within HCFCD facilities that does not fully comply with the Harris County rules. Design engineer is required to prepare back-up documentation for a variance. Submission of a variance must be done in consultation with the Authority.

1.3.3 Authority Support

1.3.3.1 General

The Authority will support the project by:

A. Take the lead in submitting TxDOT permit approvals. As such, the Design Engineer shall coordinate all TxDOT interfaces with the Authority.

B. TCEQ approval of the Water Receiving Facilities design will be performed by the Authority. The Design Engineer shall design all work in conformance with TCEQ rules and regulations.

1.3.3.2 TxDOT

The Design Engineer will submit to the Authority the permit application for the crossing including all crossing details including the appropriate traffic control plan. The Design Engineer will provide all engineering data necessary to obtain the permits. The permit application will be filed no earlier than the 60% Submittal and no later than the 95% Submittal, depending on the complexity of the proposed crossing.

The Design Engineer is responsible for obtaining background (record drawings) and right-of-way information from TxDOT.

Chapter 2

Program Criteria

2.1 GENERAL

The successful accomplishment of the goals and objectives planned for the Program demands a high degree of organization and standardization within the design development (as well as during the subsequent construction activities). The construction packages required to complete the proposed improvements contain many similar activities, and their design should benefit from the cumulative input of ideas and thoughts from each member of the Program Team.

Representative standards or procedures are listed within this Design Manual, and specific design criteria are grouped by common categories.

The Program Criteria presented in this Design Manual is not meant to be all-inclusive or to substitute for sound professional judgment on the part of the team members. It is not the intent of this Design Manual to provide a complete guide to water line design.

2.2 TECHNICAL STANDARDS

The following standards are to be followed by Design Engineer unless otherwise instructed by the Authority. The Design Engineer should become familiar with the following publications and sources and adhere to the applicable standards, which they present.

A. "RULES AND REGULATIONS FOR PUBLIC WATER SYSTEM," Texas Commission on Environmental Quality (TCEQ), Water Utilities Division.

B. Various publications by the American Water Works Association (AWWA).

C. Requirements by regulatory agencies and approving authorities such as TxDOT, Harris County, City of Houston, and railroad companies.

2.3 DESIGN CRITERIA

The Design Criteria presented below includes various elements to successfully design the Authority's projects.

2.3.1 Hydraulic Criteria

The following subsections define hydraulic criteria for NHCRWA transmission mains. The design definition and development of major water lines involve many hydraulic considerations. Some of the more important criteria are listed here; others may arise as the Program advances and input is received from the Design Engineers or the Authority's Consultants.

Pressure Conditions

Pressure	psi
Maximum Discharge Pressure into Primary Distribution System	120 psi
Range of Delivery Pressures of MUD Tie-in Connections with PRVs	35 – 85 psi

Velocity Considerations

Velocity	fps
Desired velocity	4 fps
Maximum velocity under any demand condition	6 fps

(This maximum velocity may be adjusted after consideration of head loss; conditions.)

Pipe Friction Factors (Hazen Williams "C" Factor)

Pipe Size	Roughness Coefficient
20-inch and smaller pipes	110
24-inch and larger pipes	120

Demand Peaking Factors

Demand	Peaking Factor
Average Daily Flow to Peak hour Ratio	3.2

Maximum System Pressures (Including Surge Conditions)

The maximum pressures anticipated are the greater of the following criteria.

A. 150 psi test pressure, or

B. The maximum design pressure as specified in the appropriate AWWA Manual of Water Supply Practices, Standards, Design Criteria or Specifications, such as M9, "Concrete Pressure Pipe" or M11, "Steel Pipe – A guide for Design and Installation," or others - applicable to the different types of pipes.

C. For transient analysis maximum system pressures are based upon equipment closing times:

Closing Times	Seconds
Pressure reducing valves and check valves	2.0 – 5.0 seconds (maximum)
Pump control valves	30 seconds (minimum)

In accordance with standard criteria and acceptable engineering practice, air release; vacuum relief; and/or air/vacuum relief valves should be installed at all high points and such other intermediate points as determined during design. For certain projects the Authority will provide recommended locations for these protection valves based on the transient analysis.

2.3.2 Pipe Design and Material

The Design Engineer has the responsibility to identify the proper pipe material for special installation requirements for their specific project.

The Design Engineer shall review the pipe design requirements based on combined loading conditions including design, operating and surge pressures, as well as backfill cover and live loads. The Design Engineer is to identify unusual or unique pipe considerations in the Contract Documents (refer to Chapter 7). This effort is to include identifying minimum pipe wall thickness, special coatings, specific bedding and backfill material, etc.

Pipe materials must conform to AWWA Standards and the Authority's standard specifications. The Authority allowed pipe materials are listed below based upon accepted sizes.

Pipe Material	Pipe Diameter (Inches)
Polyvinyl Chloride	$\leq$ 30
Ductile Iron	$\leq$ 64
Prestressed Concrete Cylinder	24 - 96
Bar Wrap Concrete Cylinder	24 - 60
Steel	$\leq$ 96

The criteria used to evaluate each pipe material include system flexibility, hydraulic efficiency, manufacture and availability, surge protection, maintenance, susceptibility to environment, and costs.

2.3.3 Valves

Different types of valves are required for Authority water lines, each with its own specification. The primary types (classification) of valves which may be required are isolation valves, air and vacuum valves, combination air valves, and control valves. All valves shall conform to applicable AWWA Standards as modified by the Authority's Standard Specifications. Valves and other appurtenances must also meet or

exceed NSF-61 Standards (those in direct contact with the water flow). The requirements of the Standard Specifications shall govern when in disagreements with AWWA Standards or Manuals of Standard Practice.

2.3.3.1 Isolation Valves

Valve information to be identified by the Design Engineer include type of valve (gate, butterfly, etc.); spacing; location, and performance and equipment specifications. Spacing and type of valve based on water line diameter is summarized below.

Type	Size	Approximate Maximum Spacing (feet)
Gate	≤12-inch	1,500
Gate or Butterfly	16-inch to 24-inch	2,000
Butterfly	30-inch to 42-inch	3,000
Butterfly	≥48-inch	5,000

The Design Engineer shall consider the use of gate valves when connections to other critical line segments. Consult with the Authority to confirm these locations.

2.3.3.2 Combination Air Valves

The number and location of these valves is to be determined by the Design Engineer in accordance with acceptable design practice including site conditions and related factors. In certain cases, the Authority will provide the Design Engineer with specific requirements as to size and location of valves as recommended by the transient analysis.

Both single-body and duplex-body combination designs may be used, depending on the size, location, and other factors for a specific installation.

2.3.3.3 Vacuum Relief-Air Inlet Valves

When performed by the Authority, transient modeling shall be based on exclusive use of vacuum relief-air inlet valves in combination with side-mounted air release valves (rapid air inflow with slow release) as the surge protection devices. The type of device must be distinguished from others which allow rapid air release, or which have slow or dampened closure.

The Design Engineer shall coordinate his design efforts for these locations with the Authority due to standardization of certain elements of the vacuum relief valve designs.

2.3.3.4 Control Valves

Control valves are required on the refill lines connecting the water receiving facility (WRF) ground storage tanks (GST) to the Authority's water lines. Due to the nature of the application, and the potential for some throttling, these should be ball valves equipped with electric or hydraulic operators to facilitate remote operation. Although a guideline design will be provided by the Authority, the Design Engineer is responsible for adapting the design to the site-specific requirements of the WRF.

2.3.4 Flushing Hydrants

The Authority requires the installation of hydrants to flush the water line. The flushing hydrants are not used for fire protection and thus the spacing should generally follow the design guidelines contained herein for spacing.

2.3.5 Drain Lines

Water line drain line are to be provided for proposed water lines 24-inch and larger. Place one or more per contract, as determined feasible by Design Engineer and agreed to by the Authority. Drain line does not need to drain entire length of line; it does need to drain into an enclosed storm sewer.

2.3.6 Thrust Restraint

The Design Engineer shall determine the proper restrained joint or other mechanism required to resist the forces developed by the internal water pressure at all bends, tees, and other fittings including any proposed connections to existing water lines. Existing lines and proposed lines 12-inch diameter and less are to be restrained with concrete thrust blocks. For lines 16 inches in diameter and larger, restraint is to be provided.

Thrust restraint calculations shall be based on the use of Prestressed Concrete Cylinder Pipe (PCCP) in buoyant conditions for water lines 24-inch and larger. Use ductile iron pipe for water lines less than 24-inches. Where a specific pipe material is specified on the plans, use that pipe material and appropriate factors for determining thrust restraint. Use appropriate AWWA method to calculate restraint length. However, passive resistance of soil will not be permitted in calculation of thrust restraint.

2.3.7 Tracing and Warning

Tracing wire shall be required for all non-metallic water lines, and any sewer lines installed as part of the project. Where any water line crosses a road ROW or a pipeline/CenterPoint corridor a water line marker shall be placed at both ROW lines listing a phone number to contact before you dig.

Chapter 3

Design Guidelines

3.1 GENERAL

The following design guidelines are not meant to be all-inclusive or to substitute for sound professional judgment on the part of the team members. The Design Engineer shall adhere to the following guidelines unless otherwise approved by the Authority. It is the Design Engineer responsibility to identify any variance from the guidelines necessary to successfully complete the project and enable the Authority to adequately maintain the water line.

3.2 METHOD OF CONSTRUCTION

The method of construction for each water line will primarily be based on open-cut construction which consists of opening a trench with a minimum width. The trench may have vertical or steep side slopes utilizing proper shoring. The sides may be laid back to a safe slope based on the soil characteristics toward the top of the trench. Placement of a sand layer in the bottom of the trench will be for the pipe embedment. Wet trenches may require 6-inches crushed stone with geotech fabric or well pointing, or some other means of dewatering, depending on the local groundwater conditions. After proper bedding, installation, and testing, the trench shall be backfilled and compacted. In paved areas, the existing pavement shall be removed prior to the trenching and restored (reconstructed) after the water line installation is complete.

In some areas where open cut construction may not be feasible or may create too much impact to the area "trenchless" alternatives will be considered (refer to Chapter 3). This is the responsibility of the Design Engineer to identify these areas and evaluate alternatives. Consideration shall be given to reducing impact to the public and traffic, mature specimen trees and cost effectiveness. Input and final approval will be provided by the Authority.

Water lines constructed under signalized intersecting streets will be installed by trenchless methods unless an alternate method is approved by Harris County or the City of Houston. When determining the limits of trenchless, all approaches, including left-turn lanes, at signalized intersections should remain open to traffic.

Water lines under esplanade openings serving public streets, whether signalized or unsignalized shall be installed using trenchless methods. Esplanade openings serving schools, or other major traffic generators, shall remain open, unless school is not in session.

3.2.1 Design Engineer's Responsibility

It is the Design Engineer's responsibility to evaluate the specific crossing or section of water line to be installed via trenchless and identify the best and most cost-effective method. The Design Engineer's recommendations should be based on numerous factors such anticipated subsurface soil conditions, depth of cover, allowable settlement at the surface and ability to effectively dewater the trenchless excavation.

3.2.2 Trenchless Construction

The following guidelines have been developed to assist the Design Engineers with the development of their crossing details when the use of trenchless construction has been recommended by the Design Consultant and approved by the Authority.

Critical in the development of the crossing details is the determination of the proposed method of construction (e.g., augering, tunneling or horizontal directional drilling (HDD). Use of horizontal directional drilling (HDD) to cross requires prior approval of the Authority.

3.2.2.1 Augering

Augering generally involves the direct installation of the water line in the hole created by the auger machine. For specific crossing such as TxDOT and rail roads, the use of a smooth wall steel casing is required. The casing serves as the spoil removal system. As the auger advances, the casing pipe is advanced.

A wet auger (slurry auger) procedure using minimal water for lubrication may also be used. Jetting is not allowed. A dry auger is when no water is used to advance the auger.

Generally, this type of water line construction is used for the smaller pipe sizes, such as 20 inch and smaller. Augering is normally limited to smaller water line diameters and shorter sections of installations.

The Design Engineer shall familiarize themselves with the Authority's Standard Specifications for further guidance.

3.2.2.2 Steel Casing

The casing pipe shall be in accordance with the Authority's Standard Specifications and the latest AWWA and TxDOT specifications (when crossing TxDOT ROW). The annulus between the casing and the surrounding soil does not require grout unless the contractor has, in the opinion of the inspector, over-cut the hole. The proposed water line is to be installed within the casing pipe with casing spacers in accordance with the Authority's Standard Details. Refer to the Standard Specifications for how the water line is to be installed within the casing.

The casing shall extend the width of TxDOT's right-of-way and the Harris County or City of Houston rights-of-way when a casing is required.

For crossing underneath elevated roadway sections, the casing shall extend 5 feet beyond the bridge drip line. For other crossings, the casing shall extend to the centerline of the outermost ditches or 5 feet back of the existing curbs.

3.2.2.3 Tunneling

This method of construction generally is used to install pipe sizes 24 inch and larger and includes the use of some type of cutting mechanism in advance of the casing or liner installation. Some methods of tunneling include hand tunneling, tunnel boring machines, or micro-tunneling. These techniques include the advancement of a pipe or liner system immediately behind a tunneling device. A jacking system is generally used to advance the cutting and casing system.

3.2.2.4 Tunnel Method Selection

The Design Engineer is responsible, in consultation with the Geotechnical Consultant, in determining the minimum tunneling requirements. For example, if the soil conditions are unstable and surface settlement must be minimized, the Design Engineer shall identify the acceptable tunneling method(s) for the specific crossing to mitigate the risks to the crossing. Cost effectiveness must be considered during the evaluation.

When requested by the Authority, the Design Engineer is expected to provide the engineering justification for the proposed tunneling method.

3.2.2.5 Tunnel Liner

When specifying tunneling, a liner system shall be provided to protect the integrity of the roadway or railroad. The following guidelines should be followed:

A. Steel ring beams with wood laggings, timber bracing such as breast boards, supports, and struts are not allowed within the TxDOT right-of-way.

B. The annulus between the soil and the steel liner plates must be grouted. Grouting will take place after every 10 feet of advancement. Furthermore, the annulus between the liner and the water line pipe must be grouted. Grouting between the water line pipe and liner can be performed after the completion of the water line installation.

C. Smooth wall welded steel pipe casing, in accordance with the Authority's Standard Specifications and the latest AWWA specifications is an acceptable liner material for tunneling applications. Grouting of the annular space between the casing and the carrier pipe with a diameter less than 36 inches is not required provided the liner is designed to carry all loads. Grout is required between the casing and all carrier pipe with a diameter of 36 inches and greater.

D. For crossing underneath elevated sections, the tunnel liner shall extend 5 feet beyond the bridge drip line. For other crossings, the tunnel liner shall extend to the centerline of the outermost ditches or a minimum of 5 feet back of the existing curbs.

3.2.2.6 Tunnel Shafts

The Design Engineer shall consider the tunnel shaft requirements. This includes the size requirements for the selected tunneling method, potential for ground loss and impacts to adjacent structures and utilities, ability to effectively dewater the shaft excavation, and anticipated loading on the shaft support system. This does not require the Design Engineer to design the tunnel shaft. Rather to consider the specifics of the site so the contractors bidding the project have more insights to the expected challenges with installing the tunnel shafts. This may require the Design Engineer to require specific shaft construction techniques.

3.2.2.7 Horizontal Directional Drilling (HDD)

The use of HDD is an option for trenchless construction. However, when requiring the use of HDD, the Design Engineer shall confirm the HDD section:

A. Is deep enough to avoid "fracking out" of the drilling mud.

B. Changes in the horizontal and vertical alignment can be accommodated by the Authority's allowed pipe materials.

C. Verification of adequate ROW for the entry and exit of the HDD.

D. There is sufficient lay down area for the stringing of the pipe material within the ROW or Authority acquired easements.

E. The water line can be accessed by the Authority for future maintenance.

Refer to the Authority's Standard Specifications for additional requirements for HDD sections.

3.2.3 Groundwater Control

Consult the Geotechnical Report for when existing groundwater conditions will likely impact the tunneling operations. Well point or other dewatering systems will not be permitted within the TxDOT or rights-of-way or across Harris County or City paved roadways.

3.3 SPECIAL CROSSINGS

The Program includes numerous crossings of special design significance. These include bayous, streams, highways, railroads, and perhaps special pipeline corridors. Their complexities have wide variations and may require coordination or approvals from several agencies. It is the Design Engineer's responsibility to obtain all permits and approvals, including letter of no objection (LONO).

3.3.1 Highway and Railroad Crossings

In general, TxDOT and railroad crossings should be encased in a steel casing or a steel tunnel liner. The specific design details for each crossing will depend on the special requirements of the agency, which has authority of the crossing. The Design Engineer is responsible for determining the specific requirements of the agency and coordinating his design accordingly.

3.3.2 Crossing or Parallel to Streams and Channels

Comply with Harris County Flood Control (HCFCD) rules for construction impacting HCFCD maintained facilities. Water line crossings of waterways or other drainage channels will normally be underground depending on the specific crossing features, conflicts, or restrictions of the specific crossings. Elevated crossings should have a minimum elevation of one foot above the 100-year floodplain. Elevated crossings should maintain a minimum 10-foot horizontal clearance from existing bridge structures.

Minimum clearances on underground crossings shall be no less than 5- feet range depending on the soil conditions and HCFCD requirements. Actual clearance shall be based on geotechnical investigation.

Design shall identify ultimate channel width and depth and accommodate future channel improvements. In HCFCD ROW, provide a single bollard for each vent pipe, and locate near ROW edge.

3.4 DESIGN CONSIDERATIONS

3.4.1 Record Drawings

The Design Engineer shall review the existing record information (private utility block maps and record drawings/as-built drawings) and use sound engineering judgment to resolve areas of conflict or questions that arise during design. Use of existing information should account for the accuracy of the features identified by the topographic surveys and encountered field conditions.

3.4.2 Alignment

The proposed water line routes are based on traffic patterns and land use; right-of-way (ROW) and easement availability; existing utilities, pavement condition, landscape features; and proposed improvements along the route.

After the survey and record research efforts are complete, the Design Engineer shall walk the route to verify

accuracy of the completed base sheets (plan and profile). The Design Engineer is to present the final alignment for the proposed water line which will minimize both public inconvenience and anticipated construction cost. The proposed horizontal alignment is to be placed as described below in the following descending order of preference:

A. In a separate water line easement

    1. When the easement is adjacent to Harris County ROW, the minimum width of easement for lines 12 inches in diameter shall be 10 feet, and for lines 16 inches in diameter and larger shall be 20 feet. The water line shall be located within the easement to facilitate installation and maintenance. The easement may need to be enlarged in the vicinity of the isolation valve to accommodate the service manhole, depending on the size of the water line and service manhole.

    2. When the easement is not adjacent to public ROW, the minimum easement width for a 12-inch water line shall be 20 feet and for lines 16 inches and larger in diameter shall be 30 feet, with the water line off set centered within the easement width to improve installation, maintenance, and access.

B. In HCFCD rights-of-way or easement

    1. The horizontal location of the water lines should be a minimum of 10 feet from the ROW or easement line to the centerline of the pipe, the minimum easement width shall be 20 feet.

    2. Consideration shall be given to offset the centerline of the water line based on the channel's existing high bank placement relative to the ROW or easement line.

C. In median of street ROW

D. Behind curb in street ROW

E. Under pavement in street ROW

Horizontal and vertical alignments are to be chosen to minimize conflicts with existing utilities.

The minimum depth of cover is 6 feet in improved areas (curb and gutter with storm sewer system) from top of curb (TOC). In unimproved areas (open roadside or drainage ditches), the minimum depth of cover is 8 feet, unless otherwise approved by the Authority.

Where possible, minimize using manufactured pipe bends for water lines. When feasible use either beveled or deflected (off set) joints for changes in the vertical or horizontal alignments. Maximum deflection with beveled end = 5 degrees (slope = 0.0875 foot/foot).

Unless otherwise instructed by the Authority, the Design Engineer will assume lines 24-inch and larger to be Prestressed Concrete Cylinder Pipe (PCCP) for the basis for the detailed alignment. Since PCCP has the largest wall thickness of the generally acceptable pipe materials, a detailed alignment designed with PCCP should accommodate the other pipe materials.

3.4.3 Isolation Valve Placement

Locate isolation valves to facilitate access for operating. Locate valves with service manholes so they are accessible by a truck-mounted mechanical valve operator.

When there is a water line tied to a Water Receiving Facility (WRF) and the transmission line serving the plant is looped, place three valves along each branch.

For 16-inch and larger water lines, the Design Engineer shall determine the restrained length on both sides of valves when flow is anticipated in the water line to be in two directions.

All lateral lines shall have an isolation valve near the tee connection. Locate valve along the street right-of-way line projected (extended) across the connecting line whenever possible.

3.4.4 Air Valve Placement

Place combination air and vacuum valves on the water line at selected high points in the water line profile and at specified locations such as bayou and highway crossings. Place air valves at high points in the direction of normal flow in the water line.

The inlet/outlet vent elevation shall be a minimum of one foot above the 100-year floodplain as established by FEMA or 4 feet above natural ground, whichever is higher.

Care should be taken to locate the valve such that it is protected from tampering and/or damage.

Locate vent piping at property (lot) lines, unless otherwise approved by the Authority, so that minimal obstruction occurs to the adjacent property owners. Locating vent piping in the esplanades is to be avoided but, if necessary, requires the Authority's approval.

Adjust high points to optimize (reduce) the number of air valves required to maintain a typical air valve spacing of 500 ft or greater. Coordinate location with transient recommendations.

3.4.5 Manways

Provide 24-inch access manways with manhole at 10-feet upstream and downstream of proposed butterfly to allow internal access to lines 36-inch and larger. Provide access manways spaced no more than 900 feet to allow internal access. Manway should be placed at each end of project limits to facilitate removal of dish head plug.

3.4.6 Flushing Hydrants Placement

Spacing of the flushing hydrants should consider capability of the discharged water to flow into adjacent drainage system, if available. Spacing shall generally adhere to the following and are to be near isolation valves:

Scenario	Approximate Maximum Spacing (feet)
For dedicated lines to WRF	3,000
Transmission lines (24-inch and larger)	3,000 – 5,000

When determining the spacing, the discharge piping at the meter and flow control station will normally account for flushing the line. Flushing hydrants are to be placed at property lot lines, unless otherwise approved by Authority. When feasible, locate at low points in the water line and where multiple Authority lines intersect – place on one of the intersecting lines.

3.5 GENERAL DESIGN GUIDELINES

Below is a listing of design items to assist the Design Engineers involved on the Program. This list is not intended to be a comprehensive listing of all design tasks. Rather, it is an effort on the part of the Authority to identify some key design items in the design process to assist the Design Engineers to meet the Authority's expectations when completing their work.

A. Method and type of connections to the Authority's existing water lines are to avoid system shutdowns when possible. Final acceptance of such connections will be made by the Authority.

B. The centerline of any water line shall be no closer to a building line, building foundation or building slab than 10 feet for water lines 12 inches in diameter and smaller and no closer than 15 feet for water lines 16 inches in diameter and larger.

C. Maintain a minimum horizontal distance from outside wall of water line to outside wall of storm sewer of 4 feet.

D. At storm sewer crossings, maintain a minimum vertical distance from outside wall of water line to outside wall of storm sewer of 2 feet.

E. If the ultimate top of curb (TOC) is known for a specific roadway, the depth of cover will be a minimum of 6 feet from the proposed TOC to the proposed water line. Depth of cover will need to comply with Harris County or the City of Houston, based on road right-of-way ownership.

F. Place air release and vacuum relief vents at right-of-way line while not obstructing sidewalks or access to the adjoining property. Locate vacuum relief vent piping at lot line unless otherwise approved.

G. The vent elevation for air/vacuum valves shall be 1 foot above the 100-year floodplain as established by FEMA or 4 foot above natural ground, whichever is higher. Consult with the Authority if one, two, or three bollards are required. Locate based upon field observations.

3.6 PAVEMENT REPLACEMENT

The Authority does not control the public road rights-of-way in any area. Therefore, the Design Engineer should avoid placing the proposed water lines under roadway pavement, unless crossing the road or prior approval from Harris County or the City of Houston has been obtained by the Authority.

When roadway pavement is removed, the pavement section to be reconstructed shall be as required by Harris County or the City of Houston and agreed to by the Authority.

3.6.1 Concrete Pavement

Unless otherwise required by Harris County or the City of Houston, concrete pavement removal shall meet the following.

A. When the proposed water line is parallel to the pavement, replace concrete pavement to the existing longitudinal joint for the full width and to the nearest expansion joint on either end of the excavation area. *For Harris County: Concrete thickness to be replaced to existing thickness or meet current criteria for developer projects whichever is greater*.

B. When the proposed water line is perpendicular to the pavement, comply with the limits required by Harris County or the City of Houston. In general, replace concrete pavement for a minimum width of 10 feet either end of the excavation or to the expansion joint if it is closer. If after replacement the nearest expansion joint is less than 10 feet, then replace concrete pavement to the expansion joint.

C. Show limits of replacement on the drawings.

3.6.2 Flexible Base Pavement

A pavement design evaluation and analysis will be performed by the Design Engineer for roadways requiring major or total reconstruction and for roadways consisting of flexible pavement. Unless otherwise required by Harris County or the City of Houston, partial removal of flexible pavement shall meet the following.

A. For parallel applications, when the contractor damages or removes flexible base pavement, the entire lane width affected will be milled and overlaid with an equivalent thickness of asphalt for the length of the trench plus a 50-foot length beyond both ends of the excavated area.

B. For perpendicular water line crossings, the lane(s) affected will be milled and overlaid with an equivalent thickness of asphalt for a length of 50 feet beyond the excavated area.

C. Where the flexible base pavement is to be removed, it will be saw cut at the limits of the replacement.

D. Show the limits of replacement on the drawings.

3.7 GEOLOGICAL FAULTS

For a particular contract package, it may be discovered the line segment will cross a geological fault. This information may be based on the geological information available to the Design Engineer or his Geotechnical Consultant or site observations.

When it is determined that a line segment will cross a geological fault, the Authority will provide guidance or take the lead as determined by the Authority. A specific course of action is to be followed.

A. Determine if the fault is active or has the potential to become active during the design life of the project.

B. If it is determined the fault is inactive, and has no potential to become active, the design should not be affected.

C. If the fault is active or has the potential to become active, the design of the water line must take the potential movements of the fault (horizontal and/or vertical) into consideration. The action taken should be as follows:

1. Attempts will be made to determine the exact location of the fault and identify the intersecting point of the water line at the fault. These tasks will be carried out by a qualified Geotechnical Consultant.
2. The fault location may be determined by a combination of surface observations and a subsurface investigation based on logged borings used to study the local stratigraphy.

3. Once the location is determined, the potential horizontal and vertical movement of the fault will be estimated. Estimated horizontal and vertical movements will help the Design Engineer determine the hazard zone which includes a portion of the line before and after the fault that will be impacted by ground movement from the fault. This task requires a literature research and sound engineering judgment. It will be accomplished by the Geotechnical Consultant.

D. Based upon the geotechnical investigation, the detailed segment design can continue. There are no standard designs for fault crossings, but the following alternatives are options to assist the Design Engineer in his design:

1. ***Do Nothing:*** The potential activity of a particular fault may not warrant or require any corrective action. In some cases, the decision may be made to accept the anticipated fault movement, and to repair the line as necessary.

2. ***Modify the Pipe Design:*** Some allowance for minor ground movement may be provided by the particular pipe material selection (e.g., steel pipe) or by increasing the strength of the pipe design.

3. ***Use Low Shear Strength Backfill:*** A low shear strength backfill may provide a zone of absorption around the pipe. It is assumed that such a zone would deform (shear) prior to (or relatively independent of) the pipe. In addition, use lightweight trench backfill material to reduce the weight and confining pressure on the pipe.

4. ***Use Specially Designed Pipe Joints and Sections:*** The pipe joints can be designed with flexibility to undergo fault-induced strain prior to the pipe being ruptured.

5. ***Install a Jacked Slab:*** Partial resistance of the ground movement can be provided by installing a reinforced concrete slab in lieu of the normal pipe bedding. A jacked slab with an overlapping hinge located near the fault can provide additional resistance to the rotation and sliding movements of the fault. This slab can be re-leveled from time to time by the injection of pressure grout. Some pipe strain will still occur and must be accounted for in pipe and joint design.

6. ***Use Rigid Composite Section:*** Place the pipe inside a primary tunnel liner with an annular grout forming a rigid shell that will protect the pipe within the hazard zone. A flexible composite section is completed at each end of the rigid section to counteract bending movements and elongation with the section of pipe crossing the fault. Rigid composite section bridges the fault crossing and transfers movement of the fault to flexible composite sections on either end of the rigid section.

7. ***Use a Sacrificial Liner:*** Place the pipe inside a protective "shell" (the sacrificial liner) that deforms during any fault movement. The annular space between the pipe and the shell absorbs the movement before it reaches the pipeline. (Note: the pipe must also be able to absorb longitudinal movement as the fault shifts.)

8. ***Place Line Above Grade:*** If the alignment is adjusted to aboveground – in an inverted "U," the fault movement can be partially absorbed (through the use of flexible joints). This arrangement also simplifies the field monitoring of the fault crossing.

9. ***Use Various Combinations of the Above:*** The corrective actions listed above may be used individually or in combination, dependent on the characteristics of the specific faults.

A site-specific program should be developed during the design process and be in place during construction and throughout the life of the fault crossing design.

Chapter 4

Plant Connections – Water Receiving Facilities (WRFs)

4.1 PLANT CONNECTIONS

Obtain record drawings for original plant yard piping and other plant improvements. Review record drawings and identify specific issues which affect the proposed connection(s). Based on record drawings, field survey and SUE Level A, if performed reflect such appropriate information on the plans. Determine the material for the existing piping and design accordingly. Design above ground plant piping for steel or ductile iron pipe with 100% restrained joints. Flange joints to be used for connection to meters, valves, and other couplings, as per Engineer's design. Avoid direct bury of couplings or other similar type of connections. Provide appropriate detail views and sections.

Develop a valve or plant shutdown sequence for construction causing any portion or entire plant shutdown. Plan sequence in coordination with the Plant Operator, as approved by the Authority. Include sequence in Bid Documents. Prepare a plan view showing the location of the existing valves, with status of working condition, required to facilitate proposed Work. Identify in Bid Documents, "critical stages of the Work" requiring shutdown of the facility. Require contractors to provide a minimum of 72 hours of written notification before beginning construction, and it is to be performed in the presence of the Plant Operator.

During design, request a coordination meeting between the Engineer, Program Manager, WRF Engineer, and Plant Operator to discuss potential problems with proposed Work and obtain list of "undocumented unknown." Any need, such as time of outages, etc., should be incorporated into the design.

4.2 WATER RECEIVING FACILITIES

Design Manual Requirements are being updated.
In the meantime, consult with the Authority for guidelines.

Chapter 5

Support Services

5.1 INTRODUCTION

Topographic surveys, easement surveying, geotechnical investigation, environmental site assessments Phase II, and traffic control plans, storm water pollution prevention plans, and subsurface utility engineering normally will be the responsibility of the Design Engineer.

The Authority will, using other consultants, provide the Design Engineer with additional services when the effort extends to more than one project within the Program or to maintain consistency across all Authority projects. The anticipated additional services to be provided by the Authority include survey controls, Environmental Phase I (or its equivalent), corrosion control investigation, transient (surge) analyses, and tree protection plans. The Authority will only provide transient analyses for certain water line segments. Other support services will be provided by the Authority as their need is identified.

5.2 SURVEYING

The following guidelines are to be followed for all surveying and mapping to be performed by the project surveyor under the direction of the Design Engineer for the Program. It is the Design Engineer's responsibility to manage the schedule and quality of the project surveyor's work.

5.2.1 General Requirements

5.2.1.1 References

The following regulations are to be followed by Design Engineer's surveyor. The Design Engineer's surveyor is expected to adhere to the applicable regulations.

A. Texas Statute Occupations Code, Title 6, Subtitle A, Chapter 1001 Texas Board of Professional Engineers and Land Surveyor.

B. Texas Statute, Occupations Code, Title 6, Subtitle C, Chapter 1071 Land Surveyors.

C. Texas Administrative Code, Title 22, Part 6, Texas Board of Professional Engineers and Land Surveyors.

D. Texas Society of Professional Surveyors (TSPS) Manual of Practice for Land Surveying in Texas, latest edition.

5.2.1.2 Survey Conformity

All topography shall conform to a Category 6, Condition 2 survey and all surveys relating to the right-of-way or easement alignment and acquisition shall conform to a Category 1B, Condition 2 or Condition 3 survey as defined in the Texas Society of Professional Surveyors "Manual of Practice for Land Surveying in the State of Texas."

All drawings, parcel index maps, parcel maps, and metes and bounds descriptions shall be sealed and signed by a Texas Registered Professional Land Surveyor who was responsible for the work.

5.2.1.3 Survey Controls

The horizontal and vertical control for the Program is to be set on a Program wide basis by a surveyor on behalf of the Authority. Use the following the horizontal and vertical datum and scale factor, unless otherwise provided by the Authority at the beginning of the project.
Surveys shall be based upon the Texas State Plane Coordinate System (South Central Zone), North American Datum (NAD 83). Coordinates are to be in surface value in U.S. survey feet and may be converted to Grid coordinates by multiplying by a scale factor of 0.99992513.

5.2.1.4 Quality Assurance

Field Surveying and work used in the development of construction drawings, calculations and preparation of rights-of-way maps, and field note descriptions shall be accomplished under the direct supervision of a Registered Professional Land Surveyor of the State of Texas and performed in compliance with the regulatory requirements.

5.2.1.5 Recording Field work

Field work shall be recorded in field books or on total station database printouts.

5.2.2 Topographic Surveying

5.2.2.1 Project Baseline

The project baseline stationing to be coordinated with the Authority. Station numbering to be continuous and sequential as possible, unless otherwise approved by the Authority.

5.2.2.2 Monumentation

The project baseline must be monumented at its beginning, end, and at all angle points with markers of a permanent nature, such as iron rods or spikes. Set swing ties for all monuments to allow easy recovery. Set markers at a maximum of 1,000 feet on all long lines. Found existing right-of-way monuments or property corners must be shown and located by station and distance, right or left from the baseline. Monuments used to establish the baseline must be identified as "Control Points," and their relationship to the proposed or existing right-of-way lines must be shown.

Show location and identification of existing NHCRWA survey monuments by station and distance, right or left of the project's baseline. Tie in the project monuments to existing monuments maintained by others such as TxDOT, Harris County Flood Control District and the City of Houston, as required to properly prepare the design by the Design Engineer.

5.2.2.3 Ties

Make ties to the found right-of-way monuments and property corners to the project baseline (see above).

5.2.2.4 Temporary Benchmarks

Set temporary benchmarks within 200 feet of the beginning and end of the project and at intervals not to exceed 1,000 feet throughout the project.

5.2.2.5 Topographic Features

Record all topographic features 20 feet past the public right-of-way, permanent easement, and any temporary construction easement of the project and on all intersecting streets for 50 feet beyond the intersection of the right-of-way lines, including but not limited to the following items:

A. Fire hydrants, water meters, valves, blow offs.

B. Gas meters, valves, and lines with size and depth.

C. Power poles, and telephone and electrical pedestals.

D. Storm Sewer inlets, manholes, and junction boxes.

E. Wastewater manholes and cleanouts.

F. Existing pavement edges, markings, driveways, crossovers, sidewalks, fences (including type of surface materials of all streets, driveways, and sidewalks).

G. Right-of-way/markers and pipeline markers (provide information from pipeline marker sign). Provide the pipeline(s) size, location, and depth.

H. Identify ditches, swales and grade breaks, brush or tree lines, and tree types larger than 4 inches in diameter. Caliper of tree to be measured 1 foot above the ground.

I. Identify culvert sizes and flow lines.

J. Size and location of other utilities (gas mains, electric, telephone, cable TV, Communication fiber optics, etc.).

Identify horizontal locations of existing manholes, angle points, bends, etc., for existing sanitary sewers, water lines, storm sewers, and pavement features such as radius returns and centerlines of boulevard openings, etc. Provide vertical elevation of existing sanitary sewers, water lines, storm sewers, pipelines, and other utilities from record drawings, field verification or from Subsurface Utility Engineering (SUE) information.

5.2.2.6 Cross Sections

Cross sections shall be taken at intervals of 100 feet; and at 20 feet beyond the ROW or easement limits.

5.2.3 Parcel Maps for Property Acquisition

5.2.3.1 General

Below are some general requirements for guiding the project surveyor on preparation of the parcel maps for property acquisition. Design Engineer to provide to project surveyor the template parcel map provided by the Authority at the start of the project. **No changes to the Authority's template is permitted without approval from the Authority.**

5.2.3.2 Parcel Designation

Parcel designations shall be based on the Authority's Project Number, followed by a hyphen and the parcel number, and ending with the designation of water line easement (WLE), temporary construction easement (TCE) or access easement (AE). For example, a parcel will be designed as 37A-12 WLE.

Parcel numbering to be shown on the Parcel Index Map (PIM) and coordinated with the Authority.

5.2.3.3 Abstracting

Surveyor shall obtain all documents (subdivision plats, ownership deeds, easements documents, and right-of-way drawings) necessary to establish the existing right-of-way lines of roads within project area. All easements affecting the project must also be obtained. The surveyor shall also be responsible for obtaining the ownership deeds and easements for properties where additional rights-of-way or easements will need to be acquired, including adjoining property owners.

Surveyor shall confirm the current ownership of any pipeline(s) and easement. Provide the name of the successors and contact information to the original recorded pipeline. Provide the original and successor recorded documents for the pipeline easement.

5.2.3.4 Boundaries

For each parcel of land to be acquired, locate the boundaries of the property, showing course and distance of all property lines. Show and identify lot and block lines on the survey map (acreage, and subdivision if tract is part of subdivision). Adjacent parcels owned by the same person shall be counted as one parcel.

Identify the corners with found iron pins or set with other suitable markers. If the property being surveyed requires separation into smaller parcels, designate and identify each parcel.

5.2.3.5 Acreage

Indicate on each survey parcel map the following:

A. Amount of acreage in the parent tract.

B. Amount of acreage in the taking.

C. Amount of acreage in the remainder after the taking.

D. Name(s) of the current owner(s) and Deed Reference(s).

5.2.3.6 Existing Easements

Show all existing easements that affect the property. Compute the area in each easement within the taking and show same on alignment. If two or more easements overlap, compute the extent of the overlap and show this information on the alignment.

5.2.3.7 Encroachments

Show all structure, features, driveways, utilities and other encroachments which are within the proposed easement. Identify the extent of the encroachment.

5.2.3.8 Inside Taking Area

Locate, identify, and show on the survey parcel map the measured distance from the nearest property line to all lakes, ponds, watercourses, and man-made physical objects situated on, under, or over the property in the taking area.

Provide: 1.) parcel index map of overall project 2.) Individual parcel plat of each taking. Include all building lines and existing easements which will affect the property, and list all zoning classifications, restrictions, or buildings codes if any.

5.2.3.9 Outside Taking Area

Locate, identify, and show on the survey parcel map the measured distance to all lakes, ponds, watercourses, and man-made physical objects situated on, under, or over the parent tract, which are not in the proposed right-of-way (easement) taking, but lie within 20 feet of the taking area.

5.2.3.10 Flood Information

Indicate on the parcel map and parcel index map, the location of the floodway and floodplain limits, if applicable to the taking area. Such information shall be obtained from the Permit Section of the County Engineer's office or FEMA.

5.2.3.11 Parcel Maps Presentation

Below are some requirements for the development of the parcel maps.

A. Prepare the parcel map at a scale sufficient to clearly show all the detail which may be necessary in the acquisition.

B. Identify width of street or road on parcel map.

C. Identify existing and proposed right-of-way or easement taking lines on parcel index map and show all control points (PIs, PCs, PTs, etc.) with suitable markers.

D. Show all monuments which are used and noted in metes and bounds descriptions.

E. Show all fences and identify their type(s).

5.2.4 Metes and Bounds Descriptions for Acquisition

The Design Engineer shall have the project surveyor utilize the Authority's standard template for metes and bounds easement preparation. **No changes to the Authority's template is permitted without approval from the Authority.**

5.2.4.1 Property Description

The surveyor shall furnish property description as follows:

A. Refer to the Authority's designated parcel number.

B. Description to be a metes and bounds description and parcel map unless it describes a whole lot or block within a subdivision the map or plat of which has been recorded in the Real Property Records of Harris County.

C. The type or font used in the description is to be dark and unblurred so that it can be easily reproduced on a copy machine and is to be consistent with example provided by Authority.

D. For all descriptions and sketches the paper size shall be 8.5 inches by 11 inches or 8.5 inches by 14 inches.

E. Identification of the land being described shall be by tract or parcel number, project name, and project number shown in the upper right-hand corner or top of the description page or pages. When the description covers more than one page, each page should be marked numerically to indicate the page sequence and the total number of pages used in the description.

5.2.4.2 Preamble

In accordance with the Authority's easement template, an introductory paragraph referred to as a Preamble is required. The Preamble is to include the total acreage and square footage of the Parcels contained in this tract. The Preamble should also include the total acreage and square footage of the Parent Tract and reference its current owner.

The Preamble shall include:

A. Description of the area in the taking, stated in acres and square feet.

B. Location.

C. Survey name and abstract number.

D. Size of parent tract and recording reference information.

E. Name of grantor, recording reference, and date of the last deed of conveyance relative to the tract being described.

F. Point of Beginning, (and Point of Commencement if one is used) in description and on the parcel map shall be tied to a fixed and easily ascertainable position.

G. Provide surface coordinates for Point of Commencement and Point of Beginning in the metes and bounds description and on the parcel map.

H. When contiguous tracts have the same owner, these tracts are to be combined into one tract, and the combined tracts are to be titled Parcel "A," Parcel "B," etc. (See example below. Coordinate with the Authority before finalizing description).

EXAMPLE
TRACT 6

PARCEL "A"	PARCEL "B"
0.62 ACRE (27,007 S.F.)	0.83 ACRE (36,154 S.F.)

I. If the tract is divided into parcels, then follow the whole tract. Preamble should be the Parcel "A" Preamble and field note or metes and bounds descriptions showing the total acreage and square footage in the parcel taking. Following this, the same procedure should be used for all other parcels being described.

5.3 GEOTECHNICAL INVESTIGATIONS

5.3.1 Introduction

The Design Engineer shall have a geotechnical report prepared by a qualified Geotechnical Consultant who is a subconsultant to the Design Engineer. The geotechnical investigation's main purposes are to evaluate the existing soil conditions along the proposed water line alignment and to provide specific project related recommendations to the Design Engineers concerning the design aspect of the project. These

recommendations are to include sheeting, shoring, and/or bracing requirements for construction along with dewatering and tunneling recommendations.

5.3.2 Design Engineer's Responsibility

The Design Engineer is responsible for verifying geotechnical investigation performed by Geotechnical Consultant is in conformance with these guidelines, project specific conditions and design requirements.

The Design Engineer's role includes:

A. Work with Geotechnical Consultant to develop proper scope for project and keep the Geotech Consultant informed of project direction.

B. Provide a copy of the proposed water line alignment.

C. Provide survey information of the borings (after drilling) to Geotechnical Consultant to use in the report.

D. Provide the base map for Geotechnical Consultant to use as the Boring Plan.

E. When a project involves special structures, provide a copy of the final structural design to the Geotechnical Consultant to perform the Geotechnical recommendations.

5.3.3 Program Criteria

To coordinate the multiple phases of the Program, a degree of standardization is necessary. The following is a partial list of references incorporated into the Program that pertain to the geotechnical services:

A. Standard Specifications

B. Standard Details

C. Various ASTM standards for geotechnical analyses

D. Unified Soil Classification System (USCS)

E. OSHA Soil Types

F. Laboratory tests shall be performed by Geotechnical Consultant with current accreditation by the American Association of Laboratory Accreditation (A2LA).

G. For tunnels/trenchless sections, perform continuous soil sampling from 5 feet above the excavation crown to 5 feet below the excavation invert level.

5.3.4 Site Access

The Geotechnical Consultant shall obtain permits, including the payment of the required fess, and arrange for access to boring locations on private property. The Geotechnical Consultant shall be responsible for cleanup and site restoration upon boring completion, commensurate with the site conditions. Unless otherwise directed by the Authority, when the geotechnical investigation will require entry onto private property, the Geotechnical Consultant is to be assisted by the Design Engineer in obtaining permission to enter the private property including the necessary right-of entry (ROE).

5.3.5 Field Work

The Geotechnical Consultant shall provide for the safety of boring sites, including traffic control commensurate with the traffic and road conditions while working in street right-of-way. Traffic control shall be in accordance with the Texas Manual of Uniformed Traffic Control Devices (TMUTCD),

Where possible the borings should be drilled on the centerline along the proposed alignment for proposed open cut sections. For proposed tunnel/trenchless sections, borings shall be drilled outside the alignment but within 40 feet of the centerline of the alignment. If utility conflicts prevent the proposed boring locations from occurring, the Geotechnical Consultant shall attempt to shift the boring longitudinally along and within the proposed trench prior to moving outside the trench area.

Proposed soil boring locations, including pavement cores, are subject to approval by the Authority.

Geotechnical Consultant shall look for signs of visual staining of the soil in the samples, note any odors and identify such in the report.

Typical Boring Placement		
Construction Type	Approximate Spacing	Depth
Open Cut	500-600 feet ≥ 24-inch diameter 750-850 feet ≤ 20-inch diameter	15 feet for excavations up to 10-foot deep Excavation depth plus 10 feet for excavations between 10-foot and 25- foot deep. For lines >/= 24", one and one half times the excavation depth for excavations greater than 25-foot deep.
Augered	500 feet	5-foot below the proposed invert level.
Tunnels and Microtunnels	500 feet	Minimum one tunnel diameter or 15 -feet below the proposed invert level (whichever is greater).

Shafts for Tunnels	I per tunnel At each location if shafts >200 feet apart	For lines >/= 24", 15 feet below the bottom of shaft but not less than 30 feet total depth.

All excess core samples are to be maintained by the Geotechnical Consultant for pickup by the Cathodic Protection Consultant. The Geotechnical Consultant will coordinate pick up with Cathodic Protection consultant.

5.3.6 Boring Logs

5.3.6.1 Boring Logs Requirements

Boring logs are to include the following information as a minimum:

A. Project number

B. Boring number

C. Boring location – station and either offset or distance from curb and one other semi-permanent features.

D. Date of field work

E. Depth to groundwater (both at end of drilling and 24-hour readings)

F. Depth to caving

G. Completion depth

H. Soil and sample symbology

I. Soil description

J. Geotechnical analytical data

K. Annotation of any PPCA, odor and sheen encountered while performing the borings and the respective depth encountered.

A draft copy of the boring logs is to be submitted to the Design Engineer approximately 2 weeks after the completion of the field work along with recommendations for additional boring locations (if required).

5.3.6.2 Backfill of Borings

Completed borings are to be backfilled by cement-bentonite or non- shrink grout using a tremie method. Additionally, bore holes through pavements are to be restored with the same or equivalent materials as existing pavement. The Geotechnical Consultant is responsible for cleanup upon boring completion, commensurate with the site conditions.

5.3.7 Piezometers

5.3.7.1 Piezometer Requirements

Piezometers are to be included in the scope of the Geotechnical Investigation if the project includes any of the following:

A. Excavation exceeding 15 feet in depth.

B. Crossing underneath a major drainage channel.

C. Crossing underneath a major TxDOT or Harris County Toll Road Authority corridor, including major thoroughfares.

D. Tunneling (hand or Tunnel Boring Machine) or Microtunneling installations for lengths > 150 feet.

E. Horizontal Directional Drilling (HDD) installation for lengths > 250 feet.

Spacing between piezometers shall be no greater than 2,500 feet for pipelines ≥ 24 inches. One piezometer shall be installed within the footprint of a tunnel shaft when the tunnel length is > 150 feet.

A minimum of two water level readings are required on each piezometer. The Geotechnical Consultant shall read water levels at 24 hours and 30 days (long term) after the installation of the piezometer, unless otherwise approved by the Program Manager.

Piezometers shall be installed in accordance with the applicable rules and regulations of the Texas Department of Licensing and Regulation (TDLR). A piezometer installation report shall be included in the geotechnical investigation report.

5.3.7.1 Backfill of Piezometers

The Geotechnical Consultant shall plug piezometer(s) installed for the project in accordance with the TDLR (Chapter 76 of Texas Administrative Code (TAC)) soon after measuring long term water level readings. A copy of the Piezometer Installation and Plugging Reports (submitted to the TDLR) shall be included in the Geotechnical Investigation Report.

5.3.8 Laboratory Testing

The selection of appropriate laboratory tests beyond the above tests is left to the discretion of the Geotechnical Consultant in consultation with the Design Engineer.

To assist in properly classifying the soils in general accordance with ASTM D2487, the laboratory testing program shall include a minimum of one set of Liquid and Plastic Limits (ASTM D4318) and Percent Passing Number 200 Sieve (ASTM D1140) tests on a representative cohesive soil sample in each boring.

The water content test (ASTM D2216) shall be performed on all cohesive soil samples to determine the moisture profile.

The Unconfined Compression Strength test (ASTM D2166) shall not be performed on a soil sample containing seams or slickensides.

All the test results shall be summarized in the report in table format. The Geotechnical Consultant shall include the summary of the test results.

5.3.9 Geotechnical Report

5.3.9.1 General

A sample table of contents is included as *Exhibit 5-A* and the components are further described in the paragraphs below. These descriptions are considered a guideline to the minimum requirements. The report content shall be project specific.

The report is to be organized as described below and submitted as a draft to the Design Engineer. The Design Engineer is to review and comment and forward their comments to the Authority. The Design Engineer's comments and the Authority's comments are to be addressed by the Geotechnical Consultant prior to finalizing the report.

The report shall describe the existing soil conditions along the proposed water line route and the water table elevations at the time of the field investigations The Geotechnical Consultant shall review the soil foundation design for the special structure and verify the Soil Foundation recommendations were interpreted properly.

A Draft report is required prior to 60% Submittal- and the final report prior to 95% Submittal.
The Geotechnical Consultant is to contact appropriate agencies for other borings in the area. While the Geotechnical Consultant is not responsible for the accuracy of these borings, this information, along with boring logs performed, are to be included in the Geotechnical Consultant Recommendations section of the report. The other agency boring logs are also to be included in an appendix.

5.3.9.2 Report Organization

The following Geotechnical Report organization is to be followed for all Authority projects.

1. *Executive Summary* – Summarize work performed, the findings, and any pertinent recommendations.

    1.1. Scope of Work – Summarize scope of work outlined in proposed scope of services.

2. *Subsurface Investigation Program* – Include the number of borings and piezometers, range of depth, rational for boring locations, and field and sampling protocol in this section., note any odors encountered, specifically of hydrocarbon nature, during drilling, and summarize this information in the report. A statement shall be included in the report stating whether unusual staining or odors were encountered.

3. *Laboratory Testing Program* – State the types of geotechnical analyses conducted and refer to the appropriate appendices for results. A summary of all tests results should be included as an appendix.

4. *Subsurface and Site Conditions*

    4.1. Geology

    4.2. Natural Hazards – Discuss any subsidence or geological faults that are located in the area. Comment on the activity or potential activity of any identified fault during the design life of the water line. If an active fault is discovered, notify the Program Manager and additional investigation may be warranted and alternate construction methods may need to be investigated.
    4.3. Site Stratigraphy and Geotechnical Characterization – Summarize soils encountered along proposed alignment, noting any anomalies or features which could impact

construction such as sands, etc. Refer to geologic cross section. Cross section should include both reference borings and stationing. The cross section should be drawn to scale and use USCS symbols. Also note the thickness of pavement when coring. A minimum number of pavement cores will be required, depending on if a portion the project is under roadway pavement. This requirement should be discussed between the Design Engineer and the Program Manager prior to field activities. Provide pavement core results in a tabular format.

4.4. Groundwater – Discuss groundwater levels encountered and method of measurement. Provide water level readings in a tabular format.

5. *Geotechnical Engineering Recommendations*

5.1. Trench Excavation – Recommend slopes, critical heights, etc., based on OSHA soil types. Discuss bearing pressures, bedding, backfill, excavation wall and bottom stability. Give an example calculation of bracing pressures.

5.2. Excavation Dewatering – Based on soil types and groundwater levels, recommend excavation dewatering methods and anticipated locations where such efforts may be necessary. Recommendations shall be for open cut installation, limits of tunneling and associated shafts.

5.3. Railroad Loads – Include backfill and bedding operations and example calculations for overburden soils pressures and liner loads in this section. Include project specific railroad load recommendations and example calculations where applicable.

5.4. Pressures on Primary and Permanent Liners – Give liner design recommendations and example liner design calculations.

5.5. Piping System Thrust Restraint – Include recommendations and example calculations using AWWA for thrust blocking and parameters and/or coefficient values for the design of restrained joints. Note: Passive resistance of soil is not allowed.

5.6. Discuss Influence of Tunneling on adjacent structures.

5.7. Lateral Earth Pressure Diagrams, including tunnel shafts – Include for both clays and sands as they pertain to each project. Include wall and bottom stability.

6. *Limitations*

7. *Authorization and Credits*

8. *References*

5.4 ENVIRONMENTAL

5.4.1 Introduction

Based upon the environmental investigation performed for the TWDB SWIFT funding, specific environmental investigations may be undertaken to confirm and determine the extent of Recognized Environmental Conditions (RECs) such as potentially petroleum contaminated areas (PPCA).

For SWIFT funded projects, the Design Engineer is required to review the environmental data forms (EDF) project specific conditions to confirm if an Environmental Site Assessments (ESA) Phase II and/or specific designs are required for the project. The Authority will provide guidance should environmental issues be identified during the design and the project is not SWIFT funded.

The more extensive ESA Phase II will be performed by the Design Engineer's Environmental Consultant when the EDF reveals an area of environmental concern along the project alignment. When requested by the Authority, the Design Engineer shall perform an ESA Phase II. These guidelines address the scope of work for ESA Phase II. Field investigations that include environmental sampling, laboratory testing/analysis of samples, regulatory standard review, recommendations, and reporting are considered Phase II.

De minimis conditions that generally do not present a material risk of harm to public health, or the environment are not recognized environmental conditions (RECs). Contamination of properties adjacent to the subject property may migrate into the construction zone or later adversely impact operations. The ESA Phase II investigation will be performed to evaluate how existing RECs may affect the design, construction, and operation of the proposed project.

5.4.2 ESA Phase II Goals and Procedures

The goals of the Phase II ESA would be:

A. Determine the approximate source, extent, and nature (liquid, absorbed, vapor, and dissolved phases) of hydrocarbon or other suspected contaminants in the proposed project ROW.

B. Evaluate existing and potential impacts to planned construction in or adjacent to the area of a suspected release.

Provide sufficient information to develop adequate health and safety measures for future planned construction activity in the area,

5.4.3 Referenced Standards

ESA Phase II site investigations will be performed in compliance with all appropriate local, State, and Federal health and safety laws, regulations, standards, and procedures. ASTM field and laboratory methods pertaining to environmental site characterization and performance of Phase II ESAs, sampling, screening, and laboratory analyses shall be followed; these standards include but are not limited to ASTM E1903 and ASTM D5730. Analytical laboratory data shall be performed by a Texas accredited environmental laboratory.

The ESA Phase II or environmental investigation reports will include text sections, tables, and figures shown in the sample *Table of Contents* in the attached *Exhibit 5-B.* The environmental investigation data will be presented using the methodology described below. All soil shall be classified using the Unified Soil Classification System (USCS).

The ESA Phase II report will include a site plan indicating the location of known contaminated sites as well as an Executive Summary. A site plan showing existing and proposed water line or facilities will be provided in a suitable scale considering the extent of investigation and details to be displayed. Locations of borings from previous investigations will be shown together with borings and other explorations performed for the project.

If required, the ESA Phase II report will contain specific project-related recommendations to assist the Design Engineer in properly designating the limits of PPCA or other contaminants on the Drawings.

Organic vapor screening of sample head space will be performed in the field as part of the sample collection.

One soil sample at a minimum from each soil boring is required for laboratory analysis. However, it is the Engineer's/Geologist's discretion to collect more samples when necessary. One sample should be collected from the zone exhibiting the highest organic vapor reading; or if the organic vapor readings are non-detect, the sample will be collected from immediately above the saturated zone. This field screening information will be recorded on the boring log, along with the depth at which groundwater is first encountered.

If the source of the REC has been identified during the environmental records review (or by other means) as a release of gasoline, diesel fuel, waste oil, jet fuel, or aviation gasoline from a petroleum storage tank; soil sample analytical testing will be conducted to meet the latest requirements for determining action levels using applicable U.S. EPA test methods stipulated by the current applicable state environmental regulations.

A. Benzene, toluene, ethylbenzene, and total xylenes (BTEX).

B. Total Petroleum Hydrocarbon (TPH) testing is required for screening of polynuclear aromatic hydrocarbons (PAHs) during initial release determination activities. The TPH test method shall conform to the latest TCEQ Methods for carbon-chain speciation and program compliance requirements.

C. Analyses will be conducted at the discretion of the Engineer/ Geologist when the source of contamination is diesel, waste oil, or jet fuel.

Analysis for the presence of polycyclic aromatic hydrocarbons (PAHs,) for example, acenaphthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, fluorine, naphthalene, phenanthrene, pyrene, and indeno (1,2,3-cd) pyrene, or metals will be conducted as warranted.

In locations where potential contamination is apparently due to buried structures, borings will be advanced to a maximum depth of 35 feet, or 5 feet below the planned structure or water line, whichever is shallower. Borings may be advanced to greater depths if warranted by site-specific circumstances. Borings may be terminated at a shallower depth, at the discretion of the Engineer/Geologist.

5.4.4 Planning

5.4.4.1 General

Based on the findings of the EDF or other environmental investigation, RECs may have been identified in connection with or adjacent to the proposed ROW or property.

Phase II ESA field work will be based on the results of the identification of REC's. ESA Phase II will be performed to identify areas that may affect the proposed project. The ESA Phase II scope is not to determine remediation requirements.

5.4.4.1 Health and Safety

A health and safety plan must be prepared by the Environmental Consultant prior to drilling. As a minimum, the plan is to provide for open borehole and work area monitoring for organic vapors. The plan will define action levels for levels of personal protection based upon the open borehole monitoring. The plan will include provisions for explosive gas monitoring and monitoring for other potential hazards.

5.4.5 Field Investigation

5.4.5.1 Soil Borings and Sampling

At least one environmental boring will be made in areas with RECs associated with future construction. The boring locations will be based on consideration of hydrogeologic characteristics of the subsurface soils, which can be determined from previous investigations in the area and knowledge of local geology. (See *Section 6.3.6, Boring Logs* for required information.)

A. The Design Engineer's Environmental Consultant is required to locate underground utilities, contact local call before digging services, and obtain any permits necessary.

B. Soil sampling equipment shall be decontaminated between samples. Latex gloves or neoprene gloves will be worn during other sampling and decontamination procedures.

C. A qualified hydrogeologist/geologist and/or environmental engineer is to be onsite to oversee drilling activities, collect and screen soil samples, and prepare detailed soil boring logs.

D. For each boring, split-spoon or Shelby tube samples will be collected continuously to the total depth of the boring. Boring logs shall identify:

    1. Soil classification

    2. Detection of hydrocarbon or other odors

    3. Visible hydrocarbon or other contamination (if present, include the degree, location, and extent of staining)

    4. Field screening for organic vapors with a Photoionization Detector (PID), Organic Vapor Analyzer (OVA) or Organic Vapor Meter (OVM).

    5. Other field screening as required by the type of contaminant and environmental media tested under the relevant regulatory program.

E. Soil sample descriptions include those described by *Section 6.3.6, Boring Logs*, as well as measurements of monitoring collected per sample and depth to groundwater.

F. Potential sources of contamination, which were identified, and areas of potential contamination which were investigated, will be clearly described. Areas of contamination within or adjacent to the project right-of-way which are confirmed, and their spatial relationship to the planned construction activity, will also be clearly identified.

5.4.5.2 Groundwater Samples

If groundwater is encountered in borings drilled to investigate a REC, and field screening of soils immediately above the groundwater interval indicates the presence of potential contamination, a groundwater sample is to be collected.

5.4.6 Analytical Sampling

The analytical methodologies are to be determined based on the nature of the potential contaminant. All analytical tests will be performed in accordance with the latest applicable EPA test procedure and TCEQ guidance. In general, the quality assurance program should be consistent with the National Environmental Laboratory Accreditation Conference standards.

Laboratory reports for samples are to include the following information:

A. Date of collection

B. Date of extraction, analysis, and report

C. Extraction and analytical methods used, including applicable EPA/TCEQ testing protocol

D. Method detection limits

E. Standard utilized in the analysis

F. Sample identification number and depth

G. Laboratory QA/QC report

5.4.7 ESA Phase II Report

5.4.7.1 Report and Contaminant Identification

The ESA Phase II report will address the basis for determining which contaminants are potentially present and the methods used to verify their presence or absence. Where specific contaminants are present, the report will describe the laboratory concentrations and appropriate regulatory action levels defined as the lowest applicable protective concentration level (PCL) stipulated by the latest regulatory guidance under the Texas Risk Reduction Program (30 TAC Chapter 350).

5.4.7.2 Site Characterization

Geologic characteristics which affect the migration potential of a contaminant will be addressed. Geotechnical soil testing will also include shear strength, grain size, compressibility, and unconfined soil strength, as appropriate.

5.4.7.3 Extent of Contaminant

The Phase II ESA report will describe, based on the available information, the estimated vertical and areal extent of potential contamination which may be encountered during construction. The determination of probable extent should be based on reasonable interpretation of both analytical and geological data. The ESA Phase II report shall generally comply with the report outline suggested by ASTM E1903, Section 9 and Appendix X3.

The ESA Phase II report shall concisely summarize the linear extent (e.g., the stationing), location, and nature of encountered contaminants, and present this information relative to regulatory criteria for release identification. The report will clearly address the following:

A. Comparison of contaminant concentration to regulatory criteria for protective concentration levels (PCLs).

B. Identification of specific health and safety measures, which may be followed to allow planned construction to proceed.

C. Potential for contaminated runoff entering the work area.

D. Potential effects of contaminated media on long-term durability of the water line and other proposed improvements.

5.4.7.4 Impact on Planned Construction

The ESA Phase II report shall address the potential impact of the contamination on the planned construction including the potential for contaminant impact on construction dewatering. Specifically, the report will address the potential for migration of contamination from the investigated sources and shallow groundwater into the construction area, due to groundwater withdrawal and/or groundwater level drawdown. The effect of dewatering will include health and safety procedures as well as requirements for containment and disposition of extracted groundwater in accordance with local, State, and Federal regulatory requirements.

5.4.7.5 Evaluations and Recommendations

If contaminants are encountered, the ESA Phase II report is to provide recommendations for additional investigations, which may be necessary to adequately delineate a contaminated zone, considering its potential effect on the planned construction activities.

The site characteristic and soil characteristics of significance will be described with particular emphasis on the occurrence of transmission soils at or below the elevation in which contamination was detected, or which have potential for providing pathways for contaminant migration.

In areas where contamination is encountered, the ESA Phase II report will provide recommended alternatives to minimize its effect on planned construction.

5.5 TRAFFIC CONTROL PLAN

5.5.1 Standards and Guidelines

The Texas Manual on Uniform Traffic Control Devices (TMUTCD) (with latest revisions) is essential to the development of the Traffic Control Plan (TCP). The TCP will be reviewed for compliance in accordance with the guidelines set forth in the TMUTCD.

The TCP shall show construction sequences and the necessary traffic control phases, complete with barricades, signing, striping, delineation, detours, signal modifications, temporary traffic signals, and any other devices to protect the traveling public and the construction crews. This should be accomplished with the least inconvenience to the traveling public while permitting expeditious completion of the project.

When project impacts Harris County Road, City of Houston, or TxDOT ROW use the specific agencies traffic control standards. TCP for portions of the project is to be addressed with typical details and standards from these agencies, when possible, along with appropriate general traffic notes.

Particular attention during design and review of TCPs for projects that are not typical, or routine is required and may involve any of the following design elements:

A. Signalized intersections of streets

B. Traffic control and detours along major thoroughfares and primary collectors

C. Projects involving school crossings or detours affecting school access (pedestrian and vehicle) when schools are in session.

D. Projects involving closing or limiting access to loading dock areas for larger trucks.

5.5.2 Plan Development

Provide a detailed traffic control plan in conformance with the TMUTCD and addressing the following.

A. Existing field conditions regarding roadways and access to adjacent properties shall be verified and shown on the drawings.

B. A separate phase shall be shown each time changes in the traffic pattern and/or construction sequence is required. Show all traffic control devices for each phase of the project. Use typical phasing or steps (i.e., sequences) where appropriate.

C. Each phase of the TCP shall show the location of the traffic flow indicated by directional arrows.

D. The construction areas will be clearly defined by appropriate identification, such as cross-hatching. All barricades, traffic barriers, vehicle impact attenuators (VIA's) delineators, pavement markings, construction signing, and traffic signal changes shall be shown on each drawing.

E. Where narrow medians or restricted pavement widths exist, outside widening should be considered to provide adequate lanes during construction. The width of temporary lanes should not be less than 10 feet.

F. Only a roadway that is existing or under construction, including proposed temporary pavement, shall be shown on the drawings. Roadway that has been removed in a previous phase or that will be built in later phases should not be shown.

G. Show complete detour routing and signing for all road closures.

H. Cross sections shall show the traffic lanes, construction pavement markings, delineators, barriers, buffer zone for barrels and concrete traffic barriers (CTBs), pavement drop-off, and construction detail for each roadway variation.

All construction signing shall be represented pictorially and designated with the appropriate identification number as shown in the TMUTCD. All other traffic control devices shall be shown pictorially on the drawings and cross sections and be fully identified.

5.5.3 General Notes and Specifications

Standardized General Notes shall be added to the TCP drawings by the Design Engineer for clarity. Do not duplicate information contained in the Authority's Specifications or the General Construction Notes for the project.

5.5.4 Graphical Standards

TCP drawings shall be of a large enough scale to depict all existing and proposed structures as they occur in each phase and step, but not smaller than 1 inch = 100 feet. A 1 inch = 40 feet or 1 inch = 50 feet scale is generally adequate for the TCP's specific details. A smaller scale requires prior approval of the Authority.

Other specific graphic requirements, such as title block, lettering size, sheet format, standard detail design sheets, etc., are included in the Authority's graphic standards.

5.5.5 Submittal

The Design Engineer shall review the conceptual TCP with the Authority around the 30% Submittal. The goal of the review is to confirm the approach to managing the traffic does not unnecessarily impact adjacent property owners and businesses and to confirm if additional easements may be required for the implementation of the TCP.

5.6 TPDES STORM WATER PERMITTING

5.6.1 Introduction

The Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit (CGP) require construction projects that will disturb less than 1 acre and are not part of larger common plan of development, coverage under the CGP is not required. If the project will disturb 1 acre to less than 5 acres of land, which is defined by the CGP as a small construction activity, the requirements of either Section D.1 or D.2 of the CGP must be met, as summarized below. Refer to the Authority's Standard Specifications for further guidance.

A. Obtain a copy of the TCEQ's TPDES CGP

B. Develop a Storm Water Pollution Prevention Plan (SWPPP), pursuant to Section II.D.2 of the CGP

C. Complete and post a site notice, as provided in Attachments 1 and 2 of the CGP

D. If the project will disturb 5 acres or more, which is defined by the CGP as a large construction activity, the requirements of Section D.3 of the CGP must be met, as summarized below.

    1. Obtain a copy of the TCEQ's TPDES CGP

    2. Develop a SWPPP, pursuant to Section II.D.3 of the CGP

3. Complete and submit a Notice of Intent (NOI) to the TCEQ

4. Submit a Notice of Termination (NOT) once the site has reached final stabilization

5.6.2 Requirements

The SWPPP must describe and ensure the implementation of practices that will be used to reduce the pollutants in storm water discharges associated with construction activity and assure compliance with the terms and conditions of the CGP. At a minimum, the SWPPP must include the information provided in Section III.F of the CGP. A general SWPPP outline for the plan is as follows:

A. Regulations

B. Project Information

C. Site Description

1. Description of the Construction Activity
2. Schedule and Sequence of Major Activities
3. Estimated Total Site Area and Disturbed Area
4. Soil Description/Quality of Discharge
5. Location and Site Map
6. Asphalt and Concrete Plants
7. Receiving Waters
8. Copy of TPDES Permit Number TXR150000

D. Controls

1. Erosion and Sediment Controls
2. Stabilization Practices
3. Structural Control Practices
4. Permanent Storm Water Controls
5. Other Controls
6. Approved State and Local Plans

E. Maintenance

F. Inspection of Controls

G. Non-Storm Water Discharge Components

H. Technical Specifications

I. Certifications

J. Forms

5.7 SUBSURFACE UTILITY ENGINEERING (SUE)

5.7.1 Introduction

Quality Level A (QL-A) (aka Level A SUE) Test Hole Services involves accurately locating horizontal and vertical position of subsurface utilities (and pipelines) by excavating test holes using vacuum excavation techniques and equipment that is nondestructive to utilities. Test hole services includes the following. Level A SUE will be performed for pipeline crossings if the pipeline owner does not provide field verification of their pipeline. When SUE is performed on a pipeline, the Design Engineer must coordinate and notify the owner in advance.

Level A SUE will be performed on other critical crossings such as duct banks, and other key private utilities crossed where clearances are critical to the water line construction. For existing water lines and other public utilities which can be identified by survey elevations of manholes or which clearances to the proposed water line are not of concern, "critical locates" should be used (refer to Chapter 5 and the Authority's standard specifications).

5.7.2 CenterPoint Energy Facilities

The Design Engineer shall coordinate with CenterPoint Energy (CPN) to have them locate their own gas lines when required.

5.7.3 Protocol

The Design Engineer's SUE Consultant is to provide all equipment, personnel and supplies required to perform the locating services. Additionally, the SUE Consultant shall:

A. Conduct appropriate investigation of site conditions and utilize the Plan and Profile Drawings to plan site access and utility excavations.

B. Contact Texas One Call to provide notification of the excavations to be performed, including type of utility, excavation location and depth, and excavation schedule.

C. Contact and coordinate with utility owners or representatives that want to on site during excavations.

D. Where necessary, obtain permit to perform excavation(s) and comply with permit requirements.

E. Excavate test holes at selected locations, identified in Table 1 attached, to expose utilities such a manner that ensures safety of excavations and integrity of location measurements. Vacuum excavations shall comply with applicable utility damage prevention laws.

F. Excavations will be performed using vacuum excavation equipment that is non-destructive to existing facilities. If contaminated soils are discovered during the excavation process, the Authority shall be notified immediately.

G. Furnish and install survey markers directly above the centerline of utility structure. Measure and record:

    1. Horizontal and vertical locations of top and center of excavation (pre-excavation).

    2. Actual depth to top of utility referenced to a survey marker installed directly above the centerline of the exposed utility pipeline or structure.

3. Outside diameter of utility and configuration of non-encased, multiconduit systems.

4. Photographs: Take at least two (2) photos at each test hole; one photo showing test hole location and other photo showing exposed utility.

H. For excavations within roadway pavement, backfill around exposed facility/utility using pea gravel.

I. Backfill excavations and repair pavement corings where necessary. Restore sites to pre-excavation conditions.

J. Evaluate and compare field information with utility information described in utility records and resolve conflicts.

5.7.4 Report

Prepare Test Hole Reports/Excavation Summary Sheets to include utility location data and supporting pertinent information, similar to example report shown in the attached copy of Exhibit 5-C "SUE Level A – Report" from Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, CI/ASCE 38-02.

5.8 CATHODIC PROTECTION

5.8.1 Introduction

The Authority will provide the Design Engineer with a site recommendation from the Corrosion Consultant, specifications, and standard details for the Cathodic Protection System for water lines 24-inch and larger. The details will show specific items required for the Cathodic Protection of the various types of pipe material for 24-inch lines or larger. This includes buried metallic and concrete pipes which are subject to soil corrosion and deterioration.

It is the Design Engineer's responsibility to incorporate the Corrosion Consultant's recommendation into the plans and specifications and package for bidding. The Design Engineer will incorporate the appropriate details, show location, and test stations, etc. The provided details will be signed and sealed by the corrosion consultant.

5.8.2 Corrosivity Conditions

The type of protection to be used is dependent on the circumstances of each situation, and these will be investigated during design by a corrosion specialist directly under contract to the Authority for proposed water lines 24-inch and larger.

A. The corrosiveness of the soil shall consider the soil resistivity, pH levels, and chloride ion concentration.

1. Criteria for soil resistivity are listed below.

Resistivity (ohm-cm)	Category
Below 500	Very Corrosive
500 – 1,000	Corrosive
1,000 – 2,000	Moderately Corrosive
2,000 – 10,000	Mildly Corrosive
Above 10,000	Progressively Less Corrosive

2. A pH of 3.0 and below is very corrosive to metallic structures and detrimental to concrete structures. Preventive measures are necessary for metallic and concrete structures in areas that have an extremely low pH.

3. A critical value for chloride ion concentrations relative to the corrosion of reinforcing steel with concrete structures has not been clearly established. Concentrations of 550 ppm and greater in soils are shown to cause corrosion.

B. The control of stray currents is the most important aspect of corrosion considerations.

1. Stray currents affect ductile iron, prestressed concrete cylinder, bar wrapped pipe, and steel piping. A cement mortar coating is not a high dielectric coating and does not present an adequate barrier to stray current corrosion.

2. Stray current can be generated by existing cathodic protection systems. Every natural gas, oil, and hazardous liquid piping system is required to have cathodic protection; therefore, the existence of such systems must be considered, and the impact of their stray currents controlled.

5.8.3 Corrosivity Study

The corrosivity study by the Cathodic for the pipeline will consist of the following:

A. Soil resistivity measurements will be recorded every 1,000 feet along the pipeline route in accordance with ASTM G57. Measurements will be performed from grade to depths of 5 feet, 10 feet, and 20 feet.

B. The proposed pipeline will be surveyed with respect to crossing foreign pipelines and paralleling utility systems. Specifically, existing cathodic protection systems and locations for foreign line test stations will be identified.

C. The pipeline route will be surveyed for stray DC earth current activity including structure-to-soil potential measurements on existing facilities and earth gradient measurements where points of contact on existing structures are limited. These tests will be performed approximately every 1,500 feet as access permits to available structures, such as fire hydrants, power pole grounds, and foreign line crossings.

D. The proposed pipeline alignments will be surveyed to locate areas where AC power is available should current protection be required.

E. Upon completion of the testing, a final written report will be submitted to include all data, data analysis, and a general description of the corrosion protection requirements for each of

the pipe materials (steel, ductile iron, PCCP). Specifically, soil resistivity measurements shall be calculated in the layers from 10 to 15 feet and from 15 to 20 feet.

5.8.4 Cathodic Protection Design

The corrosion protection design will consist of several activities:

A. Soil samples provided by the geotechnical firm shall be laboratory tested by the Cathodic Protection Consultant.

B. A design report/memo will be prepared and provided to the Design Engineer which will describe the cathodic protection requirements for the following:

1. Dielectric Coating Materials
2. Cathodic Protection System Type
3. Anode Requirements
4. Test Station and Permanent Reference Cell Requirements
5. Stay Current Control
6. Cased Crossings
7. Foreign Line Test Stations
8. Treatments For Lateral Line Connections

C. In addition to the above, the Cathodic Protection Consultant will provide detail drawings summarizing the recommended protection. These will seal and signed prior to the Design Engineer finalizing the project documents.

D. Following incorporation of the design drawings and specifications by the Design Engineer, the Cathodic Protection Consultant will review the Design Engineer's documents to ensure compliance with the requirements.

5.9 TRANSIENT (SURGE) ANALYSIS

For certain design packages, the Authority will provide the Design Engineer with the results of a transient analysis for the proposed water lines under potential surge and operating conditions. The analysis will identify the reach of the project requiring surge protection, and size and spacing requirements for protection devices. Those devices will normally consist of vacuum relief and/or air/vacuum relief valves. It is the Design Engineer's responsibility to incorporate the identified recommendations. The placement of these devices will need to be optimized with other air valves determined to be necessary during design.

5.10 TREE PROTECTION PLAN

5.10.1 General

For areas along the proposed water line alignment which will impact specimen and mature trees, the Authority will utilize the services of a certified arborist. The arborist will develop specific guidelines for the Design Engineer to include into the drawings.

5.10.2 Design Engineer's Responsibilities

The Design Engineer is to provide the drawing CAD files to the Arborist for him to use to develop the tree protection plan. It is still the responsibility of the Design Engineer to mitigate the impact to existing trees when feasible.

Chapter 6

Development of Drawings

6.1 INTRODUCTION

The Authority has specific requirements for both the construction drawings. The following guidelines are to be followed to the extent possible. The Design Engineer shall use these guidelines unless otherwise directed by the Authority.

6.1.1 Construction Drawings - General

The format or structure of the construction drawings will conform to a series of Program Standards covering size, type, and content. For example, certain specified sheets will be included in each construction package, such as sheet layout, general construction notes, baseline ties and benchmarks, monumentation benchmark data, etc.

Sample drawing will be provided by the Authority and are to be used as a guide for design standardization and are not intended to be all encompassing to cover every scenario and circumstance the Design Engineer may encounter. Sample drawings will be provided at the start of the project design.

All sheets shall have standard title blocks as provide by the Authority.

6.1.2 CAD Standard

6.1.2.1 Computer Aided Design (CADD)

Preparation of drawings, plans, prints, and other related documents shall be using AutoCAD.

6.1.2.2 Pen Tables

Pen tables in the form of CTB and STB files are to be used for the standardization of graphic reproduction of plans and are provided for black and white plans, and for color for exhibits and for aerial drawings and exhibits deliverables. CTB and STB files with the “FULL” nomenclature are for 22”x34” sheet sizes, and “HALF” nomenclature are for 11”x17” sheet sizes to be print from a 22”x34” sheet size scaled by half the drawing scale size. The pen table are the following:

Black & White:

A. NHCRWA-BW-FULL.CTB
B. NHCRWA-BW-FULL.STB
C. NHCRWA-BW-HALF.CTB
D. NHCRWA-BW-HALF.STB

Color / Aerial Reprographics:

A. NHCRWA-CLR-FULL.CTB
B. NHCRWA-CLR-FULL.STB
C. NHCRWA-CLR-HALF.CTB
D. NHCRWA-CLR-HALF.STB

6.2 DRAWING DEVELOPMENT GUIDELINES

Below are requirements to preparing and assembling the construction drawings for the project.

6.2.1 Drawing Size

The graphic standards for plan and profile on sheet size ANSI D, 22”x34”, shall apply to drawings of 1 inch = 20 feet scale.

6.2.2 Drawing Scales

Standard scales permitted for plans and profiles of paving and utility construction drawings are as follows:

Typical Drawing Scales

Drawing Type	Scale
Overall Index Sheet Layouts	1 inch = 50 feet
General and Enlarged Plan Views	1 inch = 20 feet 1 inch = 40 feet*
General and Enlarged Plan Views – Traffic Control	1 inch = 50 feet 1 inch = 100 feet
General and Enlarged Plan Views – Structural	1/8 inch = 1 foot 1/4 inch = 1 foot 1/2 inch = 1 foot
Profile Views	1 inch = 2 feet vertical 1 inch = 4 feet vertical*
Structural Sections, Details	1/4 inch = 1 foot 1/2 inch = 1 foot 3/4 inch = 1 foot 1 inch = 1 foot
Enlarged Sections, Details	1½ inches = 1 foot 3 inches = 1 foot

*Only if approved in advance by the Authority

A. The above scales are minimum; larger scales may be used to show details of construction. Provide a bar scale to the sheet to warn that a drawing may not be at its original full-size scale.

B. Deviation from specified scales can only be permitted with the special approval of the Program Manager.

C. Single-banked plan and profile drawings are required.

D. When multiple views on a drawing are not to the same scale, the appropriate scale shall be centered 1/4 inch below the title of each view. The title block scale shall read “as shown.”

E. When the entire drawing (such as a diagram or a schematic) is not to scale, the words “No Scale”

shall be noted in the title block. If only one view on the drawing is not to scale, the notation "No Scale" shall be placed below the view in question.

F. Details of special structures not covered by standard drawings (e.g., channel crossings, special manholes, junction boxes) shall be drawn using the same scale for both vertical and horizontal dimensions.

6.2.3 Leaders and Dimension

A. Use straight leader lines with closed, filled arrows.

B. Leader style shall attach leader landing at center of multi-line text.

C. Place leader lines as close as possible to object being identified.

Dimension Setting	Value for Proposed	Value for Existing
Extension line beyond dimension line	0.10"	0.10"
Extension line offset from object	0.10"	0.10"
Arrow Size	0.15"	0.10"
Dimension Text Style	Standard	Standard
Dimension Text Height	0.10"	0.08"
Dimension Primary Units	1(Decimal)	1(Decimal)
Dimension Precision	0.0	0.0

6.2.4 Lettering

A. Use standard text height of 0.10" for most drawings annotations with text style using Standard font. Use Table in section 6.2.3 as a general text property guide.

B. Text shall be in designated Model Space.

C. Justify text top left, top right or middle center as best applicable for each case.

Existing/Proposed	Text Style	Printed Height	Printed Width
Proposed Text and Dimensions	Standard	0.10”	1.0
Existing Text and Dimensions	Standard	0.08”	1.0
Survey Spot Elevations	Standard	0.08”	1.0
Sheet numbers, detail titles, section or detail call outs, match line labels, table and location map sub-titles, and column headings	Standard	0.20”	1.0
Stacked fractions, symbols, small detail annotation	0.10”	0.10”	1.0

6.2.5 Cover Sheet

D. Provide a cover sheet for projects meeting the Authority’s standards. Project title shall include project number, line sizes with a descriptive beginning and ending. Drawing sheet numbers and titles shall be listed on the Sheet Index.

E. Include an area key map and vicinity map to identify project location.

F. Vicinity map shall show key streets or intersections at an appropriate scale for easy project site location.

G. Identify locations and names for water receiving facilities (WRF) on cover sheet area map.

H. Each set of engineering drawings shall contain paving and utility key drawings indexing specific plan and profile sheets.

6.2.6 Legend and Abbreviations

The Legend and Abbreviation Sheets are to be incorporated into the plan set. The Legend and Abbreviation Sheet .dwg file incorporates the graphic representation of the Existing Improvements and Proposed Improvements required for depicting the line drawings and features on the base drawings with the associated line weight along with the associated naming layer conventions for the respective features in the Legend and Abbreviation Sheet.

6.2.7 Sheet Layouts

When developing the different sheet layouts (sheet layout, core boring plan, parcel index map), Design Engineer shall prepare with the intent to make these sheet readable and to only show the necessary information to convey the intent – and not all the different water line call outs, etc.

6.2.8 Construction Notes

6.2.8.1 General Construction Notes

General Construction Notes shall be placed in columns on a separate drawing with single-spaced lines within each note (1/16 inch apart) and double-spaced (1/4 inch) between notes. The general note column shall be no wider than 5¼ inches plus a 1/4-inch margin between the notes and the drawing border and shall be left-justified.

Do not duplicate requirements contained in the Authority's Standard Specifications. Refer to the sample drawings for further information.

6.2.8.2 Construction Notes from Third Parties

The Design Engineer is to add the standard notes from the private utilities, pipeline companies, TxDOT, Harris County, HCFCD and the City of Houston. It is the responsibility of the Design Engineer to review these standard notes and confirm there are no conflicts with the Authority's Standard Specifications, Standard Details or this Design Manual.

6.2.8.3 Specific Construction Notes

Specific notes show information pertaining to that drawing's features. Specific notes shall be an enhancement or supplement to the drawings. Locate these notes near the title block information and, when possible, in the same area of the drawing.

Lines within each specific note shall be single-spaced, and notes shall be separated vertically at least 1½ spaces. A 1/4-inch space shall separate the note and the drawing border horizontally. Notes shall be left-justified. Specific notes shall be separated horizontally by at least two spaces. Numbers shall be the same height as the letters. Do not duplicate note numbers on the same drawing.

6.2.9 Existing Features Presentation

Below is a listing of general design requirements to be shown on the Design Engineers drawings to meet the Authority's expectations in presenting the developed design.

A. Water meters are to be shown in the plan view, but small customers service lines ($\leq$ 2 inches in diameter) are not.

B. Show existing water lines based on record drawing depth. Call out line size and material type.

C. All utilities larger than 4-inches in diameter shall be shown in the profile.

D. Show all sanitary sewer service lines.

E. Show wastewater manholes and cleanouts and identify size, depth, and material type.

F. Show storm Sewer inlets, manholes, and junction boxes size, depth, and material type.

G. Show core-boring location in plan view on each applicable plan and profile sheet.

H. Show size, location, and depth of other utilities (gas mains, electric, telephone, cable TV, Communication fiber optics, etc.).

I. Identify trees by their common names (pine, oak, etc.). Unless actual canopy size is significantly different, radius of tree canopy shall be 1 foot for each 1 inch of trunk diameter. Canopy for pine and palm trees are to be shown to reflect tree.

J. All overhead electrical lines must be noted and documented on drawings. Show overhead electric lines, guy wires, and service poles as they connect to power poles, transmission towers, etc.

K. The location, size, and composition of driveways must be documented on drawings.

L. Label the existing roadway width, surfacing type, and thickness.

M. Show all street and road alignments on drawings.

N. Show both esplanade noses or the centerline of esplanade openings, including esplanade width.

O. Show both roadways on paving sections with an esplanade.

P. Label property ownership with business name and physical address.

Q. Where applicable, show HCFCD official channel and numbers along with common name, if one exists.

R. At pipeline crossings, identify the following:

1. Product in the pipeline and whether it is under high pressure.

2. Any required advance notifications to the pipeline owner, along with contact person and phone number.

3. Show on the drawings the SUE Level A findings for the pipelines. Place information near where the Level A SUE effort was performed.

S. When a section of existing storm sewer is removed temporarily to facilitate water line installation, it will be reinstalled as approved by Harris County or City of Houston.

T. Show and identify location of the Control monuments and temporary benchmarks used for elevation control with the vertical datum.

6.2.10 Proposed Improvements

Follow the guidelines below for preparing the construction drawings. Refer to the Authority's example set of drawings which will be provided at the start of the project.

A. ***For Specimen Trees 12 inches and larger:*** Auger or tunneling construction methods, under selected specimen trees, may be used to the extent practical.

1. Specimen trees located in the ROW and adjacent to the contractors' work area are to be fenced off with a minimum 4-foot-high orange safety fencing or as recommended by the Authority's Arborist.

2. No tree protection or removal can occur to trees outside the public ROW or the Authority's easements.

3. Follow the Authority's graphic requirements to identify the specimen of tree.

4. Refer to the Authority provided tree protection plan for insertion into the drawings and other project specific requirements.

B. A Plan stationing must run from left to right, except for short streets or lines originating from a major intersection, where the full length can be shown on one sheet.

C. Do not use the center line of the water line as the drawing baseline.

D. A north arrow is required on all sheets placed in the upper righthand corner of the sheet. The north arrow should be oriented either toward the top or to the right. This requirement is waived under the following conditions subject to approval by the Authority:

1. A section of water line of less than 2,000 ft.

2. If the proposed water line changes multiple directions and it simplifies following the design by having some sections of the water line with the arrow down or to the left.

3. If necessary, show the entire WRF site on a single plan sheet.

4. It is the Authority's preference to have a continuous baseline for the main water line (backbone) when organizing the plan and profile sheets. The main water line is to be shown followed by the lines (fingers) extending to the WRFs. Show the WRF lines from west to east.

E. Show ties on drawings to monuments when applicable; otherwise, make a statement on the cover sheet referencing assumed control coordinates.

F. Each sheet of the plan and profile shall have a benchmark elevation and description defined.

G. Develop drawings to accurate scale showing proposed pavement, typical cross sections, details, lines and grades, and existing topography within street right-of-way, and any easement contiguous or perpendicular with the right-of-way.

H. At the intersection, the cross-street details shall be shown at sufficient distance (50- foot minimum distance outside the primary roadway right-of- way) in each direction along cross street.

I. Match lines between plan and profile sheets shall not be placed or shown within cross street intersections including cross street right-of-way. Establish match lines a minimum of 100 ft from edge of intersecting street rights-of-way, unless otherwise approved by the Authority. At no time show less than 50 ft.

J. Provide a separate profile when proposed alignment extends along an intersecting street, or when the line will extend across a roadway or easement more than 20 feet or when there is a vertical

change in the crossing.

1. Align plan views with profile view.

2. Show a maximum of 500 LF per plan view and a minimum of 300 LF.

K. Provide natural ground profiles for each right-of-way line and along profiles for proposed easement profiles.

L. All valves shall be constructed with valve boxes or service (i.e., actuator/operator) manholes, as defined by the Authority standard requirements.

M. Cathodic Protection – show test stations, rectifier units, and other appurtenances on plan and profile sheets and recommended by the Authority's cathodic protection consultant (refer to Chapter 6).

N. Sanitary sewer crossings should be designed in accordance with TCEQ regulations.

O. Maintain 9-foot-horizontal separation from sanitary sewers if sewer is not a pressure rated pipe. If sewer is pressure rated pipe, maintain 4-foot-horizontal separation from sewer. (Consult TCEQ regulations.)

P. For water lines 30-inch and larger use internal elliptical dish head plugs at the end of segments. Provide blind flange for smaller line sizes.

Q. When using numerical notation, place commas at appropriate locations.

R. Limit the length of the inclines to approximately one or two pipe sections (20 to 40 feet) by using a 5° deflection (8.75% slope). If a steeper incline is needed, use standard bends of 22.5° (41.41% slope) or 45° (100% slope). When possible. combine angle bends" to reduce overall number of bends.

S. At locations of proposed water line appurtenances, show in the profile limits of special or specific backfill material to be used in the pipe zone.

T. Backfill of Existing Storm Sewer. When crossing under an existing storm sewer using open cut method, show in the profile the use of cement stabilized sand in the water line trench zone backfilled for 3 to 5 feet either side of the storm sewer the spring line of the storm sewer.

U. Where any water line crosses a road ROW, including TxDOT, or a pipeline/CenterPoint corridor show on the drawings the Authority's water line marker in accordance with the Authority's Standard Detail at both ROW lines.

V. When replacing driveways, match the existing width and curvature radius of existing driveway.

W. Basic plan and profile sheets shall contain the following information:

1. Identify lot lines, property lines, easements, rights-of-way, and HCFCD outfalls. Include lot number or recorded acreage information.

2. Label each plan sheet as to street/easement widths, pavement widths, pavement thickness where applicable, type of roadway materials, curbs, intersection radii, curve data, stationing, existing utilities (type and location), and any other pertinent feature affecting design.

3. Show utility lines, regardless of size, in the plan view, including communication and fiber optic cables. Show utility lines 4 inches in diameter or larger within the right-of-way or water line easement in profile view.

4. Graphically show flow line elevations and direction of flow for existing ditches.

5. Label each feature, utility, existing condition on each plan & profile sheet.

6. For water lines 36-inch or larger, graphically show bends in plans per AWWA bend configuration.

7. Align plan view with profile view including when using a separate plan and profile sheet. Show start of match line at same distance from the edge of the sheet.

8. Identify "Critical Locates" in plan view. Critical Locates are defined as locations where proposed water line will cross a utility and the potential exists such that there will not be sufficient clearance during the construction of the proposed water line, or the potential exist for a conflict between the two.

    i. Gravity sanitary and storm sewer lines do not require critical locates unless a manhole is not within a sufficient distance ($\leq$ 100 feet) of the potential crossing for the proposed water line and the grade of utility in conflict cannot be reasonably determined.

    ii. Water lines that will be crossed and may not have sufficient clearance from the proposed water line will require critical location. Critically locate major customer service connections, 4-inch and larger when such service lines will be crossed by the proposed water line.

9. Show entire width of road ROW and existing topographic feature when water line is adjacent and parallel to road.

10. For street reconstruction, show in profile the centerline elevation at the property line of existing driveways. Identify type and width of driveways.

11. Only call out minimum clearances to utilities when clearance is two (2) feet or less.

12. For plant work, use a grid system to locate proposed work.

13. Bridge Structures.

    i. When water line alignment is adjacent or crosses bridges, overpasses, and underpasses, show top of pavement, edge of bridge in the plan view.

    ii. Show column, foundations including depth from record drawings, and any retaining wall or permanent shoring system in the profile.

    iii. Depict existing bridge foundation information in the profile.

6.2.11 Details

The Design Engineer shall utilize the Authority's standard details as applicable (see the Authority's website). The Authority's standard details are not intended to cover every situation. Design Engineer is responsible for reviewing these standards and propose modifications as required for the specific project needs. Such modifications require the approval of the Authority.

The Design Engineer is responsible for developing site specific details as required to provide a complete design. Such details need to be consistent with the Authority's existing standard specifications and details and shall be drawn to scale. Examples of such specific details include when making a connection to an existing large diameter water line with a proposed large diameter water line, when the standard details are not appropriate due to differing site conditions or constraints, and when a standard detail does not exist for the specific application.

6.3 DRAWING CHANGES

Changes made to drawings during design do not need any revision notations on the border. The drawing status block is intended for revisions after completion of the final drawings, for formal changes made by addendum during the bid phase and for recording "as-built" information.

A change on a drawing revised by addendum is noted by describing it in the revision block, circling the revised area with a "revision cloud" on the drawing, and placing the revision number in a triangle inside the circled area.

6.4 DELIVERABLES

The Design Engineer shall deliver to the Authority the AutoCAD (.DWG) design files, including: Plotting parameter files of all types

A. Font libraries

B. Cell libraries

C. Patterning libraries

D. Color tables

E. All parameter files associated with the use of AutoCAD software.

6.5 SAMPLE DRAWINGS

Sample drawings will be provided by the Authority and are to be used as a guide for design standardization. Sample drawings are not intended to be all encompassing and to cover every scenario or circumstance the Design Engineer may encounter. Consult with the Authority for guidance when scenarios or circumstances are not covered.

Chapter 7

Development of Project Manual

7.1 GENERAL

The Authority has standard front end bidding documents, which the Design Engineer is to utilize for his project. However, each project within the Program is unique and may require some project-specific construction specifications or special provisions.

The Design Engineer will be provided with an electronic set of front end documents. Standard Specifications are available on the Authority's website for review and selection for the Project. The Design Engineer shall review this information and recommend any changes related to their specific project or other needs to the Authority.

7.2 STANDARD SPECIFICATIONS

7.2.1 Modifications

No modifications to the Authority's standard front end documents.

Supplementary specifications will be project specific and contain the project's information within the header, this shall be clearly identifiable to contractors. Specifications required, but not contained in the Standards, and revisions of the Authority's Standard Specifications are to be developed by the Design Engineer. These specifications shall contain the project's information within the header to distinguish from an Authority Standard Specification from a project specific specification.

7.2.2 Document 00003 – Table of Contents

The Authority's approach in preparing the Project Manual relies significantly on the Table of Contents. Capitalized specification sections indicated in the Table of Contents are included as part of the North Harris County Regional Water Authority's standard technical specifications and the contractor is expected to incorporate these listed Authority Standard Specifications as part of their bid. The Design Engineer is not to include the capitalized specifications in the Project Manual.

The date shown next to each Specification represents the date on which this Specification was last modified or added. If this date is after the Contractor's bid submittal date, the Contractor must use the applicable specification shown on the Authority website shown as "Prior Specifications", which shall become part of the Project Manual.

The Authority's Standard technical specification sections marked with an asterisk (*) are amended by a supplemental specification and placed in front of the specification title it amends. The Design Engineer is to include in the Project Manual both the Supplement and the original specification it amends.

7.2.3 Document 00300 – Bid Form

The Design Engineer is responsible for developing the bid items for the project consistent with the Authority's format and organization. The Design Engineer shall verify the bid items listed have a corresponding specification which identifies how the item is measured and paid for (SY, CY, Each, etc.).

7.2.4 Document 00800 – Supplementary Conditions

The Design Engineer shall recommend to the Authority requirements to be included in Document 00800 – Supplementary Conditions. These will include insurance and indemnification requirements from the pipeline companies (contained in their letter of no objection (LONO). From time-to-time other contractual changes may be necessary which belong in Document 00800. Any additions or revisions to Document 00800 require prior Authority approval.

7.2.5 Section 01110 – Summary of Work

The Design Engineer is expected to make Section 01110 – Summary of Work project specific. Consult with the Authority for the latest template for this section. This section is not to a repeat of the bid form or other requirements contained on the drawings. This is to be a summary of the nature of the work for the Contractor's quick reference. Items such as pipeline crossing requirements including a copy of the LONO, interim milestones, and specific coordination and contact information for specific properties, can be included in Section 01110.

7.3 GUIDELINES FOR COMPILING

The Design Engineer is to provide Document 00004, Index of Drawings; Document 00300, Bid; Section 01110, Summary of Work; and Special Supplements in Microsoft Word format. These documents will then be returned to the Design Engineer to include in the Final Bid Documents.

The front end documents define and prescribe the responsibilities and relationships of the contracting parties, and make provisions for the contract's administration from the bidding stage to project closeout. The front end documents comprise:

A. Notice to Bidders

B. Instructions to Bidders

C. Bid Form

D. Contractor's Qualification Statement

E. Contract for Construction

F. Bid Guarantee & Bonds

G. General Conditions of the Contract for Construction

H. Supplementary Conditions

I. Special Conditions

The Design Engineer is responsible to:

A. Review the standard specifications,

B. Familiarize himself with the contents,

C. Utilize the specifications in a project specific mode,

D. Be responsible for their content, and

E. Prepare necessary supplements to the standard to specifications pertaining to the specific project.

TxDOT, Harris County and City of Houston specifications shall be reviewed and included, where appropriate, in the project construction as specifications.

The Design Engineer is to recommend the proposed Liquidated Damages amount and provide supporting documentation when requested by the Authority.

7.4 SCHEDULE

Refer to the authorized scope of services for the schedule for submitting the various Project Manual elements discussed above.

At the 60% submittal, the Design Engineer is to provide preliminary "redlined" front end documents to the Authority for review. As appropriate, suggested revisions will be incorporated into "Supplementary Specifications" that will supersede the Authority's standard published technical specifications.

The final front end portion of the Contract Documents is to be prepared by the Design Engineer for the 95% Submittal.

Chapter 8

Contract Administration

8.1 GENERAL

The following is only a partial listing of the contract administration. Design Engineer shall refer to the Authority's Professional Services Agreement and the authorized Scope of Services for the project for additional requirements.

8.2 SCHEDULE

A Project Schedule will be developed and submitted by the Design Engineer based on the scope of work. Approval of the Project Schedule is required before processing the Design Engineer's first invoice. The Project Schedule should include all major milestone activities and identify the critical path to the timely completion of the Project.

Once the Project Schedule is approved by the Authority, any changes require approval from the Authority.

8.3 DELIVERABLES

A. Original specifications with original signature(s) and seal(s).

B. Electronic files for the construction drawings (refer to Chapter 5).

C. Survey deliverables: Metes and bounds description and sketch (as required by project scope)

D. Design report

E. QA/QC documentation

8.4 DESIGN REPORT

The Design Engineer shall compile the following documents developed during the course of the project and submit prior to completing the design phase of the work.

A. Contract duration days

B. Thrust restraint calculations

C. Tunnel liner thickness determination

D. Sheet by sheet quantity takeoff

E. Engineer's construction estimate with supporting documentation

8.5 CONFORMED AND RECORD DRAWINGS

The Design Engineer shall prepare conformed drawings which incorporate any addendum requirements into the drawings. The conformed drawings will be used by the awarded contractor and the Authority's construction management team.

The Design Engineer shall document on the Record Drawings, generated at the end of construction, each valve used (i.e., manufacture, number of turns, direction to open). This is in addition to field changes recorded on the contractor's as-built drawings.

Identify the pipe material used on the note sheet and all P&P sheets near the record drawing stamp. If the Design Engineer decides to make contractor's record drawing changes via CAD, then plot a new set of Mylars. Deliver along with the new Mylars and the original signed PLANS.

8.6 DOCUMENT MANAGEMENT

The Design Engineer will be provided direction on the use of the Authority's Document Management Software – Kahua. The Design Engineer is to use the software to upload invoices and other documents requested by the Authority.

APPENDIX

EXHIBIT 5-A

GEOTECHNICAL REPORT
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EXECUTIVE SUMMARY

1. INTRODUCTION
   - 1.1. General
   - 1.2. Location and Description of the Project
   - 1.3. Scope of Work

2. SUBSURFACE INVESTIGATION PROGRAM

3. LABORATORY TESTING PROGRAM

4. SUBSURFACE AND SITE CONDITIONS
   - 4.1. Geology of the Coastal Plain
   - 4.2. Natural Hazards (Faults, Subsidence, etc.)
   - 4.3. Site Stratigraphy
   - 4.4. Groundwater (described by street and identified as whether immediate readings, 24-hour reading, or piezometer/water well readings)

5. GEOTECHNICAL ENGINEERING RECOMMENDATIONS
   - 5.1. Trench Excavation Considerations
   - 5.2. Excavation Dewatering (brief overview or detailed recommendation, depending on scope of work)
   - 5.3. Vehicular Traffic and Railroad Loads (effect on construction and design)
     - 5.3.1. Pipeline Crossing at Freeway
     - 5.3.2. Pipeline Crossing at Railroad
   - 5.4. Pressures on Primary and Permanent Liners
   - 5.5. Piping System Thrust Restraint
   - 5.6. Influence of Tunneling on Adjacent Structures
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6. LIMITATIONS

7. AUTHORIZATION AND CREDITS

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EXHIBIT 5-B

ENVIRONMENTAL INVESTIGATION REPORT
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   Purpose of the Investigation
   Limitations of the Environmental Investigation
   Scope of Work
   Regulatory Requirements

2. BACKGROUND INFORMATION
   Chemicals of Concern and Exposure Pathways
   Location and Number of Soil Borings
   Sampling Plan and Laboratory Analysis
   Health and Safety and Environmental Monitoring
   Quality Assurance/Quality Control

3. RESULTS OF THE SUBSURFACE INVESTIGATION
   Summary of the Field Investigation
   Analysis and Interpretation of Results
   Regulatory Requirements

4. CONCLUSIONS
   Summary of the Investigation Results
   Impact on Planned Construction

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   b. Petroleum Storage Tank System or Other Suspected Release Sources
   c. Potentially Impacted Areas

EXHIBIT 5-C

SUE Level A - Report

Aurora Technical Services, LLC
engineering + construction management

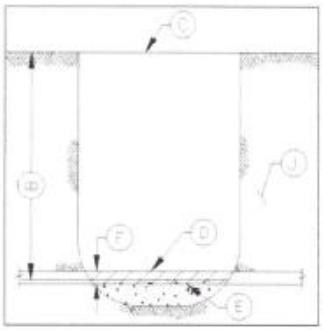
ATS Job# NHCRWA
County Name Harris
Street Name 13611 Balmore Cir
Project IA-5; Champions MUD

Test Hole No. 1
Utility 12" Water Line
Date 01/16/2023
Utility Found 12" Water Line & 2" Gas Line

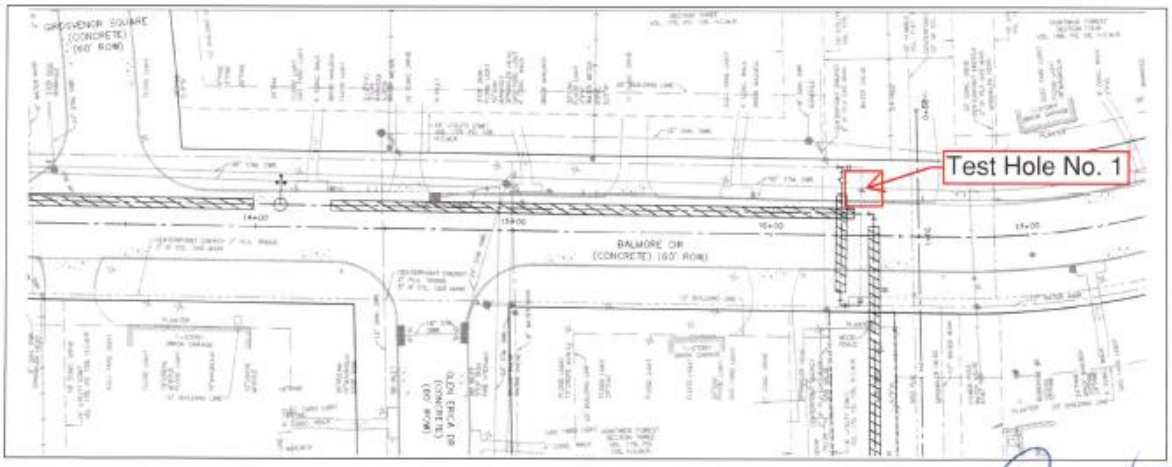
TEST HOLE DATA

A. Northing N/A
   Easting N/A
B. Depth of Hole 6 Feet
C. Elevation Grade @
   Top of Hole N/A
D. Elev. @ Top of Utility N/A
E. Elev. @ Bottom of Utility N/A
F. Width or Dia. Of Utility N/A
G. Material of Utility Ductile Iron
H. Condition of Utility N/A
I. Thickness of Pvmt N/A
   Base, etc. N/A
J. Description of Soil Clay

TOP



PROFILE



PLAN

B.M. _____ Elev. = _____ Description _____
Northing: _____ Easting: _____
B.M. _____ Elev. = _____ Description _____
Northing: _____ Easting: _____
Remarks Performed a 24 inch trench at a depth of 6 feet. The 12 -inch water line was encountered in-line with the valve stack approx. 3 feet from the back of curb at a depth of 5 feet.

STATE OF TEXAS
RAFAEL ORTEGA
80253
REGISTERED
PROFESSIONAL ENGINEER
1-25-2023

Aurora Technical Services, LLC
Texas Registered Engineering Firm F-2059