North Harris County
REGIONAL WATER
Authority

DESIGN MANUAL

ADOPTED FOR USE BY:

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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, as well as maintaining regulatory compliance. This last assignment is paramount because the Harris-Galveston Subsidence District (the "HGSD") had published its 1999 Regulatory Plan, updated in 2013, requiring our area to reduce groundwater withdrawals to not more than 20 percent of total water demand by the year 2030. 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 (COH). The treated surface water source will be the Northeast Water Purification Plant (NEWPP). An expansion project is underway at the NEWPP whereby the Authority will be furnished with an additional 113 million gallons per day of treated surface water.

1.2 PROGRAM CONCEPTS

Several general and specific concepts were identified during the early stages of Phase I of the Program and others are anticipated as the Program definition continues to evolve. The current concepts have been grouped under the broad headings of Administrative, Design, Construction, and Support Services.

1.2.1 Administrative

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.

1.2.1.1 Role of Program Manager

Program Manager Interaction

The Program Manager has an active, central interaction with all members of the team.

North Harris County Regional Water Authority

The North Harris County Regional Water Authority (Authority) has contracted with AECOM Technical Services, Inc. ("AECOM") for the Program Management services for these improvements. AECOM 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 time 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 expeditiously for these important components of the water system.

Design Engineer

The Program Manager will maintain effective control and overview of the engineering assignments through a comprehensive system of cost, schedule, and performance monitoring. The specific requirements for these control procedures are addressed in the individual engineer agreements as well as in the Program discussions held between Design Engineers and the Program Manager.

These requirements contribute to the development of detailed project plans and documents and depend on the periodic submission of essential project data and information by the individual Design Engineers. Standard design, document formats, monthly reports, design reviews, monthly invoices, and such similar requirements form a part of these administrative procedures.

Additional Services

The Program Manager will, through the use of other consultants, provide the Design Engineer with additional services for the Program. The initial additional services provided include control surveys; corrosion control investigation studies, design, and guidelines; and design input. The Program Manager will provide additional surge

analyses for certain specific water mains and will make the results of those analyses available to the appropriate Design Engineers. Topographic surveys, geotechnical investigation, environmental site assessments, and traffic control plans may be the responsibility of the Design Engineer and will be issued authorization if developed and approved as part of the scope of work associated with the project assignment. Other support services will be provided by the Program Manager as their need is identified and their authorization is approved by the Authority.

1.2.1.2 Role of the Design Engineer

The specific tasks to be performed by the Design Engineer are defined in Scope of Services of the Design Engineer's contract. 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 Program Manager."*

In carrying out these essential services, the Design Engineer shall carefully coordinate their design efforts, drawings, and details with the Program Manager; the Design Engineers involved in projects adjacent to or tying into his project; and such public agencies, utility companies, and other parties as may be required to successfully complete the project.

1.2.2 Design

The Program Concepts established deal with combined transmission/distribution systems, service areas, and water demands. These Concepts are presented here for general information and to establish overall objectives for the Surface Water Transmission Program.

1.2.2.1 Corrosion Control

The design of each construction package for the Program will include Cathodic Protection coupled with the use of bonded dielectric coatings where applicable. The type of protection to be used is dependent on the particular circumstances of each situation, and these will be investigated during design by a corrosion specialist directly under contract to the Authority.

1.2.2.2 Traffic Control

The Traffic Control Plans (TCP) for construction projects will be reviewed for compliance in accordance with the guidelines set forth in the latest edition of the Texas Manual on Uniform Traffic Control Devices (TMUTCD). A sizeable percentage of these projects are typical or routine in scope. 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) in which schools are in session

d. Projects involving closing or limiting access to METRO bus routes

During the development of the design for the water system, Design Engineers will be required to complete TCPs utilizing Federal, State, and County traffic control standards, in accordance with the guidelines set forth in the TMUTCD, latest edition. Provide appropriate traffic general notes and traffic control construction costs estimates as necessary for their design. The TCP shall show detailed construction sequences and the necessary traffic control phases, complete with all barricades, signing, striping, delineation, detours, signal modifications, temporary traffic signals, and any other devices to protect the traveling public and provide safety to the construction forces. This should be accomplished with the least inconvenience to the traveling public consistent with expeditious completion of the project in time and costs.

1.2.2.3 Construction Documents

The Program contains multiple construction packages scheduled over a significant time period. It is in the best interests of the Authority that these packages present a uniform description of the proposed improvements. In addition, certain elements of the Program have a commonality found throughout most of these design packages – such as corrosion control, valves, etc. As a result, standard design format and graphic standards will be used throughout the construction documents.

e. 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 sheet, such as sheet layout, core boring sheet, baseline ties and bench marks, monumentation bench mark data, etc.

f. Selected standard design drawings will be provided to the Design Engineers, where applicable, for incorporation into the design packages.

g. Selected Standard specifications will also be provided.

h. The Design Engineer is expected to:

- Complete front-end documents,

- Review these specifications,
- Familiarize himself with the contents,
- Utilize the specifications in a project specific mode,
- Ultimately be responsible for their content, and
- Prepare all modifications to specifications pertaining to specific project.

1.2.2.4 Quality Control

The quality control of the project is the responsibility of the Design Engineer. As part of the quality control, the Design Engineer is to walk the project at least twice:

i. The first time, before the 50% Submittal, to verify accuracy of the survey and assess design requirements.

j. 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 walk-through.

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 Program Manager. The quality control reviews may occur simultaneously with the 10% and 50% submittals but shall occur prior to the 75% and 95% submittals. A copy of the review comments generated by the quality control reviewer(s) shall be submitted to the Program Manager with the 75% and 95% submittals.

1.2.3 Construction

At this stage of the Program, certain construction concepts have been defined and additional concepts will develop as the Program continues.

1.2.3.1 Method of Construction

The method of construction for each Contract Package will be based on open-cut water main construction consisting of opening up a trench with a minimum width at the bottom equal to the diameter of the pipe plus certain minimum side clearances. The trench may have vertical or steep side slopes requiring 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 to provide a working platform in wet bottom trenches, well pointing or some other means of dewatering may be required depending on the local groundwater conditions. In some areas, open cut construction may not be feasible, and “trenchless” alternatives will be studied. This is the responsibility of the Design Engineer to identify these areas and evaluate alternatives. Input and final approval will be provided by the Program Manager.

After the 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 main installation is complete.

1.2.3.2 Pavement Replacement

During design, the pavement section to be reconstructed shall be agreed to by the Program Manager. A pavement design evaluation and analysis will be performed by the Design Engineer for roadways requiring major or total reconstruction and/or roadways consisting of flexible pavement.

1.2.3.3 Utility Conflicts

The proposed water line network superimposed upon the existing infrastructure will encounter utility conflicts. The Design Engineer is to employ best practices, extra care and effort to locate all existing utilities and obstructions which may be in conflict. Where necessary, the Design Engineer may work with the Program Manager to request Subsurface Utility Engineering, ("SUE") and other methods of field exploratory work to identify the exact location of utilities and pipelines. All potential conflicts must be considered during design.

k. The extent of conflicts may, during design, dictate the location or depth of the water main and shall be carefully coordinated. All efforts should be made to resolve utility conflicts in the most economical manner consistent with the engineering constraints.

l. The Design Engineer is responsible for contacting the private utility companies and requesting that 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.

1.2.4 Support Services

As stated earlier, the Authority will provide various support services for the Design Engineer. The support services provided by the Program Manager are common to most projects and are briefly discussed below. Some of these include administrative procedural modifications intended to improve the final project and to enhance the process of communication.

1.2.4.1 Surge Analysis

For certain design packages, the Authority will provide the Design Engineer with the results of an analysis related to the proposed pipeline under 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. These large capacity valves will always include a small capacity, slow air release function as well. It is the Design Engineer's responsibility to accurately incorporate the identified recommendations. The placement of these devices will need to be coordinated with other air valves determined to be necessary during design.

1.2.4.2 Cathodic Protection System

The Authority will provide the Design Engineer with a site recommendation from the Corrosion Consultant, specification, and

standardized details for the Cathodic Protection System. The details will show specified items required for the Cathodic Protection of the various types of pipe material used. It is the Design Engineer's responsibility to accurately incorporate the Corrosion Consultant's recommendation into the plans, specifications and estimate package for bidding.

1.2.4.3 Geotechnical Investigations

The Design Engineer is to have a geotechnical report prepared describing the existing soil conditions along the proposed water main route along with the water table elevations at the time of the field investigations. The geotechnical report will contain specific project related recommendations to be used in the proper design of the water main and associated appurtenances.

1.2.4.4 Environmental Site Assessments

The Design Engineer may be asked to perform Environmental Site Assessments (ESA) for each project which will require right-of-way or easement acquisition. Based upon the ESA findings, specific environmental investigations may be undertaken to confirm and determine the extent of Recognized Environmental Conditions(RECs) (PPCA). The Design Engineer will provide the Program Manager with soil contamination reports describing any PPCA found. The report will contain specific project-related recommendations to assist the Design Engineer in properly designating the limits of PPCA on the Drawings.

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.

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

2.2 REFERENCES

It is not the intent of this Design Manual to provide a complete guide to water line design. The existing literary files contain a great wealth of technical guidance with which the Design Engineers should be familiar. The Program Manager has produced certain documents and standards, which contain criteria applicable to this Program.

2.2.1 Technical Standards

Public agencies and authorities also influence the design of municipal projects. These sources provide established criteria, which may be applicable. The Design Engineer should become familiar with the following publications and source and adhere to the applicable standards, which they present.

- "Rules and Regulations for Public Water System," Texas Commission on Environmental Quality (TCEQ), Water Utilities Division.
- Various publications by the American Water Works Association.
- Requirements by regulatory agencies and approving authorities such as TxDOT, Harris County, City of Houston, and railroad companies.

2.2.2 Graphical Standards

Specific criteria for the Program are included in Chapter 4, General Graphic Requirements.

2.3 DESIGN

The initial Program criteria are presented below and include selected hydraulic criteria and comments on such related items as route alignments, surge analysis, and corrosion control.

2.3.1 Hydraulic Criteria

The following subsections define hydraulic criteria for NHCRWA transmission mains.

2.3.1.1
Pressure Conditions

The design definition and development of major water mains involve many hydraulic considerations. Some of the more important and obvious criteria are listed here; others may arise as the Program advances and input is received from the Design Engineers.

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

2.3.1.2
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.)

2.3.1.3
Pipe Friction Factors (Hazen Williams "C" Factor)

Pipe Size	Roughness Coefficient
36-inch and smaller pipes	110
42-inch and larger pipes	110

2.3.1.4
Demand Peaking Factors

Demand	Peaking Factor
Average Daily Flow to Peak hour Ratio	3.2

2.3.1.5
Maximum System Pressures (including Surge Conditions)

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

1. 150 psi test pressure shall be used for transmission mains and distribution mains.

2. The maximum design pressure as specified in the appropriate American Water Works Association (AWWA) Manual of Water Supply Practices, Standards, Design Criteria or Specifications, such as AWWA M9, "Concrete Pressure Pipe" or AWWA M11, "Steel Pipe – A guide for Design and Installation," or others applicable to the type of pipe selected by the Design Engineer.

3. Other special design criteria as specified by the Program Manager.

Maximum system pressures for the Program 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. In certain cases, the Program Manager will assist the Design Engineer by providing recommended locations for these pipeline protection valves.

2.3.2 Alignment

The proposed water main routes are based on an extensive evaluation effort. Some routes have been selected based upon traffic patterns and land use; right-of-way (ROW) width; existing utilities, pavement condition, landscape features; and proposed improvements along the route.

After the survey and record research efforts are complete, the Design Engineer is expected to 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 main which will minimize public inconvenience and the anticipated construction cost. The alignment presented should include at a minimum the following considerations:

1. Horizontal alignments will be located 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 centered within the easement. The easement may need to be enlarged in the vicinity of the butterfly valve to accommodate the service manhole, depending on the size of the water lien and service manhole.

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

    b. In HCFCD right-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.

c. In median of street ROW

d. Behind curb in street ROW

e. Under pavement in Street ROW

2. Horizontal alignments will be chosen to minimize conflicts with other utilities.

3. Vertical alignments may be dictated by the presence of utility conflicts. 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 Program Manager.

4. Where possible, either beveled or deflected joints should be used for changes in the vertical or horizontal alignments.

5. During the design development projects, the Design Engineer does not generally know which pipe material will ultimately be constructed on the project. Unless otherwise instructed in writing by the Program Manager, the Design Engineer will assume the pipe material 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 all other pipe materials. Pipe details should be presented for all acceptable pipe materials.

2.3.3 Pipe Design and Material

The selection of which pipe material(s) should be specified for each Contract Package is an important decision. Each Design Engineer must address the selection of the proper pipe material(s) for their specific project.

2.3.3.1 Pipe Design

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 considerations in the Contract Documents. This effort is to include identifying minimum wall thickness, special coatings, etc.

2.3.3.2 Material Evaluation and Selection

Pipe materials must conform to AWWA Standards and the standard specifications. The pipe materials selected for the Program are listed below based upon available sizes.

Pipe Materials

Type	Size (Inches)
Polyvinyl Chloride	≤ 30
Ductile Iron	≤ 64
Prestressed Concrete Cylinder	20 - 96
Bar Wrap Concrete Cylinder	20 - 60
Steel	≤ 96

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

2.3.4 Corrosion Control

As stated in the Program Concepts, Cathodic Protection will be included in the design and construction.

1. Buried metallic and concrete structures are subject to soil corrosion and deterioration.

2. The most important indicators of the corrosiveness of the soil are the soil resistivity, pH levels, and chloride ion concentration.

Soil Resistivity

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

- 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.

- A critical value for chloride ion concentrations relative to the corrosion of reinforcing steel with concrete structures has not been clearly established. A general consensus would appear to indicate that minimum concentrations of 550 ppm in soils do cause such corrosion.

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

- Stray currents affect ductile iron, prestressed concrete cylinder, pretensioned concrete cylinder, and coated steel piping. A cement mortar coating is not a high dielectric coating and does not present a barrier to stray current corrosion.

- Stray current can be generated by 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.

2.3.5 Valves

The Program will require several different types of valves, each with its own requirements of specifications. The primary types (classification) of valves which may be required for the Program are: isolation valves, air and vacuum valves, combination air valves, pressure reducing valves, and control valves. All valves shall conform to applicable AWWA Standards as modified by the 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.

Valve characteristics or criteria include the type of valve (gate, butterfly, etc.); spacing; location, and performance and equipment specifications. A few of these items are listed below for different types of valves.

2.3.5.1 Isolation Valves

All lateral lines shall have an isolation valve near the tee connection, and the valve should be located along the street right-of-way line projected (extended) across the connecting main whenever possible. Spacing and type of valve based on water main diameter are summarized below.

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

All valves shall be constructed with valve boxes or service (i.e., actuator/operator) manholes, as defined by Program requirements. 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 district and the main transmission line is looped, place three valves at these nodes.

2.3.5.2
Combination Air Valves

Combination air and vacuum valves shall be placed on the water line at selected high points in the water line profile and at specified locations such as bayou and highway crossings. The number, size, and location of these valves is to be determined by the Design Engineer in accordance with acceptable design practice based on line size, flow rates, site conditions, and related factors. In certain cases, the Program Manager will provide the Design Engineer with specific recommendations or requirements as to size and location of valves.

Both single-body and duplex-body combination designs may be used, depending on the size, location, and other factors for a specific installation. Care should be taken to locate the valve such that the inlet/outlet vent piping is one foot above the 100-year floodplain elevation, and that the valve installation and piping is properly protected from tampering and damage. Vent piping to be located along property (lot) lines, unless otherwise approved by the Program Manager, so that minimal obstruction occurs to the adjacent property owners. Locating vent piping in the esplanades is to be avoided but, if necessary, requires approval.

2.3.5.3
Vacuum Relief-Air Inlet Valves

For certain line segments, surge modeling will be performed to determine specific location for installation of surge protection devices. In these instances, the Program Manager will provide requirements as to the size, location, and design of these installations. The surge modeling is performed based on the 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 is to coordinate his design efforts for these stations with the Program Manager due to standardization of certain elements of the vacuum relief valve station. The inlet/outlet vent elevation shall be 1 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 the valve is properly protected from tampering and/or damage.

2.3.5.4
Pressure Reducing Valves (PRV)

Pressure reducing valves may be required at line connections to the existing water distribution system. The Program Manager will provide direction to the Design Engineer as to the locations requiring PRVs. Specific line size, flow, and pressure conditions should be used to determine the size and type of PRV to be used.

The Design Engineer is to coordinate his design efforts for the PRV station with the Program Manager due to standardization of certain elements of the PRV station.

Two types of control valves are anticipated for the Program.

2.3.5.5 Control Valves

System Control Valves

These valves will serve as throttling valves. As throttling valves, their function will be to maintain acceptable distribution pressures in certain portions of the system (similar to the function of a PRV) and also to control the amount of flow into specific sub-service areas as desired by the Authority's central control center. This remote-control function will be based on feedback to the central control center from the grid pressure monitoring system.

Presently, these control valve stations will consist of AWWA ball valves with the hydraulic operations located in underground vaults. A complete design, for design contracts that are affected, will be provided by the Program Manager. This design will include the valve, piping, instrumentation, communication equipment, and vault design.

Storage Tank Control Valves

In addition to the system control valves, as described above, control valves are required on the refill lines connecting the satellite ground storage tanks to the conveyance 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. A complete design, for design contracts that are affected, will be provided by the Program Manager.

Use a maximum of 4 feet of vertical 48-inch diameter risers. Increase size of access manholes to 84- or 72-inch diameter when depth extends beyond 20 feet. Manholes should not be placed in a vehicle path, if possible.

2.3.6 Manholes

Provide a petroleum-based tape encapsulating all bolts in access manholes and valve vaults, including pressure-reducing stations.

2.3.7 Manways

Manways shall be no less than 24 inches. Add two lifting eyes for manways and flanges larger than 24 inches. Require contractors to install new bolts and gaskets whenever they have to remove an existing manway or flange. Provide a minimum 4-inch opening on top of each manway cover.

Provide 24-inch access manways with manhole approximately 10-feet upstream and downstream of proposed butterfly to allow internal access. Provide access manways spaced no more than 900 feet to allow internal access.

2.3.8 Thrust Restraints

The Design Engineer shall carefully design 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 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 as specified. Thrust restraint calculations shall be

based on the use of Prestressed Concrete Cylinder Pipe (PCCP) in buoyant conditions. Where a specific pipe material is specified on the Drawings, use that pipe material and appropriate factors for determining thrust restraint. Passive resistance of soil will not be permitted in calculation of thrust restraint.

Show thrust restraint limits based on PCCP.

2.3.9 Plant Connections and Expansions

Obtain copy of piping lay schedule (if available) for original piping. Review lay schedule and identify specific issues which affect the proposed connection(s). Compare to the record drawings and reflect such appropriate information on the Drawings. Determine the joint configuration for the existing piping and design accordingly. Design plant piping for steel pipe with welded 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 Program Manager and the Water Plant Manager. 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. Identify to contractors that a minimum of 72 hours of written notification is required before beginning the construction, and it is to be performed in the presence of the Water Plant Manager.

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

Provide to the Program Manager, copies of the shop drawings, piping lay schedules, existing water mains/valves layout, encompassing four street blocks around the facility. Information to be indexed and bound in three-ring binders with dividers, as approved by the Program Manager. Provide two copies of the binders.

2.3.10 Critical Locates

Critical Locates are defined as locations where proposed water main will cross a utility and the potential exists such that there will not be sufficient clearance during the construction of the proposed water main.

General Guidelines for Critical Locates:
Sanitary sewer lines and storm water lines do not require critical locates, unless a manhole is not within a sufficient distance ($\leq$ 30 feet) of the potential crossing for the proposed water main and, therefore, grade of utility in conflict cannot be reasonably determined.

Water lines that will be crossed and may not have sufficient clearance from the proposed water main will require critical location. Do not critically locate service connections.

2.3.11 Geological Faults

The Design Engineer for a particular contract package may discover that the line segment under design will cross a geological fault. This information may be based on the geological report for that segment, or it may be based on other information available to the Design Engineer.

When it is determined that a line segment will cross a geological fault, a specific course of action is to be followed.

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

    - If the fault was identified as a result of the geological report, the report should comment on the activity or potential activity.

    - If the fault was identified by other means, the Design Engineer should notify the Program Manager. The Program Manager will then authorize the work to be performed.

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

3. 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:

    - Attempts will be made to determine the exact location of the fault and identify the intersecting point of the water main at the fault. These tasks will be carried out by a qualified geotechnical consultant.

    - 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.

    - Once the exact 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 must sustain ground movements from the fault. This task requires a literature research and sound engineering judgment. It will be accomplished by the geotechnical consultant.

4. Based upon the geotechnical investigation, the detailed segment design can continue. There are no standard designs for fault

crossings, but the following alternatives have been prepared by the Program Manager to assist the Design Engineer in his design:

a. ***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.

b. ***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.

c. ***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.

d. ***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.

e. ***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.

f. ***Use Rigid Composite Section:*** Place the pipe inside a primary tunnel liner with 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.

g. ***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.)

h. ***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.

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

A monitoring program should be planned during the design process and should be in place during construction and throughout the life of the fault crossing design.

2.3.12 Special Crossings

The Surface Water Transmission 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.

Require contractors to install a water main marker at all crossings of gas/petroleum pipeline corridors. Markers are to be approved by the Authority.

2.3.12.1 Highway and Railroad Crossings

In general, major highway and railroad crossings should be encased in 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 should become familiar with the "Utility Accommodation Policy" prepared by TxDOT (commonly referred to as Plate 8) and adhere to the design requirements of that document for the design of highway crossings.

The Design Engineer should coordinate all necessary TxDOT interface with the Program Manager.

The Design Engineer is responsible for determining the specific requirements of the railroad and coordinating his design and schedule accordingly.

2.3.12.2 Stream and Ditch Crossings

Water line crossings of waterways or other drainage channels may either be aboveground or underground depending on the particular features, problems, 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 are normally in the 5-foot range.

2.3.12.3 Parallel Pipelines and Crossings within HCFCD Facilities

In accordance with Harris County Flood Control District's (HCFCD) Policy Criteria & Procedure Manual, Section 14.2 has specific criteria and conditions for crossings within HCFCD maintained facilities. Minimum cover over pipelines shall be 5 feet below the ultimate channel bottom across the entire ultimate right-of-way.

Additionally, Section 14.3 requires a Request for Variance for any pipelines within HCFCD facilities that are parallel to a channel or detention basin. Approved variances have required a minimum cover of 5 feet below the ultimate channel bottom for pipelines within and parallel to HCFCD right-of-way.

2.3.13 City of Houston Block Maps and Record Drawings

The Design Engineer is responsible for preparing the Drawings. As such, the Design Engineer is expected to review the existing record information (block maps, record drawings, and as-built drawings) and use sound engineering judgment in resolving areas of conflict or questions that arise during design.

Use of existing information should account for the accuracy of the existing information and features identified by the topographic surveys and existing field conditions.

2.3.14 Additional Design Guidelines

Below is a listing of design items that are not to be overlooked by designers 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 Program Manager to identify a few key design items early in the design process in an effort to assist the Design Engineers to complete their work.

Item Guidelines

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

2. All utilities larger than 2 inches in diameter are also shown in the profile.

3. Show all sanitary sewer service lines.

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

5. Design the water line using Prestressed Concrete Cylinder Pipe (PCCP).

6. Connections to existing systems are to be determined by the Program Manager.

7. Water main interconnect piping materials shall be appropriately considered and designed on a project specific basis. 8. 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.

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

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

    If the ultimate TOC is known for a specific roadway, the depth of cover will be 6 feet from the proposed TOC to the proposed water line. Harris County will provide this information, if known, when the route approval is provided.

11. 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.

12. Isolation valve spacing is approved by Program Manager.

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

14. Location of air release/vacuum valves – use the highest elevation based on flow direction.

15. Location, size, and species of trees within Harris County Rights-of-Way or easements must be documented. During design, tree removal and relocation is the least preferred choice and shall be avoided.

    a. ***For Specimen Trees 12 inches and larger:*** . Auger or tunneling construction methods, under selected specimen trees, may be used to the extent practical. . Provide a tree protection plan with the construction plans.

    b Specimen trees located in the ROW and adjacent to the contractors work area are to be fenced off with 4-foot high orange safety fencing.

    c. ***Urban Forester:*** Provide when necessary an urban forester for the preparation of a tree protection plan.

16. All overhead electrical lines must be noted and documented on Drawings.

17. The location, size, and composition of driveways must be documented on Drawings.

18. Cathodic Protection – need to show test stations, rectifier units, and other appurtenances.

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

20. Maximum deflection with beveled end = 5 degrees (slope = 0.0875 foot/foot).

21. 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.)

22. Water line drain line – one or more per contract, as determined by Design Engineer and agreed to by Program Manager. Drain line does not need to drain entire length of line; it does need to drain into a storm sewer.

23. Flexible Base Pavement:

    a. For parallel applications, when the contractor damages or removes flexible base pavement, the 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 applications (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.

24. Concrete Pavement:

    a. For parallel applications, replace concrete pavement to the existing longitudinal joint for maximum lane width of 12 feet and to the nearest sawed or expansion joint on either end of the excavation area 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 expansions joint.

    From Harris County: Concrete thickness to be replaced to existing thickness or meet current criteria for developer projects whichever is greater.

    b. For perpendicular applications, 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.

25. Use internal elliptical dish head plugs at the end of segments.

26. When preparing bid items, the items should be grouped and shown on standard bid form by activity and size. For example:

    - Water: List by larger diameter to smaller diameter.
    - Sanitary sewer.
    - Drainage: Reinforced concrete pipe (RCP), inlets, and manholes together
    - Traffic control
    - Cathodic protection

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

28. When documenting bid items, reference only specification section for each item.

29. 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 22.55° (41.41% slope) or 45° (100% slope).

30. At pipeline crossings, identify the following:

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

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

    c. If the product is petroleum, investigate if the area has potential petroleum contamination that the contractor should be made aware.

    d. Verify the pipelines were probed near the proposed waterline crossing.

31 Pipe Bedding:

    Bank sand will be used as the embedment material for the pipe bedding, haunching, and initial backfill zone (12 inches above top of pipe).

32. Backfill of Existing Storm Sewer:

    When crossing under an existing storm sewer using the open cut method, the water line trench zone shall be backfilled for 3 to

5 feet either side of the storm sewer with cement stabilized sand to the spring line of the storm sewer.

33. Removal and Replacement of Storm Sewer:

    When a section of existing storm sewer is removed temporarily to facilitate water line installation, it will be reinstalled as approved by the County Engineer during plan review.

34. In HCFCD ROW, provide 1 bollard for vent pipe, located near ROW.

35. Provide isolation valve on downstream side of "Tee."

36. Four-Way Signalized Intersection:

    Water lines constructed under four-way signalized intersecting streets will be installed by tunneling or bore and jack methods, unless an alternate method is approved by the County Engineer during plan review.

    All approaches, including left-turn lanes, at signalized intersections should remain open to traffic, unless otherwise approved by the County Engineer during the plan review process.

37. Median Openings:

    All median openings to private drives can be open cut. Water lines under median openings serving public streets, whether signalized or unsignalized should be installed by tunneling or bore and jack methods, unless otherwise approved by the County Engineer during the plan review process.

    From Harris County: Median openings serving schools or other traffic generators will remain open. When school is in session.

38. Signage Requirements:

    a. Identification or Warning Method:

       A detectable warning tape or similar device will be used in open trenches of non-metallic water lines that either cross or are within the ROW. The use of a steel rebar will not be acceptable. Where any water line crosses a County ROW a small warning sign shall be placed at both ROW lines listing a phone number to contact before you dig.

39. Driveway Replacement Guidelines:

    Match the existing width and curvature radius of existing driveway.

2.4 TRAFFIC CONTROL PLAN

The following Program criteria, specifically relating to preparation of Traffic Control Plans (TCP) for individual design projects, outline minimum requirements. These guidelines are presented in order to achieve uniformity of organization and standardization within the design development as well as during construction activities for each project.

2.4.1 Standard and Guidelines

The Texas Manual on Uniform Traffic Control Devices (TMUTCD) 1980 (with latest revisions) is essential to the development of the TCP, and such drawings are to be included in the TCP, as required.

Other standard reference drawings available as needed are TxDOT Barricades and Construction Standards [Drawings BC(1)-98 through BC(9, 9A, 9B, and 9C)-98] (latest revisions), Concrete Traffic Barriers (CTB), and Construction Vehicle Impact Attenuators (VIA). These standards are available from the Houston District of TxDOT.

2.4.2 Plans

Specific tasks which are anticipated to be required in support of the design efforts are:

1. Provide a detailed traffic control plan in conformance with the TMUTCD.

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

    b. Show all traffic control devices for each phase of the project. A separate phase shall be shown each time changes in the traffic pattern and/or construction sequence is required. 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, VIA's delineators, pavement markings, construction signing, and traffic signal changes shall be shown on all plans.

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

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

    g. Show 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 CTB, pavement drop-off, and construction detail for each roadway variation.

i. 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 in the plans and cross sections and fully identified.

2. Provide all technical services (office computations and drafting) under the direct supervision of a Registered Professional Engineer, licensed in the State of Texas.

3. Schedule a conceptual TCP review meeting with the Program Manager prior to the 75% Submittal.

2.4.3 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 Specifications.

2.4.4 Graphical Standards

1. These plans shall be to 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 shall require prior approval of the Program Manager.

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

2.5 REGULATORY AGENCIES

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

- Public entities
- Public utilities
- Private utilities

The Design Engineer is responsible for the following tasks:

- Resolve the specifics of his design with the applicable agency.
- Keep the Program Manager apprised of the status of the approval process involving pertinent agencies until such time as final approval is granted.

2.6 TPDES STORM WATER PERMITTING

The Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit (CGP) (TPDES Permit Number TXR150000) became effective on March 5, 2003. For 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.

- Obtain a copy of the TCEQ's TPDES CGP
- Develop a Storm Water Pollution Prevention Plan (SWPPP), pursuant to Section II.D.2 of the CGP
- Complete and post a site notice, as provided in Attachments 1 and 2 of the CGP

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.

- Obtain a copy of the TCEQ's TPDES CGP
- Develop a SWPPP, pursuant to Section II.D.3 of the CGP
- Complete and submit a Notice of Intent (NOI) to the TCEQ
- Submit a Notice of Termination (NOT) once the site has reached final stabilization

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 at the construction site 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:

1.0 Regulations

2.0 Project Information

3.0 Site Description

A. Description of the Construction Activity

B. Schedule and Sequence of Major Activities

C. Estimated Total Site Area and Disturbed Area

D. Soil Description/Quality of Discharge

E. Location and Site Map

F. Asphalt and Concrete Plants

G. Receiving Waters

H. Copy of TPDES Permit Number TXR150000

4.0 Controls

A. Erosion and Sediment Controls

B. Stabilization Practices

C. Structural Control Practices

D. Permanent Storm Water Controls

E. Other Controls

F. Approved State and Local Plans

5.0 Maintenance

6.0 Inspection of Controls

7.0 Non-Storm Water Discharge Components

8.0 Technical Specifications

9.0 Certifications

10.0 Forms

2.7 SUMMARY

The members of the Program Team share a common goal of providing the Authority with those improvements necessary to distribute the 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 Program Manager.

These are general guidelines and appropriate modifications shall be made by the Authority.

Chapter 3

Survey Requirements

3.1 GENERAL

The following guidelines are to be followed for all surveying and mapping to be performed for the Program.

3.2 REFERENCES

State of Texas Professional Land Surveying Practice Act, latest revision.

Texas Board of Professional Land Surveying (TBPLS) Professional and Technical Standards (Texas Administrative Code, Title 22, Part 29, Chapter 663, Subchapter B, Professional and Technical Standards)

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

3.3 CONTROL SURVEYS

The main horizontal and vertical control for the Program is to be set by others and will be furnished to each surveyor along with the horizontal and vertical datum and scale factor at the beginning of the project.

3.4 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.

Surveys shall comply with the latest revision of the Professional Land Surveying Practice Act of the State of Texas and shall have the imprinted or embossed seal of the responsible Registered Surveyor and be dated and signed by the Surveyor.

3.5 FIELD WORK

Field work shall be recorded in field books or on total station database printouts. Record the field book number in the title block on each drawing (sheet) that shows surveyed information.

3.5.1 Recording Field work

3.5.2 Monumentation

The control line or construction 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. Baseline stationing to be coordinated with Program Manager. Station numbering to be continuous, unless otherwise approved by Program Manager.

3.5.3 Ties

Make ties of the found right-of-way monuments and property corners to the horizontal control furnished by the Design Engineer.

3.5.4 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.

3.5.5 Centerline and Angles

Record the centerlines and angles of intersections of side streets with the main roadway centerline station.

3.5.6 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 a distance of 20 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, and lines with size, depth and type.

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

c. Power poles, telephone, and electrical pedestals.

d. Storm Sewer inlets, manholes, and junction boxes with size, depth, and type.

e. Wastewater manholes and cleanouts with size, depth, and type.

f. Existing pavement edges, 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). 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. Provide the pipeline(s) size, location and depth. If the pipeline company requires their line to be located by the use of potholes, coordinate with the Program Manager for authorization.

h. Identify ditches, swales, 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. Identify culvert sizes and flow lines.

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

3.5.7 Cross Sections

Cross sections shall be taken at intervals of 100 feet; and at 20 feet beyond the ROW or easement limits. For levels recorded in field books, record rod readings, or elevations as numerator and distance right or left of the base or centerline as the denominator. Data collector of a total station can be used to acquire necessary elevations at required intervals.

3.6 Abstracting

Surveyor is responsible for obtaining 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 study area. All easements affecting the project must also be obtained. The surveyor will also be responsible for obtaining the ownership deeds and easements for properties where additional right-of-way or easement will need to be acquired, including adjoining property owners.

3.7 Right-Of-Way Maps For Property Acquisition

3.7.1 Boundaries

For each tract or parcel of land to be taken, locate the boundaries of the property, showing course and distance of all property lines. If applicable, show and identify lot and block lines on the alignment map (acreage, and subdivision if tract is part of subdivision). Adjacent tracts owned by the same person shall be counted as one tract.

Identify the corners with found iron pins or other suitable markers. If the property being surveyed requires separation into smaller tracts or parcels, designate and identify each tract or parcel. All designations should be by Arabic numerals first, then alpha designations. Coordinate parcel numbering with the Program Manager.

3.7.2 Acreage

Indicate on the alignment map the following for each parcel or tract:

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).

3.7.3 Easements

Show all easements that will affect the property. Compute the area in each such 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.

3.7.4 Encroachments

Show all encroachments which will affect the property and identify same on alignment. Indicate the measured extent of the encroachment.

3.7.5 Inside Taking Area

Locate, identify, and show on the alignment or parcel index 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. Include all building lines and existing easements which will affect the property, and list all zoning classifications, restrictions, or buildings codes if any.

3.7.6
Outside Taking Area

Locate, identify, and show on the alignment or parcel index 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.

3.7.7
Flood Information

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

3.7.8
Alignment Map Scale

Prepare the alignment or parcel index map at a scale sufficient to clearly show all the detail which may be necessary in the opinion of the Program Manager.

3.7.9
Street Width

Identify width of street or road on alignment map.

3.7.10
Right-of-Way and Control Points

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

3.7.11
Street Location

Identify on alignment or parcel index map, the location of street or road or watercourse, which is referred to in the metes and bounds descriptions including recording data.

3.7.12
Monuments

All monuments which are used and noted in metes and bounds descriptions and sketches should be identified on alignment, parcel index, and survey control maps.

3.7.13
Surveyor

Show on the alignment map, the name and business address of the surveyor, the date the survey was made, and certification by the surveyor that the alignment map was prepared from measurements made on the site, that all easements and encroachments are accurately shown on the alignment map, and that there are no easements or encroachments known to the surveyor which are not shown on the alignment map. Certification should be signed and sealed.

3.7.14
Fences

Show all fences and identify their type(s).

3.7.15
Coordinate System

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 or as provided by the Program Manager.

3.7.16
Seals

All right-of-way alignment drawings, parcel index maps, and metes and bounds descriptions will be sealed with the seal of a Registered Professional Land Surveyor and signed by the surveyor whose seal appears thereon. The date that document was signed shall be so noted.

3.7.17 Survey Conformity

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

3.8 METES AND BOUNDS DESCRIPTIONS FOR PROPERTY ACQUISITION

3.8.1 Property Description

Furnish property description as follows:

a. Description to be a metes and bounds description and sketch unless it describes a whole lot or block within a subdivision the map or plat of which has been approved by the County Engineer and Commissioners' Court and which has been recorded in the Real Property Records of Harris County.

b. Description to be typed.

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.

d. Description to be prepared on white bond paper. For all descriptions and sketches the paper size shall be 8.5 inches by 11 inches.

e. Identification of the land being described shall be by tract or parcel number, project name, and project number typed 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 page sequence and the total number of pages used in the description.

f. Introductory paragraph (Preamble) should include:

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

    2. Location.

    3. Survey name and abstract number.

    4. Size of parent tract and recording reference information.

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

g. Point of Beginning, (and Point of Commencement if one is used) in description and on the sketch shall be tied to a fixed and easily ascertainable position. This position must be indicated on the alignment, parcel index, and control maps. Provide surface coordinates for Point of Commencement and Point of Beginning in the metes and bounds description and on the sketch. See Paragraph 3.7.15 for information regarding coordinate system. 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 Program Manager before finalizing description).

EXAMPLE
TRACT 6

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

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.

If the tract is divided into parcels then following 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 issued for all other parcels being described.

i. All right-of-way descriptions will be sealed with seal of a Registered Professional Land Surveyor and signed by the surveyor whose seal appears thereon. The date that document was signed shall be so noted.

j. Provide area and closure calculations as computed by COGO or other surveying software.

3.9 CONSTRUCTION DRAWINGS

3.9.1 Baseline

The actual baseline used to perform the field survey shall be used as the project baseline.

3.9.2 Existing Monuments or Property Corners

Found existing right-of-way monuments or property corners must be plainly shown on the drawings and located by station and distance, right or left from the transit line, or construction baseline. Monuments used to establish the construction line must be identified as "Control Points," and their relationship to the construction baseline and to the proposed or existing right-of-way lines must be shown.

3.9.3 Existing NHCRWA Monuments

Show location and identification of existing NHCRWA survey monuments by station and distance, right or left of the project's construction 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.

3.9.4 Control Monuments

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

3.9.5 Side Streets

Show baseline angles of the intersection of side streets with the main roadway centerline. Where bearings are used, identify source of bearings and show bearings on both base or transit line and project's construction baseline when they are not the same line.

3.9.6 Utilities and Paving

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) or pothole information.

3.9.7 Bridges

For bridges, overpasses, and underpasses, show top of pavement at gutter line and centerline for the following location:

a. Construction joints, armor joints, or expansion joints.

b. At intervals between bents that correspond to the increments used for dead load deflection calculations.

3.9.8 Bridge Centerline Information

For bridges and grade separation, identify all proposed centerline and curve information plus:

a. Surface coordinates for control points so that an inverse between coordinates reflects a surface distance. Identify origin of coordinate system used.

b. Show coordinates of centerline or base line at all PIs.

c. Show coordinates of all curb lines at their intersection with the centerline of bents and abutments for irregular structures.

3.9.9 Electric Lines

Show overhead electric lines, guy wires, and service poles as they connect to power poles, transmission towers, etc.

3.9.10 Record Drawings

Obtain record drawings of adjacent connecting existing water line segments from the NHCRWA. Show all adjacent existing facilities.

3.9.11 Diagonal Crossing

Identify actual measurements of diagonal crossing and any difference between the stationing or scaled measurements on plan and profile sheets.

Chapter 4

Graphics Requirements

4.1 GENERAL

Graphic requirements for engineering drawings.

4.2 DEFINITIONS

Computer Aided Drafting Design (CADD) - Preparation of drawings, plans, prints, and other related documents through the use of computer equipment and software programs.

4.3 DESIGN REQUIREMENTS

A. Provide a cover sheet for projects involving three or more design drawings (excluding standard detail sheets). Drawing sheet numbers and titles shall be listed on the Sheet Index.

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

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

B. Drawings shall be prepared on 22-inch by 34-inch ANSI standard drawing sheets.

C. Show service area on cover sheet or area map.

D. Final design drawings shall be produced by CADD on mylar using non-water-based ink. Do not use adhesive-backed material on final drawings. Stick-ons may be allowed with approval of the Program Manager for a minor correction during the final review process.

E. Details of special structures (not covered by approved standard drawings, such as stream or gully crossings, special manholes, or junction boxes) shall be drawn with vertical and horizontal scales equal to each other.

F. Each set of engineering drawings shall contain paving and utility key drawings indexing specific plan and profile sheets. Standard Details, where applicable, shall be included. All sheets shall have standard title blocks. Where applicable, show HCFCD key drawings and numbers.

G. Draw key overall layouts to a minimum scale of 1 inch = 200 feet.

H. 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.

I. 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:

1. A storm water or sanitary sewer with flow from west to east or from south to north.

2. A primary outfall drainage ditch with flow from west to east or from south to north.

3. Stationing is intended to start from the cardinal points of the compass and proceed in the direction of construction.

J. 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 inch = 5 feet 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 Program Manager

1. Scales of Paragraph 4.4.J.2 above 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.

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

3. Single-banked plan and profile drawings are required; double-banked plan and profile sheets are allowed in

certain situations such as off-site utility lines in undeveloped areas.

4. 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."

5. 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.

6. 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.

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

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

M. Identify trees by their common names (pine, oak, etc.). 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.

N. A copy of the final plat for new development shall be included with the final design drawings when submitted for final approval.

O. If a roadway exists where drawings are being prepared to improve or construct new pavement or a utility, label the existing roadway width, surfacing type, and thickness.

P. Show all street and road alignments on drawings.

Q. 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 with the right-of-way. At the intersection, the cross-street details shall be shown at sufficient distance (20-foot minimum distance outside the primary roadway right-of-way) in each direction along cross street for designing adequate street crossings.

R. Match lines between plan and profile sheets shall not be placed or shown within cross street intersections including cross street right-of-way.

1. 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

S. Provide natural ground profiles for each right-of-way line. Easement profiles shall conform to Paragraph 4.4.T.1.

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

1. Identify lot lines, property lines, easements, rights-of-way, and HCFCD outfalls.

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

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

5. Label proposed top of curb grades except at railroad crossings. Centerline grades are acceptable only for paving without curb and gutters.

6. Show in profile curb return elevations for turnouts.

7. Gutter elevations are required for vertical curves, where a railroad track is crossed.

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

9. Show both existing and proposed station esplanade noses or the centerline of esplanade openings, including esplanade width.

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

11. Show in plan view station PCs, PTs, and radius returns. Show in profile station radius returns and grade change PIs with their respective elevations.

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

13. Depict existing bridge foundation information in the profile.

14. Show bridge subsurface features based on Record Drawings.

4.4 GRAPHIC STANDARDS

4.4.1 CAD Standardization

The Legend and Abbreviation Sheets provided as *Exhibit 4-A* is for reference and use by the Design Engineer in preparation of the drawings. *Exhibit 4-A* is a sample template 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 reprographic pen and/or line weight along with the associated naming layer conventions for the respective features in the Legend and Abbreviation Sheet.

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:

1. NHCRWA-BW-FULL.CTB
2. NHCRWA-BW-FULL.STB
3. NHCRWA-BW-HALF.CTB
4. NHCRWA-BW-HALF.STB

Color / Aerial Reprographics:

1. NHCRWA-CLR-FULL.CTB
2. NHCRWA-CLR-FULL.STB
3. NHCRWA-CLR-HALF.CTB
4. NHCRWA-CLR-HALF.STB

4.4.2 Plan and Profile

The graphic standards for plan and profile on sheet size ANSI D, 22"x34", shall apply to drawings of 1 inch = 20 feet scale. For smaller scale drawings such as Tabloid size, 11"x17", shall apply to drawings of 1 inch = 40 feet scale , with the use of proportionally smaller scaled line sizes from a 22"x34" drawing. *Exhibit 4-B* includes reference plan and profile sheets for use by the Design Engineer.

4.5 NOTES

General Construction Notes convey information common to the components to several or all the drawings in the package. General Construction Notes shall be an enhancement or supplement to the

drawings and not a duplication of requirements contained in the Standard Specifications. The incorporation of specifications as a part of the notes is **strongly discouraged**.

4.5.1 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.

4.5.2 Specific 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 in close proximity to 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 numbers on drawings.

4.6 SEALS/SIGNATURES

Affix seals in accordance with State Board of Registration Rules.

Interim submittals must carry the name, P.E. number, and date of the responsible engineer. (These drawings need to be identified as to the level of completeness.)

Final drawings require the stamp of a Registered Professional Engineer in the State of Texas, his or her signature, and the date below the seal. Sealing a drawing shall be performed by the responsible engineer. When more than one seal appears on the drawing, identify the level of responsibility for each engineer.

Revisions to drawings that have been stamped by a Registered Professional Engineer must be initialed and dated below the stamp or in the revision block column designated for the initials by the same engineer who signed the original work. If this cannot be done, another Registered Professional Engineer in the State of Texas can affix his or her seal to the drawings, enter his or her signature and the date, identifying responsibility for the specific revision.

4.7 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 letter or number in a triangle inside the circled area.

4.8 SCHEDULE OF DRAWINGS

The Schedule of Drawings for each design package contains mandatory drawings. These drawings are listed below in the required order:

1. Cover Sheet and Vicinity Map
2. Harris County Express Review Sheet [If Applicable]
3. Harris County Flood Control District Review Sheet [If Applicable]
4. Index Sheet (combined with Cover Sheet if enough room)
5. General Construction Notes
6. Legend and Abbreviations
7. Private Utility Notes
8. Sheet Layout Plan/Core Boring Plan(s)
9. Parcel Index Maps
10. Baseline Ties and Bench Marks
11. Monumentation Benchmark Data
12. Horizontal and Vertical Control
13. Plan and Profile Sheets
14. Special Details (e.g., bridge piles, etc.)
15. Detail Sheets [See NHCRWA Standard Details on web site]
16. Cathodic Protection Sheets [If Applicable]
    a. Cathodic Protection Details – Prestressed Concrete Cylinder Pipe
    b. Cathodic Protection Details – Steel Pipe
    c. Cathodic Protection Details – Ductile Iron Pipe
    d. Cathodic Protection Details for Impressed Current Systems
    e. Cathodic Protection Test Station Details
17. Traffic Control
    a. General Notes
    b. Traffic Control Construction Sequence Plans

c. Traffic Control PlanSheets

d. Standard Pavement Marking Details

e. Barricade Standard Details

18. Tree Protection Plans & Details

19. SWPP Notes, Plans & Details

20. Water Receiving Facilities – Chloramination Sheets

21. Water Receiving Facilities – Electrical/I&C Sheets

22. Water Receiving Facilities – Detail Sheets

    a. Combination Air Valve and Details

    b. Flow Meter/Flow Control Valve Station Process Schematics

    c. Standard Flow Meter Station

    d. Standard Flow Control Valve Station

    e. Automatic Control Valve Enclosure Details

    f. Ground Storage Tank Riser Details

    g. Mechanical Details

    h. SCADA Panels

    i. Customer Control Panel Details

4.9 DELIVERABLES

The following checklist is a summary of the items that the Design Engineer shall deliver to the Program Manager:

1. Original tracings with original signatures and seals

2. MicroStation (.DGN) or AutoCAD (.DWG) design files, including:

    a. Plotting parameter files of all types

    b. Font libraries

    c. Cell libraries

    d. Patterning libraries

    e. Color tables

    f. All parameter files associated with the use of application software

g. Acceptable media (tape or disk) with label

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

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

5. Design report

6. QA/QC documentation

4.10 REFERENCE EXHIBITS

While the information presented in the following standard exhibits are specific for the intended use on NHCRWA projects, the exhibits 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. The following standard exhibits include:

- Exhibit 4-A: Legend and Abbreviation Sheets
- Exhibit 4-B: Plan and Profile Sheets.

EXISTING PLAN VIEW

- WATER METER
- WATER VALVE (GATE)
- BUTTERFLY VALVE W/OPERATOR MANHOLE
- FIRE HYDRANT/FLUSHING VALVE
- TAPPING SLEEVE & VALVE
- REDUCER (8" 6")
- ROUND CONNECTION
- SANITARY SEWER CLEANOUT & MANHOLE (CO, S)
- STORM SEWER MANHOLE (S)
- STORM SEWER INLETS ('B' 'B–B' 'C' 'C–1' 'C–2' 'C–2A' 'GRATE')
- CULVERT PIPE AND HEADWALL
- TOP OF CURB ELEVATION (TC=XX.XX)
- GUTTER ELEVATION (G=XX.XX)
- TOP OF PAVEMENT ELEVATION (TP=XX.XX)
- CONTOUR LINE (MAJOR) (XX.XX)
- CONTOUR LINE (MINOR) (XX.XX)
- ROW LINE
- PROPERTY LINE (R)
- LOT LINES
- EASEMENT LINE
- WATERLINE EASEMENT
- TEMPORARY CONSTRUCTION EASEMENT
- ACCESS EASEMENT
- MAINTENANCE EASEMENT
- CENTER LINE OF ROW
- TRANSIT LINE
- EDGE OF DITCHES
- CENTER LINE OF DITCHES
- EDGE OF DITCHES
- FENCE LINE, WOOD
- FENCE LINE, CHAIN LINK
- FENCE LINE, BARBED WIRE
- FENCE LINE, HOG WIRE
- EDGE OF CONCRETE
- CURB LINE
- CONCRETE WALK
- EDGE OF ASPHALT
- EDGE OF SHELL OR GRAVEL
- DIMENSION LINE (28" 3.50')
- CENTERPOINT ENERGY AERIAL LINE (P)
- CENTERPOINT ENERGY UNDERGROUND LINE
- GAS LINE
- MISC UNDERGROUND LINE
- PIPELINE OR WESTERN UNION CONDUIT (IDENTIFY CONDUIT)
- AT&T CONDUIT
- CABLE TV OR FIBER OPTIC (IDENTIFY CONDUIT)

PROPOSED PLAN VIEW

- WATER METER
- WATER VALVE (GATE)
- BUTTERFLY VALVE W/OPERATOR MANHOLE
- FLUSHING HYDRANT
- TAPPING SLEEVE & VALVE
- REDUCER (12" 8")
- ROUND CONNECTION
- SANITARY SEWER CLEANOUT & MANHOLE (CO, S)
- STORM SEWER MANHOLE (S)
- STORM SEWER INLETS ('B' 'B–B' 'C' 'C–1' 'C–2' 'C–2A' 'GRATE')
- CULVERT PIPE AND HEADWALL
- TOP OF CURB ELEVATION (TC=XX.XX)
- GUTTER ELEVATION (G=XX.XX)
- TOP OF PAVEMENT ELEVATION (TP=XX.XX)
- CONTOUR LINE (MAJOR) (XX.XX)
- CONTOUR LINE (MINOR) (XX.XX)
- ROW LINE
- PROPERTY LINE (R)
- LOT LINES
- EASEMENT LINE
- WATERLINE EASEMENT
- TEMPORARY CONSTRUCTION EASEMENT
- ACCESS EASEMENT
- MAINTENANCE EASEMENT
- CENTER LINE OF ROW
- TRANSIT LINE
- EDGE OF DITCHES
- CENTER LINE OF DITCHES
- EDGE OF DITCHES
- FENCE LINE, WOOD
- FENCE LINE, CHAIN LINK
- FENCE LINE, BARBED WIRE
- FENCE LINE, HOG WIRE
- EDGE OF CONCRETE
- CURB LINE
- CONCRETE WALK
- EDGE OF ASPHALT
- EDGE OF SHELL OR GRAVEL
- DIMENSION LINE (28" 3.50')
- CENTERPOINT ENERGY AERIAL LINE (P)
- CENTERPOINT ENERGY UNDERGROUND LINE
- GAS LINE
- MISC UNDERGROUND LINE
- PIPELINE OR WESTERN UNION CONDUIT (IDENTIFY CONDUIT)
- AT&T CONDUIT
- CABLE TV OR FIBER OPTIC (IDENTIFY CONDUIT)

EXISTING PLAN VIEW

- PAVING HEADER
- BUILDING, RESIDENTIAL (RES. 1–STORY BR. BLDG.)
- BUILDING, COMMERCIAL (COMM. 1–STORY BR. BLDG.)
- TREE
- HEDGE
- IRON PIPE OR IRON ROD MONUMENT (3/4" IP)
- POINT OF INTERSECTION (PI)
- POINT OF CURVE (PC)
- POINT OF TANGENCY (PT)
- POWER POLE (P)
- POWER POLE W/ GUY WIRE (P)
- RAILROAD LINE
- WATER LINE (20" (AND SMALLER) WATER; 24" (LARGER THAN 20") WATER)
- SANITARY SEWER LINE (24" (AND SMALLER) SANITARY SEWER; 30" (LARGER THAN 24") SANITARY SEWER)
- STORM SEWER LINE (24" (AND SMALLER) STORM SEWER; 30" (LARGER THAN 24") STORM SEWER)
- SANITARY SEWER FORCE MAIN
- RECLAIMED WATER LINE (RWL)
- NON–POTABLE WATER LINE (NPW)
- GAS METER
- GAS VALVE
- MISC UNDERGROUND PIPELINE LABEL (A2)
- TXDOT MONUMENT
- NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY (NHCRWA) MONUMENT
- TRAVERSE POINT
- SIGN
- SPRINKLER
- SPRINKLER VALVE
- STREET LIGHT
- TRAFFIC SIGNAL, SIGNAL POLE
- IRON ROD / POLE
- WOOD POLE, BRICK COLUMN, BRICK PILLAR
- MAILBOX
- METAL POST
- LIGHT STANDARD
- ELECTRICAL BOX

PROPOSED PLAN VIEW

- PAVING HEADER
- BUILDING, RESIDENTIAL (RES. 1–STORY BR. BLDG.)
- BUILDING, COMMERCIAL (COMM. 1–STORY BR. BLDG.)
- TREE
- HEDGE
- IRON PIPE OR IRON ROD MONUMENT (3/4" IP)
- POINT OF INTERSECTION (PI)
- POINT OF CURVE (PC)
- POINT OF TANGENCY (PT)
- POWER POLE (P)
- POWER POLE W/ GUY WIRE (P)
- MATCH LINE
- RAILROAD LINE
- WATER LINE (20" (AND SMALLER) WATER; 24" (LARGER THAN 20") WATER)
- SANITARY SEWER LINE (24" (AND SMALLER) SANITARY SEWER; 30" (LARGER THAN 24") SANITARY SEWER)
- STORM SEWER LINE (24" (AND SMALLER) STORM SEWER; 30" (LARGER THAN 24") STORM SEWER)
- SANITARY SEWER FORCE MAIN
- RECLAIMED WATER LINE (RWL)
- NON–POTABLE WATER LINE (NPW)
- GAS METER
- GAS VALVE
- MISC UNDERGROUND PIPELINE LABEL (A2)
- TXDOT MONUMENT
- NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY (NHCRWA) MONUMENT
- TRAVERSE POINT
- SOIL BORING LOCATION (SB–#)
- SOIL BORING & PIEZOMETER LOCATION (SB–#)
- CUT AND PLUG
- ACCESS MANWAY W/ SERVICE MANHOLE
- CATHODIC PROTECTION RECTIFIER AND DEEP ANODE (R)
- EXPANSION VAULT
- INSULATING JOINT BONDING TEST (IJTS)
- BUTTERFLY VALVE W/ INSULATING JOINT BONDING TEST STATION (BVTS)
- 2–PIPELINE BONDING TEST STATION (2BTS)
- CASING TEST STATION (CTS)
- FOREIGN PIPELINE TEST STATION (FPTS)
- DIELECTRIC INSULATING JOINT (NO TEST STATION) (IJ)
- SOLID STATE DECOUPLER TEST STATION (SSD)
- MITIGATOR (M)
- COMBINATION VACUUM RELIEF AIR RELEASE VALVE W/ SERVICE MANHOLE AND VENT PIPING
- AIR VENT, VENT PIPING AND FLUSHING HYDRANT W/VAULT
- CRITICAL LOCATE, SEE SPEC 02317

MISC STANDARD ELEMENTS

N

NORTH ARROW

0 20 40 Feet(H) BAR SCALE

1 REVISION CLOUD/DELTA

NOTICE:
FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT LEAST 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS SIGNATURE DOES NOT FULFILL YOUR OBLIGATION TO CALL 811

VERIFICATION OF PRIVATE UTILITY LINES

Date

CenterPoint Energy natural gas utilities shown. (Gas service lines are not shown). This signature not be used for conflict verification.

Signature valid for six months.

Date

CenterPoint Energy/UNDERGROUND Electrical Facilities Verification ONLY. (This signature verifies existing underground facilities – not to be used for conflict verification)

Signature valid for six months.

Date

Approved for AT&T underground conduit facilities only.
Signature valid for one year.

NO.	DATE	REVISION	APP.

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094–1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F–3580

[DESIGN CONSULTANT LOGO]

[DESIGN ENGINEER NAME]
[ADDRESS LINE 1]
[ADDRESS LINE 2]
PHONE:
TX FIRM NO.:

ENGINEER'S SEAL

[PROJECT NAME]
[PROJECT DESCRIPTION]

LEGEND AND ABBREVIATIONS SHEET 1 OF 2

HORIZ: N/A
VERT: N/A

SHEET NO. ___ OF XXX

DRAWING SCALE

REVISION DATE: 09/10/2020

LAST MODIFIED: Sep 22, 2020 – 4:59pm BY USER: berdugoa
DWG. LOCATION: C:\Users\berdugoa\Documents\AECOM\Projects\NHCRWA\CAD Standardization of Legend & Plot Style\2020-09-22\
DWG. NAME: Standardize Legend & Abbreviation Sheet – NHCRWA Border – 2020.09.22.dwg
PEN TABLE: NHCRWA–BW–HALF.CTB

EXISTING PROFILE VIEW

- NORTH OR EAST PROPERTY LINE
- SOUTH OR WEST PROPERTY LINE
- NORTH OR EAST CURB
- SOUTH OR WEST CURB
- NORTH OR EAST DITCH
- SOUTH OR WEST DITCH
- CULVERT — NORTH OR EAST CULVERT
- CULVERT — SOUTH OR WEST CULVERT
- CENTERLINE OF ROW
- CENTERPOINT ENERGY CONDUIT — CENTERPOINT ENERGY CONDUIT
- GAS LINE — GAS LINE
- WESTERN UNION — WESTERN UNION
- AT&T CONDUIT — AT&T CONDUIT
- 20" (AND SMALLER) WATER LINE / 24" (LARGER THAN 20") WATER — WATER LINE
- WATERLINE 24" DIA. AND LARGER IN TUNNEL
- BUTTERFLY VALVE W/OPERATOR MANHOLE
- ACCESS MANHOLE
- 24" (AND SMALLER) SANITARY SEWER / 30" (LARGER THAN 24") SANITARY SEWER — SANITARY SEWER LINE
- 24" (AND SMALLER) STORM SEWER / 30" (LARGER THAN 24") STORM SEWER — STORM SEWER LINE
- SANITARY SEWER FORCE MAIN
- RWL / RWL — RECLAIMED WATER LINE
- NPW / NPW — NON-POTABLE WATER LINE
- CENTERPOINT ENERGY MANHOLE
- AT&T MANHOLE
- WATER LINE MANHOLE
- SANITARY SEWER MANHOLE & CLEANOUT
- STORM SEWER MANHOLE
- STORM SEWER INLET

PROPOSED PROFILE VIEW

- NORTH OR EAST PROPERTY LINE
- SOUTH OR WEST PROPERTY LINE
- NORTH OR EAST CURB
- SOUTH OR WEST CURB
- NORTH OR EAST DITCH
- SOUTH OR WEST DITCH
- CULVERT — NORTH OR EAST CULVERT
- CULVERT — SOUTH OR WEST CULVERT
- CENTERLINE OF ROW
- CENTERPOINT ENERGY CONDUIT — CENTERPOINT ENERGY CONDUIT
- GAS LINE — GAS LINE
- WESTERN UNION — WESTERN UNION
- AT&T CONDUIT — AT&T CONDUIT
- 20" (AND SMALLER) WATER LINE / 24" (LARGER THAN 20") WATER — WATER LINE
- WATERLINE 24" DIA. AND LARGER IN TUNNEL
- BUTTERFLY VALVE W/OPERATOR MANHOLE
- ACCESS MANHOLE
- 24" (AND SMALLER) SANITARY SEWER / 30" (LARGER THAN 24") SANITARY SEWER — SANITARY SEWER LINE
- 24" (AND SMALLER) STORM SEWER / 30" (LARGER THAN 24") STORM SEWER — STORM SEWER LINE
- SANITARY SEWER FORCE MAIN
- RWL / RWL — RECLAIMED WATER LINE
- NPW / NPW — NON-POTABLE WATER LINE
- CENTERPOINT ENERGY MANHOLE
- AT&T MANHOLE
- WATER LINE MANHOLE
- SANITARY SEWER MANHOLE & CLEANOUT
- STORM SEWER MANHOLE
- STORM SEWER INLET

ABBREVIATIONS

ABS	– ASBESTOS	
AC	– ASBESTOS CEMENT	
ACMS	– AC MITIGATION SYSTEM	
AI/VR	– AIR INLET / VACUUM RELIEF	
&	– AND	
@	– AT	
ASPH	– ASPHALT	
℄	– BASELINE	
BL	– BUILDING LINE	
BFV	– BUTTERFLY VALVE & ASSEMBLY	
℄	– CENTER LINE	
CCFTS	– CASED CROSSING AND FOREIGN LINE TEST STATION	
CLR	– CLEARANCE	
CLSM	– CONTROLLED LOW STRENGTH MATERIAL	
CMP	– CORRUGATED METAL PIPE	
COH	– CITY OF HOUSTON	
COMM	– COMMUNICATION	
CONC	– CONCRETE	
CNP	– CENTERPOINT ENERGY POINT	
CPP	– CONCRETE POWER POLE	
CTB	– CONCRETE TRAFFIC BARRIER	
CTMS	– COMPUTERIZED TRAFFIC MANAGEMENT SYSTEM	
DEF	– DEFLECTION	
DI	– DUCTILE IRON	
DIA	– DIAMETER	
DIP	– DUCTILE IRON PIPE	
DR	– DRIVE	
DP AD	– DEEP ANODE	
DRWY	– DRIVEWAY	
E	– EAST	
EJB	– ELECTRICAL JUNCTION BOX	
EL/ELE	– ELEVATION	
ELEC	– ELECTRIC	
ELP	– ELECTRIC LIGHT POLE	
ESMT	– EASEMENT	
ETJ	– EXTRATERRITORIAL JURISDICTION	
EXIST/EX	– EXISTING	
FH	– FIRE HYDRANT/FLUSHING HYDRANT	
FL	– FLOW LINE	
FO	– FIBER OPTIC	
FOC	– FACE OF CURB	
FTS	– FOREIGN LINE TEST STATION	
GI	– GRATE INLET	
GIP	– GALVANIZED IRON PIPE	
GPL	– GAS PIPELINE MARKER	
GV	– GATE VALVE & ASSEMBLY	
GYA	– GUYWIRE ANCHOR	
HC	– HARRIS COUNTY	
HCFCD	– HARRIS COUNTY FLOOD CONTROL DISTRICT	
HCTRA	– HARRIS COUNTY TOLL ROAD AUTHORITY	
HMAC	– HOT MIXED ASPHALT CONCRETE	
HP	– HIGH PRESSURE	
HPS	– HIGH-PRESSURE SODIUM	
HVTL	– HIGH VOLTAGE TRANSMISSION LINE	
HWY	– HIGHWAY	
ICV	– IRRIGATION CONTROL VALVE	
ID	– INSIDE DIAMETER	
INV	– INVERT	
INTP	– INTERMEDIATE PRESSURE	
IP	– IRON PIPE	
IR	– IRON ROD	
ITS	– ISOLATION TEST STATION	
JT	– JOINT	
JUNCT	– JUNCTION	
LF	– LINEAR FEET	
LN	– LANE	
LPCB	– LOW PROFILE CONCRETE BARRIER	
LT	– LEFT	
LS	– LOW LIFT PUMP STATION	
MAX	– MAXIMUM	
METRO	– METROPOLITAN TRANSIT AUTHORITY	
MIN	– MINIMUM	
MH	– MANHOLE	
MON	– MONUMENT	
MP	– METER POLE	
N	– NORTH	
N/A	– NOT APPLICABLE	
NG	– NATURAL GROUND ELEVATION	
NHCRWA	– NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY	
NO	– NUMBER	
NTS	– NOT TO SCALE	
OCEL	– ON CURVE ELEVATION	
OFS	– OFFSET	
OH	– OVERHEAD	
PA	– PLANT AIR	
PC	– POINT OF CURVATURE	
PCC	– POINT OF COMPOUND CURVATURE	
PCCP	– PRE-STRESSED CONCRETE CYLINDER PIPE	
PED	– PEDESTAL	
PERM	– PERMANENT	
PGL	– PROFILE GRADE LINE	
ℙ	– PROPERTY LINE	
PI	– POINT OF INTERSECTION	
PLA	– PLASTIC	
PLM	– PIPELINE MARKER	
PLYPH	– POLYPHOSPHATE	
PM	– PROGRAM MANAGER	
PP	– POWER POLE	
PPC	– POWER POLE WITH CONCRETE	
PRES	– PRESSURE	
PROP	– PROPOSED	
PSW	– PLANT SURFACE WATER	
PT	– POINT	
PTS	– POTENTIAL TEST STATION	
PVC	– POLYVINYL CHLORIDE	
PVI	– POINT OF VERTICAL INTERSECTION	
PVT	– POINT OF VERTICAL TANGENCY	
PVMT	– PAVEMENT	
RCB	– REINFORCED CONCRETE BLOCK	
RCP	– REINFORCED CONCRETE PIPE	
RD	– ROAD	
REINF	– REINFORCED	
RIM	– RIM ELEVATION OF INLET/MANHOLE	
RJ	– RESTRAINED JOINT	
ROW	– RIGHT OF WAY	
RR	– RAILROAD	
RT	– RIGHT	
S	– SLOPE	
SDWL	– SMALL DIAMETER WATER LINE	
SHT	– SHEET	
SPEC	– SPECIFICATION	
STA	– STATION	
STL	– STEEL	
STM	– STORM	
SWBMH	– SOUTHWESTERN BELL TELEPHONE MANHOLE	
SWR	– SEWER	
TBM	– TEMPORARY BENCHMARK	
TOC	– TOP OF CURVE	
TCE	– TEMPORARY CONSTRUCTION EASEMENT	
TCM	– TELECOMMUNICATION CABLE MARKER	
TEL/TELE	– TELEPHONE	
THK	– THICKNESS	
TOE	– TOP OF ELEVATION	
TOP	– TOP OF PAVEMENT	
TS	– TRAFFIC SIGN	
TSB	– TRAFFIC SIGNAL BOX	
TSP	– TRAFFIC SIGNAL POLE	
TXDOT	– TEXAS DEPARTMENT OF TRANSPORTATION	
TYP	– TYPICAL	
UE	– UTILITY EASEMENT	
UG	– UNDERGROUND	
UPRR	– UNION PACIFIC RAILROAD	
VPI	– VERTICAL POINT OF INTERSECTION	
W	– WEST	
W/	– WITH	
W/O	– WITHOUT	
WL	– WATER LINE	
WLE	– WATER LINE EASEMENT	
WME	– WATER METER EASEMENT	
WWB	– WATER WALL BARRIER	
(R)	INFORMATION OBTAINED FROM RECORD DRAWINGS, NOT FIELD VERIFIED	
(NR)	NO RECORD INFORMATION FOUND	
(SUE)	INFORMATION OBTAINED FROM SUE	

NOTICE:
FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT LEAST 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS SIGNATURE DOES NOT FULFILL YOUR OBLIGATION TO CALL 811

VERIFICATION OF PRIVATE UTILITY LINES

Date
CenterPoint Energy natural gas utilities shown. (Gas service lines are not shown). This signature not be used for conflict verification.
Signature valid for six months.

Date
CenterPoint Energy/UNDERGROUND Electrical Facilities Verification ONLY. (This signature verifies existing underground facilities – not to be used for conflict verification)
Signature valid for six months.

Date
Approved for AT&T underground conduit facilities only.
Signature valid for one year.

NO.	DATE	REVISION	APP.

North Harris County REGIONAL WATER Authority

AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

[DESIGN CONSULTANT LOGO]

[DESIGN ENGINEER NAME]
[ADDRESS LINE 1]
[ADDRESS LINE 2]
PHONE:
TX FIRM NO.:

ENGINEER'S SEAL

[PROJECT NAME]
[PROJECT DESCRIPTION]
LEGEND AND ABBREVIATIONS
SHEET 2 OF 2

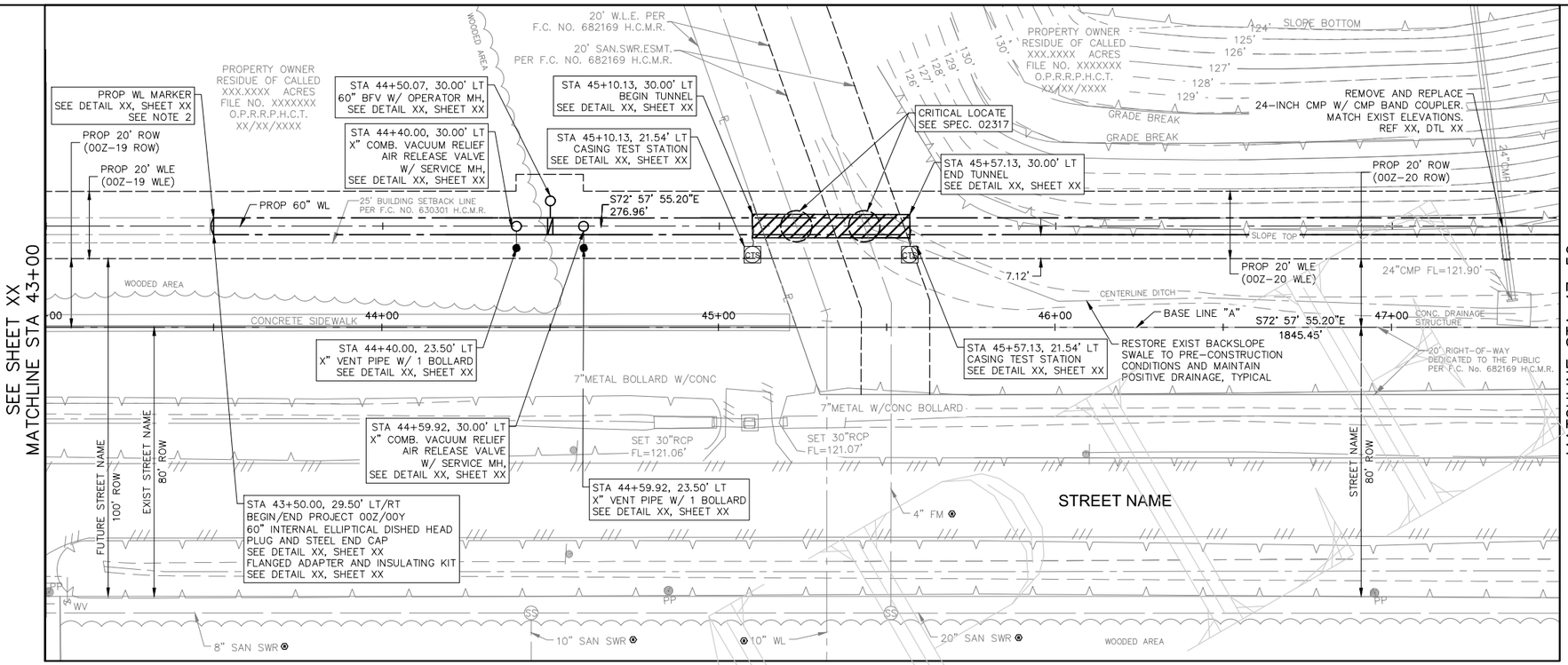
HORIZ: N/A
VERT: N/A

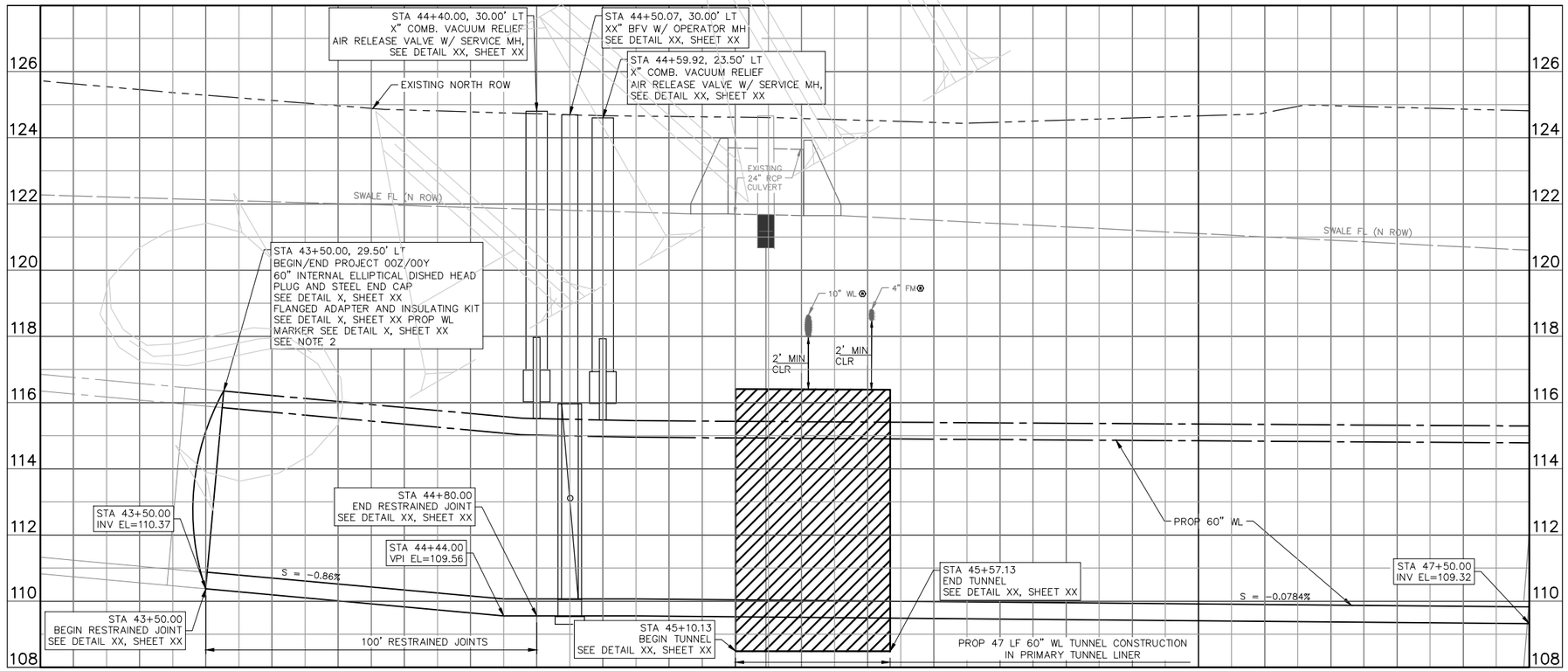
SHEET NO. ___ OF XXX

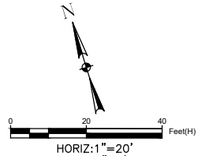
DRAWING SCALE

REVISION DATE: 09/10/2020

LAST MODIFIED: Sep 29, 2020 - 7:48am BY USER: berdugoo
DWG. LOCATION: C:\Users\berdugoo\Documents\AECOM\Projects\NHCRWA\CAD Standardization of Legend & Plot Style\2020-09-22\
DWG. NAME: Standardize Legend & Abbreviation Sheet - NHCRWA Border - 2020.09.22.dwg
PEN TABLE: NHCRWA-BW-HALF.CTB







NOTES:

1. EXCEPT FOR TREES SHOWN ON PLANS OR DETERMINED BY PROJECT MANAGER TO BE PROTECTED, CONTRACTOR SHALL CLEAR AND GRUB ALL TREES AND VEGETATION WITHIN LIMITS OF WATERLINE EASEMENTS (WLE). TREES AND PLANTS OUTSIDE LIMITS OF WATER LINE EASEMENTS OR SHOWN ON PLANS TO BE PROTECTED ARE TO REMAIN IN PLACE, PROTECTED FROM DAMAGE AND MAINTAINED BY CONTRACTOR. SEE SPECIFICATION 01562 FOR ADDITIONAL TREE AND PLANT PROTECTION REQUIREMENTS.
2. IN THE EVENT ADJOINING PROJECT 00Z IS COMPLETED AND HYDROTESTED BEFORE PROJECT 00Y, CONTRACTOR SHALL REMOVE THE EXISTING END CAP (BY OTHERS), CONNECT TO PROJECT 00Y AND REMOVE AN EXISTING 60" ELLIPTICAL DISHED HEAD PLUG (BY OTHERS).

BENCHMARK:

HC FLOOD PLAIN REF. MARK NO. XXXXXX
ELEV XXX.XX

FROM THE INTERSECTION OF XXXXXXXXXXXXXXXXXXXX AND XXXXXXXXXXXXXX, TRAVEL XXXX ON XXXXXXXXX X.X MILE TO BRIDGE. MONUMENT IS ON XXXXXXXXXXXXXXXXXX.

X = 3,XXX,XXX.XX Y = 13,XXX,XXX.XX

(NAVD 1988, 2001 ADJ.)

FLOOD PLAIN MANAGEMENT DATA:

100–YEAR FLOOD PLAIN WATER SURFACE ELEVATION WITHIN CHANNEL XXXX–XX–XX (XXXXXXXXXXXX) = XXX.XX AS PER THE FIRM MAP NO. 48201C0435M REVISED OCTOBER 16, 2013 NAVD 1988, 2001 ADJUSTMENT. THIS PROJECT IS LOCATED IN UNSHADED ZONE "X".

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[DESIGN CONSULTANT LOGO]

[DESIGN ENGINEER NAME]
[ADDRESS LINE 1]
[ADDRESS LINE 2]
PHONE:
TX FIRM NO.:

ENGINEER'S SEAL

PROJECT 00Z
PROP. 60" WATERLINE
PLAN & PROFILE
STA 43+00 TO STA 47+50

HORIZ: 1"=20'
VERT: 1"=2'

SHEET NO. ___ OF XXX

DRAWING SCALE

REVISION DATE: 09/28/2020

PEN TABLE: NHCRWA–BW–HALF.CTB
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Chapter 5

Augering and Tunneling Guidelines Within Texas Department of Transportation Rights-of-Way

5.1 GENERAL

The selected water main routes will result in several crossings of the Texas Department of Transportation's (TxDOT) rights-of-way. These guidelines have been developed to assist the Design Engineers with the development of their crossing details.

The policy of TxDOT is to have a water main encased when crossing their right-of-way in the interest of public safety. Traditionally, encasement of a water main has been accomplished through the use of smooth wall welded steel pipe; however, due to the construction methods proposed in the Program, general guidelines are presented herein and are to serve as general policies for the development of crossing details.

Critical in the development of the crossing details is the determination of the proposed method of construction (e.g., open cut, augering, or tunneling).

5.2 GUIDELINES

Generally, this type of water line construction under a TxDOT right-of-way is used for the smaller pipe sizes, such as 20 inch and smaller. Augering within TxDOT rights-of-way generally involves the use of a casing, which serves as the spoil removal system. As the auger advances, the casing pipe is advanced.

5.2.1 Augering

A wet auger (slurry auger) procedure using minimal water for lubrication may also be used. Jetting is not allowed. TxDOT will provide a permit inspector who will observe the use of water used for lubrication to guard against over-bore while constructing the crossing.

When designing a water main crossing of a TxDOT right-of-way and augering is specified or anticipated, a casing pipe shall be specified. The casing pipe shall be in accordance with the provision of the Standard Specifications and the latest AWWA and TxDOT specifications. The annulus between the casing and the surrounding soil does not require grout unless the contractor has, in the opinion of the TxDOT inspector, over-cut the hole. The proposed water main is to be installed within the casing pipe. Refer to the Standard Specifications for how the water main is to be installed within the casing.

5.2.2 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 pipe placement 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 piping system.

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

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

2. 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 carrier pipe must be grouted. Grouting between the carrier pipe and liner can be performed after the completion of the water line installation.

3. Smooth wall welded steel pipe casing, in accordance with the 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 and is cathodically protected. Grout is required between the casing and all carrier pipe with a diameter of 36 inches and greater.

4. The use of jacked reinforced concrete pipe is acceptable provided the pipe is specified with gasketed joints. The annulus between the soil and the reinforced concrete pipe must be grouted. Grout is not required between the liner and carrier pipe with a diameter less than 36 inches provided the reinforced concrete pipe is designed to carry all loads. Grout is required between the liner and all carrier pipe with a diameter of 36 inches and greater.

5.2.3 Open Cut

TxDOT will allow open-cut construction within their right-of-way when the State roadway is elevated and the pavement below the elevated section is not maintained by TxDOT. Under this application, a smooth wall welded steel casing or a smooth wall welded steel split casing shall be used as encasement methods. The steel casing shall be in accordance with the Standard Specifications and the latest AWWA specifications. Grout between the soil and steel casing is not required.

Extreme care should be exercised in selecting the alignment of this type crossing to maximize the horizontal distance from the bridge abutments and columns to the trench wall. The Program requirements

for minimum cover over a water main will apply within the TxDOT right-of-way.

5.2.4 General

Well point systems will not be permitted within the TxDOT right-of-way.

Generally, when tunneling, access pits shall be constructed at least 5 feet behind the curb or 10 feet outside the edge of pavement in the case of an open ditch section. Use bracing to stabilize the soil and to avoid a shaft failure and possible pavement system damage. Locate shafts outside the TxDOT right-of-way whenever possible. Furthermore, additional rights-of-way and temporary easements should be avoided.

If required by TxDOT, markers will be installed at the right-of-way line to mark the crossing locations. The marker should indicate the water line size and the agency to contact for information on the water line.

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

Any TxDOT right-of-way marker that will likely be destroyed during construction shall be identified to be replaced. Furthermore, any right-of-way marker required to be moved during construction shall be installed at its original location and to its original condition.

TxDOT specifications shall be reviewed and included, where appropriate, in the project construction as specifications.

5.3 PROCEDURES

The Design Engineer will submit the permit application for the crossing including all crossing details to TxDOT. The Design Engineer will provide all engineering data necessary to obtain the permits. The permit application will be filed no earlier than the 50% Submittal and no later than the 95% Submittal, depending on the complexity of the proposed crossing.

The Design Engineer should request crossing design guidance and background (record drawings) and right-of-way information from TxDOT.

The traffic control plan must be approved by the TxDOT Area Engineer. The Design Engineer shall also be responsible for obtaining this approval.

Chapter 6

Specification Development

6.1 GENERAL

The Program Manager has developed bidding documents for use on water main construction projects, which the Design Engineer is to utilize for his project. However, each project within the Program is unique and may require project-specific construction specifications or special provisions.

The Design Engineer will be provided with an electronic set of bidding documents, which will include construction specifications and details. The Design Engineer should review this information and recommend any changes related to their specific project or other needs to the Program Manager.

At the approximate 75% completion level of the project, the Design Engineer is to submit preliminary "redlined" bidding documents to the Program Manager for review. As appropriate, suggested revisions will be incorporated into "Supplementary Specifications" that will supersede the published technical specifications. 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, are to be developed by the Design Engineer. These specifications will also contain the project's information within the header.

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 publish 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:

- Notice to Bidders
- Instructions to Bidders
- Bid Form
- Contractor's Qualification Statement
- Contract for Construction
- Bid Guarantee & Bonds
- General Conditions of the Contract for Construction

- Supplementary Conditions
- Special Conditions

The front end portion of the Contract Documents is to be prepared by the Design Engineer between the 95% and 100% Submittal marks. Changes may be made to the frontend documents during this period.

6.2 SCHEDULE

The specification schedule is shown below:

Milestone	Action
50% Review	Design Engineer receives sample Contract Documents, including the Technical Specifications.
75% Review	Design Engineer submits comments on the specifications to the Program Manager. This is to be done by Design Engineer sufficiently in advance to permit the Design Engineer to comply with agreed schedule for the 95% Submittal.
95% Review	Design Engineer submits up to five sets of the 8 ½-inch by 11-inch Final Bidding Documents to the Program Manager for the 95% Review Submittal.
100% Submittal	If necessary, comments made by Program Manager are addressed and word processing effort repeated. Design Engineer submits Final Bidding Documents to enable Program Manager to advertise and receive bids on CivCast.
Final Reproduction	Design Engineer submits the required number of the Final Bidding Documents.
Addenda	Design Engineer submits appropriate addenda to questions relating to Bidding Documents.

Chapter 7

Support Services

7.1 GEOTECHNICAL

7.1.1 Introduction

The purposes of the geotechnical investigation are to evaluate the existing soil conditions along the proposed water main route and to provide recommendations to the Design Engineers concerning the design aspect of the project. These recommendations include sheeting, shoring, and/or bracing requirements for construction. If required, the Design Engineer will perform the investigation to determine the level and extent of potential environmental contamination (ESA Phase II).

Design Engineer's Role

- Work with Geotechnical Consultant to develop proper scope for project.
- Provide survey information of the borings (after drilling) to Geotechnical Consultant to use in the report.
- Provide the base map for Geotechnical Consultant to use as the Boring Plan.

7.1.2 Program Criteria

Verify geotechnical investigation performed by Geotechnical Consultant for conformance with these guidelines, project specific conditions and design requirements. In order 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:

- Standard Specifications
- Standard Details
- Various ASTM standards for geotechnical analyses
- Unified Soil Classification System (USCS)
- OSHA Soil Types
- Laboratory tests shall be performed by Geotechnical Consultant with current accreditation by the American Association of Laboratory Accreditation (A2LA).
- For tunnels/trenchless sections, perform continuous soil sampling from 5 feet above the excavation crown to 5 feet below the excavation invert level.

7.1.3 Standard Details

The standard bedding and backfill details and tunnel details are subject to change. Therefore, it is the Geotechnical Consultant's responsibility to verify whether these details apply.

7.1.4 Site Access

Unless otherwise agreed, the Geotechnical Consultant shall obtain permits 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 Program Manager, 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).

7.1.5 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),

The recommended boring spacing and depths are given in Table 7.1, unless otherwise authorized by the Program Manager. Additional borings at a closer spacing may be required to define stratigraphic anomalies or to define soil conditions within tunnel shafts, auger pits, or other areas of inconsistent stratigraphy. The scope may need to be expanded or modified on a case by case basis as determined necessary by the Program Manager and Geotechnical Consultant.

The Geotechnical Consultant should be provided with a copy of the proposed water main alignments, as determined at approximately the 10 percent review level and once the alignment issues have been resolved. Where possible the borings should be drilled on the centerline along the proposed alignment. For proposed tunnel/trenchless sections, borings shall be drilled outside the alignment but within 20 feet of the centerline of the alignment. If utility conflicts prevent this from occurring, the Geotechnical Consultant shall attempt to relocate the boring longitudinally along and within the proposed trench prior to moving outside the trench area. Geotechnical Consultant shall look for obvious signs of visual staining of the soil in the samples, note any odors and identify such in the report. Proposed soil boring locations, including pavement cores, are subject to approval by the Program Manager.

Table 7.1		
UNDERGROUND UTILITIES		
Construction Type	Approximate Spacing	Minimum Depth
Open Cut	500 feet ≥ 24-inch diameter 750 feet ≤ 20-inch diameter	o 15 feet for trenches up to 10-foot deep o Trench depth plus 10 feet for trenches between 10-foot and 25-foot deep. o One and one half times the trench depth for trenches 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-foot below the proposed invert level (whichever is greater).
Shafts for Tunnels	I per tunnel. At each location if shafts >100 feet apart	1.5 times the shaft diameter below the bottom of the shaft but not less than 30 feet.

ln addition, all excess core samples are to be maintained by the Geotechnical Consultant until Cathodic Protection recommendations are made. The Geotechnical Consultant will provide excess core borings to the Corrosion Consultant.

7.1.6 Piezometers

Piezometers may 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.

d. Tunneling (hand or Tunnel Boring Machine) or Microtunneling installation for an extended length.

Piezometers shall be installed in accordance with the applicable rules and regulations of the Texas Department of Licensing and Regulation (TDLR).

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.

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 tunnel is for an extended length > 100 feet..

A piezometer installation report shall be included in the geotechnical investigation report.

7.1.7 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.

7.1.8 Backfill of Boring

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.

7.1.9 Boring Logs

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

- Project number
- Boring number
- Boring location – station and either offset or distance from curb and one other semi-permanent feature

- Date of field work
- Depth to groundwater (both at end of drilling and 24-hour readings)
- Depth to caving
- Completion depth
- Soil and sample symbology
- Soil description
- Geotechnical analytical data

7.1.10 Geotechnical Report

A sample table of contents is included as *Exhibit 7-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 Program Manager. The Design Engineer's comments and Program Manager's comments are to be addressed by the Geotechnical Consultant prior to finalizing the report.

Submit a separate Geotechnical Letter Report for Trench Safety that meets the requirements of State law. The letter report will be included in the Contract Documents.

When a project involves special structures, provide a copy of the final structural design to the Geotechnical Engineer who performed the initial Geotechnical recommendations. The Geotechnical Engineer will review the soil foundation design for the special structure and will verify that the Soil Foundation recommendations were interpreted properly.

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 gathered during the records review, are to be included in the Geotechnical Engineering Recommendations section of the report. The logs are also to be included in an appendix.

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

1.0 Introduction

1.1 General – Refer to the project number

1.2 Location and Description of the Project

1.3 Scope of Work – Summarize scope of work outlined in cost proposal and task order.

2.0 *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. The Geotechnical Consultant is to look for any signs of visual staining of the samples, 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.

3.0 *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.

4.0 *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 the soils encountered along the proposed alignment, noting any anomalies or features which could inhibit construction such as sands, Recognized Environmental Conditions (RECs), 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 the length of the project. This requirement should be discussed between the Design Engineer and the Geotechnical Consultant 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.

5.0 *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 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, tunneling, and shafts.

5.3 Vehicular Traffic and Railroad Loads – Include backfill and bedding operations and example calculations for overburden soils pressures and liner loads in this section. Include project specific vehicular and 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: The 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.

6.0 *Limitations*

7.0 *Authorization and Credits*

8.0 *References*

7.2 ENVIRONMENTAL SITE ASSESSMENTS

7.2.1 Introduction

The Design Engineer will provide an Environmental Site Assessment (ESA). The Design Engineer is required to check the environmental assessment work provided by the Environmental Consultant for conformance with project specific conditions and design requirements. The purpose of this document is to present guidelines for the performance of Phase I and Phase II ESAs. These studies would be performed for property acquisition and for linear projects in areas planned for facility construction and operation. The purpose of these studies is not to determine regulatory reporting or cleanup (remediation) requirements, or to determine where contamination may exist outside the proposed project area.

These guidelines address the scope of work for Phase I ESAs and Phase II ESAs. Phase I ESAs consist of environmental and past land use records collection and review, site inspection, interviews, and

reporting. Field investigations that include environmental sampling, laboratory testing/analysis of samples, regulatory standard review, recommendations, and reporting are considered Phase II or Environmental Investigations in this document. The more extensive Phase II ESA is performed when the Phase I ESA reveals an area of environmental concern at the property under investigation.

The Phase I ESA will identify recognized environmental conditions at properties encumbered by the presence or likely presence of any hazardous substances or petroleum products due to (1) any release to the environment; (2) conditions that indicate a release has occurred; or (3) a material threat of a future release to the environment. Deminimis conditions that generally do not present a material risk of harm to public health or the environment are not recognized environmental conditions (RECs). Contamination at properties adjacent to the subject property may migrate into the construction zone or later adversely impact operations. The Phase II ESA investigation will be performed to evaluate how existing RECs may affect the design, construction and operation of the proposed facility.

7.2.2 Phase I ESA Goals and Procedures

The Phase I ESA will generally include the following tasks:

a. Environmental records search and historical site documentation review for potential sources of contamination with respect to the selected alignment or facility location. Records search will be in accordance with recognized industry practice and standards (i.e., ASTM E1527).

b. The records search will typically include, but not be limited to, the following data sources:

	Approximate Minimum Search Distance, miles (kilometers)
Federal NPL site list	1.0 (1.6)
Federal Delisted NPL site list	0.5 (0.8)
Federal CERCLIS site list	0.5 (0.8)
Federal CERCLIS NFRAP site list	0.5 (0.8)
Federal RCRA CORRACTS facilities list	1.0 (1.6)
Federal RCRA non-CORRACTS TSD facilities list	0.5 (0.8)
Federal RCRA generators list	property and adjoining properties
Federal Institutional control/engineering control registries	property only
Federal ERNS list	property only
State and tribal lists of hazardous waste sites identified for investigation or remediation:	

State and tribal equivalent NPL	1.0 (1.6)
State and tribal equivalent CERCLIS	0.5 (0.8)
State and tribal landfill and/or solid waste disposal site lists	0.5 (0.8)
State and tribal leaking storage tank lists	0.5 (0.8)
State and tribal registered storage tank lists	property and adjoining properties
State and tribal institutional control/engineering control registries	property only
State and tribal voluntary cleanup sites	0.5 (0.8)
State and tribal Brownfield sites	0.5 (0.8)

Other types of environmental records maintained by the Department of Health/Environmental Division, Fire Department, local or regional planning department or agency, local building permit/inspection department, local/regional pollution control agency, local/regional water quality agency, local/regional oil and gas well permit/closure agency, or local electrical utility companies (for records relating to PCBs). The records accessed may include local or area Brownfield sites, landfill/solid waste disposal sites, including HGAC's closed landfill inventory (CLI), hazardous or contaminated site lists, locally registered petroleum storage tanks, local land records (for activity and use limitations), records of emergency release reports (42 U.S.C. 11004), and records of contaminated public wells. Reviews of regulatory records and files will be conducted to identify RECs, historical REC, controlled REC, and de minimis conditions.

If regulatory records indicate that an LPST site or National Priorities List (Superfund) facility are located within 500 feet of the subject property, the latest comprehensive assessment or monitoring report available from the TCEQ or the Harris County Pollution Control Services Department shall be reviewed and summarized in the Phase I ESA report. If an LPST site is identified, TCEQ records and files will be reviewed to determine the extent of soil and/or groundwater contamination and the remediation status so that the appropriate REC determination can be made. If a Federal NPL site is located within approximately 1/4 mile of the site available records and files maintained by the public library shall be reviewed and summarized in the Phase I ESA report.

The historical records and document review to establish past uses of the subject property shall include a desk-top evaluation for the potential presence of waters of the United States, including wetlands resources. Historic aerial photographs and historical U.S. Geological Survey topographic survey maps shall be obtained and rectified. Infrared and digital ortho-photo quarter quadrangle (DOQQ) maps

shall also be obtained along with the appropriate National Wetland Inventory (NWI) maps developed by the U.S. Fish and Wildlife Service. Maps of the subject property shall be developed to include the boundaries of the 100-year and 500-year floodplain, historic and existing stream channels, and possible wetlands and surface water bodies to be included in the Phase I ESA report.

In addition to the records review, the Phase I ESA will also include the following tasks:

- A site reconnaissance of the property will be made to visually and physically observe the subject property and any structures not obstructed from view. The site reconnaissance will be conducted to identify RECs in connection with the subject property.

- The site reviews will also include interviews with current owners/occupants and appropriate government officials as appropriate. The interviews will include discussions with owners and/or occupants of the property who are knowledgeable of the present and past uses and physical characteristics of the property. Interviews will also be conducted with appropriate governmental officials to obtain any known information regarding environmental hazards associated with the property. (Examples of governmental officials that may be interviewed include local fire, health, environmental, solid and hazardous waste regulatory agencies.)

The results of the environmental records search will be adequately documented to identify the methodology used, the records reviewed, and the results of the assessment. Sites which have the potential for presence of hazardous substances or petroleum products (RECs), wetlands, and floodplains will be clearly identified and shown on a map.

To the extent practicable, interviews shall be conducted with owner or occupants of facilities immediately adjacent to the subject property as follows:

- All commercial businesses that typically use hazardous chemicals or petroleum substances, such as dry cleaners, photo developers, mortuaries, gasoline stations, and automotive service centers.

- Selected or representative commercial establishments that do not typically use hazardous chemicals or petroleum substances.

- All facilities identified in the regulatory records review and all industrial facilities in the project vicinity.

If the site is an area of known oil and gas production operations, an oil and gas records survey shall be included in the Phase I ESA. Contamination or releases from these areas are subject to the Railroad Commission of Texas regulations related to environmental release determination, release reporting, cleanup, closure, and well plugging.

The Phase I ESA report shall identify RECs and make recommendations for a Phase II ESA, as appropriate. These recommendations shall be based on the presence of RECs and shall be of sufficient detail to establish the requirements (work plan) of a Phase II ESA investigation. Phase I ESAs shall conform to ASTM E1527 report format to the extent possible and text sections, figures and appendices shown in the sample *Table of Contents* in the attached *Exhibit 7-B.*

7.2.3 Phase II ESA Goals and Procedures

The goals of the Phase II ESA would be:

- Determine the approximate source, extent, and nature (liquid, absorbed, vapor, and dissolved phases) of hydrocarbon or other suspected contaminants in the proposed project ROW.
- 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 activity in the area, including geotechnical investigation and construction.

7.2.3.1 Referenced Standards

Phase II ESA 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 the 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 may be obtained from a Texas accredited laboratory.

The Phase II ESAs or environmental investigation reports will include text sections, tables, and figures shown in the sample *Table of Contents* in the attached *Exhibit 7-C*. The environmental investigation data will be presented using the methodology described in *Section 7.2.4*. All soils shall be classified using the Unified Soil Classification System (USCS).

The Phase II ESA 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 planned facilities will be provided in a suitable scale considering the extent of the investigation and the details to be displayed. The locations of borings from previous investigations will be shown together with borings and other explorations performed for the project.

- Soil classification
- Detection of hydrocarbon or other odors
- Visible hydrocarbon or other contamination (if present, include the degree, location, and extent of staining)

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

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

Organic vapor screening of sample head space will be performed in the field as this will impact 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:

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

2. Total Petroleum Hydrocarbon (TPH) testing is required for screening of 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.

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

4. Analysis for the presence of polynuclear 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 pipeline, whichever is shallower. Borings may be advanced to greater depths if warranted by site-specific circumstances. Borings maybe terminated at a shallower depth, at the discretion of the Engineer/Geologist.

7.2.3.2 Planning

Based on the findings of the Phase I ESA, RECs may have been identified in connection with or adjacent to the proposed ROW or property.

After the Phase I ESA has been completed, the need for additional investigation of documented contaminated areas will be identified. Phase II ESA field work will be based on the results of the Phase I ESA, identification of REC's, and recommendations of the Phase I ESA. Phase II ESA will not be performed to determine remediation requirements but to identify areas that may affect the proposed project as planned.

7.2.3.3 Health and Safety

A health and safety plan will be prepared prior to drilling. As a minimum, the plan will 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.

7.2.3.4 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 7.1.9, Boring Logs* for required information.)

1. The subcontractor will locate underground utilities, contact local call before digging services, and obtain any permits necessary.

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

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

4. For each boring, split-spoon or Shelby tube samples will be collected continuously to the total depth of the boring. Soil sample descriptions to include those described by *Section 7.1.9, Boring Logs*, as well as measurements of monitoring collected per sample and depth to groundwater.

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.

7.2.3.5 Phase II ESA Report and Contaminant Identification

The Phase II ESA 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 reported 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).

7.2.3.6 Extent of Contaminant

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

7.2.3.7 Impact on Planned Construction

The Phase II ESA report will 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:

- Comparison of contaminant concentration to regulatory criteria (PCLs).
- Identification of specific health and safety measures, which may be followed to allow planned construction to proceed.
- Potential for contaminated runoff entering the work area.
- Potential effects of contaminated media on long-term durability of the installation of facility operation.

The Phase II ESA report will 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.

7.2.3.8 Phase II ESA Report Recommendations

The Phase II ESA report will 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 Phase II ESA will describe the disposition of drill cuttings and well purge water will be in accordance with Federal, State, and/or local regulations. If off-site disposal is necessary, the cuttings and well purge water will be containerized and clearly labeled until they can be removed from the site. Wastes will be of disposed within a 60-day time frame. All completed waste manifests are to be returned to

the Program Manager. Chain-of-custody documentation will be provided for all samples submitted for laboratory analysis.

7.2.3.9 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 may need to be collected.

7.2.3.10 Analytical Sampling

The analytical methodologies are to be determined based on the nature of the potential contaminant as described in *Section 7.2.3.7*. 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 will include the following information:

- Date of collection
- Date of extraction, analysis, and report
- Extraction and analytical methods used
- Method detection limits
- Standard utilized in the analysis
- Sample identification number and depth
- Laboratory QA/QC report

7.2.4 Phase II ESA Evaluations and Recommendations

The site characteristic and soil characteristics of significance to the design and construction work 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. Geologic characteristics which affect the migration potential of a contaminant will be addressed. Geotechnical soil testing will include shear strength, grain size, compressibility, and unconfirmed soil strength, as appropriate.

7.2.4.1 Site Characterization

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

EXHIBIT 7-A

GEOTECHNICAL REPORT

Sample Table of Contents

EXHIBIT 7-A (Continued)

Sample Table of Contents (Continued)

EXHIBIT 7-B

PHASE I ENVIRONMENTAL SITE ASSESSMENT

Sample Table of Contents

EXHIBIT 7-C

ENVIRONMENTAL INVESTIGATION REPORT
Sample Table of Contents
ASTM D1903 Appendix X3

7.3 CATHODIC PROTECTION

7.3.1 Introduction

A Cathodic Protection study will be conducted after the specific water line alignment has been determined. The study will be performed after the 50% review and will be forwarded to the Design Engineer after its completion. Based upon the results and recommendations from the cathodic protection study, the Design Engineer will incorporate the appropriate details, show location, and test stations, etc.

7.3.2 Corrosivity Study

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

- 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.
- The proposed pipeline will be surveyed with respect to crossing of foreign pipelines and paralleling utility systems. Specifically, existing cathodic protection systems and locations for foreign line test stations will be identified.
- 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.
- The proposed pipeline alignments will be surveyed to locate areas where AC power is available should impressed current protection be required.
- 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.

7.3.3 Corrosion Protection Design

The corrosion protection design will consist of a number of activities:

- Soil samples provided by the geotechnical firm shall be laboratory tested.
- A design report will be prepared and submitted that will describe the corrosion protection requirements for the following:
    - Dielectric Coating Materials
    - Cathodic Protection System Type
    - Anode Requirements
    - Test Station and Permanent Reference Cell Requirements

- Electrical Isolation
- Stray Current Control
- Cased Crossings
- Foreign Line Test Stations
- Treatments for Lateral Line Connections

- In addition to the above, the standard details that are applicable to the project for each pipe type will be compiled and submitted as an Appendix.
- Any changes that are required to the general SWTP specifications shall be submitted.
- Following preparation of the design drawings and specifications, cathodic protection contractor will review the documents to ensure compliance with the requirements.

Chapter 8

Contract Reviews and Reports

2025 Water Distribution and Transmission System

8.1 Approval/Permit Checklist [1]

Water Project No.: _____

Contract No.: _____

Program Manager Coordinator: _____

Design Engineer: _____ Phone No.: _____

APPROVAL/PERMIT	RESPONSIBLE	DATE SUBMITTED	DATE APPROVED	COMMENTS
Underground Utilities CenterPoint Energy (Electric)	Design Engineer			
CenterPoint Energy (Gas)	Design Engineer			
AT&T	Design Engineer			
Other Telephone	Design Engineer			
Fiber-Optic	Design Engineer			
Oil & Gas Company(s)	Design Engineer			
Cable TV	Design Engineer			
Other	Design Engineer			
Right of Way Temp. Construction Easement	Design Engineer			
Railroad Notification & Approval	Design Engineer			
Right-of-Entry	Design Engineer			
County/State HCTRA	Design Engineer			
Harris Co. Flood Control	Design Engineer			
Harris Co. Right-of-Way Permit	Design Engineer			
Texas Dept. of Transportation	Design Engineer			
Miscellaneous				

(1) ***The purpose of this checklist is to serve as a reminder to the Design Engineer of the approvals needed through the design process***.

2025 Water Distribution and Transmission System

8.2 Plan Review Summary

Plan Review	Action
50%	Design Engineer delivers 3 full-size and 2 half-size sets of plans. AECOM reviews the sets and returns these sets to the Design Engineer with comments.
75%	Design Engineer submits 5 sets of the contract documents and technical specifications and 3 full-size and 2 half-size sets of plans with traffic control plan to AECOM for review. AECOM returns specifications and plans to the Design Engineer with comments. May include initial review submittal (electronic) to TWDB.
95%	Design Engineer delivers 3 full-size and 2 half-size sets of plans and the 50% and 75% review sets to AECOM for review. Five copies of the contract documents and technical specifications are also to be delivered. A draft 100% design report is also submitted. AECOM forwards the sets for review by the Authority and returns these sets to the Design Engineer with comments.
TCEQ Submittal	Design engineer delivers 2 half-size sets of plans and 2 copies of the bid form with quantities along with the technical specifications. These four documents are to be sealed, signed, and dated.
100%	Design Engineer delivers 3 full-size and 2 half-size final plans and the 95% review set to AECOM along with up to 5 bound sets of contract documents and technical specifications. Provide Engineer's estimate of probable construction cost.
TWDB Submittal	Design engineer delivers one full-size and one half-size set of final plans and two sets of bound specifications for TWDB Final review. Documents shall be sealed, signed, and dated.
Bid Phase	Design Engineer delivers CD with PDF scan of each approved plan sheet, along with an unbound set of contract documents and technical specifications.
Construction Phase	Design Engineer delivers CD with PDF scan of each approved plan sheet and any addendums issued.
Record Drawing	Design Engineer delivers original signed construction plans with changes reflected by contractor and AECOM. Record drawing stamp, engineer's seal, date, and signature to be on every sheet of the PLANS. 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 on his CAD system, then plot a new set of Mylars. Deliver along with the new Mylars and the original signed PLANS.

2025 Water Distribution and Transmission System

8.3 Monthly Progress Report

8.3.1 Utilize Standard Project Dashboard

8.3.1.1 Incorporate Gantt style Project schedule.

8.3.1.2 Identify accomplishments from the current reporting period.

8.3.1.3 List anticipated major activities for the next reporting period.

8.3.1.4 Identify any outstanding issues or issues that required input from the Program Manager or NHCRWA.

8.3.1.5 Provide any updates available to the Opinion of Probable Construction Cost.

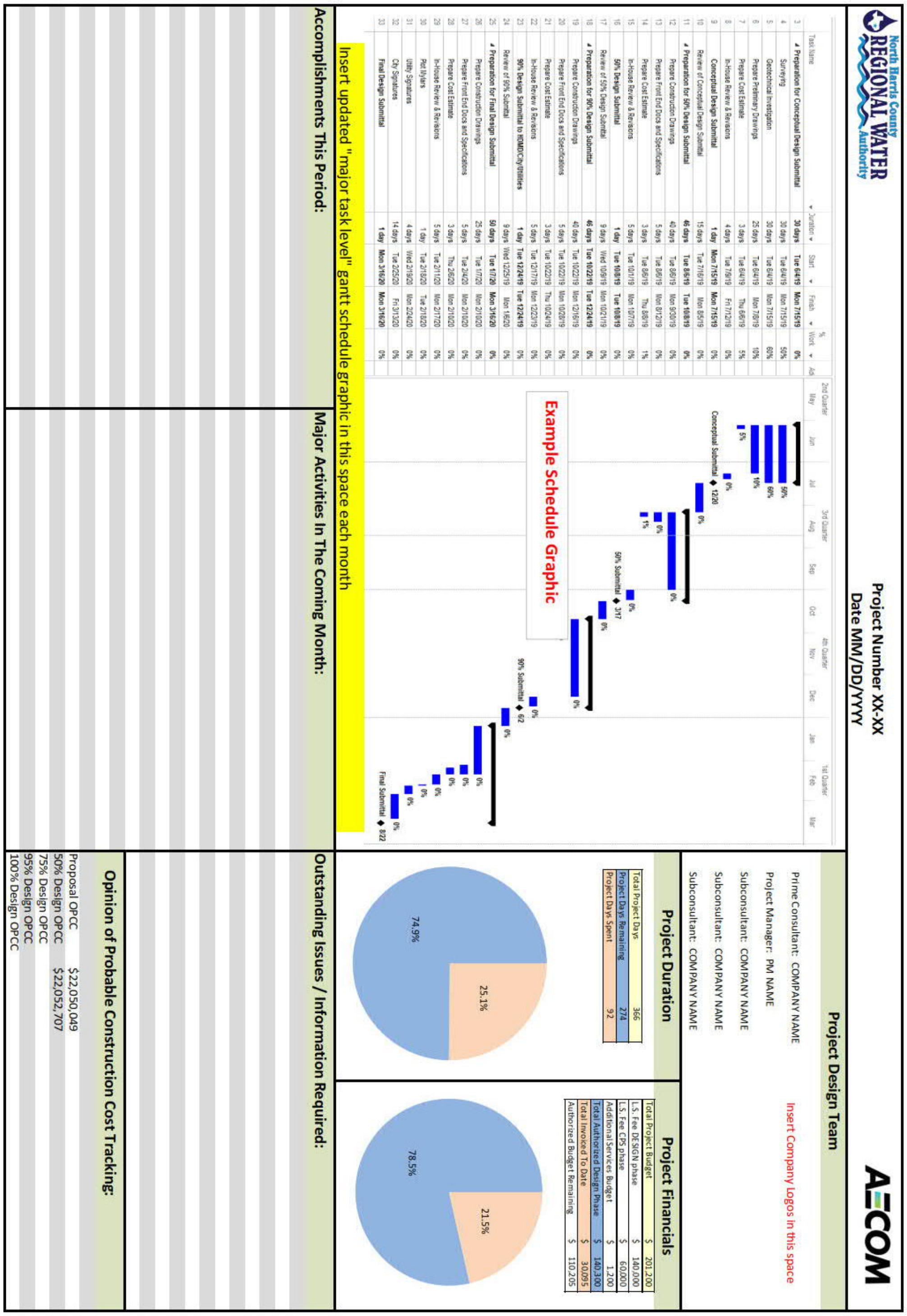
8.3.2 Project Duration

8.3.2.1 For purposes of Monthly Progress reporting, the reported project duration would be the days from the issued notice to proceed versus the agreed days to complete final Engineering Services, excluding any duration for Construction Phase Services.

8.3.3 Project Financials

8.3.3.1 For purposes of Monthly Progress reporting, the reported project financials shall be based upon the current invoiced amount versus the current authorized amount, excluding any Construction Phase Services authorization amount. Any Additional Engineering Services that require specific authorization by the Program Manager prior to performing the service and have not had such authorization issued should also be excluded from this calculation.

Monthly Progress Report Template



2025 Water Distribution and Transmission System

8.4 Estimated Completion Level by Sheet Per Review

Sheet Name	50% Review	75% Review	95% Review	100% Review
Cover Sheet/Vicinity Map	90%	100%	100%	†
Index Sheet	90%	90%	100%	†
Construction Notes	75%	90%	100%	†
Sheet Layout and Core Boring Plan	75%	90%	100%	†
Baseline Ties/Bench Marks	75%	90%	100%	†
Monumentation	75%	90%	100%	†
Plan/Profile Sheet(1)(3)	75%	90%	100%	†
Standard Details	50%	90%	100%	†
Special Details	25%	75%	100%	†
Cathodic Protection(2)		25%	100%	†
Traffic Control	25%	90%	100%	†
Final Design Report			90%	100%
Specifications	10%	75%	100%	†

† – 100% Complete and Signed

(1) – Show proposed utility relocations.

(2) – Cathodic Protection study should be requested no later than the submission of the 75% submittal.

(3) – Submit preliminary one-line vertical profile with 50% review.

2025 Water Distribution and Transmission System

8.5 Preliminary Engineering Report

1. Alignments
    a. Horizontal
    b. Vertical
    c. Factors Affecting Vertical and Horizontal Alignments
2. Construction Constraints
3. Construction Easement Requirements
4. Utility Easement Requirements
5. Easement/Street Crossing Constraints
6. Proposed Connections
7. Utility Relocations
8. Utility Outages
9. Pipe Materials
10. Special Problems
11. Cost Estimates
12. Operational Analysis

2025 Water Distribution and Transmission System

8.6 Final Design Report

1. Special Consideration (narrative; include sketches/photos if appropriate)

    a. Easements
    b. Constructability
    c. Utility relocations (public and private)
    d. Special Provisions to Technical Specifications (list unique items and provide narrative)
    e. Geotechnical Report
    f. Environmental Reports
    g. Surge Analysis
    h. Other

2. Design

    a. Pipe design (AWWA Manual M-11, M-9)
    b. Thrust restraint calculations
    c. Tunnel liner calculation
    d. Pavement replacement design
    e. Horizontal control of pipe segments (a.k.a. pipeline closure)
    f. System connections
    g. One-line vertical profile
    h. Major product cut sheets and sources on products
    i. Disturbed area calculation
    j. Vertical alignment plotted on the geotechnical subsurface profile

3. Approval

    a. Regulatory approval correspondence
    b. Permits
    c. Quality control comments
    d. Project walk, verification letter

4. Construction Cost

    a. Engineer’s estimate (including back-up)
    b. Quantity takeoff (on sheet-by-sheet basis)

A draft version of the above items is to be submitted along with the 95% Submittal. At the completion of the design effort (100% Submittal), final Design Report in a format approved by the Program Manager.

Chapter 9

Contract Administration

9.1 SCHEDULE

A Project Schedule will be developed and submitted by each Design Engineer with their Proposal for Professional Engineering Services based on the scope of work. Each activity within the Schedule will have its own weighting and these should be used as the basis for overall Progress Reporting. The Project Schedule should include all major milestone activities and identify the critical path to Project completion.

9.2 PROGRESS DASHBOARD

A Project Dashboard for each Design Contract will be prepared and updated monthly. This will serve as backup for the Monthly Invoices submitted by the Design Engineers. The Project Dashboard will incorporate a schedule of the major activities from the Project Schedule along with the major milestones (Partial Review, 50% and Final Drawing Submittal, etc.). The Design Engineer should also incorporate topics they consider appropriate for the monthly report along with a brief summation of the past month's activities. Next month's anticipated accomplishments and any special problems are to be included in the report. Monthly Progress Dashboards are to be submitted whether or not an invoice is submitted.

9.3 INVOICING

Monthly Progress Invoices consist of the following items:

- Estimate for Payment,
- Standard Estimate Cover Page
- Project Dashboard

These invoices must be received by the Program Manager prior to the monthly invoice date established in the Agreement for Professional Engineering Services between the NHCRWA and the Consultant. No charges for services beyond those formally authorized shall be included. Invoices are to be submitted with backup invoices from all subconsultants being utilized. Invoices are to be submitted via PMIS document management system.

9.4 DOCUMENT MANAGEMENT

The Program Management Information System (PMIS) is comprised of electronic processes, procedures and systems necessary to provide a continuous, consistent, systematic and integrated process for monitoring, tracking, forecasting and controlling the Program, project data and documents. Proper management of information facilitates the timely and proper distribution of documents to the Program Management Team, other internal and external stakeholders, and third

parties. The ability to store, readily share, and retrieve documents, data, reports, and similar instruments are examples of the program's viability for successful execution and completion. Based on the overall Program status, the Program Management staff can formulate alternatives, make decisions, and implement appropriate actions in a timely and cost-effective manner. The PMIS is configured to the Authority processes to manage the capital dollars and documents related to traditional PMCM engagements.

The PMIS is comprised of two major components:

a. Proliance – A Document Management System (DMS) that is to be used for document transmittal, distribution control, and information management.

b. ProjectSight - Designed for Construction Management/Inspection Services and field applications via the ProjectSight app on an iPad and/or electronic field tablets.

9.4.1 Software

The PMIS includes a web-based Program / Project Management application portal making it accessible in the office or on-site and enabling real-time communication. This design encourages collaboration with outside partners while still controlling the level of access to the system.

The system provides the following functions:

- Document Management (Submittals, RFIs, Card Catalogs, Drawings, Meeting Minutes, Correspondence)
- Site Communications (Non-Conformance, Daily Work Journals)
- Budget and Cost Management (Budget, Scope, Contracts, Variation Orders, Invoices)
- Cost Forecasting (Cash-flow, Earned Value)
- Scheduling and Resource
- Reporting

9.4.2 Users

The Authority's Program Management Team is the primary user of the PMIS. Secondary users include the Authority's contracted consultants, contractors, and other parties to whom the Authority grants access. Individual user accounts and access rights of these are granted based on recommendations from the Consultants and as approved by the Authority's Program Manager. Due to cost considerations, the Authority will typically limit the Consultant to two (2) user accounts.

The PMIS electronic system is accessed via internet website. The Proliance website address is https://projects.goamps.com/Proliance/. Users must log in with a user name and password which will be assigned by the Administrator with approval by the Authority's Program Manager.

The Authority has access to all files and information on the electronic systems. The Program Manager has access to all files and information vital to fulfilling their contracted responsibilities in facilitating the management of the Program. Consultants and construction contractors shall have access to all files and information vital to fulfilling their contracted responsibilities pertaining to specific portions of the Program or Projects. Users not mentioned will be granted access by the Authority on a case-by-case basis. The Program Manager, with guidance from the Authority, shall have primary responsibility for granting and/or approving access rights to users, and the Administrator shall be responsible for establishing those access rights (i.e., establishing a username and password for logging in, etc.).

9.4.3 Structure

9.4.4 Functions

PMIS is organized using different "dashboards" that serve as home screens for each different user who logs in. The dashboard has tabs, links, and other features to allow users to access the files and other information based upon their individual access rights.

The following is a list of functions of the PMIS. More functions may be developed as the need is identified by the Program Management Team. A user's guide (Proliance Manual) that details the functions and their use will be distributed to users upon completion of training.

Storage

The PMIS is the only electronic file storage site of the Program and all Projects. Users will post files to the PMIS with the capability to provide read-only and/or editable electronic files to the electronic system.

Retrieval

The PMIS is the primary tool for retrieval of the Program and Project electronic files. The identifiers and tags selected when files are posted to the PMIS will allow users to search for files using a number of different categories as well as a keyword search.

Submittal/Distribution

9.4.5 Accessibility

As an electronic storage and retrieval process, the PMIS allows for the easy and efficient submittal/distribution of the Program and Project files and information. Upon uploading a file to the PMIS, users shall designate recipients to be notified via email with a message and link to the file location.

Tracking

When review of an uploaded file is required, the PMIS allows for the tracking of document review via an inputted workflow for the distribution and tracking of documents throughout a given review process. Tracking functions are based on process workflows developed by the Program Management Team. The completion of a particular event(s) by a user triggers a notification to another user(s) for initiation of the next event. Notification is sent via email.

Calendar and Reminders

The PMIS also supports a calendar function allowing designated users to add key milestones, deadlines, meetings, reviews and other events related to the Program or a specific Project. The PMIS automatically adds certain events to the calendar. For instance, when a review is initiated or completed, the PMIS will add that event to the calendar.

Calendar event reminders may also be set for automatic delivery to event participants through the PMIS. Reviews initiated through the PMIS will automatically generate a reminder to reviewers and the review requestor when reviews are not completed within a user-selectable length of time.

Document Management

The PMIS plays a key role in document management for the Program and Projects. It is used as a tool by the Managers and Administrators for fulfilling their duties related to Program and Project files and information.