Section 24 - Pipelines and Appurtenances

A. Introduction – The HRSD interceptor system conveys wastewater to the treatment plants through a network of gravity sewers, force mains, pressure reducing stations, pressure control valves, and pump stations. This section includes specifics for design and construction of force mains, , sanitary sewer gravity mains and manholes, and valves and other appurtenances. This section also includes specifics for the design of temporary diversion and line stop systems. Designers for planned work on or near HRSD pipelines are to follow these requirements and use the appropriate details contained in Section 36 - Standard Details, appropriate technical specifications contained in Section 40 - Master Specification Sections, and other referenced checklists or forms within this manual.

B. General – The following items apply to all HRSD pipelines.

1. Design Specifics:

   a. Design and construction is to be in accordance with current *Commonwealth of Virginia Sewage Collection and Treatment Regulations (SCAT)*.

   b. Pipeline design flows are provided by HRSD. HRSD will provide pipe sizes for force mains and gravity mains based on the HRSD regional hydraulic model.

   c. HRSD desires to bid alternative materials to increase competition wherever possible. Typical materials used are lined ductile iron, FRP, PVC, and HDPE. HRSD has more experience and operational knowledge with ductile iron for use in force mains than these other materials. Other materials should be considered as appropriate based on site-specific conditions and current technology.

   d. Evaluate all utility crossings and critical tie-in points for conflicts. Conflicts shall be determined by the HRSD Project Manager and/or FIRM with concurrence from the Operations Department on a case by case basis. Maintain a minimum 18-inch vertical separation for all utility crossings and/or 10-feet horizontal separation from buried utilities unless otherwise approved by HRSD. Other conflicts may be identified on a project case by case basis for such concerns as maintenance of operation of valves and air vents or access to buried pipelines for condition assessment programs.

   e. The use of conflict structures is not permitted in the HRSD system.

   f. In situations where jurisdictional gravity sanitary sewer mains are crossed over within 36-inches of vertical clearance by the newly installed gravity sewer main or force main or the HRSD force main or gravity main is to be installed within 36-inch vertical clearance under the jurisdictional gravity sanitary sewer mains, these jurisdictional mains shall be Closed Circuit Television (CCTV) inspected preconstruction and post construction by the HRSD Contractor as a record for potential settling or misalignment issues.

g. Obtain information on existing subsurface utilities to the applicable Utility Quality Level as defined in the A.S.C.E. Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data (A.S.C.E. 38-02). Locate utilities in pipeline corridor in accordance with Utility Quality Level B. Utilities crossing the proposed pipe shall be located in accordance with Utility Quality Level A.

h. Maintain a minimum of ten feet from the centerline of the pipe to the edge of the easement or right of way. Where easements are through parcels (vs. along the edge), provide minimum of 30 foot wide easement. Refer to Section 36 - Standard Details section for standard easement plat requirements.

i. Provide bollards to protect and locate air vents, valve boxes, manholes, etc. in fields and areas where these structures are likely to be damaged or covered by vegetation or soil. Potential areas include cultivated fields or woods.

j. Do not install lined ductile iron pipe or fittings within 8 feet of chemical injection stations as pipe, gaskets, and the ceramic epoxy lining may be damaged. Consult with the lining manufacturer in such situations.

k. When existing pipe is to be abandoned, consider the need to abandon in place and/or removal. For pipe abandoned in place, fill pipe with lightweight grout (flowable fill) when pipe is 24" in diameter and larger.

l. Installation records shall be kept in a digital spreadsheet containing X,Y,Z coordinates for top of pipe elevations at each joint, fitting, valve and connection points. Refer to Master Specification Section 01323 - Record Documents, for X,Y,Z accuracy requirements.

2. Corrosion Prevention:

a. Evaluate the need for and, if required, design for external corrosion protection based on soil conditions or stray currents from other utilities. Provide electrical isolation at outlet valves and connections to adjacent pipeline sections if cathodic protection or bonded joints are required.

b. Evaluate the need for interior and exterior linings and coatings based on specific site conditions.

c. Where force mains discharge into gravity systems, special consideration shall be given to corrosion protection of the force main, manhole and gravity sewer. The design must also minimize turbulence**.**

3. Protective Linings:

a. Corrosion Resistant Lining for pipelines – For ductile iron pipe and fittings, the products described below have been approved and shall be specified as acceptable alternatives. Unless specifically approved by HRSD, all ductile iron pipe and ductile or cast iron fittings used for force main shall be lined. Specific requirements associated with each of these linings are contained in Master Specification 02510 – Ductile Iron Pipe within this manual.

    i. Internal Lining – The lining material for pipe and fittings shall be Permox CTF, Induron Coatings Protecto 401 or TNEMEC Series 431.

4. Bid Document Development

    a. Where appropriate, utilize details, bid and payment items from the *Hampton Roads Planning District Commission (HRPDC) Regional Construction Standards (* latest edition*)*.

    b. Provide details on the drawings indicating bedding, backfill and surface restoration requirements for the project.

    c. Pavement replacement details, traffic control and similar type issues must be coordinated with the appropriate municipalities, VDOT, etc.

    d. Include adequate survey data, including pipeline centerline stationing. State Plane coordinates – Virginia South / NAVD 88 Datum required. Accuracy should be within 0.1 of foot in the horizontal and vertical plane. All fittings/appurtenances to be GPS surveyed. References on drawings to allow for Contractor to perform field layout of proposed work. Refer to Section 6 - Drawings, Record Drawings, and Valve Guides in this manual for specific requirements.

    e. Handling of Lined Ductile Iron Pipe and Fittings – Ductile iron pipe and fittings lined with any of the standard corrosion resistant linings must be handled only from the outside of the pipe and fittings. No forks, chains, choker cables, hooks, or straps shall be placed inside the pipe or fittings for lifting, rigging, positioning, or laying. Straps will be used for lifting.

C. Force Mains

1. Design Specifics:

    a. Use c=130 for force mains for all flow calculations.

    b. Maintain a minimum cover of three (3) feet. Maximum cover is eight (8) feet with exceptions made on a case by case basis by HRSD's Project Manager.

    c. Consider potential for future development in determining depth of cover.

d. Design the vertical alignment of the force main to provide a positive grade. Minimum desirable slope is 0.20%. Include the slope and elevations on the profile drawing. Provide a copy of the continuous profile for HRSD's review as soon as the majority of the crossing utilities have been identified.

e. Limit maximum pipe joint deflections to 50% of manufacturer's maximum allowable deflection.

f. When HRSD installs new pipe or replaces force mains under major roadway intersections, the project should be designed and constructed to minimize the need for HRSD to perform future maintenance, repairs, and tie-ins within the intersection. Best practices include: replacing all old piping and valves within the intersection, not leaving any active portion of existing force main within the intersection (which may be a future failure point), and configuring the terminus points of the intersection work to facilitate connection of future pipelines leading to the intersection. Design consideration should be given to enhance future worker safety and minimize future traffic disruptions associated with the operation and maintenance of the new force main.

g. Verified high points in the pipe profile shall be field tapped for insertion of a corporation stop for an air vent assembly in lieu of factory taps for the air vents based on the Bid Document drawing locations. A stainless steel tapping saddle shall be used. Where field taps are made the protective lining shall be repaired in accordance with manufacturer recommendations.

h. Design new force mains for a minimum pressure of 100 psi at the high point in the line. Obtain anticipated range of operating pressures from the HRSD Project Manager. This may require higher design pressures but will not be used to justify lower design pressures.
    i. HRSD will run the Interceptor System model to verify positive pressures at minimum flows or indicate the need for pressure sustaining valves.

i. Provide positive means of removing air from the ends of the lines during testing and all operating modes.

j. Isolation valve placement shall be:
    i. Force main valve placement at 2,500 lf to 3,000 linear feet using best engineering judgment. All mainline valves shall be restrained.
    ii. All pump stations shall have a mainline valve on both sides of the emergency pump connection.
    iii. All major creek crossings shall have a mainline valve, tee and branch valve on each side of the crossing.

k. Obtain local municipality and HRSD input on the location and size of outlet valves. Design in accordance with Section 36 - Standard Details in this manual.

l. The minimum distance between taps on an HRSD force main is 1,000 linear feet. Exceptions will be considered on a case by case basis by HRSD Interceptors and the HRSD Project Manager.

m. Indicate the limits of restrained pipe on the profile.

n. Specifics on pipe thrust restraint:
   i. Use manufacturer's standard pipe restrained joints where restraint is required.
   ii. Do not use thrust blocks unless absolutely necessary at tie-ins to existing facilities and only after approval from HRSD Interceptor Operations and the HRSD Project Manager.
   iii. Wedge type retainer glands manufactured by EBAA, Sigma, Smith-Blair Camlok and Ford Meter box are acceptable.
   iv. Proprietary restraint systems, such as the U.S. Pipe "HP Lok" system, shall be considered on a case by case basis as recommended by the FIRM and HRSD Project Manager.

o. For ductile iron pipe, specify the following:
   i. Use special Class 51 minimum wall thickness.
   ii. Flanged joints, if used, shall be Class 125 per ANSI B16.1.
      1) The use of flanged pipe in buried conditions is not preferred. Use will be considered on a case by case basis by HRSD Interceptor Operations and the HRSD Project Manager.
   iii. Standard fittings shall be in accordance with AWWA C110 or AWWA C153.
   iv. Threaded bells shall not be used.

p. Use lined eccentric reducers; match grade at top of pipe.

q. The use of Foster® mechanical joint adaptors, as manufactured by Infact Corporation, for use on ductile iron pipe 6" through 36" diameter shall be allowed on a case by case basis. Justification for use shall be project specific and request for approval shall be provided in writing to the HRSD Project Manager.

r. In order to facilitate ease of pipeline tie-in and to correct for minor pipeline alignment discrepancies two (2) ductile iron long body sleeves to be designed at each tie-in. A single ductile iron long body sleeve may be used with the approval of HRSD Interceptors and the HRSD Project Manager based upon the alignment.

s. Provide sequence of construction and tie-in details for connections to ensure that connections can be accomplished without spills or interruptions to service. Use the checklist in Section 26 – "Checklist for Tie-Ins to Existing Interceptor Force Mains" within this manual.

t. Install tracer wire and utility marking tape on non-ferrous pipe installations, and utility marking tape on ferrous pipe installations unless otherwise directed. Tracer

wire access boxes shall be installed at a maximum distance of 400 feet. Do not use air vents or valve boxes as tracer wire access boxes. Section 36 – Standard Details, Detail No. 253 - Tracer Wire Locator Box shall be used for the tracer wire access point. There shall be adequate wire in the tracer wire access point to pull wire 24 inches outside of the box. Tracer wire to be tested for continuity as part of acceptance testing.

i. Copper tracer wire shall be 10 gauge, solid wire with plastic coating.
ii. Subsurface utility marking tape shall be of a durable, metalized, plastic film, for identification of all sanitary sewer lines. Bright green tape imprinted with the legend "Caution-Sewer Below" shall be used. The utility marking tape shall be manufactured by Griffolyn Co. or approved equal. Tape shall be placed no less than 6 inches and no more than 12 inches below the proposed finished grade.

u. For HDPE or PVC pipe, an appropriately sized mandrel may be required to be pulled through the pipe after installation to verify that allowable deflection has not been exceeded, if there are concerns about a section of installed pipe. Proper design and installation is required related to proper bedding, backfill, and compaction to prevent pipe deflection.

2. Hydrostatic Pressure Test Procedures:

a. Regarding use of the pressure gauge to be used for the hydrostatic test, the following options are identified. Coordinate with the HRSD Project Manager for the option to be utilized:
   i. Contractor to provide the pressure gauge for acceptance test along with a certified validation of recent calibration of this gauge. Calibration shall be within 12 months of planned hydrostatic test date. Contractor to provide a valved connection point to allow installation and removal of the test gauge without affecting line pressure.
   ii. HRSD to provide the pressure gauge for acceptance test along with a certified validation of recent calibration of this gauge. Contractor to provide a valved connection point to allow installation and removal of the test gauge without affecting line pressure.

b. Hydrostatic tests shall be a minimum duration of one hour. Test pressure at the high point in the new force main shall be 150% of operating pressure or 100 psi, whichever is less.

c. Contractor shall provide the capability to add water to the line during the test and will be required to add up to the allowable leakage at the end of the test period.

d. Allowable leakage shall be in accordance with Virginia Department of Environmental Quality (VDEQ) SCAT regulations and AWWA C-600 procedures.

e. Contractor shall open all outlet valves and end of line valves to allow testing of all blind flanges, plugs, etc.

f. Contractor shall install corporation stops at ends of line to remove air for testing. Plug these upon completion of testing.

g. Verify the appropriateness of the testing procedure for plastic pipe materials, if used. To account for expansion, prior to testing, HDPE pipe shall be filled to the required test pressure. The test pressure shall be maintained for a minimum of three (3) hours by adding make up water hourly as required. After three (3) hours water shall be added to reestablish test pressure and the actual test may begin.

h. The "Report of Hydrostatic Pressure Test" form to document the results is found in Attachment A to this Section.

i. Provide required pipe restraint to accomplish hydrostatic pressure test.

j. Pressure testing of new force main shall not take place against new or existing HRSD valves or extend into existing pipe or facilities without written approval from the HRSD Project Manager.

k. Hydrostatic pressure tests on taps to Prestressed Concrete Cylinder Pipe (PCCP) shall be for a duration of thirty (30) minutes at 50 psi for all tap sizes.

l. The Contractor or the FIRM shall notify the HRSD Pretreatment and Pollution Prevention (P3) Division and the appropriate Treatment Process Engineer for the receiving HRSD facility prior to discharing water used during hydrostatic testing. Notification shall be made a minimum of 24 hours in advance of the planned discharge.

D. Line Stops

1. The Design and Construction Divisions have seen the need for line stop and bypass system installations on force mains increase dramatically over the past decade. HRSD has also seen an increase in the number of line stop companies entering the wastewater market over this same period of time. The Master Specification 02531 – Line Stops on Sanitary Sewer Force Main Systems in Section 40 and the Checklist for Line Stop Installation in Section 25 of this manual are to be used for consistency for all line stop submittals and installations on HRSD force mains. This section establishes guidelines for HRSD staff and FIRMs for use and editing the HRSD Line Stop Master Specifications, including FIRM and personnel qualification requirements into the Bid Documents, and specific design considerations for line stops and bypass systems.

2. Design Considerations - The designer of line stops and bypass systems need to evaluate the following risks on a case by case basis:

a. How long will the line stop/bypass be in place? This issue needs to be discussed with HRSD Interceptor Systems and their knowledge of the force main system to determine if bypass through the line stop housing will be permitted verses a requirement to install additional tapping sleeves and valves for the bypass. The designer shall prepare head loss calculations for all bypass flows proposed through the line stop housing to compare different line stop companies and their published literature on housing design and head losses.

b. Does the interceptor system have a history of significant debris/rags at pump stations upstream and downstream of the project site? This issue is also important for a bypass design related to clogging risk and pressure spikes in the force main leading to a risk of pipeline failure and sanitary sewer overflows.

c. Can a zero or low flow (velocity 2 fps or less) situation be created to insert the line stop plug? This issue has arisen numerous times for recent past line stop installation, where the line stop field crew has requested a zero flow during insertion and removal of the stopper unit. This issue needs to be clarified with HRSD Interceptor Systems prior to the Bid Documents being advertised for construction bids.

d. What type of response would be necessary if the line stop housing becomes clogged and what are the overflow risks? Evaluate responses to include pump and haul scenarios at impacted pumping stations (HRSD, jurisdictional, private), response time to unclog the line stop housing, additional materials on site, and other backup plans. If bypass through the line stop housing is recommended by the designer and confirmed by HRSD, then the contingency plan development, submittal and approval must be incorporated into the Bid Documents.

3. Qualifications to be incorporated into Bid Documents - The following qualifications for the line stop firm and key personnel shall be incorporated into the Instructions To Bidders (Section 00200); Article 3 – Qualification of Bidders. Any revisions to these qualifications shall be coordinated and approved by HRSD's Project Manager and the Engineering Contract Specialist.

   3.01 To demonstrate needed qualifications for the Project, the apparent low Bidder and other Bidders as requested by the Owner or the Engineer shall submit a completed copy of the attached Questionnaire and documentation of experience required in Paragraphs 3.02, 3.03, and 3.04 within twenty-four (24) hours of the Bid opening. Additional information may be requested after the Questionnaires are received if, in the opinion of the Engineer, the information submitted is insufficient to complete the evaluation of the Bidder.

   3.02 Bidders and sub-bidders shall be fully knowledgeable, competent, and experienced and shall meet the minimum requirements defined herein for the construction of line stops for similar projects. The Bidder and/or sub-bidder and their respective superintendents shall have successfully completed projects of similar length/size, material, diameter, and installation conditions as follows:

A. Line stop sub-bidder and the sub-bidder's on-site superintendent shall have experience with installation of at least five (5) line stops on 20-inch or larger cast iron, ductile iron, or prestressed concrete cylinder pressure pipelines over the past five (5) years. Additional line stop sub-bidder experience requirements are listed in Article 3.04 below.

B. Self-performing of line stops by the General contractor shall not be permitted. This includes installation of "bag stops".

3.03 The Bidder shall provide required documentation for their experience, for sub-bidder's experience, and for all on-site superintendents' experience. Documentation shall include project titles, Owner's and Engineer's names, addresses and phone numbers, lengths, diameters, and materials of construction, and project values. Attach additional pages to the questionnaire as necessary to provide this information.

3.04 Qualifications of Line stop Sub-Bidder:

A. The line stop sub-bidder shall have a minimum of five (5) years documented, uninterrupted service with furnishing line stop equipment for sanitary sewer force mains on the type and size of pipe described in the description of work. Provide detailed reference information including:

1. Project name, location of the work, and start and completion dates.

2. Description of project including equipment provided, size of pipe, and type of force main.

3. Project owner contact information, including their contact name, address, phone and e-mail.

4. General contractor name, their contact person, address, phone and e-mail.

B. The line stop sub-bidder shall have completed five (5) successful line stop installations for sanitary sewer force main systems over the past five (5) years and shall provide the following information:

1. Project name, location of the work, and start and completion dates.

2. Description of project including services provided, size of pipe, and type of force main.

3. Project Owner contact information, including their contact name, address, phone and e-mail.

4. General contractor name, their contact person, address, phone and e-mail.

C. The line stop sub-bidder shall have a minimum of two (2) line stop superintendents currently employed with their company. Each line stop superintendent shall have a minimum of three (3) years continuous employment with the line stop company and shall provide the following information:

1. Names of a minimum of two (2) line stop superintendents currently employed with line stop sub-bidder, including number of years of employment with line stop sub-bidder's company.

D. Each line stop superintendent shall have completed three (3) successful line stop installations for sanitary sewer force main systems over the past three (3) years. Provide the following information:

1. Project names, location of the work, and start and completion dates.

2. Description of projects including services provided, size of pipe, and type of force mains.

3. Project owner contact information, including their contact name, address, phone and e-mail.

4. General contractor name, their contact person, address, phone and e-mail.

E. The line stop sub-bidder shall have an established training program for their employed line stop superintendents. Copies of the line stop sub-bidder training program shall be submitted. The line stop superintendent shall have appropriate training on the equipment that is to be used. All line stop superintendents proposed for this work must be graduates of the training program. Submit copies of the following:

1. Copies of line stop sub-bidder training program.

2. Copies of training certifications for a minimum of two (2) line stop superintendents currently employed by line stop sub-bidder's company.

F. The line stop sub-bidder shall utilize a qualified licensed professional engineer(s) to review all orders, ensure proper design, verify tolerances, and ensure that all services (standard or special) are completed in accordance with applicable AWWA, ANSI, and/or ASME codes. This

engineer(s) must be capable of quantifying the range of hydraulic loss through the line stop system and have sufficient pipe design and restraint experience/knowledge with (at a minimum) the pipes specifically listed in the description of work. All submittals from the line stop sub-bidder must be stamped by the referenced licensed professional engineer(s).

4. Liquidated Damages - consideration should be given by the designer for Liquidated Damages to be included in the Agreement for Emergency Designation Projects for late delivery and installation of line stops / bypass system after an agreed upon date by HRSD and the line stop company and/or General Contractor.

E. Valves

1. Gate valves and plug valves shall be considered in the design, and specified as appropriate per the particulars of each project. At present, HRSD allows both gate valves and plug valves for direct bury applications with approval by the valve manufacturer for such use with raw wastewater.

   a. For large diameter valves, consider the length of bonnet and location of valve nuts (main and bypass) when determining force main alignment.

   b. All valves shall be fully opened and closed for one cycle before installing to verify operation and record actual number of turns. Certified maximum operating torque on the valve shaft and the mechanical advantage of any geared actuator shall be provided by the manufacturer and shall be included on the shop drawing submittal provided to HRSD.

   c. Valves shall be capable of drip-tight, bi-directional shutoff.

   d. Bi-directional hydrostatic testing of valves shall be conducted by the valve manufacturer. A certificate of compliance, including test methods and results, shall be provided to HRSD for each valve and included with the shop drawing submittal to the HRSD Project Manager. Minimal acceptable test pressures shall be in accordance with applicable AWWA valve standards (C-500, C-509, C-515 and C-517) for the valve type specified.

   e. Mainline plug valves to be installed on concrete pipe force mains may require special bedding. The FIRM to evaluate the loading, strain, and settlement potential of the valve and the connecting pipes and develop installation details, plan notes, and technical specification language as needed for the development of the Bid Documents and Drawings.

   f. The following requirements shall be used for the specific type valve to be installed:

      i. Valves three inches and larger shall be designed for a cold working pressure of not less than 150 pounds per square inch and tested at a pressure of not less

than 300 pounds per square inch. Valves 16 inch and smaller shall operate in a vertical position and valves over 16 inches shall operate in a horizontal position. Gearing, 4:1 ratio, shall be provided on valves 16 inches and larger. Gear cases and shafts shall be the "totally enclosed type, suitable for buried service." Valves shall be furnished with a standard wrench nut (two inch), shall be of non-rising stem configurations and shall open left (counter-clockwise). Valve ends shall be provided as indicated in the construction documents. Specified valves shall be in conformance with one of the following requirements.

1) Resilient wedge Seated Gate Valve – Shall conform to AWWA C509 or C515 and be fusion bonded epoxy coated on both the interior and exterior of the valve and in accordance with AWWA C550. Resilient seated gate valves shall not be used in the horizontal position.

2) Double Disc, Parallel Seat Gate Valve – Shall conform to AWWA C500 and shall be coated with an asphaltic varnish in compliance with NSF-61. Seats in the body shall be replaceable without removing the valve from the pipeline. Discs are to be free to revolve 360 degrees. Discs shall be cast iron and bronze faced. Valves installed in the horizontal position shall be furnished with bronze rollers, bronze tracks and bronze scrapers. Valves in accordance with Section 4.4.8.1.1 of AWWA C500 will not be allowed. Bypasses shall be provided on double disc gate valves 36 inches and larger.

3) Eccentric Plug Valve – Shall conform to AWWA C517 and shall have an exterior and interior coating of epoxy. Valve body and plugs shall be ASTM A 126 Class B cast iron. Plugs shall be solid one piece with a cylindrical seating surface eccentrically offset from the center of the shaft. Plug facing shall be Buna-N with a minimum hardness (Shore A) of 70 durometer. Seats shall be welded in overlay of minimum 1/8" inch thick nickel raised surface. Bearings shall be permanently lubricated 316 stainless steel. Packing shall be multiple v-type or u-cup type. Washers at the top and bottom of the plug journal shall be provided to keep grit and debris out of the bearings and packing. Plug valves in the horizontal position shall be installed so that the plug rotates upward as the valve opens. The operator nut and stem shall be protected with a collar during shipping and installation.

   For exposed service applications plug valve shaft seals shall be externally adjustable and repackable without removing the actuator or bonnet from the valve under pressure. The actuator mounting bracket shall allow access to the packing gland and provide an air gap to visually inspect the packing.

   For buried service applications shaft seals shall be fully enclosed and protected from the surrounding groundwater and soil via full

circumferential metal to metal contact between the bonnet and the actuator body or by other means as approved by HRSD.

2. Disposition of existing inline valves to be taken out of active service is as follows:

    a. Valves oriented horizontally shall be opened fully and abandoned in place after the valve is inspected for deterioration. If HRSD, or FIRM, determines deterioration may compromise future integrity of the interceptor force main the valve shall be removed.

    b. Valves oriented vertically shall be removed unless otherwise approved by HRSD Project Manager.
        i. For vertically aligned valves that are not practical to remove, then develop a sequence to remove the actuator and working components, and then install a gasketed flange plate.

    c. All existing branch valves on the affected section of the interceptor force main shall be replaced.

3. Automatic air release valves may be approved for use in the HRSD system on a case by case basis, reviewed for use and approval by the HRSD Project Manager and with concurrence from HRSD's Operations Department.

F. Gravity Interceptors and Manholes

1. Use n=0.013 for gravity interceptors for all flow calculations.

2. General flow information will be provided based on HRSD's Regional Hydraulic Model. Final line sizing must consider the pump capacity of the pump stations discharging into the line.

3. Provide smooth transitions at connections, manholes and structures to minimize turbulence and release of hydrogen sulfide.

4. For manholes on large diameter lines (>20"), at force main discharge manholes, and at heavily traversed or difficult operating locations, manholes shall be made of corrosion proof materials. Use of corrosion proof materials for manholes, frames and covers at all other locations will be considered on a case by case basis as recommended by the FIRM and HRSD Project Manager.

5. Testing

    a. Perform infiltration, exfiltration or air testing in accordance with VDEQ SCAT regulations.
    b. Consider pulling mandrel through completed lines to verify that the pipe is not deflected beyond the manufacturer's specified deflection limits.