

**CITY OF HOUSTON  
DEPARTMENT OF PUBLIC WORKS  
AND ENGINEERING**

**GROUNDWATER PLANT  
DESIGN GUIDELINES**



**Carol Ellinger Haddock, P.E.  
Director**

**Suhail Kanwar, P.E.  
City Engineer**

**JULY 2021**

**GROUNDWATER PLANT DESIGN GUIDELINES**

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**CITY OF HOUSTON**  
**GROUNDWATER PLANT DESIGN GUIDELINES**

**SECTION 1**  
**SITE REQUIREMENTS**

**SECTION 1 - SITE REQUIREMENTS**

1.01 SECTION INCLUDES

- 1.01.A Requirements for conveyance of plant site property to the District or City.
- 1.01.B Minimum geometric requirements for sites and access roads.
- 1.01.C Fencing requirements.
- 1.01.D Site grading requirements.

1.02 DESIGN REQUIREMENTS

1.02.A Legal:

- 1. Properties for water plant, well, and tank sites shall be conveyed in fee to the district or the City of Houston.
- 2. Sites shall meet at least one of the following conditions for access:
  - a. Have 60 feet or more of frontage directly on at least one public street having a right-of-way width not less than 60 feet.
  - b. Have at least a 60-foot-wide fee strip access from a public street having a right-of-way width not less than 50 feet.
  - c. If either condition 2.a. or 2.b. is met, an access easement of not less than 30 feet in width may also be provided from a public right-of-way to the site. If an access road along the easement is proposed, no other access road is required.
- 3. One hundred fifty-foot radius well sanitary control easement measures, approved by the Texas Commission on Environmental Quality, are required.

1.02.B Minimum Site Size:

- 1. Minimum site size shall be 5,000 square feet.
- 2. Well-only sites must also be of a size and shape such that the area shown in Figure F 1, Minimum Working Area for Well Only Site, can be located wholly within the site.

## 1.02.C Access Road:

1. Provide an all-weather road of not less than 12 feet in width to the site.
2. Inside the site, an all-weather surface shall be provided for reasonable access to wells, booster pumps, chlorine rooms, fuel tanks, and other areas requiring proximate vehicle access.

## 1.02.D Internal Site Horizontal Spacing:

1. Wells:
  - a. Locate wells a minimum of 40 feet from the site boundary at the point of access. Provide 60 feet by 40 feet of open area on one quadrant of the well for laying out drill pipe during well repair.
  - b. No site boundary, public street right-of-way, utility easement, or power company aerial easement shall encroach on the area within 40 feet in front of the well and 20 feet on either side of the well. No physical obstructions in the site shall be within this area.
  - c. With the exception of well discharge piping, splash pads, and auxiliary power with ancillary facilities, all plant equipment, fences, plant structures, and aboveground piping shall be at least 30 feet from wells.
  - d. Where space permits, locate well discharge piping and auxiliary power at right angles to the direction of well access.
2. Elevated Storage Tanks: No site boundary, public street right-of-way, utility easement, or power company aerial easement shall be within 30 feet of the outer perimeter of the elevated tank at its maximum section.
3. Ground Storage Tanks:
  - a. Locate ground storage tanks a minimum of 20 feet from any site boundary, public street right-of-way, utility easement, or power company aerial easement.
  - b. Locate ground storage tanks a minimum of 20 feet from plant structures and equipment.
  - c. Provide at least 10 feet of clearance between ground storage tanks and centerline of plant piping, except where segments of piping are routed directly to the tank.

## 1.02.D

*continued*

## 4. Yard Piping:

- a. Underground yard piping larger than 6 inches shall be separated at least 4 feet between nominal outside diameters.
- b. Provide a minimum of 3 feet of clearance for aboveground yard piping to include all flanges, valves, activators, supports, and appurtenances.
- c. Centerline of yard piping shall be minimum of 6 feet from site boundaries and utility easements.
- d. Locate underground yard piping so that thrust blocking, if any, will be located wholly within the site boundary and does not encroach upon an easement outside the site boundary. Encroachment upon access fee strips is permitted.

## 1.02.E

## Fencing:

1. Enclose all sites with an intruder resistant fence with (1) a minimum height of 6 feet and topped with three strands of barbed wire or (2) a fence with a minimum height of 8 feet without barbed wire.
2. Fences, including barbed wire if used, shall be located completely inside the site boundary. Refer to Figure F 2, Chain Link Fence.
3. Fencing may be of any of the following construction:
  - a. Chain link.
  - b. Chain link with wood slats/plastic slats.
  - c. Cedar picket, 6-inch wide picket minimum with pickets bolted or screwed to steel frames connected to galvanized steel posts. Allow for appropriate visibility between the slats.
  - d. Precast concrete.
  - e. Any other as approved by the City Engineer.

## 1.02.F

## Grading and Drainage:

1. Use drainage swales, sidewalks and driveways, culverts, storm sewers, or a combination thereof for internal site drainage.

1.02.F

*continued*

2. If an offsite storm sewer or major drainage channel is available, site drainage shall be collected into an internal storm sewer system before leaving the site.
3. Internal storm sewer system shall be sized for site drainage and shall have capacity for water well blow off, tank overflow, and drainage.
4. All unsurfaced areas on the site and access strip shall be seeded and fertilized or hydromulched.
5. Meet the requirements of Section 19 (Flood Plain) of the Houston City Code.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 2**

**WATER WELLS**

**SECTION 2 - WATER WELLS****2.01 SECTION INCLUDES**

- 2.01.A Design requirements for water wells, piping, and well pumps
- 2.01.B Requirements for construction of water well facilities.
- 2.01.C Specification requirements.

**2.02 DESIGN REQUIREMENTS****2.02.A General:**

1. Design water wells to operate automatically without requiring direct operator control. Equip wells with controls to allow for manual operation.
2. Secure applicable subsidence agency permits prior to drilling well.
3. Domestic wells shall be gravel packed.

**2.02.B Location:**

1. A 1,000 gallon per minute (gpm) or larger well shall be a minimum of 2,000 feet from another 1,000 gpm or larger well which is screened in the same aquifer. No minimum separation is required if the wells are in different aquifers.
2. Whenever possible, do not drill a new public water supply well on the perimeter of the development it is to serve.

**2.02.C Sizing:**

1. Minimum well size is generally 1,000 gpm. The casing and liner (interior casing) diameters shall be sized to allow the pump to be lowered into the liner based on the manufacturer's minimum clearances between the pump and the liner. Engineer shall demonstrate that sufficient piezometric head is available above the casing/screening lap to allow for lowering the pump to a sufficient depth to provide capacity for a 20-year period based on the most current available 10-year draw down data from the Harris Galveston Subsidence District.

## 2.02.C

*continued*

2. Water wells with less than 1,000 gpm shall be allowed for the following conditions:
  - a. Districts that are planned to be converted to surface water prior to January 1, 2010 by a regional water authority may install a well sized to meet their needs.
  - b. Districts that are planned to be converted to surface water after December 31, 2009 and before December 31, 2015 by a regional water authority may install a well sized to meet their needs, but not less than 500 gpm.
  - c. For Districts that are not a part of the long range plan of a regional water authority, water wells with capacities of less than 1,000 gpm shall be reviewed on an individual basis.
  - d. No guidelines are established for wells less than 300 gpm. Wells 300 gpm to 600 gpm shall be in accordance with Section 12.02.A.
3. Water wells with capacities of less than 1,000 gpm shall be reviewed for type of construction, pumping equipment, liner sizes, demand, aquifer yield, water quality, etc.

## 2.02.D

Piping:

1. Design piping so that the well will discharge directly to ground or elevated storage tanks, if provided.
2. The well may have a direct pipe connection, including disinfection, into the distribution system. Design this direct connection to allow emergency operation of the well independent of booster pumps, ground storage tanks, or pressure tanks. The well and disinfection system shall be designed to operate under such conditions.
3. Size the pump column pipe to provide a minimum velocity of 4 feet per second to raise any sand to the surface.
4. Aboveground piping:
  - a. The well discharge piping shall be sized for proper operation of the check valve and water meter. Normal velocities should be 4 to 8 feet per second.

## 2.02.D.4

*continued*

- b. Provide a sample tap (Figure F 3, Sample Tap) and an air release valve (Figure F 4, Air Release Valve for Wells Less than 1,500 gpm, and Figure F 5, Air Release Valve for Wells 1,500 gpm and Larger) before the check valve.
  - c. Provide a pressure gauge between the check valve and flowmeter.
  - d. Provide 10 pipe diameters of straight pipe leading into the water meter and a minimum of 2 pipe diameters of straight pipe downstream of the water meter or install in accordance with meter manufacturer's recommendations, whichever is greater.
  - e. The well blow-off shall be installed downstream of the flowmeter.
  - f. Refer to Figure F 6, Typical Well Piping Details, for typical location of well discharge piping appurtenances.
5. Where a well is capable of pumping directly into the distribution system, a minimum chlorine contact time of 20 minutes shall be achieved by one of the following:
- a. Use of line storage before the first user is tapped onto the line.
  - b. Use of a hydropneumatic tank.

## 2.02.E

Pumps:

1. Pumps may be either line shaft turbine or submersible.
2. A pump may be installed in a well that has a design capacity greater than the rated capacity of the pump.
3. The pump should have adequate submergence to allow a pumping level decline for approximately five years based on historic regional decline in the area.

## 2.02.F

Motors:

1. Size electric motors to carry the full load of the well pump without using motor service factor.
2. Motor enclosures may be open drip-proof, WP-1, or totally enclosed fan-cooled.
3. Minimum efficiency of well motors shall be 95 percent.

## 2.02.F

*continued*

4. Provide an anti-reverse ratchet or timer lockout for all vertical turbine pumps. Should the ratchet fail during normal operation, the motor will not start until reverse rotation has stopped. The timer lockout shall provide for two delays in series.
5. In all cases, provide a timer on the well motor start circuit to prevent starting of the well within 300 seconds of shutdown.
6. Motors should be selected to allow compliance or modification for compliance with the City of Houston Noise Ordinance.

## 2.02.G

Construction:

1. If excavated mud pits are used, they shall:
  - a. Include an impervious, synthetic lining on the bottom and sides of the pits.
  - b. Provide drainage so that run-off from the pits does not reach the water well.
  - c. Be cleaned out after drilling the well and filled to grade with a fill material approved by the Engineer.
2. Testing is to be performed as follows:
  - a. Run an Eastman Inclination Survey in the test hole and reamed hole.
  - b. Run an Electric Induction Log in the test hole.
  - c. Run a Compensated Density Neutron Log, with gamma radiation shown, in the test hole.
  - d. Run a Spectra-Log in the test hole to determine if harmful radiation exists where a strong gamma-ray signal appears on a Compensated Density Neutron Log, or where known radiation problems exist within the water production zone.
3. An attempt shall be made to reach a specific capacity of 18 gallons-per-minute-per-foot of drawdown after 12 hours of continuous well operation.

## 2.02.G

*continued*

4. Provide a groundwater elevation monitoring system using an air line run to 5 feet above the pump bowls or other method allowed in the latest revision of AWWA A100.
5. Extend well liner a minimum of 20 feet below the bottom screen.
6. Minimum recommended lap between casing and liner of 50 feet.

## 2.02.H

Address the following in the specifications:

1. Size, wall thickness (minimum 0.5 inch), and planned length of casing and blank liner.
2. Size, material, and anticipated length of screen.
3. Test hole procedures including diameter, depth, and required tests.
4. Cementing procedures.
5. Gravel pack material and method of placement.
6. Test pumping equipment.
7. Development procedures.
8. Disinfection, bacteriological, and chemical testing procedures.
9. Capping procedures.
10. Pump details including capacity, component materials, setting, and column size.
11. Procedures to follow if the test hole or well is to be abandoned.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 3**

**BOOSTER PUMPS**

**SECTION 3 - BOOSTER PUMPS**

## 3.01 SECTION INCLUDES

3.01.A Design requirements for water plant booster pumps and motors.

3.01.B Specification requirements.

## 3.02 DESIGN REQUIREMENTS

3.02.A Variances:

1. Obtain approval from the Department of Public Works and Engineering for exceptions or deviations from these requirements. Exceptions or deviations will be granted on a project specific basis only.

3.02.B Sizes:

1. Follow applicable Hydraulic Institute (HI) Standards for the design of new booster pumps and appurtenances for a new GW Plant. Provide calculations and recommendations in the Preliminary Engineering Report.
2. Minimum combined pump and motor efficiency shall not be less than 75 percent.
3. Pumps shall be installed in combinations that will allow for flexibility of operations. Options include:
  - a. The use of a small capacity "jockey" pump for low demand situations to minimize wear on larger pump starting equipment.
  - b. The use of controls that allow alternate operation.
  - c. Other pumps sized as required to meet actual design flows and pressures required.
  - d. The use of variable speed pumps and equipment.
4. Pumps of the same location should be designed for the same discharge pressure.

3.02.C Types of Pumps:

1. The following types of pumps are acceptable:

## 3.02.C.1

*continued*

- a. Horizontal split case centrifugal.
- b. End suction centrifugal.
- c. Vertical turbine ("can") pumps.

## 3.02.D

Operations:

1. Pump speed shall not be greater than 1,800 rpm.
2. Minimum discharge pressure shall be 60 psi.
3. Pump operation shall be controlled by pressure differentials as a function of system demand. Pressure sensing shall be in accordance with Section 6 of these Guidelines.
4. Booster pumps shall be locked out of operation by activation of ground storage tank low-level cut-off alarm circuit.

## 3.02.E

Motors:

1. Electric motors under 300 horsepower shall be 3-phase, 460-volt operation. Motors 300 horsepower and larger may operate at higher voltages. Booster pumps at a plant shall be three phase and shall operate at the same voltage as the other booster pumps.
2. Size electric motors to accommodate the maximum design operating load of the booster pump without using motor service factor.
3. Service factor on motors shall be 1.15 minimum.
4. Motor enclosures may be open drip-proof, WP-1, or totally enclosed fan-cooled.
5. It is recommended that motors 150 horsepower or greater have reduced voltage, auto-transformer starting, 65 percent tap.
6. Minimum efficiency of electric motors to be 95 percent.
7. Include space heaters on motors that are not located within buildings.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 4**

**HEADERS AND YARD PIPING**

**SECTION 4 - HEADERS AND YARD PIPING**

## 4.01 SECTION INCLUDES

- 4.01.A Material requirements for headers and yard piping.
- 4.01.B Design requirements for suction and discharge headers.
- 4.01.C Design requirements for yard piping for potable water.
- 4.01.D Specification testing requirements.

## 4.02 MATERIALS

## 4.02.A Ductile Iron Pipe:

1. Pipe:
  - a. Centrifugally cast in molds.
  - b. Minimum Thickness Class:
    - (1) Class 53 for exposed or threaded service.
    - (2) Class 51 for buried service.
2. Fittings:
  - a. Flanges drilled for Class 125 in accordance with ANSI B16.1 may be used for operating pressures to 250 psi. For operating pressures exceeding 250 psi, provide ANSI B16.1, Class 250 flanges.
  - b. Exposed service fittings to be flanged and buried service fittings to be push-on with mechanical (gland type) joints at fittings and valves.
3. Nuts and bolts: Stainless steel 316.
4. Gaskets: Grade 1 (rubber).
5. Internal Coatings: Cement mortar or as approved by the City Engineer.
6. External Coatings:
  - a. Exposed service: Epoxy/polyurethane paint system.

## 4.02.A.6

*continued*

- b. Buried service: Coal tar coated and polyethylene encased; hot-applied coal tar tape coating; or cold-applied tape coating system.

## 4.02.B

## Steel Pipe:

1. Fabricated or Mill Type:
  - a. Minimum Wall Thickness:
    - (1) Less than 5 Inch Diameter: Schedule 40
    - (2) 6 to 10 inch diameter: 3/16 inch
    - (3) 12 to 14 inch diameter: 7/32 inch
    - (4) 16 to 42 inch diameter: 1/4 inch
    - (5) 48 to 60 inch diameter: 3/8 inch
    - (6) 66 to 72 inch diameter: 1/2 inch
2. Fittings:
  - a. Flanges drilled for 150 psi application.
  - b. Exposed service fittings to be flanged, welded, or coupled.
  - c. Buried service fittings to be welded or coupled.
3. Nuts and Bolts: Hot-dipped galvanized steel, painted.
4. Gaskets: Butyl or EPDM.
5. Internal Coatings: Cement mortar or epoxy paint or as approved by the City Engineer.
6. External Coatings:
  - a. Exposed service: Epoxy/polyurethane paint system.
  - b. Buried service: Coal tar coated and polyethylene encased; hot-applied coal tar tape coating; or cold-applied tape coating system.

## 4.03 DESIGN REQUIREMENTS

4.03.A Follow applicable Hydraulic Institute Standards for the design of headers, yard piping, valves, and appurtenances for a new Ground Water Plant. Provide calculations and recommendations in the Preliminary Engineering report.

## 4.03.B Velocities:

## 1. Suction Headers:

- a. Flow velocity in suction piping, before any reducers, shall not exceed 4 feet per second.
- b. Flow velocity in suction headers shall not exceed 4 feet per second.

## 2. Discharge Headers:

- a. Flow velocity in discharge piping shall not exceed 6 feet per second.
- b. Flow velocity in discharge header shall not exceed 5 feet per second.

## 3. Yard piping: Velocity in yard piping shall not be less than 2 feet per second or more than 8 feet per second.

## 4. Calculate velocities assuming both suction feeds are open and both distribution lines are open from the discharge header (i.e., one-half of total flow in each direction).

## 5. Do not include the capacity of stand-by pumps in the calculation of peak flow maximum velocities.

## 6. For well discharge lines, see Section 2, Water Wells.

## 4.03.C Anchorage and Blocking:

1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends. Refer to Figure F 7, Thrust Block Details.
2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall. Concrete blocks shall not cover pipe joints.

## 4.03.D Suction and Discharge Headers:

1. Headers located next to walls or structures shall be a minimum of 3 feet to the outside of the pipe from such walls, structures, to allow for access to valves and fittings.
2. Provide adequate space and access between headers, piping, pumps and motors to allow proper clearances and access for maintenance and repair. Specific requirements will depend upon actual physical layout and sizes of components.
3. Suction headers shall be supplied from two sources, preferably one at each end. Provide cut-off valves to allow for isolation of header from each supply source. Provide at least one intermediate cut-off valve in the header to allow for at least one pump to be supplied at all times.
4. Discharge headers shall feed the distribution system through two separate supply lines. Provide cut-off valves to allow each distribution line to be isolated. Provide at least one intermediate cut-off valve in the discharge header to allow at least one pump to supply either distribution line at all times.
5. Suction piping from the suction header to pump suction nozzles shall be as short and direct as possible and should be larger in diameter than pump suction nozzles to minimize suction head loss. Reducers used in suction piping shall be eccentric reducers installed with the flat side on top to reduce air pockets trapped in the suction lines.
6. Pump suction piping should be as straight as practical. Avoid placing 90-degree bends directly in front of pump suction and discharge nozzles.
7. Suction and discharge headers shall be equipped with air release valves on both sides of suction and discharge header isolation valves.
8. Where applicable: Suction and discharge headers shall be equipped with chemical injection connections on both sides of suction and discharge header isolation valves.
9. Discharge headers shall be equipped with pressure gauges on both sides of discharge header isolation valves.

## 4.03.E Suction and Discharge Header Valves:

1. Provide cut-off valves on suction piping and discharge piping of each pump for isolation from header.
2. Provide a slow closing check valve or other control valve on discharge pipe of each pump between the pump and the cut-off valve to limit reverse flow from the pressure system into the ground storage tank when the pump stops.
3. Use check valves with controlled rate of closure as may be needed to reduce water hammer potential on discharge piping.
4. Any valve 16" or greater inside a DWO facility that is on suction/discharge line should be a butterfly valve.

## 4.03.F Yard Piping

1. Clearance between waterlines and sanitary sewers shall conform to requirements set forth for water distribution systems in the "Rules and Regulations" for Public Water Systems published by the TCEQ.
2. Locate yard piping in areas easily accessible for maintenance.
3. Yard piping shall have two points of interconnect with distribution system lines and a feed to the hydropneumatic tanks, if supplied.
4. Yard piping shall be considered to end at the point of connection to the Distribution system line.
5. Standard sizes noted in AWWA Standards may be used except 10-inch and 14-inch unless already in place.
6. Between discharge header and distribution system, provide a minimum of 20 pipe diameters of straight pipe to allow future discharge meters installation. If below grade, provide a vault for the future meter.

## 4.03.G Yard Piping Valves:

1. Install valves in a manner which will allow easy access and operation.
2. Valves installed below ground shall have valve boxes and shall be located outside paved areas and other areas normally traveled by vehicles.

## 4.03.G

*continued*

3. Size and type:
  - a. Gate valves shall be used for 2-inch through 12-inch diameters unless 14-inch diameter is already in place.
  - b. Use butterfly valves on lines 16 inches and larger in diameter, unless otherwise approved.
  - c. The use of gate valves on lines larger than 14 inches in diameter must be approved by the City Engineer.
4. For maintenance purposes, butterfly valves 24" and larger inside and outside of DWO facilities need to be located in a service manhole.
5. Any valve inside the gate of a DWO facility must be positioned in such a way that the wheel can be easily and safely reached by an operator. If the position requirement can not be met, appropriate accommodations, such as steps and an elevated platform, must be provided so the valve can be safely and easily operated.

## 4.03.H

Testing Requirements:

1. Test piping systems upon completion of piping and prior to application of insulation on exposed piping or covering concealed or buried piping.
2. Isolate equipment which may be damaged by the specified pressure test conditions.
3. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates.
4. Completely assemble and test new piping systems prior to connection to existing pipe systems.
5. Test pipe at 1.5 times the maximum working pressure or 125 psi, whichever is greater.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 5**

**BOOSTER PUMP BUILDINGS**

**SECTION 5 - BOOSTER PUMP BUILDINGS**

## 5.01 SECTION INCLUDES

5.01.A Design requirements for booster pump buildings.

## 5.02 DESIGN REQUIREMENTS

## 5.02.A General:

1. Do not put chlorination equipment or store chlorine bottles in the same room as pumps, motors, and electrical equipment. Provide a separate room specifically for chlorination. See Section 10, Chlorination Systems, for chlorination design criteria.
2. Locate controls and electrical equipment in a room separate from piping, pumps, and motors. The floor of the electrical/control room shall be raised above the pump room floor level, or all electrical and control equipment shall be installed on raised housekeeping pads.
3. Locate buildings a minimum of 20 feet from plant site property lines to help eliminate vandalism and to facilitate access for maintenance and repair.
4. Buildings shall conform to applicable local, state, and federal building codes and requirements, including OSHA requirements.
5. Concrete work shall conform to the latest revision of ACI 318, ACI 301, and other applicable ACI specifications.
6. A soils investigation with recommendations for foundation design shall be performed by a geotechnical engineer.
7. Pump buildings shall be constructed of fire-proof reinforced concrete or reinforced masonry construction; do not use metal buildings. Building and roof shall have a minimum design life of 15 years.
8. Wiring shall conform to the most current revision of the National Electric Code requirements for commercial or industrial wiring. Materials and equipment shall be approved and listed by Underwriters Laboratory. See Section 6, Electrical, Monitoring and Control Systems, for electrical and control requirements.

## 5.02.A

*continued*

9. Building interior spaces shall be sufficiently lighted to allow for safe and convenient operation and maintenance of equipment including pumps, motors, motor control centers, and autosensory equipment. Provide exterior lighting at exterior doors, walkways, driveways, and work areas around the buildings. Follow lighting requirements contained in OSHA standards.

## 5.02.B

Size of Buildings and Clearances:

1. Building size shall depend on specific piping layouts, number of pumps and space allotted for future expansion. Building size shall be adequate to allow access to pumps, motors, piping, valves, and electrical controls to allow for proper maintenance and removal of equipment or installation of future equipment.
2. Provide 3 feet minimum clearance between walls and piping, valves, and fittings to facilitate bolt removal and tightening.
3. Space pumps and motors to allow for maintenance of equipment.
4. Provide steps, ladders and walkways as required for access to aboveground equipment and valves. Provide safety handrails on walkways, ladders, and steps in accordance with OSHA regulations.
5. Provide outside access to the pump room through double doors or roll-up type garage doors. Size doors to allow removal and replacement of pumps and motors.
6. Provide control/electrical room with one exterior door and one door into the pump room.
7. Provide sidewalks and steps as necessary to provide paved access to exterior doors.
8. Provide adequate vertical clearance inside the pump room to allow pumps to be pulled for service. Clearance shall allow pumps to be removed from the building over piping, pumps, and other equipment.
9. Provide a traveling crane inside the building. Size the crane to easily handle large pump equipment. For smaller pumps, provide access suitable for manual lifting devices.
10. Slab elevation shall be a minimum of 6 inches above grade to allow for proper drainage.

## 5.02.C Ventilation:

1. Provide louvers of adequate size and number for proper ventilation of the pump room. Locate louvers so that good air circulation is maintained. Provide power roof fans, wall fans, or ventilators if necessary.
2. Provide louvers and fans in the control/electrical room sufficient to dissipate heat generated from motor control centers and switchgear. Consider use of dehumidifiers and heaters in control rooms if warranted.
3. Provide bird screening over louver and fan openings. Screening shall be 316 stainless steel, 16 mesh.

## 5.02.D Piping:

1. Piping arrangements and sizes will depend upon initial equipment installed, proposed future expansions, and ultimate design capacity of the plant. See Section 4, Headers and Yard Piping, for specific design criteria.
2. Piping shall be adequately supported and properly braced to restrain thrust forces.
3. Provide sleeves for piping passing through walls. Line sleeves with expansion joint material to allow for minor movements of piping and buildings. Do not use building walls to support piping.

## 5.02.E Roof:

1. Provide either:
  - a. A pitched roof with a minimum 5 on 12 slope with standing seam roofing of pre-coated galvanized steel or fiberglass asphalt shingles, or
  - b. Minimum 4-ply hot applied built-up roof with 15-year service life, adequately sloped for drainage.
2. Slope roof to drain away from entrance doors. Provide a minimum 2-foot overhang on all sides of the building.

5.02.F

Floor:

1. Provide a minimum 6 inch thick concrete floor.
2. Coat the floor with non-skid, chemical resistant material.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 6**

**ELECTRICAL, MONITORING AND CONTROL  
SYSTEMS**

**SECTION 6 - ELECTRICAL, MONITORING AND CONTROL SYSTEMS**

## 6.01 SECTION INCLUDES

- 6.01.A Design requirements for electrical and control systems for water production facilities.

## 6.02 DESIGN REQUIREMENTS

## 6.02.A General:

1. The water plant shall be provided with electrical controls and equipment to enable it to operate manually and automatically. Provide sufficient control and electrical equipment so that the water plant can operate automatically without direct operator control.
2. As a minimum, water plants shall be equipped with the systems as described herein. At the discretion of the Engineer, more complex systems may be provided.
3. Provide a time delay system to start large motors sequentially. Large motors shall not start simultaneously.

## 6.02.B Well Control System:

1. Water wells shall be controlled based on the levels in ground or elevated storage tanks, if provided.
2. Interlock well controls with the well pump motor electrical equipment so that the well pump motor is activated and deactivated automatically in response to tank level. Time delay on the well pump motor shall reset in the event of a power disruption.
3. Tank level shall be sensed by a wet tap on the lower tank shell, internal tank probes, an electronic pressure transmitter, or an ultrasonic transmitter.
4. Unless approved by the City, control equipment shall be one of the following types:
  - a. Mercury-type pressure switches with conventional relays.
  - b. Electronic pressure switches with either conventional electrical relays or a programmable controller.

## 6.02.B

*continued*

5. Provide a high pressure mercooid switch with manual reset on well discharge.
6. Chlorination control shall be in accordance with Section 10, Chlorination Systems.

## 6.02.C

Booster Pump Control System:

1. Systems Without Elevated Tanks:
  - a. Control of booster pumps shall be based on the pressure in the distribution system.
  - b. Interlock booster pump controls with pump motor electrical equipment so that successive pumps are activated on falling system pressure and deactivated on rising system pressure.
  - c. Make distribution pressure tap in either the water or air portions of the hydropneumatic tank or in the discharge line.
  - d. Unless approved by the City Engineer, control equipment shall be one of the following types:
    - (1) Mercury-type pressure switches with conventional electrical relays.
    - (2) Electronic pressure switches or pressure transmitters with either conventional electrical relays or programmable controller.
  - e. The following control features are required:
    - (1) Booster pumps shall be deactivated on low ground storage tank level with a manual override provided. Provide freeze protection for any exposed level sensor piping designed to contain water.
    - (2) Booster pump controls and hydropneumatic tank controls shall be interlocked to ensure that the proper air-water ratio is automatically maintained in the tank.

## 6.02.C

*continued*

2. Systems with Elevated Tanks:
  - a. Booster pumps can be controlled based on distribution system pressure as described above for systems without elevated tanks (see paragraph 1.02C.1), or on the water level in the elevated tank.
  - b. If the booster pumps are controlled by the elevated tank water level, the following are applicable:
    - (1) If the elevated tank is at a different location than the booster pumps, the tank water level shall be transmitted to the water plant via telemetry.
    - (2) Interlock booster pump controls with motor electrical equipment so that successive pumps are activated on falling tank level and deactivated on rising tank level.
    - (3) Unless approved by the City Engineer, control equipment shall be one of the following types:
      - (a) Mercury-type pressure switches with conventional electrical relays.
      - (b) Pressure transmitter with either conventional electrical relays or programmable controller.
    - (4) Provide a backup control system to automatically control the booster pumps in the event of loss of telemetry signal from the elevated tank.
    - (5) Booster pumps shall be deactivated on low ground storage tank level with a manual override provided.

## 6.02.D

Telemetry:

1. Control communication between a water plant and an offsite well or elevated tank shall be accomplished using telemetry equipment.
2. Telemetry equipment may utilize hard wire connection, telephone lines, radio communication, or microwave.

## 6.02.E Water Plant Monitoring Systems:

1. As a minimum, provide the following:
  - a. Propeller-type flow meter located at the water well. Meter shall have a totalizer which can not be reset. Do not use battery-powered meters.
  - b. Panel-mounted, 4-1/2-inch diameter pressure gauge or LED readout indicating the plant distribution pressure, located in the electrical/control room.
  - c. A minimum of 20 pipe diameters of straight pipe between the booster pump discharge header and the distribution system tie-in to allow for future installation of discharge meters. If below grade, provide a vault for the future meters.
2. The following may be provided at the discretion of the Engineer:
  - a. 7-day recorders sized such that peak conditions do not exceed 95 percent of full scale. Distribution pressure, elevated storage and ground storage tank levels, or plant discharge flows may be recorded. Do not use strip recorders.
  - b. Alarm lights and audible and visual alarm system to indicate abnormal conditions.
3. Meet the requirements of the EPA Ground Water Rule.
4. Supervisory Control and Data Acquisition (SCADA) implementation is strongly suggested.

## 6.02.F Electrical Systems:

1. Electrical Service:
  - a. Coordinate electrical service requirements with the appropriate utility company.
  - b. The reliability of the electrical system should be the first consideration. Include automatically resetting phase monitor relays and surge arrestors.
  - c. Primary service may be brought into the water plant site.

## 6.02.F

*continued*

2. Motor Control Centers:
  - a. Design in accordance with applicable National Electrical Code requirements.
  - b. Locate indoors and provide durable nameplates on cubicles.
  - c. Provide elapsed time meters for booster pumps and well pumps.
  - d. Provide running lights for booster pumps and well pumps.
  - e. Provide durable nameplates identifying all switches, lights, gauges, etc.
  - f. Provide integrated short circuit rating in excess of that available from the utility company.
3. Wiring and Conduit:
  - a. Size in accordance with National Electrical Code requirements.
  - b. All wiring shall be installed in conduits as follows:
    - (1) Below grade - PVC conduit encased in red concrete.
    - (2) Indoors - rigid aluminum or hot-dipped galvanized steel conduit.
    - (3) Chlorine rooms - Schedule 80 PVC conduit.
    - (4) Other locations - rigid aluminum or hot-dipped galvanized steel conduit.
  - c. Wiring requirements: Wiring shall be copper.
4. Lighting:
  - a. Indoor lighting shall be fluorescent or metal halide.
  - b. Exterior lighting shall be high-pressure sodium or metal halide.

6.02.F.4.b  
*continued*

Exterior lighting is to illuminate the well and other working areas.

5. Grounding:

- a. Provide electrical service and equipment grounding as necessary to ensure grounding continuity and to ensure safety and reliability in the electrical system.
- b. When multiple motors are designed, provide a ground loop or a ground grid with multiple rods.

6.02.G Specifications:

- 1. Include product specifications for major electrical and control equipment and devices.
- 2. Include brief written functional description of automatic plant operations.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 7**

**HYDROPNEUMATIC TANKS**

**SECTION 7 - HYDROPNEUMATIC TANKS**

## 7.01 SECTION INCLUDES

7.01.A Design requirements for hydropneumatic tanks.

## 7.02 DESIGN REQUIREMENTS

## 7.02.A Construction:

1. Locate tanks wholly above grade. Tanks shall be constructed of steel with welded seams in accordance with ASME Pressure Vessel Code. Tanks shall be ASME stamped and approved.
2. Metal thickness shall be sufficient to provide at least a minimum 1/8-inch corrosion allowance and to withstand the highest expected working pressures with a four to one factor of safety.
3. Protective paint or coating applied to the inside or outside portions of the tank shall conform to current TCEQ standards.
4. No tank that has been used to store materials other than potable water shall be considered for use in a public water system.

7.02.B Piping and Valving: Provide appropriate valving to isolate each hydropneumatics tank from other portions of the system.

## 7.02.C Appurtenances:

1. Provide automatically functioning facilities for maintaining the air-water volume at the design water level and working pressure.
2. Provide a pressure release device and an easily readable pressure gauge for each tank.
3. Provide a sight gauge for reading water level in each tank.
4. Provide tanks with a means for completely draining the tank.
5. Air compressors shall be sized for a minimum of 0.25 cfm per 1,000 gallon tank capacity at 150 psi.
6. Tanks shall have an access port for periodic inspections.
7. Provide freeze protection for tank appurtenances.

7.02.C

*continued*

8. Specifications shall include tank capacity dimensions, appurtenances, pressure rating, disinfection procedures, and air compressor capacity.
9. Tanks shall be equipped with a durable and protective cabinet to house a sight glass and probe holder.
10. Tanks shall be equipped with one 24-inch diameter manhole and one 14-inch x 18-inch elliptical manhole. The 24-inch diameter manhole shall be equipped with a davit to support the manhole cover.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 8**

**POTABLE WATER STORAGE TANKS**

**SECTION 8 - POTABLE WATER STORAGE TANKS**

## 8.01 SECTION INCLUDES

- 8.01.A Design requirements for ground and elevated potable water storage tanks.

## 8.02 DESIGN REQUIREMENTS

## 8.02.A Ground Storage Tanks:

## 1. Types of Construction:

- a. Design welded steel tanks in accordance with the current revision of ANSI/AWWA D100. Steel fabrication dimensional tolerances shall be in accordance with API standards.
- b. Design bolted steel tanks in accordance with the current revision of AWWA D103.
- c. Design concrete tanks in accordance with current revision of AWWA D110.
- d. A complete soils investigation with recommendation for foundation design shall be performed by a geotechnical engineer.

## 2. Design Requirements for Steel Ground Storage Tanks:

- a. Tank inlets: One or more per tank located in the side wall of the tank and at least 45 degrees from a tank outlet. Direct flow with a 45 degree bend away from the nearest outlet.
- b. Tank outlets: On single tank installations, two per tank located at least 90 degrees apart and 45 degrees from a tank inlet. On multiple tank installations, dual outlets required on the first tank only. Outlets for booster pump suction shall be fitted with an internal 90-degree fitting turned downward. Diameter shall be equal to or larger than the suction line. The fitting shall be either a ductile iron flange and flare, a ductile iron 90 degree long radius ell, or a welded steel mitered fitting. Provide outlets with a minimum 12-inch clearance from the tank bottom.
- c. Overflow: Provide an internal overflow weir inlet with an external overflow pipe. The overflow assembly shall be sized to handle the maximum tank influent rate with a maximum water level rise over the inlet weir of 6 inches. The overflow pipe discharge shall terminate above ground, not be subject to submergence, and be fitted with a

## 8.02.A.2.c

*continued*

hinged flap valve. Top of overflow weir shall be a minimum of one foot below bottom of any roof rafter.

- d. Tank drain: One or more, not less than four inches in diameter, with valve, located a minimum practical distance above the tank floor to flow line of drain. For example, a 4 or 6 inch drain would be placed six inches above the tank floor. Larger drain sizes may be placed further from the floor. Alternatively, the Engineer may use a flush type drain in accordance with API 650, Section 3.7.8, Figure 3-10. The drain may be connected to the overflow discharge pipe outside the tank.
  - e. Interconnect line between tanks: Required for plants with more than one tank. Size the same as the tank inlet, or if combined with a tank outlet, size the same as the tank outlet, whichever is larger. Provide with isolation valves. Three valves on a tee are required if combined with a tank outlet. Locate a minimum of 12 inches above the tank bottom.
  - f. Roof vents: One or more with one vent located at or near the center of the roof at the highest point practical. Size vents for maximum influent and effluent rates. Only the effective (net) screen opening shall be considered to pass airflow. Vents are to be double gooseneck type with openings protected by 316 stainless steel screen, 16 mesh. Refer to Figure F 8, Roof Vent Detail.
  - g. Foundation: Support the tank bottom on a concrete ringwall of minimum 12-inches wide. The top of the foundation shall be at least 12 inches above finished grade. The tank bottom shall rest on a minimum of 6 inches of clean sand, free from clay, lumps, shale, loam, organic matter and other deleterious materials, with soluble ionic (salt) content limited in accordance with ASTM D4940. Slope the tank bottom at least 1 inch in 10 feet from the tank center to the outside edge.
  - h. Connections: Connections 4 inches and larger shall be flanged. Connections 3 inches and smaller may be threaded couplings.
3. Design Requirements for Prestressed Concrete Ground Storage Tanks:
- a. Tank inlets: At least one per tank located at least 45 degrees from a tank outlet. Make inlet connections through the tank bottom and provide a minimum 4-inch silt stop.

## 8.02.A.3

*continued*

- b. Tank outlets: Number and plan location is the same as for steel tanks. Make outlet connections through the tank bottom and provide a minimum 4-inch silt stop.
  - c. Tank overflow: Provide an internal overflow weir with an external overflow pipe. Size the overflow assembly to handle the maximum tank influent rate with a maximum water level rise over the weir of 6 inches.
  - d. Tank drain: One or more with an isolation valve. Make drain connections through the tank bottom and terminate in an open top concrete drain box connected to a storm sewer system or adequate site drainage swale.
  - e. Interconnect lines between tanks are required.
  - f. Roof Vents: One or more with one vent located at or near the center of the roof at the highest point practical. Size the vent for maximum influent and effluent rates. Only the effective (net) screen opening shall be considered to pass airflow. Vents shall be of the gravity type with openings protected by 316 stainless steel screen, 16 mesh.
  - g. Foundation: The tank manufacturer shall be responsible for the foundation design. The tank bottom may be below natural ground level.
  - h. Assess need for future tank connections and include in original concrete storage design.
4. Required accessories (Figure F 9, GST Accessory Detail-Plan View, illustrates typical location of tank accessories.)
- a. Roof hatch: Primary roof hatch shall have a minimum size of 30-inch diameter with 4-inch curb and shall have a cover with 2-inch downward overlap and provisions for locking. Primary location shall be offset from the exterior tank ladder centerline and located over the interior ladder. The secondary roof hatch shall be located over the tank overflow. Refer to Figure F 9, GST Accessory Detail-Plan View, and Figure F 10, Roof Hatch Detail.
  - b. Ladders: Provide an exterior steel ladder extending the full height of the tank as shown in Figure F 11, Exterior Ladder Detail). Provide exterior ladders with safety cage. Interior ladders shall be provided and offset from external ladder by at least 2 feet as shown in Figure F 12, Interior Ladder Detail and Safety Rail Detail.

## 8.02.A.4.

*continued*

- c. Roof guard rails: Provide guard rails (handrails) along the roof edge for a distance of 10 feet either side of the exterior ladder and 5 feet either side of any perimeter tank appurtenance. Refer to Figure F 13, Guard Rail Detail.
- d. Shell manholes:
  - (1) Welded steel tanks - Provide at least two. One manhole shall be 30 inches in diameter with hinged cover per AWWA standards. One manhole shall be 48 inch x 48 inch flush-type cleanout per API standards complete with hinge or davit arm. Refer to Figure F 14, 48" x 48" Flush Manway and Pipe Davit Detail. Locate the manhole approximately 180 degrees apart.
  - (2) Bolted steel tanks - Provide two flush-type cleanouts per API standards. Cleanouts shall be a minimum of 24 inches wide by 48 inches high and located approximately 180 degrees apart.
  - (3) Concrete Tanks - provide at least four manholes spaced approximately 90 degrees apart - shape shall be elliptical 24 inches by 18 inches minimum.
- e. Miscellaneous accessories: One sample cock located 3 feet above tank bottom and one pressure gauge calibrated in feet of water located 3 feet above tank bottom.
- f. Provide non skid walkways on the roof of steel tanks to reach any appurtenance.

## 8.02.B

## Elevated Storage Tanks

1. Types of construction - Reference Standard - AWWA D100, with no restriction on the style of tank.
2. Design requirements
  - a. Tank overflow: Provide an internal overflow weir and drain pipe. Size the overflow assembly to handle the maximum tank influent rate with a maximum water level rise over the weir of 6 inches. The overflow pipe shall be piped to grade and shall be fitted with a hinged flap valve. Top of overflow funnel shall be a minimum of 1 foot below bottom of any roof rafter.

## 8.02.B.2

*continued*

- b. Roof vents: One or more with one vent located at or near the center of the roof at the highest point practical. Size the vent for maximum influent and effluent rates. Only the effective (net) screen opening shall be considered to pass airflow. Vents shall be of the gravity type with openings protected by 316 stainless steel screen, 16 mesh, and designed as a secondary roof opening.
  - c. Altitude control valve: Equip all tanks with an altitude control valve or make provisions in piping design for future insertion of an altitude control valve.
  - d. The tank foundation shall be the responsibility of the tank manufacturer.
  - e. Lighting: Provide interior lighting in the dry compartment.
  - f. Comply with Federal Aviation Administration requirements with respect to warning lighting.
  - g. Provide two bollards on top of the tank per City of Houston Fire Department requirements.
3. Required Accessories:
    - a. Roof hatch: Minimum size 30-inch diameter with 4-inch curb and cover with 2-inch downward overlap and provisions for locking.
    - b. Provide necessary handrails, ladders, balconies, and safety devices per OSHA requirements.
    - c. Provide one sample cock and one pressure gauge calibrated in feet of water.

## 8.02.C

## Protective Coatings

1. Welded steel tanks shall be coated on the inside and outside excluding galvanized accessories.
2. No coatings are required for galvanized bolted steel tanks or concrete tanks, except for tank accessories that are not galvanized.
3. Coating Systems:
  - a. Coating system for the interior of the tank shall be in accordance with TCEQ requirements, must conform to ANSI/NSF Standard 61, and must be certified by an organization accredited by ANSI for use as a

8.02.C.3.a  
*continued*

contact surface with potable water.

- b. Coating system for the exterior of the tank may be as required for exposure conditions and desired aesthetics.
  - c. Do not use coating materials containing lead.
4. Cathodic protection for the interior submerged surfaces of welded steel tanks is not required but may be provided at the discretion of the Engineer.

8.02.D Specifications - Indicate type of coating system and cathodic protection system, if provided.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 9**

**EMERGENCY POWER**

**SECTION 9 - EMERGENCY POWER**

## 9.01 SECTION INCLUDES

- 9.01.A Design requirements for emergency power for water production facilities.

## 9.02 DESIGN REQUIREMENTS

## 9.02.A General:

1. Provide emergency power as required by TCEQ regulations. A generator is the preferred type of emergency power. If the Engineer selects an alternate method, reasons for the use of the alternate method must be presented with the drawings.
2. If right angle drives are used, they shall be diesel powered or natural gas powered. Do not use gasoline engines. The methods specified in paragraphs 1.02B, 1.02C, and 1.02D may be used:

## 9.02.B Preferred Method - Generator:

1. A generator may be used. The generator shall operate the following items as a minimum:
  - a. The controls, air compressor, panel lights, and exterior lights.
  - b. The well and one booster pump, or
  - c. All booster pumps with the well inoperative, not including standby pumps, if applicable.

## 9.02.C Alternate Method - Right Angle Well Drive:

1. A right angle well drive may not be used alone. A right angle drive on the well shall be accompanied by a right angle drive on at least one booster pump or a generator as outlined in this section.
2. Manual well operation is permitted.

## 9.02.D Alternate Method - Right Angle Booster Pump Drive:

1. A right angle booster pump drive unit may be used if a well right angle drive is used. The well may fill the ground storage tank by manual operation. The booster pump right angle drive unit may have manual start capabilities.

## 9.02.E Fuel Tanks.

1. For diesel engines, a fuel tank shall be provided which allows 16 hours of operation at full load if system is interconnected or multiple plants are in the system. If the plant is isolated, fuel tank shall allow for 24 hours of operation.
2. Aboveground tanks shall be used and must be Underwriters Laboratories (UL) listed (Do not use underground fuel tanks). A UL label shall be affixed to the tank.
3. Provide concrete or steel containment for the fuel tank in accordance with NFPA 30. Containment shall have a drain line with a lockable valve.
4. Use black steel piping for fuel tank connections. Do not use galvanized steel piping.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 10**

**CHLORINATION SYSTEMS**

**SECTION 10 - CHLORINATION SYSTEMS**

## 10.01 SECTION INCLUDES

10.01.A Design requirements for chlorination systems.

## 10.02 DESIGN REQUIREMENTS

## 10.02.A General:

1. Provide a chlorination system for groundwater plants to disinfect the water supply.
2. Chlorinate water before it enters the ground storage tank (pre-chlorination). Provisions for chlorinating water after it leaves the ground storage tank, but prior to entering the distribution system (post-chlorination), may be provided at the discretion of the Engineer and with City Engineer and Texas Natural Resource Conservation Commission approval.
3. The source of chlorine shall be 150-pound cylinders or ton containers, which contain chlorine under pressure. Other chlorine sources or other methods of disinfection shall require prior approval of the City Engineer.

## 10.02.B Types of Systems:

1. Pre-chlorination:
  - a. Chlorination of the plant's groundwater supply shall be accomplished by providing either (1) a fixed rate chlorinator for each well feeding the plant; or (2) a variable rate chlorinator or multiple fixed-rate chlorinators in plants with multiple wells and a common well collection line.
  - b. Chlorination Points:
    - (1) Add chlorine solution to the aboveground well collection pipe downstream of the well flow meter, prior to entering the ground storage tank, and prior to reaching the well connection to the distribution system.
    - (2) Chlorination connections for 1 inch and smaller solution lines shall to be a corporation cock type connection with check valve. Connections for 1½ inch through 3 inch solution lines shall be a pipe tap connection utilizing a

*10.02.B.1.b**continued*

service saddle with a shut-off valve and check valve. The diffusion tube shall project into the pipe approximately one-third the pipe diameter.

## c. Control Methods:

- (1) Chlorinators shall operate automatically whenever there is flow of water into the ground storage tanks.
- (2) Single well fixed feed rate chlorinators shall be controlled by an electric solenoid valve in the injector water supply line. The solenoid valve shall open automatically when there is well flow.
- (3) Multiple well variable feed rate chlorinators shall be controlled by an electric solenoid valve in the injector water supply line. The solenoid valve shall open automatically when there is well flow. A flow meter with flow rate transmitter is required in the common well collection line for control of the chlorine feed rate.
- (4) Multiple well/multiple fixed rate chlorinators function as single well fixed rate chlorinators with a separate solenoid for each well tied to that well's fixed rate chlorinator.

## 2. Post-chlorination (if provided):

- a. Chlorination of water after leaving the ground storage tanks shall be accomplished by a variable rate chlorinator.
- b. Chlorination points:
  - (1) Add chlorine solution to the booster pump suction piping. If possible, make chlorination connections to aboveground pipe. Connections to buried pipe shall be made inside a vault-type structure.
  - (2) Chlorination connections shall be the same as those required for pre-chlorination.
- c. Control methods:
  - (1) Chlorinators shall operate automatically whenever they are turned on and there is flow in the booster pump suction lines.

10.02.B.2.c  
continued

- (2) Chlorinators shall be controlled by an electric solenoid valve in the injector water supply line. The chlorine feed rate may be controlled based on the distribution flow rate (flow proportional control) or based on the free chlorine residual of the water as it leaves the ground storage tanks (direct residual control).

10.02.C Design Requirements:

1. The design dose rate for pre-chlorination shall be adjustable from 0 to 3 mg/l. The design dose rate for post-chlorination shall be adjustable from 0 to 1.5 mg/l.
2. Chlorinators:
  - a. Chlorinators shall be remote vacuum, solution feed type.
  - b. Fixed-rate chlorinators shall be packaged wall-mounted units complete with a manually adjustable orifice, rotameter, and injector.
  - c. Variable-rate chlorinators shall be packaged wall-mounted or freestanding units with an electric controlled rotameter to automatically adjust the chlorine feed rate, with remotely mounted injector, and rotameter.
  - d. A stand-by chlorinator is optional.
3. Accessories to be provided include weight scales, automatic switchover vacuum regulator - check units, a pressure relief valve, and necessary piping and valves.
4. Injector Water Supply:
  - a. The source of water for the injector should normally be the high-pressure side of the distribution booster pumps.
  - b. Provide a chlorine booster pump sized to provide the full required injector operating pressure. The booster pump shall take suction from the well collection line.
  - c. If the water well is designed to pump directly into the distribution system during power outage conditions, provide an auxiliary power source for the chlorine booster pump.
  - d. The injector water supply piping shall include an electric solenoid valve with valved bypass, a strainer, and necessary piping and valves.

## 10.02.C

*continued*

5. The chlorinator room shall be a separate room or structure separated from other plant facilities. The structure shall be masonry or fiberglass and shall include a ceiling-level inlet fan or fans, a floor-level back-draft damper, a heater, and outside light and fan switches. Provide a shatter-resistant window within chlorinator room entry door or wall such that chlorinator operation can be observed without entering room.
6. The ton container storage area, if provided, shall be a separate room or structure. The structure shall be masonry or metal frame. If a masonry structure is used, it shall include a 2-ton hoist system, a floor-level exhaust fan, a heater, and outside light and fan switches. If a metal frame structure is used, it shall be an open-frame type structure with provisions for securing containers from vandals. Provide a 2-ton hoist or design the structure to accommodate container delivery truck loading and unloading.
7. Required accessories include a gas mask, diffuser assembly, and chlorine leak detector.
  - a. A chlorine leak detector shall be located in each room (or structure) containing chlorination equipment, including open frame-type ton container structures.
  - b. The chlorine leak detector shall activate an alarm circuit which includes as a minimum a red rotating beacon which can be seen by the plant operator upon entering the plant site.
  - c. Provide a single self-contained breathing apparatus with 30-minute supply for each plant. Locate the breathing apparatus close to but outside of rooms or structures containing chlorination equipment.
  - d. Provide a freeze protected eye-wash station close to but outside rooms or structures containing chlorination equipment.

## 10.02.D

Specification Requirements: Include the following requirements specifications:

1. Chlorinator design feed rate and rotameter capacity.
2. Injector back pressure.
3. Chlorine booster pump rating.
4. Chlorine leak detection levels.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 11**

**DRAWING REQUIREMENTS**

**SECTION 11 - DRAWING REQUIREMENTS**

11.01 SECTION INCLUDES

11.01.A Size of drawings, drafting standards, and use of CAD.

11.01.B Recommended content of drawings.

11.02 REFERENCES

11.02.A City of Houston Design Manual for Wastewater Collection Systems, Water Lines, Storm Drainage and Street Paving.

11.02.B City of Houston Typical Details for Water Plants

11.02.C City of Houston, Infrastructure Design Manual, Section 13, GIS Data Digitization Standards

11.03 DRAWING REQUIREMENTS

11.03.A General:

1. Drawings shall be in ink or lead on mylar media with a nominal size of 24 inches by 36 inches.
2. Drawings may be produced manually or by use of computer drafting tools as long as lettering and dimensions are neat and legible.
3. Engineer shall sign and seal drawings in the construction set.
4. Number drawings in the construction set as Sheet XX of XX (total number of sheets in the set). Numbers shall correspond to the index shown on the cover sheet.

11.03.B Recommended Content for Drawings:

1. Cover sheet:
  - a. Project Title
  - b. Project Owner/Client
  - c. Vicinity Map
    - (1) General location within the City of Houston ETJ

*11.03.B.1.c**continued*

- (2) Key map and Lambert map numbers
  - d. Location Map
    - (1) Shows detailed access route to site
    - (2) May be included in Vicinity Map
  - e. Sheet Index
  - f. Engineer's seal and signature
  - g. City of Houston signature block
2. Site Plan
- a. Scale should provide legible drawing on a single 24-inch by 36-inch sheet
  - b. Boundary and easements
    - (1) Identify site boundary and easements
    - (2) Identify adjacent property owners
    - (3) Indicate sanitary control perimeter around well on site plan or on inset map to accommodate drawing scale selection
  - c. Access Road
  - d. Site Grading and Drainage
    - (1) Existing topographic features and contours
    - (2) Proposed pavement and grade elevations
    - (3) Proposed drainage facilities
      - (a) Identify components
      - (b) Show elevations
    - (4) Facility outlines and locations with:
      - (a) Dimensional system of control or

*11.03.B.2.d.(4)**continued*

- (b) Coordinate system of control
  - (5) Fences
  - (6) Benchmark
  - (7) Flood elevation - 100-year with FIRM Map reference
3. Yard Piping Plan
- a. Site boundary
  - b. Facility outlines and locations (see Site Plan)
  - c. Pipe layout
    - (1) Lines identified by text call out or by symbol and legend
    - (2) Line sizes identified by call out
  - d. Valves
    - (1) Valve types identified by text call out or by symbol and legend
    - (2) Valves sizes identified by call out
  - e. Ties to existing or future lines
  - f. Pipe elevations or depth of cover
4. Water Supply and Pump Discharge
- a. Well piping plan
  - b. Well piping section
  - c. Well foundation
5. Storage Tanks
- a. Plan layout
    - (1) Dimensions and capacities of tanks
    - (2) Orientation of piping and appurtenances

*11.03.B.5.a**continued*

- (3) Roof features and locations
  - (a) Handrails and non-skid surfaces
  - (b) Vents and hatches
- b. Tank section or elevation
  - (1) Piping elevations or location by dimension
    - (a) Suction
    - (b) Discharge
    - (c) Overflow
    - (d) Appurtenances
  - (2) Dimensions of tank
- c. Tank foundation
- d. Details
  - (1) Tank inlets
  - (2) Tank outlets
  - (3) Tank overflow
  - (4) Ladders
  - (5) Roof handrails
  - (6) Shell manholes
  - (7) Sample cock
  - (8) Pressure gauge/liquid level indication
  - (9) Drain splash box

*11.03.B**continued*

## 6. Booster Pump Station

- a. Plan layout
  - (1) Piping and valves
  - (2) Dimensions for locations
  - (3) Building footprint
- b. Piping sections
- c. Building design
  - (1) Foundation
  - (2) Structural design
  - (3) Appurtenances
  - (4) Details

## 7. Hydropneumatic Tanks

- a. Plan layout
  - (1) Capacity of tank
  - (2) Orientation of piping and appurtenances
- b. Tank section
  - (1) Piping elevations or location of dimension
  - (2) Dimensions of tank
- c. Foundation

## 8. Electrical

- a. Site plan
  - (1) Facility outlines and locations
  - (2) Service entrance location (service connection)

11.03.B.8.a

*continued*

- (3) Below grade conduit routings
  - (4) Outside light locations and orientation
  - (5) Emergency generator location (if provided)
  - b. Overline circuit diagram
  - c. Schematic wiring diagram
  - d. Ground rod/ground loop/ground grid location
  - e. Power and lighting plans for any buildings provided
9. Details
- a. Paving
  - b. Chemical feed systems - chlorination, fluoridation
  - c. Fence and gate
  - d. Fuel storage
  - e. Drainage

11.03.C

Water Plant Checklist (attached)

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**Section 12**

**INITIAL WATER PLANTS**

**SECTION 12 - INITIAL WATER PLANTS****12.01 SECTION INCLUDES****12.01.A General**

1. This section applies to development projects for, and up to, 250 equivalent residential connections required to provide potable water to future residential, commercial and/or industrial users.
2. Approval to construct initial water plants pursuant to this section is contingent upon submittal of an overall water supply and distribution plan for the development. The overall plan shall provide the preliminarily location and capacity of primary water plants, initial water plants, remote water wells, and trunk distribution lines.
3. Conform to requirements contained in other sections of this manual unless otherwise noted.

**12.02 DESIGN REQUIREMENTS****12.02.A Wells:**

1. Public wells may be straight wall wells or gravel packed, as needed, based on specific hydrogeological conditions at the proposed well site. Maximum capacity shall be 600 gallons per minute (gpm). Address size, wall thickness (minimum 0.375 inch), and planned length of casing and liner in specifications.
2. Locate wells 600 gpm or larger a minimum of 2,000 feet from another well, which is screened in the same aquifer. Wells less than 600 gpm shall be a minimum of 1,000 feet from other wells less than 600 gpm. No minimum separation is required if the wells are in different aquifers. When possible, do not locate new public water supply wells on the perimeter of the development it is to serve.
3. Minimum well size shall be 300 gpm.
4. Size casing and liner (interior casing) diameters to allow the pump to be lowered into the liner based on the manufacturer's minimum clearances between pump and liner. Maximum velocity between the pump and liner shall not exceed 8 feet per second.

**12.02.B Booster Pump:**

1. Minimum combined booster pump capacity shall be 1000 gallons per

*12.02.B.1**continued*

minute.

## 12.02.C Booster Pump Buildings

1. For plants without booster pump buildings, provide a minimum 6 inch thick concrete booster pump pad that extends at least 1 foot in each direction beyond the area required for the proposed booster pumps.
2. Conform to shelter requirements for disinfection and electrical components identified in Sections 6 and 10.

## 12.02.D Potable Water Storage Tanks:

1. Minimum ground storage tank volume shall be 80,000 gallons.

## 12.02.E Emergency Power:

1. Provide emergency power or provide electrical and mechanical devices necessary for quick connection of a portable generator. Plant operator shall be responsible for delivery, hookup, and operation of the emergency power generator.

## 12.03 QUALITY CONTROL

## 12.03.A Testing:

1. Step test completed well at 80%, 100%, 120% and 150% of design capacity for a minimum of 3 hours each with 3 hours of recovery between each step to confirm final selected capacity.
2. Test well at final selected capacity for 4 hours to verify stability in draw down.
3. An attempt shall be made to reach a specific capacity of 18 gallons-per-minute-per-foot of drawdown for a gravel-packed well and 10 gallons per minute per foot of drawdown for a straight-wall well after 4 hours of continuous well operation.

END OF SECTION

**City of Houston**

**GROUNDWATER PLANT DESIGN GUIDELINES**

**APPENDIX**

SECTION 1 - FIGURES

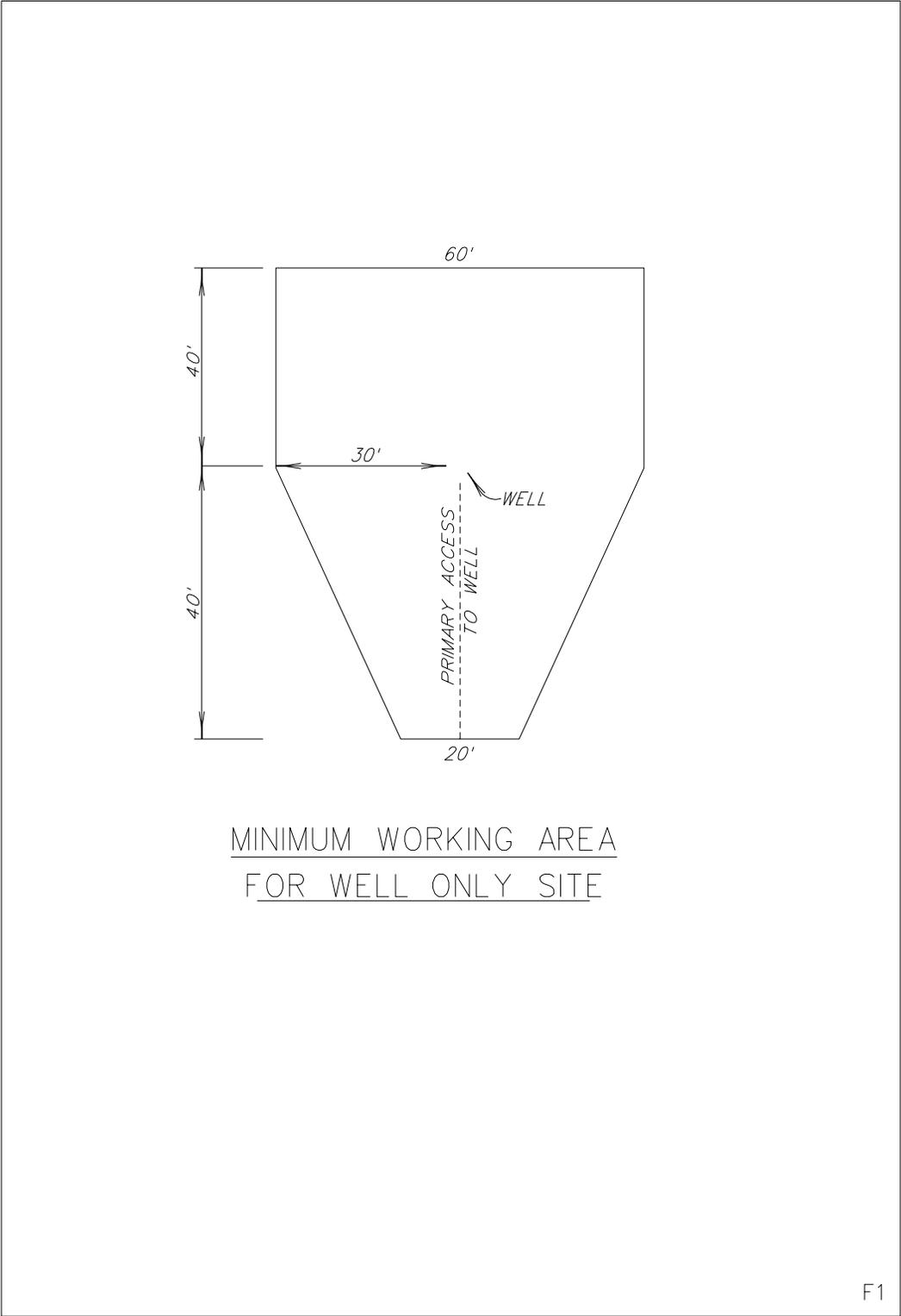
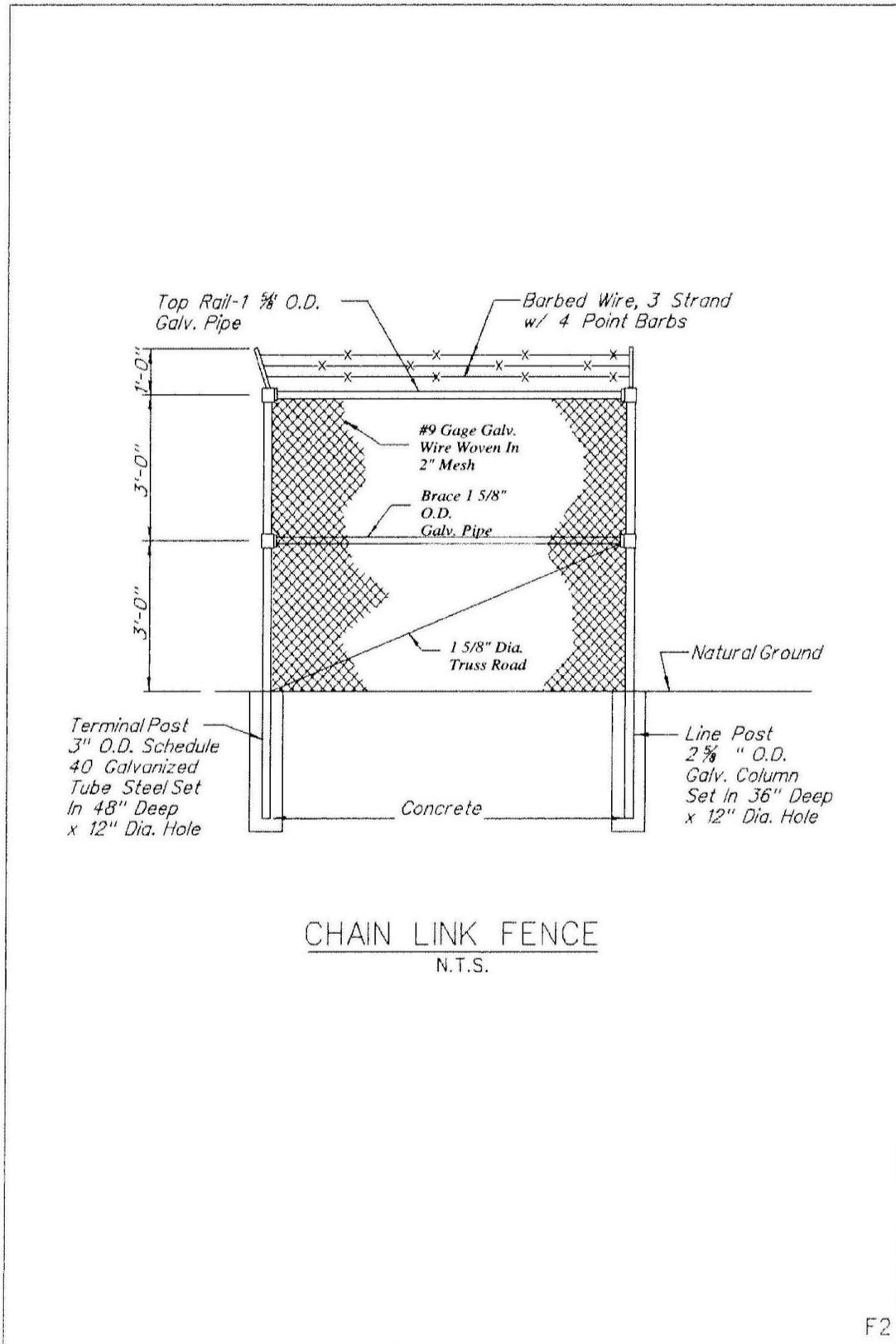


Figure F 1 - Site Requirements



CHAIN LINK FENCE  
N.T.S.

F2

Figure F 2 - Chain Link Fence

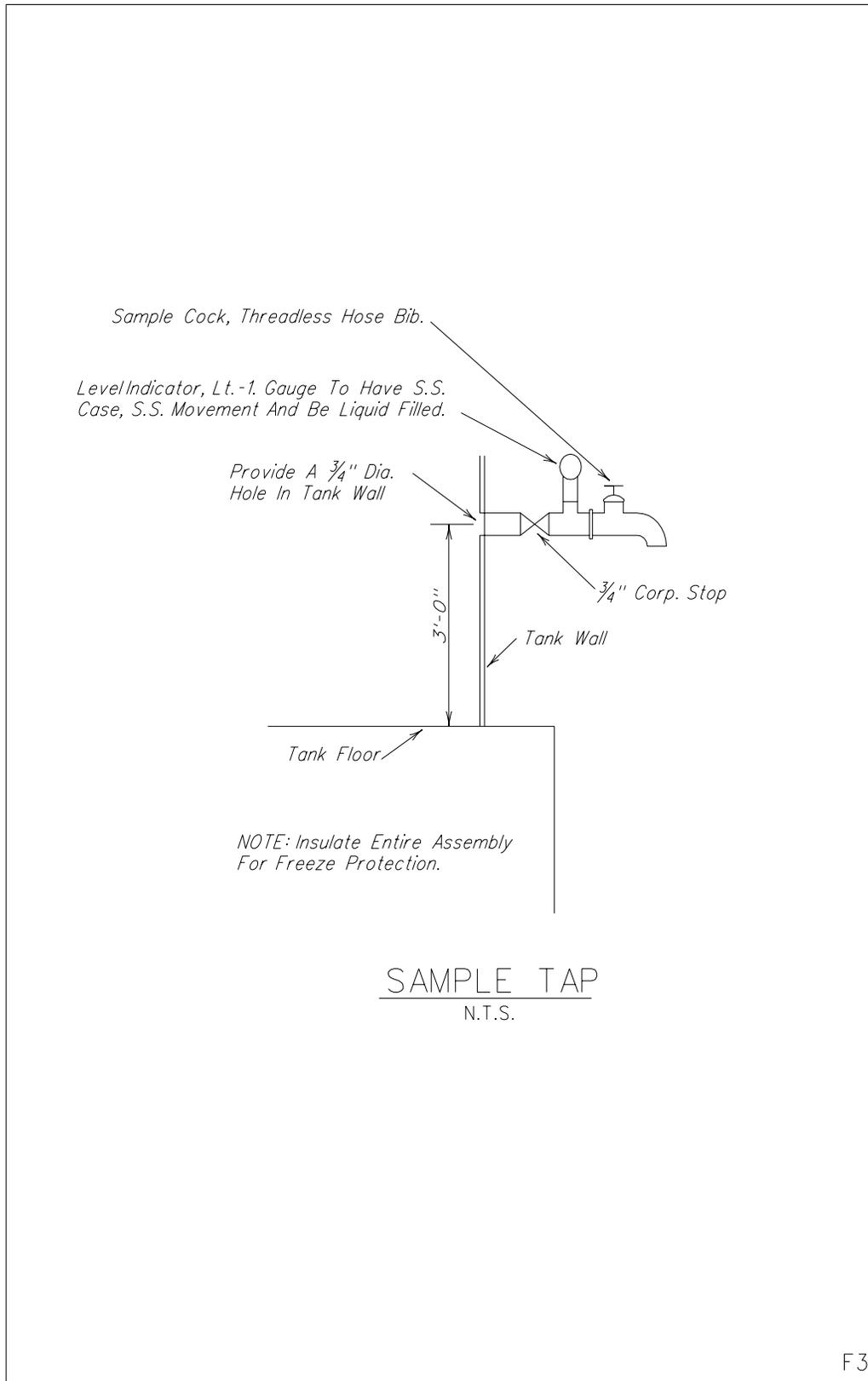
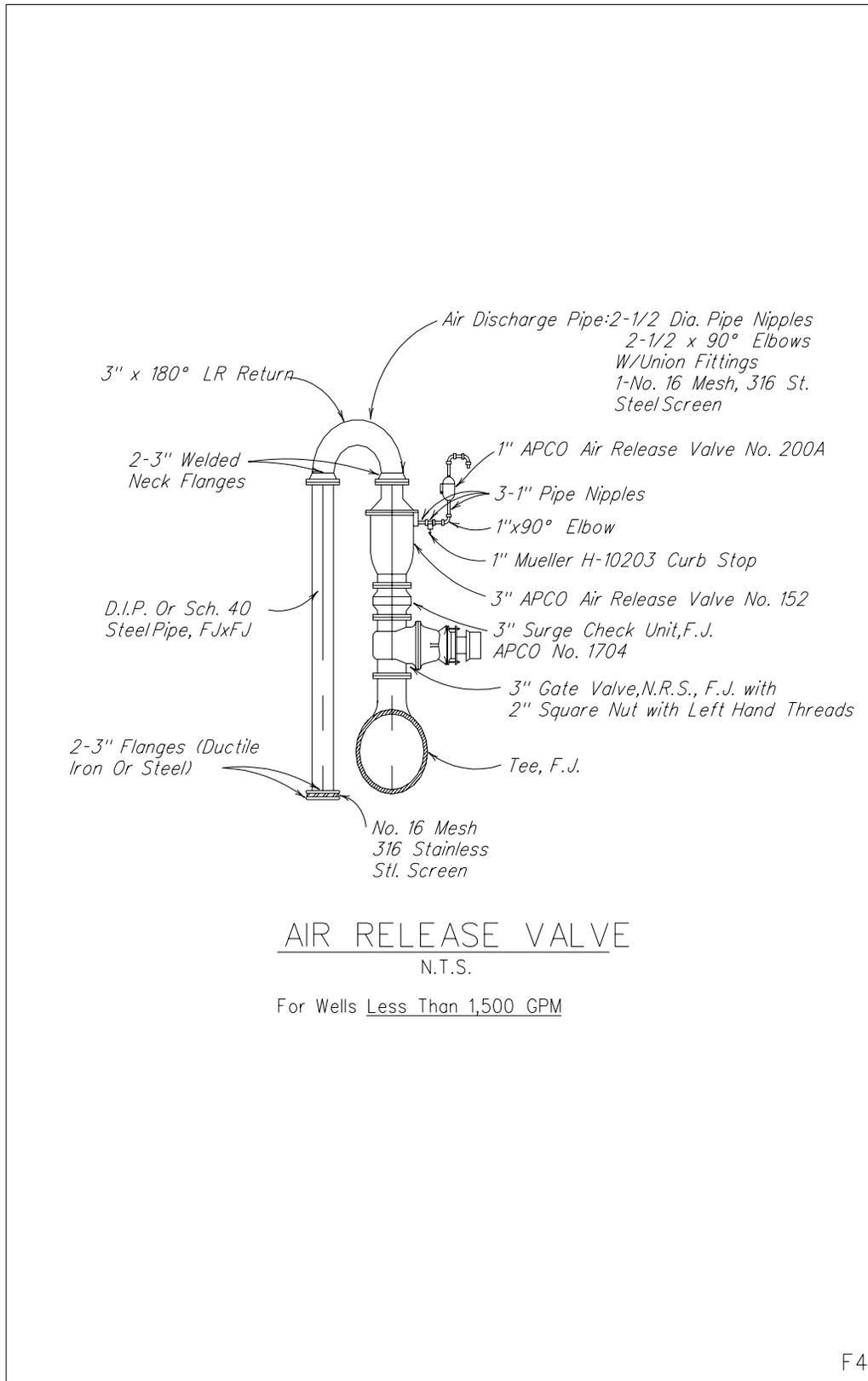


Figure F 3 - Sample Tap



F 4

Figure F 4 - Air Release Valve < 1,500 GPM

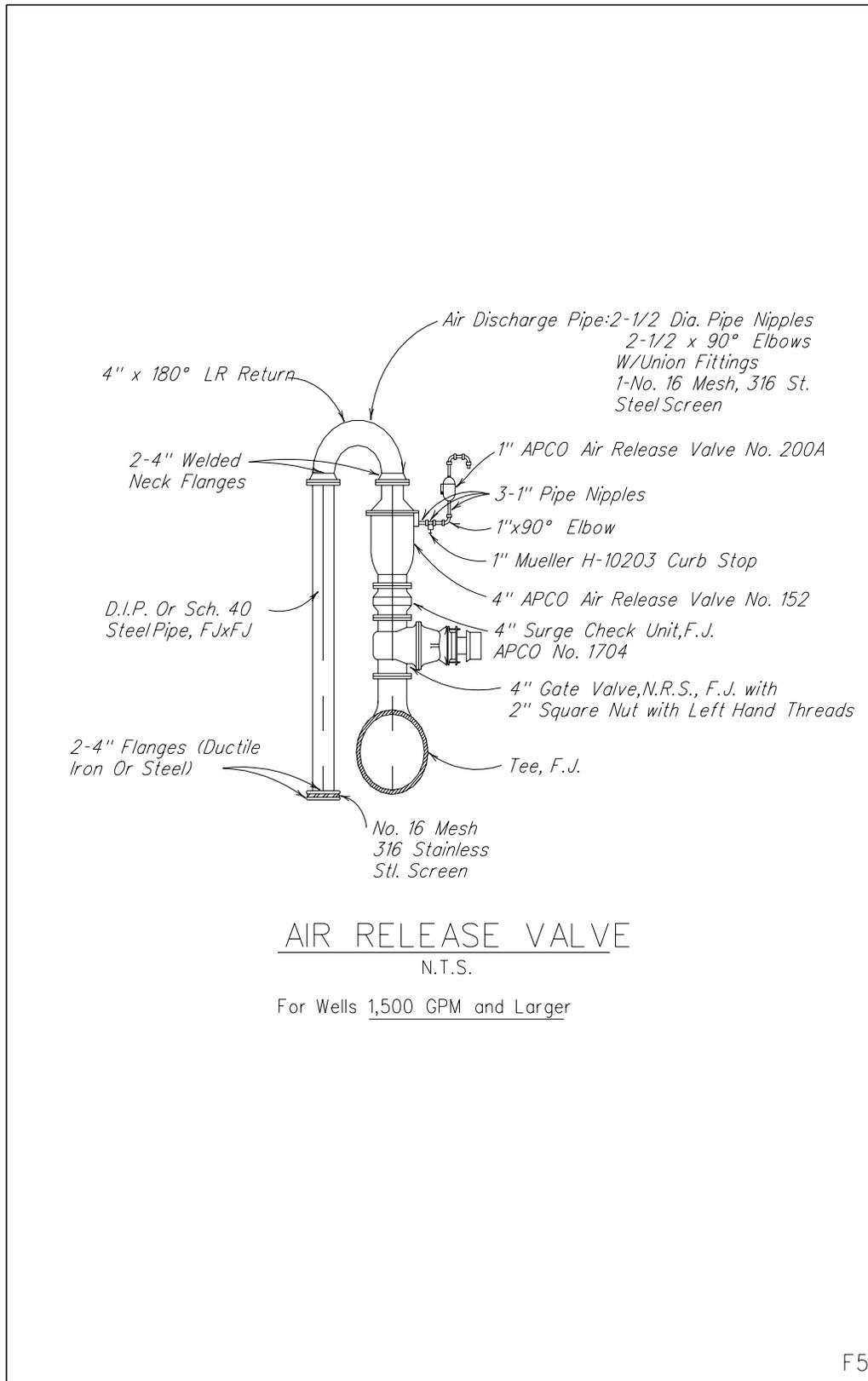
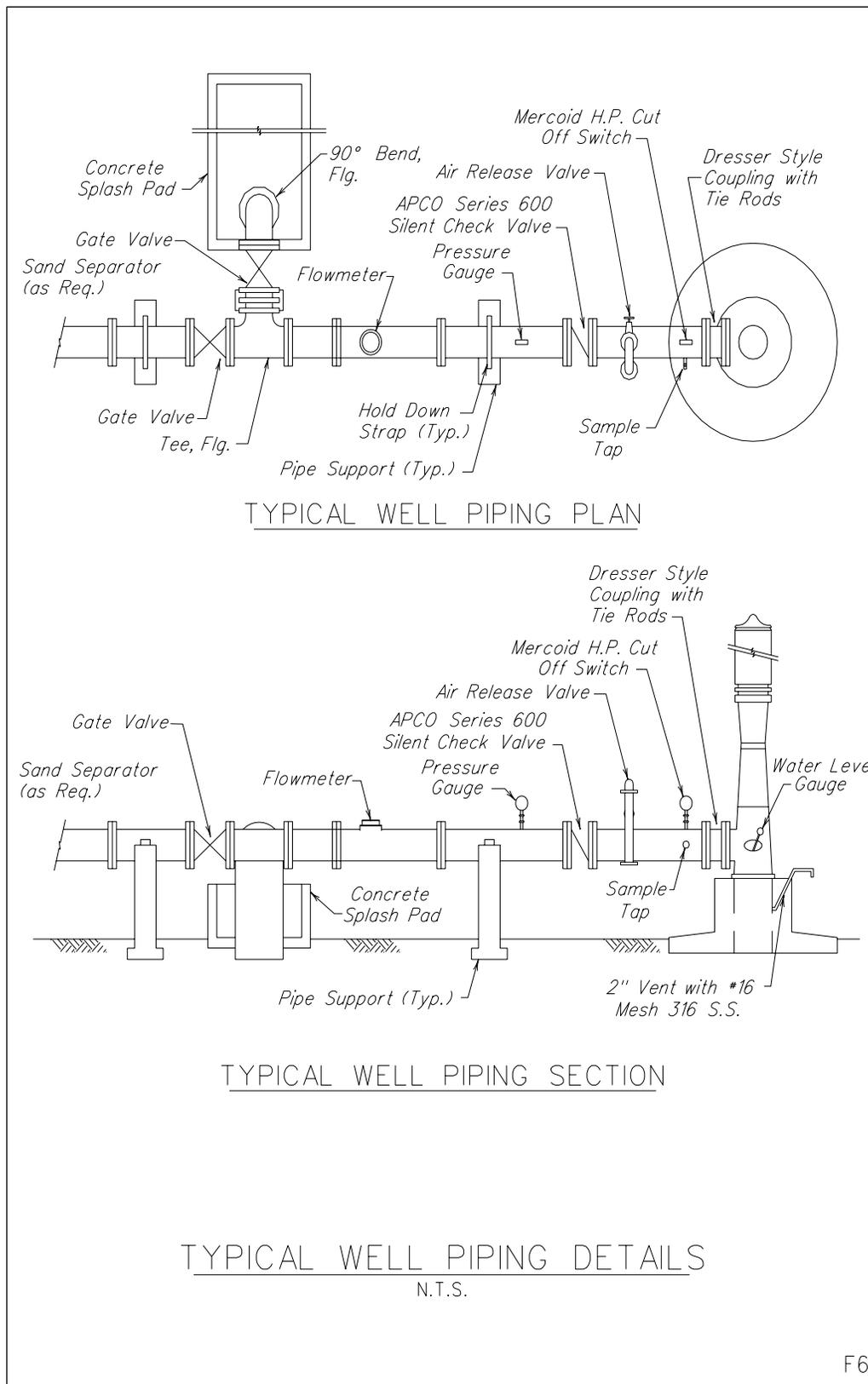
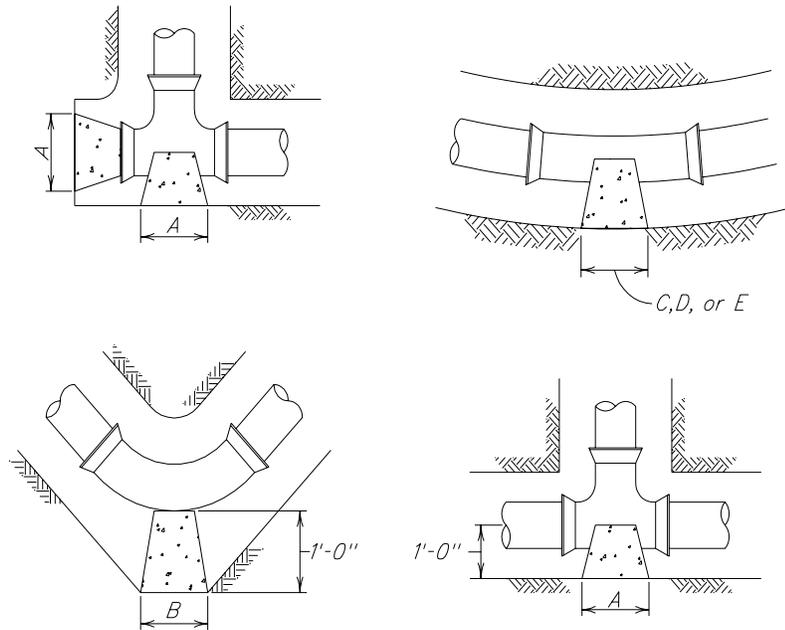


Figure F 5 - Air Release Valve > 1,500 GPM and Larger



F6

Figure F 6 - Typical Well Piping Details



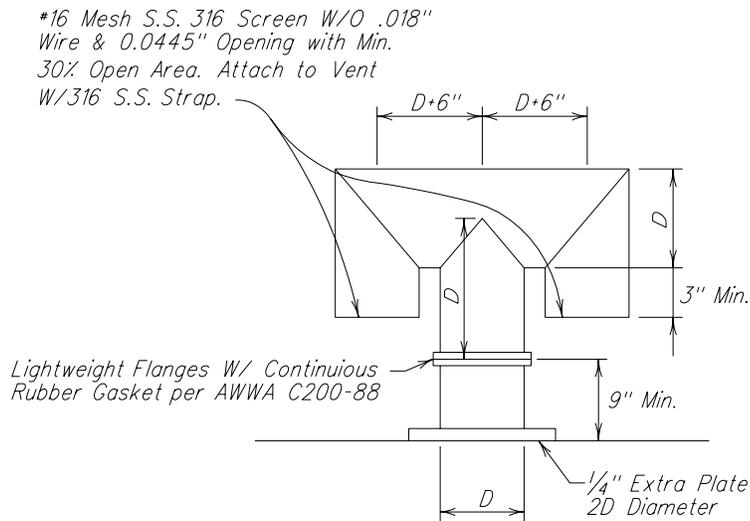
PIPE SIZE	"A" Plugs & Tees	"B" 90° Bend	"C" 45° Bend	"D" 22° 30' Bend	"E" 11° 15' Bend
10"	2'-0"	2'-3"	2'-0"	2'-0"	2'-0"
12"	2'-8"	3'-0"	2'-3"	2'-3"	2'-3"
16"	3'-6"	4'-3"	3'-0"	2'-6"	2'-6"
20"	4'-3"	5'-0"	4'-0"	3'-0"	2'-6"

- NOTES:
- Heights of all Blocks shall be equal to "A", "B", "C", "D", or "E" dimension called for.
  - All concrete to be poured against firm undisturbed soil.

THRUST BLOCK DETAILS  
N.T.S.

F7

Figure F 7 - Thrust Block Details



NOTES:

1. Vent to be Fabricated from Thin Wall Schedule 10 Steel Pipe.
2. Vent to be Coated Inside with same System specified for Inside of Tank
3. Vent to be Coated on Outside with same System specified for Tank Exterior
4. "D" is the Pipe Diameter in Inches.

ROOF VENT DETAIL  
N.T.S.

F8

Figure F 8 - Roof Vent Detail

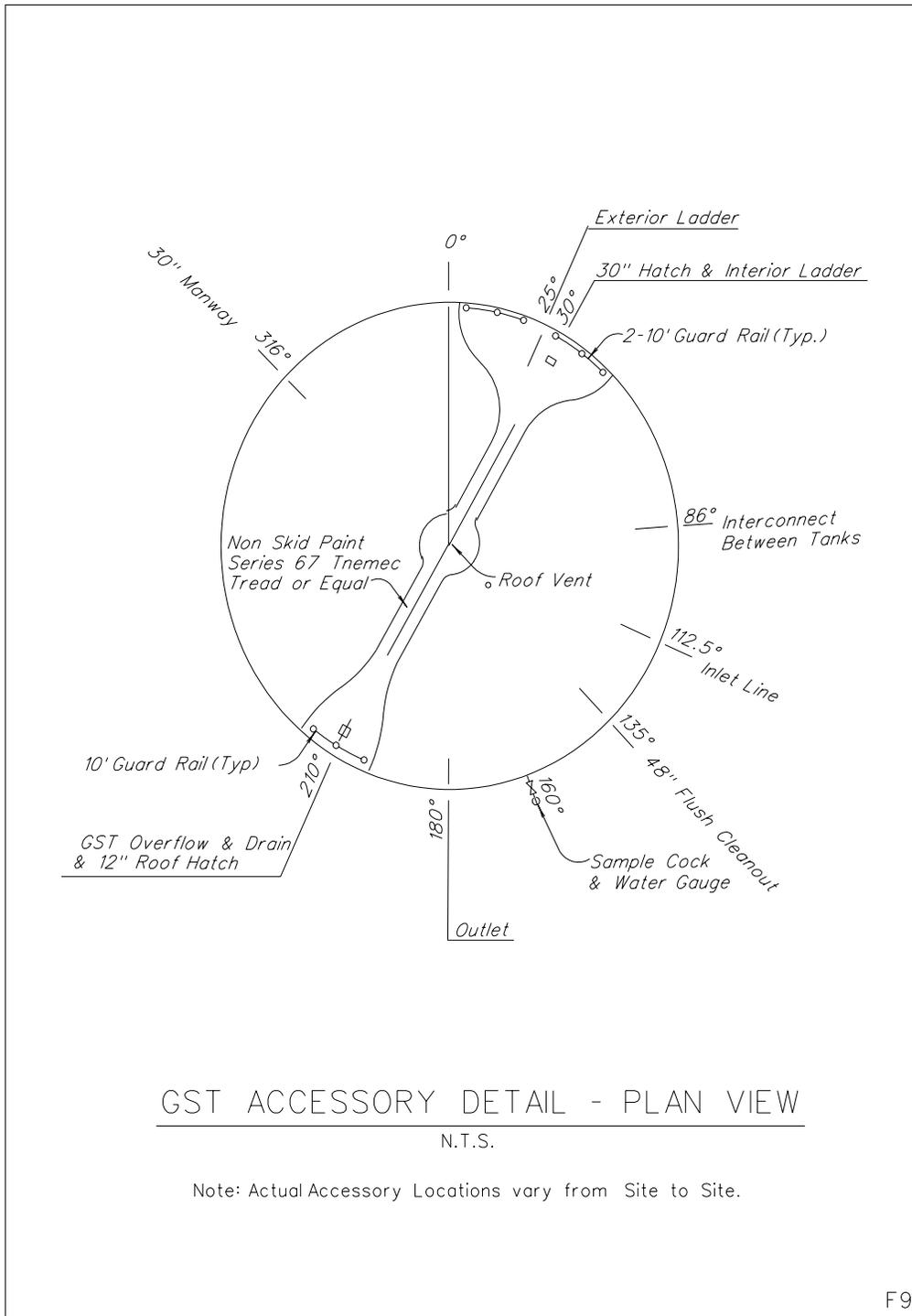


Figure F 9 - GST Detail Plan View

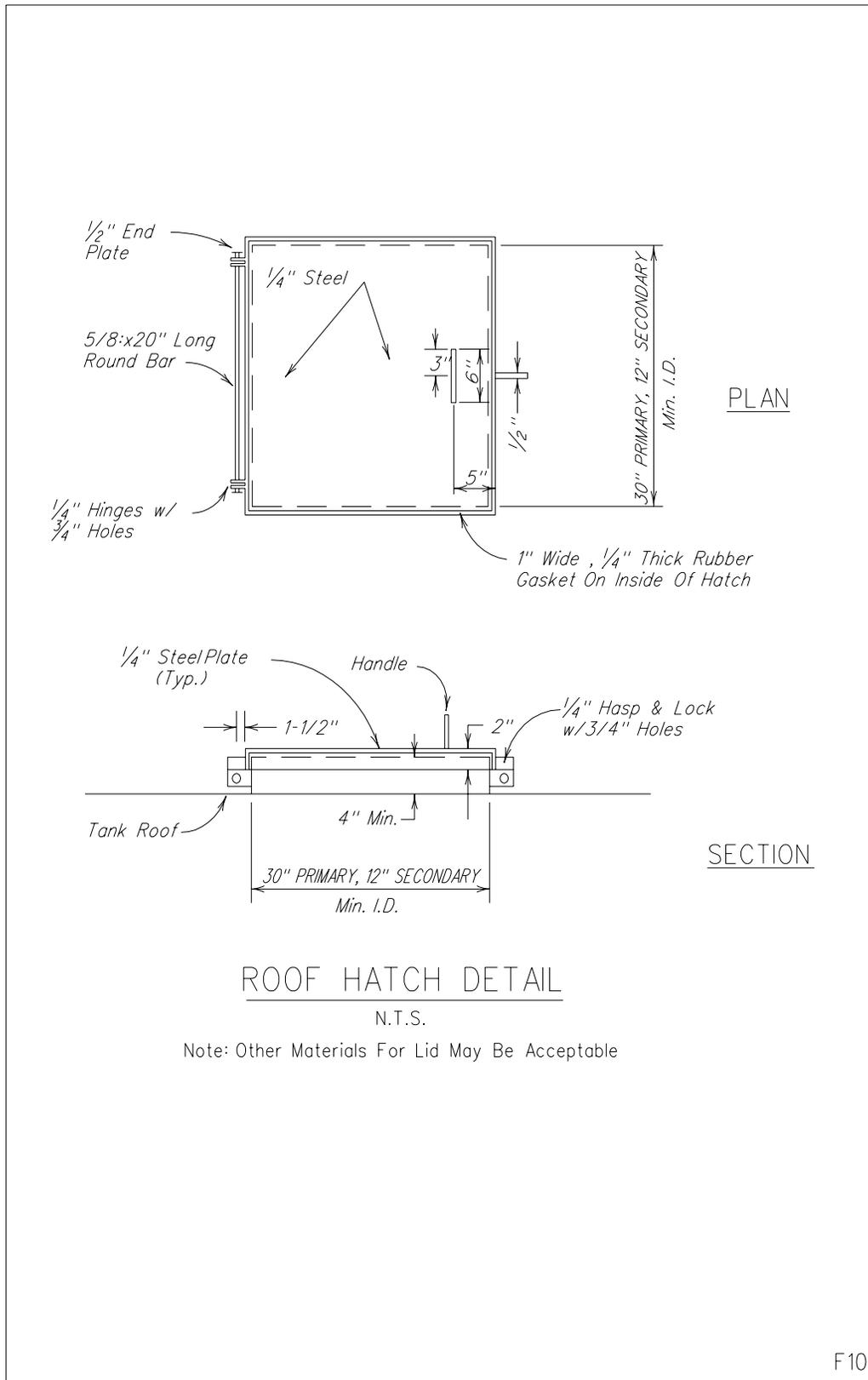


Figure F 10 - Roof Hatch Detail

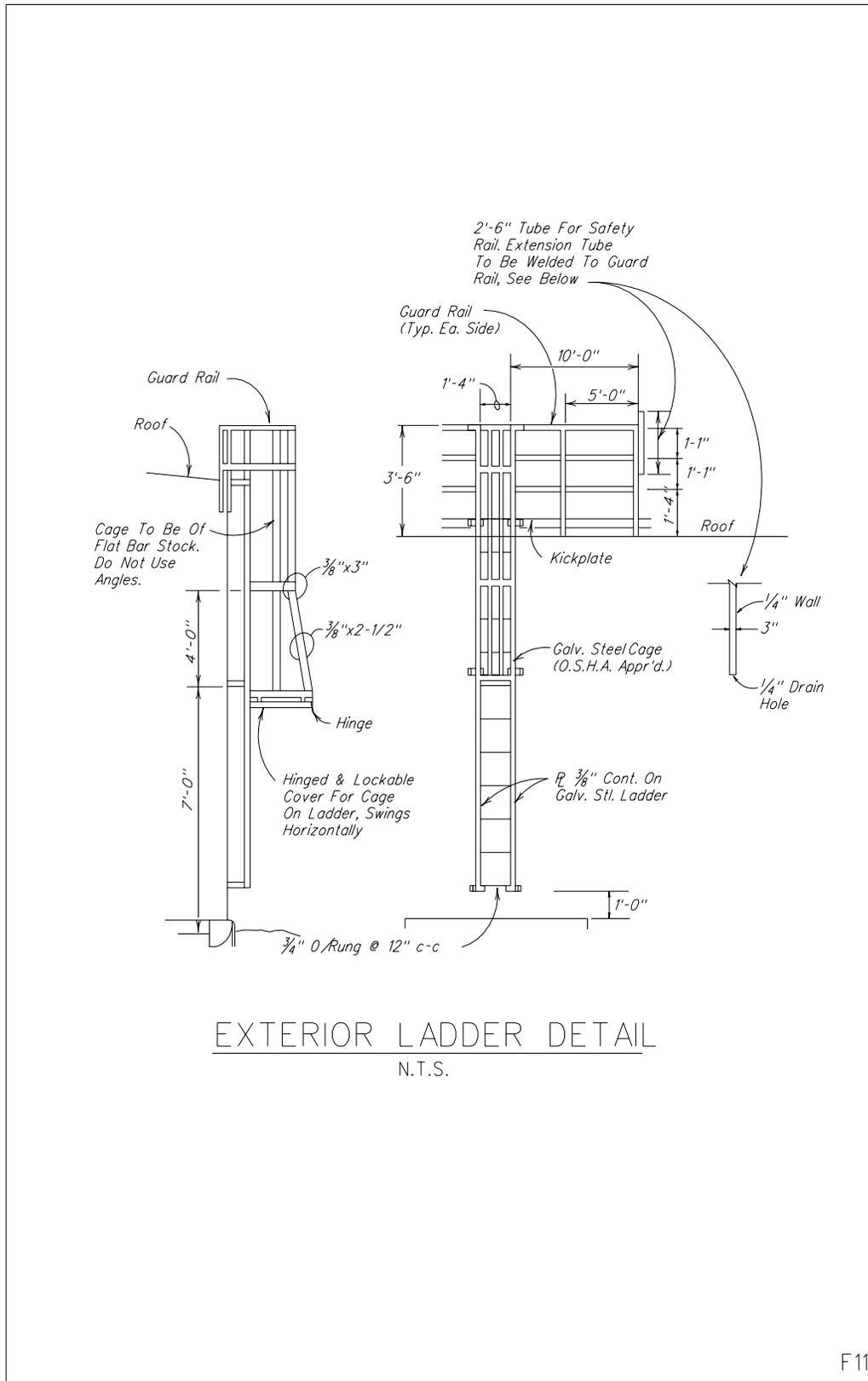
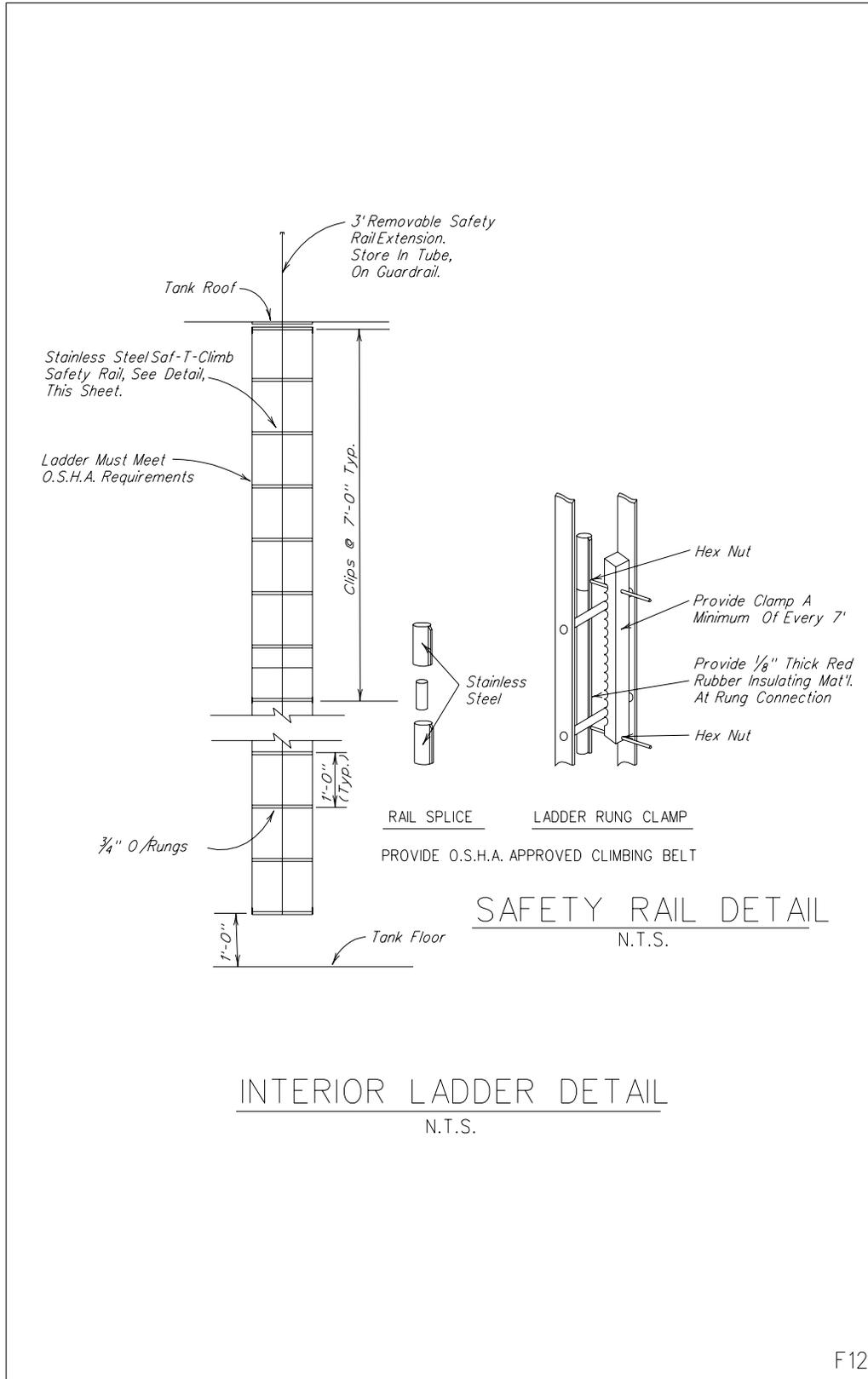


Figure F 11 - Exterior Ladder Detail



F12

Figure F 12 - Interior Ladder Detail

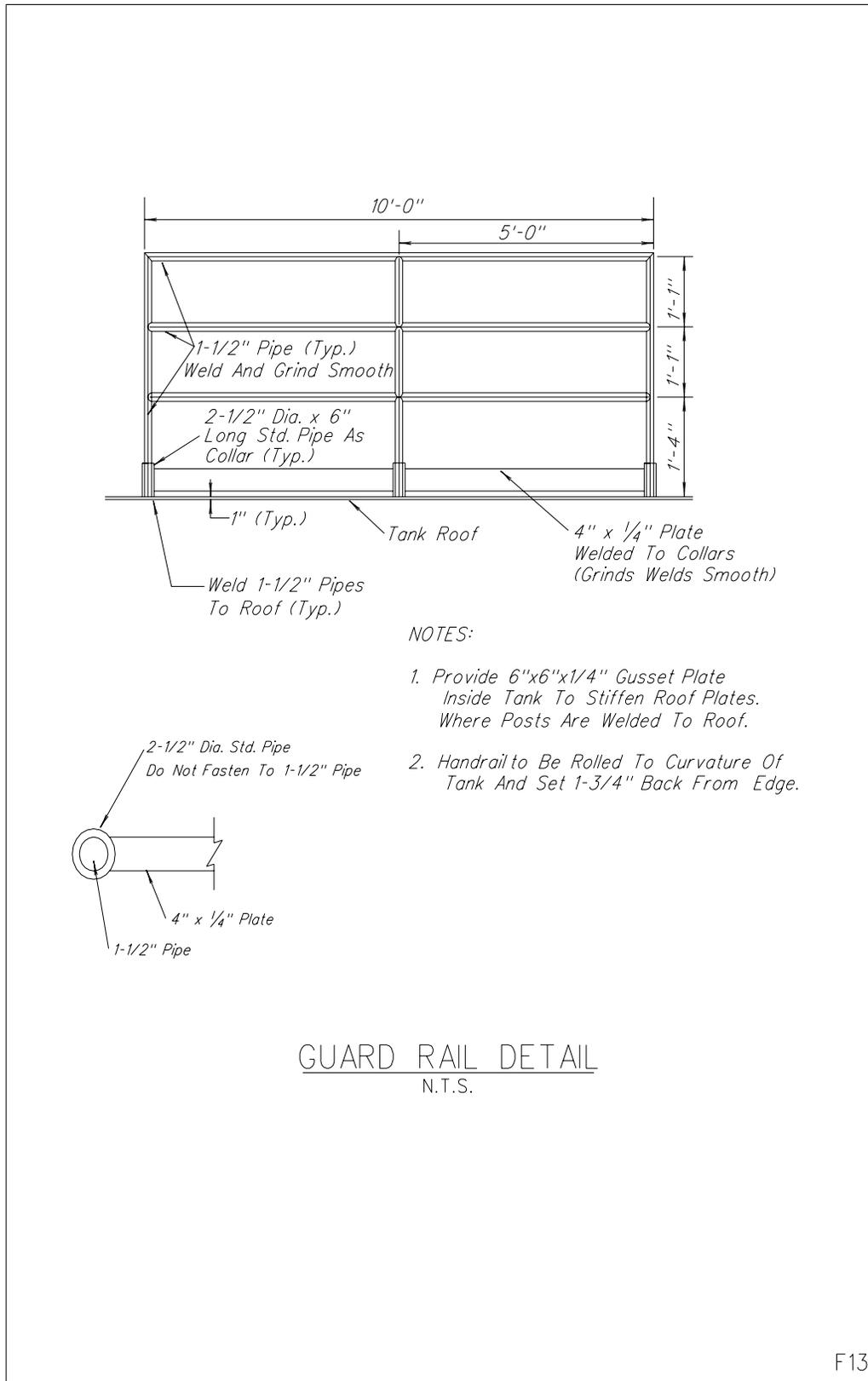


Figure F 13 - Guard Rail Detail

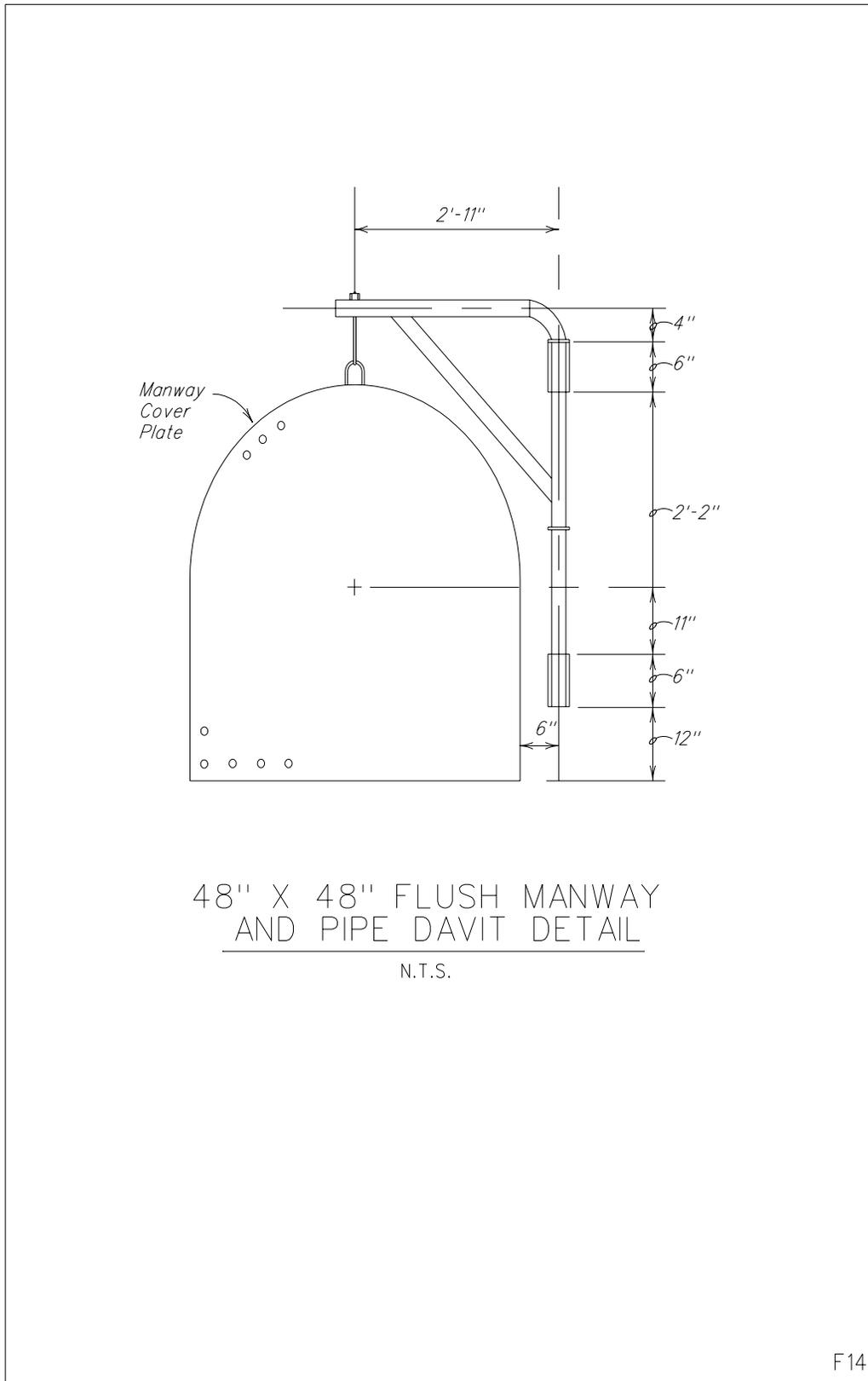


Figure F 14 - Manway and Pipe Davit Detail

**SECTION 2 - WATER PLANT CHECKLIST**WELL

Capacity  
 Eastman and other logs (vertical)  
 Seal block (3 from well surface casing)  
 Screened vent (1½" or 2" GIP, 16 mesh or finer, 316 S.S.)  
 Fdn 1-6" above grade (min.)

PUMP DISCHARGE

Air release (see detail)  
 Flex coupling  
 Sample cock (use COH standard, at least ½", need detail)  
 Chlorine tap (after meter, before other connections)  
 Meter  
 Check valve  
 Blowoff/with splash block

BOOSTER PUMP

Header velocity 4 fps max. suction; 5 fps max. discharge (6 fps max. discharge piping).  
 Minimum 1,000 GPM total  
 Valve in suction and discharge header  
 Check valve

PIPING

Use standard AWWA pipe sizes  
 Buried: use DIP with boltless push-on joints, AB fittings if possible  
 Aboveground: use DIP or steel with flanged joints  
 Maximum velocity 8 fps  
 All buried valves must have valve boxes  
 4"-14" must be gate valves; buried - push-on, boltless; aboveground - flange  
 16" or larger to be butterfly valves: buried - flange with S.S. bolts; aboveground - flange  
 20" and larger butterfly same as above  
 Thrust blocks must be provided for buried tees, bends and other fittings. No options  
 (other restraints may be used in addition)

CONTROL BUILDING

Masonry Const.  
 Slope roof to drain  
 Gas mask outside chlorine room  
 Heater in chlorine room  
 Crane and hoist required for large pump removal  
 Adequate access for smaller pump if hoist not used

GROUND TANK

Ladder safety rail (interior)  
 Ladder with cage (exterior)  
 Overflow with weir (beveled, hinged flap valve)  
 Drain with gate valve  
 Man way (48" x 48" need detail) + 24" hatch  
 Vents  
 Pressure gage  
 Sample cock  
 Inlet (minimum 45' from outlets)  
 Dual suction outlets with flared 90  
 Screens (16 mesh or finer, 316 S.S. corrosion resistant) on vents  
 Roof hatch 4" high, 2" overlap  
 2 outlets on first GST, one thereafter

HYDROPNEUMATIC TANK

4" drain with valve & splash block  
 Freeze proof sight glass  
 Air connect with probe(s)  
 Pressure gage

ELEVATED TANK 140 ft minimum  
 60 psi minimum

Drain  
 Overflow  
 Altitude valve optional with bypass or space for future altitude valve  
 Ladder with safety device  
 Single inlet/outlet if on distribution line (can replace hydropneumatic tank if close enough to booster pumps)  
 Separate inlet/outlet if direct feed from well, can replace ground storage tank, hydropneumatic tank and booster pumps.  
 Required when system exceeds 2,500 connections or equivalent.

OTHER

All drains, overflows and blowoff valves to have a minimum 6" air gap - well blowoff, ground storage tank, hydropneumatic tank and elevated tank  
 Fence, locate inside property line  
 Specifications must be submitted and approved  
 2 discharges to system