# Specifications for the Construction of Sanitary Sewers

**for:**

# The Easton at Rutgers Plaza

**Block(s): 385**
**Lot(s): 2.07**
**Township of Franklin**
**Somerset County, New Jersey**

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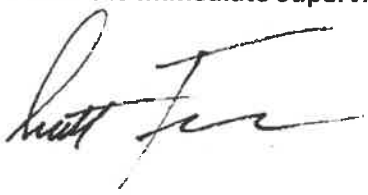

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## APPENDIX C OF THE RATES, RULES AND REGULATIONS

### FRANKLIN TOWNSHIP SEWERAGE AUTHORITY
### SEWER SYSTEM STANDARDS

A GENERAL

I. PURPOSE. These specifications are minimum acceptable standards for sanitary sewer systems in developments, subdivisions, and industrial and commercial projects lying within the jurisdictional area of the Franklin Township Sewerage Authority, or connecting to the Authority system, including the connections from main sewers to the point of connection with the building outlet. Wherever other standards are applicable or portions of this standard are contradictory, the stricter standard shall govern.

II. STANDARD DETAILS. The drawings entitled "Standard Details, Franklin Township Sewerage Authority", which comprise Appendix D of these Rates, Rules and Regulations, depict construction details for construction of sanitary sewer systems in the Township of Franklin. The Standard Details shall be adhered to at all times.

III. PRE-DESIGN MEETING. These sewer system standards are intended to provide guidance to entities contemplating construction of sewerage facilities. For sewer collection system projects, a pre-design meeting is encouraged. For pumping station projects, a pre-design meeting with FTSA and the engineer is mandatory, as these guides are not intended to be a design reference manual.

IV. APPROVALS. Drawings and specifications shall be submitted in advance for approval by the Engineer, in accordance with the Authority procedures described in the preceding portion of this section. Drawings shall include plans, profiles and details prepared by a New Jersey licensed professional engineer. No deviation from these documents will be permitted without prior approval of the Engineer. Ambiguities and inconsistencies in the specifications shall be referred to the Engineer for clarification in writing. Approval of the State Department of Environmental Protection may also be required. Approval is required of the Municipal Engineer and Director of Public Works of the Township of Franklin of the method and materials for backfilling trenches in public rights of way. Somerset County approval is required where sewers traverse county roads

V. INSPECTION. The Authority contemplates inspection of all work. The purpose of inspection is to prevent the acceptance of work that does not comply with Authority standards. The Authority will not provide direct construction supervision. No construction shall be undertaken without notice of at least two working weeks to the Authority, and without prior approval of the drawings and specifications by FTSA, MCUA and NJDEP. Work that is found faulty shall be removed and properly replaced, on the orders of the Authority's Inspector. The Authority's Inspector may stop the work if it is not being properly performed. The Authority reserves the right to re-inspect and reject faulty work until final written acceptance. Costs of inspection shall be charged to the Developer as required by the Township ordinance or the Authority's regulation.

VI. PERMITS AND FEES. The Developer, at his cost, shall obtain all necessary permits for performing the work. All fees and charges of the Township and the Authority shall be paid in accordance with existing Township ordinances or the rules and regulations of the Authority. No work may be started unless all required fees have been paid and performance and maintenance guarantees have been submitted and accepted.

VII. GENERAL REQUIREMENTS. Sewer system flow shall be one-directional, with no loops. Sewers shall be sloped in accordance with the minimum requirements of the State Department of Environmental Protection and FTSA, of which the more stringent standard shall govern. All sewer construction shall coordinate with the overall regional or FTSA sewer system master plan and needs.

All lots within the subdivision shall be sewered, and adjacent properties shall be taken into consideration when considering the sewer layout. Sewers that can be extended to serve adjacent properties shall be designed to do so.

VIII. DEFINITIONS. See Introduction & Definitions section.

B DESIGN OF SEWERS

I. DESIGN CAPACITY. Sewer capacities shall be designed for the estimated ultimate tributary population, based upon existing zoning and the FTSA approved Sewer Service Area Map. Consideration shall be given to the maximum anticipated capacity of institutions, industrial parks, etc. All sanitary sewers shall be designed to carry at least twice the estimated average daily flow when flowing half-full.

In determining the required capacities of sanitary sewers, the following factors shall be considered:

a. Maximum hourly domestic sewage flow;

b. Additional maximum sewage or waste flow from industrial plants and other non-residential sewers;

c. Inflow and groundwater infiltration;

d. Topography of area;

e. Zoning of area;

f. Depth of excavation; and

g. Pumping requirements.

II DESIGN FLOW. New sewer systems shall be designed on the basis of an average daily per capita sewage flow of not less than 100 gallons per day multiplied by an appropriate peaking factor. Flow criteria for new projects may consider guidelines established in NJAC 7:14A-23.3. An additional allowance of 500 gallons per mile per inch diameter of sewer per day shall be made for infiltration to account for future degradation of the system.

The peak flow shall be determined based upon the ratio of peak to average flow determined by the following formula:

$$\frac{Q\ peak}{Q\ Ave.} = \frac{18+P}{4+P}$$ (P = population in thousands)

The adequacy of an existing sewer to accept additional flows shall be determined by combining the proposed additional peak flow with the existing peak flow to determine the total proposed flow to be conveyed in the existing sewer. The total proposed flow shall be less than the capacity of the existing sewer. The existing peak flow shall be determined by actual flow measurements during wet weather. The method and period of measurement shall be approved by the Authority prior to installation of flow measuring devices.

For the design of a replacement sewer, the above method for determining the peak design flow shall be utilized.

III. MINIMUM SIZE. No gravity sewer conveying raw sewage shall be less than 8 inches in diameter (except for house and building connections).

IV. DEPTH. In general, sewers should be sufficiently deep to receive sewage from basements and to prevent freezing. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

V. SLOPE. All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Manning's formula using an "n" value of 0.013, except for 24 in. and larger where 2.5 feet per second shall be used. The following are the minimum slopes that should be provided; however, slopes greater than these are desirable.

Minimum Sewer Slope

| Sewer Size | Per 100 Feet |
|---|---|
| 8-inch | 0.40 |
| 10-inch | 0.29 |
| 12-inch | 0.22 |
| 14-inch | 0.17 |
| 15-inch | 0.16 |
| 16-inch | 0.14 |
| 18-inch | 0.12 |
| 20-inch | 0.10 |
| 21-inch | 0.095 |
| 24-inch | 0.080 |
| 27-inch | 0.067 |
| 30-inch | 0.058 |
| 33-inch | 0.052 |
| 36-inch | 0.046 |

Sewers shall be laid with uniform slope between manholes.

The diameter of a proposed sewer shall not be oversized unless the proposed sewer will flow at least one-half full under peak flow conditions. If a proposed sewer is to be oversized for future flow, the oversized pipe shall be laid at the minimum slope of the minimum required pipe or steeper.

Where velocities greater than 10 feet per second are attained, special provisions shall be made to protect against displacement by erosion and shock.

Sewers on 20 percent slopes or greater, shall be anchored securely with concrete anchors or equal, spaced as follows:

a. Not over 36 feet center to center on grades 20 percent and up to 35 percent;

b. Not over 24 feet center to center on grades 35 percent and up to 50 percent; and

c. Not over 16 feet center to center on grades 50 percent and over.

VI. ALIGNMENT. All sewers shall be laid with straight alignment between manholes. The alignment shall be checked by using a laser beam or lamping.

VII. CHANGES IN PIPE SIZE. When a smaller sewer joins a large one, the invert of the larger sewer shall be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

Sewer extensions should be designed for projected flows even when the diameter of the receiving sewer is less than the diameter of the proposed extensions.

VIII. CHANGES IN PIPE DIRECTION. All changes in direction shall utilize manholes. The radius of curvature of a bend within a manhole shall be not less than 1.5-times the nominal diameter of the sewer pipe.

IX. LOCATION OF SEWERS ON STREAMS. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements must be met:

a. One foot of cover is required where the sewer is located in rock;

b. Three feet of cover is required in other material. In major streams, more than three feet of cover may be required; and

c. In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.

Less cover will be approved only if the proposed sewer crossing will not interfere with the future improvements to the stream channel. Reasons for requesting less cover should be given in the project proposal.

Sewers located along streams shall be located outside of the streambed and sufficiently removed therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.

The sewer outfalls, head walls, manholes, gate boxes, or other structures, shall be located so they do not interfere with the free discharge of flood flows of the stream.

Sewers crossing streams shall be designed to cross the stream as nearly perpendicular to the stream flow as possible and shall be free from change in grade. Sewer systems shall be designed to minimize the number of stream crossings.

Sewers entering or crossing streams shall be constructed of ductile iron pipe with ball and socket joints; otherwise they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials that will not cause siltation.

Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project, specifications the method(s) to be employed in the construction of sewers in or near streams to provide adequate control of siltation and erosion. Specifications shall require that cleanup, grading, seeding, and planting or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven days.

X. AERIAL CROSSINGS. Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning and settlement.

Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between aboveground and belowground sewers.

For aerial stream crossings, the impact of floodwaters and debris shall be considered. The bottom of the pipe should be placed no lower than the elevation of the one hundred (100) year flood, or the flood hazard line if such line has been established by NJDEP.

XI. SEPARATION FROM WATER MAINS. Sewers and water mains generally shall be separated a distance of at least 10 ft. horizontally. If such lateral separation is not possible, the pipes shall be in separate trenches with the sewer at least 18 inches below the bottom of the water main; or such other separation as approved by FTSA shall be made. In general, the vertical separation at a crossing of sewer and water line shall be at least 18 inches. Where this is not possible, the sewer shall be constructed of ductile iron pipe using mechanical or slip-on joints for a distance of at least 10 ft. on either side of the crossing or other suitable protection shall be provided.

XII. Survey Datum. Sewers and manholes shall be designed based on land surveys tied to a permanent survey monument. The FTSA has adopted as its datum the NAVD 1988 and the NJ State Plane Coordinate System, NAD 1983. Manhole rims and all pipe inverts shall be identified and contours and topographic features of the ground surface along the pipeline route shall be provided. Contour intervals shall be as tabulated below:

| Slope(%) | Interval(ft) |
|---|---|

| | |
|---|---|
| 0 - 5 | 1 |
| 5 - 15 | 2 |
| > 15 | 5 |

## C EXCAVATION AND EARTHWORK

I. UTILITY IDENTIFICATION. Prior to any excavation, the Developer shall locate and mark all existing utilities and structures in the vicinity of, or intersecting the proposed sewers. The Developer shall be responsible for the continuity of such services affected by his operation, and shall maintain them in a safe and satisfactory operational condition.

II. LIMITS OF EXCAVATION. Excavation shall be made to approved lines which shall be of sufficient width for forming the pipe joints. Trench widths shall be selected so that the backfill will not exceed the safe load on the pipe. In all cases, the trench sides shall be vertical from the bottom to 12 inches above the top outside diameter of the pipe. In general, the widths of pipe trenches shall not be wider than the outside diameter of the pipe barrel plus 2 feet at the level of the top of the pipe, unless otherwise approved. All loose material shall be removed from the trench bottom before the pipe bedding is installed. In general, the limiting lines of excavation for manholes shall be determined by vertical planes 1 foot beyond the walls or as shown or as ordered. Tunneling under or undermining of roads, curbs, sidewalk or other structures will not be permitted. Roads and other structures shall be cleanly cut to a point at least 1' beyond the edge of the trench. Sidewalk and curb shall be removed to an existing joint as least 1' beyond the edge of the trench.

III. BLASTING. No blasting shall be performed by the Developer except upon written permission of the Authority. Any request shall be received by the Engineer at least 24 hours prior to start of said proposed blasting. If blasting permission is granted, the Developer shall adhere strictly to all required State and local safety regulations governing blasting and storage of explosives. In addition, the developer shall submit copies of the explosion and collapse insurance to the Authority.

The Developer shall be responsible for any damage to adjacent structures and property caused by his operations. He shall inspect all structures adjacent to the site of blasting and, where ordered by the Authority, he shall take clear, close-up photographs of these structures before and after blasting. Copies of all photographs shall be submitted to the Authority.

The Authority or its representative must be present at all times during blasting operations.

IV. SHEETING AND BRACING. Where excavations are made with vertical sides which require support, the sheeting and bracing shall be of sufficient strength to sustain the sides of the excavations and to prevent movement which could in any way injure the work, or diminish the working space sufficiently to delay the work. Sheeting shall be of a material that will not split while being driven. Special precautions shall be taken where there is additional pressures due to the presence of other structures, or loads, and in such cases the Developer shall submit, to the Engineer, a plan signed and sealed by a New Jersey Licensed Professional Engineer, showing the location and details for the proposed sheeting.

Sheeting and bracing shall conform to the requirements of the "Construction Safety Code" of the Bureau of Engineering and Safety of the New Jersey Department of Labor and Industry and the Federal Occupational Safety and Health Act (OSHA).

In trenches 12 ft. in depth and less, or where the pipe is not closer than 20 ft. to any existing building, house, or garage, sheeting and bracing may be removed at the Developer's option, providing that such removal will not endanger the work, adjacent utilities or cause settlement of pavements. In trenches greater than 12 ft. in depth, or where the pipe is closer than 20 ft. to any existing building, house or garage, the Developer will be required to leave sheeting in place. After backfilling the trench, no sheeting shall extend to within 12 in. of the ground surface.

V. DEWATERING. The Developer shall provide, operate, and maintain satisfactory facilities and equipment, including well points if necessary, with which to collect and pump all water entering excavations or other parts of the work, to suitable places for disposal. All excavations shall be kept free of water and water level kept at least 1 in. below the pipe invert, until the work to be built therein is completed. Approved settling basins and sumps shall be provided for catching and temporarily holding water containing mud, clay, sand, or other material in suspension, pumped from excavations. Such basins shall be large enough to allow storage time for the settlement of such suspended matter. The settled material shall be cleaned out frequently and disposed of as directed. Water shall not be allowed to discharge to the sanitary sewer system.

Water shall be discharged through pipes, flumes, gutters, or any other artificial means to catch basins, watercourses, ditches or any other approved locations adjoining the work. Water shall be disposed of in such a manner as to avoid interference with business, pedestrian and vehicular traffic and so as to prevent damage to property.

Lowering of groundwater to the injury or detriment of other structures shall be a part of the Developer's risk and responsibility. Any structure injured or damaged as a result of the lowering of groundwater shall be repaired or replaced to the satisfaction of the owners thereof, at the expense of the Developer.

VI. BACKFILL. All backfill shall consist of a suitable selected and approved earth generally from storage of approved excavated soil, free from organic matter, boggy, peaty, humus or other unsuitable material such as silt, rubbish, waste, ashes, or cinders as approved by the Engineer. If sufficient suitable material for backfill is not available from the excavated material, the Developer shall procure elsewhere, a sufficient quantity of suitable material and shall furnish and place such material. No frozen earth shall be used for backfill, and all stones more than 6 inches in the largest dimensions shall be removed from acceptable earth or fill and backfill. Unsuitable or excess backfill material shall be promptly removed from the site.

The Developer shall be responsible for meeting the backfill requirements of other government agencies, utilities, and landowners wherever applicable. The attention of the developer is called to the requirements of any road opening permits.

Backfills and fills shall be made to the slopes, grades and elevations shown, specified, or required. Backfills shall be compacted, as herein under specified, to a density at least equal to that of the adjacent undisturbed soil. so as to avoid future unequal settlement.

Trenches shall be backfilled from the top of the foundation material to a depth of twelve (12") inches over the pipes using only 3/4-inch clean stone. Such material shall be uniformly placed on each side of the pipe and haunched to provide adequate side support while avoiding vertical and lateral displacement of the pipe. Care shall be taken not to damage the pipe. 3/4-inch clean stone shall conform to Coarse Aggregate Size No. 6 of the New Jersey Department of Transportation Standard Specifications for Road and Bridge Construction, latest revision.

For work in trenches, the remainder of the trench shall be backfilled in accordance with the road-opening permit which is placement of Quarry Process Blend in 12" lifts or as approved by the Authority, and/or Municipal Engineer. For easements, refer to the Authority's Standard Details in Appendix D.

No backfill shall be placed until the structure has been inspected in place and approved. Backfilling shall be carried out as soon as possible after such approval, and no trenches in public streets shall be left open at the end of the workday. Steel plates over open trenches in public streets will not be allowed.

Where trenches in roadway areas cave in underneath the existing pavement, the Developer will be required to remove the pavement over the caved-in portion by saw cutting, backfill the entire area in accordance with this specification, and restore the pavement.

When sheeting is being withdrawn, all cavities left thereby shall be filled with suitable granular earth, hosed or tamped in place so as to fill all voids thoroughly.

Where embankment is shown to support the sewers or to cover the same, it shall be made to the width and slopes shown on the approved plan for the work. The ground shall be prepared by carefully grubbing and clearing it and removing all mulch and improper material of whatever nature. The embankment shall be formed of good loam, gravel or sand, free from all stones above four (4) inches in diameter, and shall not contain in any place, a proportion of stones of or greater than one part to three parts of earth. The material shall be deposited and spread in horizontal layers of not more than one foot in uncompacted thickness, each layer to be separately compacted, so that no settlement of the sewer or its appurtenances will thereafter occur. In no case, shall compaction be less than 95% Proctor density. Embankment shall be topped with 4 inches of topsoil and seeded.

VII. FOUNDATION MATERIAL. Foundation material used for pipe bedding, from a distance below the pipe invert as shown, to the lower quarter point of the pipe (6 inches minimum) shall be ¾-inch clean stone.

Additional foundation material used for replacement of unsuitable organic material or unconsolidated silts below the pipe foundation shall be Soil Aggregate Type I-5 of the NJDOTSS. It shall be compacted to 95% modified proctor in maximum of 6-inch lifts.

All foundation material shall be placed and compacted as directed and approved by the Authority or the Consulting Engineer.

VIII. PIPE DAMS. Sewer segments shall include at least one pipe dam to preclude the migration of ground water through the bedding material. Pipe dam material may be natural clay, manufactured clay panels, concrete or other suitable approved impervious material, as approved for its use. Impervious pipe dams shall have a maximum permeability of $1 \times 10^{-5}$ cm/sec. Pipe dams shall be spaced a maximum of 300 feet apart, with at least one dam between manholes.

IX. TOPSOIL. Where topsoil is located within the areas to be excavated and is of acceptable quality for re-use, it shall be stripped, cleared of stumps and roots, and stored at approved locations separate from other storage until required to be placed on top of the backfill, fill, or other areas.

In easements and all other areas where seeding or sodding is required, the Developer shall furnish and spread a minimum of 4 inches of acceptable topsoil.

The general fill or other material shall be carried to a sub-grade that permits topsoil of the required depth to be placed to bring it to the finished grade. As far as practicable, the under-lying fill shall be given time to settle through several heavy rains or by artificial wetting before the topsoil is placed.

Topsoil used in the restoration of easements shall comply with the NJDOTSS.

## D PIPE AND PIPE-LAYING

I. CAST IRON PIPE. Cast iron pipe and fittings shall be flexible joint, and shall conform to the requirements of ANSI A 21.6 and A 21.8. Thickness Class shall be as later specified for sewers. Cast iron pipe shall be used for laterals only.

A ring test shall be made on not less than 2 percent of the number of pipe of each size, except that not less than one test nor more than five tests for each size shall be required.

Flexible joint pipe shall be mechanical joint, or equal to United States Pipe and Foundry Company Tyton joint.

Mechanical joints shall conform to the requirements of ANSI A 21.10 for fittings up to and including 12 inches in size and shall be equal to the fittings shown in Section IV of the Ductile Iron Pipe Research Association's "Handbook of Ductile Iron Pipe" for fittings larger than 12 inches in size.

All cast iron pipe and fittings shall receive an interior sulfide-resistant coating acceptable to FTSA, factory applied to the manufacturer's specifications.

All cast iron pipe to be installed in acidic type soils shall receive an exterior coating of two (2) coats of asphaltic paint equal to Inertol No. 49. The total dry film thickness of the coating shall not be less than 10 mils.

II. DUCTILE IRON PIPE AND FITTINGS. Ductile iron pipe shall be push-on, mechanical, restrained push-on, flanged or Ball and Socket, as dictated by installation requirements and approved by FTSA.

Ductile iron pipe fittings (including bends, tees, etc.) shall be furnished with mechanical joint bells on all inlets, outlets, and branches, even though they may be used with flexible joint pipe.

All ductile iron pipe and fittings shall conform in all respects to ANSI A 21.51 for Thickness Class 52. Flexible joint pipe shall be equal to the "Tyton Joint" pipe manufactured by the United States Pipe and Foundry Company, or the "Super Bell-Tite Push-On Joint" pipe manufactured by the Clow Corp., and shall comply with ANSI A 21.11. and shall be equal to the product of the aforementioned manufacturers. Gaskets shall be suitable for the use and approved by FTSA. Gasket dimensions shall be in accordance with the manufacturer's standard design of dimensions and tolerances.

Plain ends of pipe for coupling joints shall be prepared in strict accordance with the requirements and instructions of the manufacturer of the coupling to be used.

Flexible couplings shall be equal to Dresser Manufacturing Company Style 53 or 153, or the similar products of the Smith-Blair or Rockwell Companies.

All ductile iron pipe and fittings shall have a protective internal sulfide-resistant lining and an exterior coating, both approved by FTSA.

At all horizontal and vertical bends and valves, force main pipe shall be harnessed back a minimum of 30 feet or three full pipe lengths, whichever is greater, in both directions. Harness rods shall be the same size as the bolts for mechanical joint pipe, AISC A-50 high strength steel, conforming to the requirements of ASTM Designation A325. Where harness rods are used in conjunction with bell/spigot joint pipe, approved socket clamps shall be installed to brace the pipe bells against movement. The set bolts in all shall be torqued to a minimum of 70 foot-lbs. to provide an adequate friction fit against movement. Properly designed thrust blocks may be utilized in conjunction with, or instead of, harness rods.

All harness rods, clamps and connectors, shall be coated with two mil thick coats of Inertol No. 49, or equal.

Alternative joint restraint systems may be submitted for approval.

III. PVC PIPE. PVC pipe and fittings from 8" to 15" diameter main line sewers shall be polyvinyl chloride bell and plain end sewer pipe and shall conform to ASTM-D3034 and Uni-Bell UNI-B-10-82. The minimum wall thickness shall be in accordance with Type SDR-35 of ASTM-D3034. The average diameter shall be no less than the nominal diameter.

The plastic material shall be equal to Type 1, Grade 1 of the specifications for Rigid Polyvinyl Chloride Compounds, ASTM Designation D-1784. Pipe and fittings from 18" to 27" diameter sewers shall conform to ASTM F679 (T-1).

Polyvinyl chloride pipe for 4" and 6" laterals and inspection risers shall be PVC Schedule 40 conforming to ASTM-D1785. Any PVC inspection risers located in pavement, sidewalk or lawn areas (or any area other than the foundation shrubbery planting strip) shall be protected by use of an appropriate casting. (Campbell Foundry #1000 with camlock or equal).

The pipe shall be capable of carrying a trench load equal to 25 feet of cover. Under conditions of maximum cover, the pipe shall be adequate to maintain a factor of safety of two against collapse. Special compaction procedures will be required as specified under "Placing and Compacting Backfill."

Pipe joints shall be of the round rubber gasket type and shall be lubricated with a vegetable compound soap purchased from the pipe manufacturer.

Pipe ring material shall be in accordance with ASTM F477-76.

PVC pipe shall be installed to the standard of ASTM D2321 or to the standards of the Authority. For each detail of installation, the stricter standard shall govern. Attention is called to the following cases where FTSA standards govern:

a) Pipe design must have a factor of safety of two against excessive deflection.

b) Excess deflection is 5% of I.D. in 90 days after backfilling.

IV. OTHER PIPE MATERIALS. Use of alternate materials of pipe not specified within these standards will be considered by the Authority and the Engineer for sewer lines 30 inches in diameter or larger, or to meet the technical requirements of unusual conditions on a case by case basis.

V. CERTIFICATIONS. Certificates of compliance shall be furnished attesting to conformance with FTSA standards, if required. Such certification shall come from the manufacturer and shall be specific to the particular items supplied for a particular project.

VI. PIPE STRENGTHS. Except where special requirements govern, the choice of pipe shall be in accordance with the following:

| SEWER PIPE SIZE | DEPTH FROM FINISHED GRADE TO PIPE INVERT (feet) | PERMISSIBLE CHOICES |
|---|---|---|
| 4-6 | 20 and less | Cast Iron Soil Pipe-Extra Heavy<br>PVC Pipe Schedule 40<br>Ductile Iron Pipe Class 52 |
| 8 | 20 and less | PVC Pipe SDR 35<br>Ductile Iron Pipe Class 52 |
| 10 | 17 and less | PVC Pipe SDR 35<br>Ductile Iron Pipe Class 52 |
| 10 | 17 to 18 | PVC Pipe SDR 35<br>Ductile Iron Pipe Class 52 |
| 12 | 11 and less | PVC Pipe SDR 35<br>Ductile Iron Pipe Class 52 |

| | | |
|---|---|---|
| 12 | 11 to 17 | PVC Pipe SDR 35<br>Ductile Iron Pipe Class 52 |
| 12 | 17 to 20 | Ductile Iron Pipe Class 52<br>Extra Strength, PVC pipe |
| *15 inches<br>And over | | Pipe Material to be Reviewed |

* The design of these size pipes for the various depths of cover shall be in accordance with the applicable ASTM and AWWA specifications and the manufacturer's recommendations.

Except where specified by the Engineer, the minimum bedding material shall be as follows:

| PIPE MATERIAL | MINIMUM BEDDING CLASS |
|---|---|
| PVC SDR 35 | B |
| Cast-Iron, Ductile Iron | C |
| Other Pipe | To be Reviewed |

The use of Type D class bedding will not be permitted for any pipes or laterals.

The bedding classes shall be as defined in Water Pollution Control Federation Manual of Practice NO. FD-5, "Gravity Sanitary Sewer Design and Construction".

VII. PIPE LAYING AND INSTALLATION. All pipe and fittings shall be installed to the lines and elevations shown or ordered, and in accordance with the manufacturer's recommendations.

Suitable tools and equipment shall be used for proper handling, storing, and laying pipe and fittings. In order to avoid damage to the interior coatings of pipe, lifting hooks or bars shall not be inserted therein. Each pipe and fitting shall be checked for defects and injuries as laying proceeds. Imperfect pipe materials shall be rejected and removed from the work. Pipe found to be defective after laying, shall be removed and replaced by undamaged material.

The interior of all pipe shall be cleaned of dirt, and other deleterious materials, and kept clean, as the next section of pipe is laid. During the progress of the work, the exposed ends of the pipe shall be provided with approved temporary covers fitted to the pipe, in order to prevent material from entering the pipe.

Where pipe must be cut to fit as closing pieces, such cuts shall be evenly and squarely made in a workmanlike manner with approved equipment. Injury to linings or coatings shall be satisfactorily repaired.

Where cast iron mechanical joint, Tyton or Ring-Tite fittings are used, the Developer shall furnish and install concrete thrust blocks, tie rods, or other approved means for preventing movements at joints, bends, tees, and other fittings as shown or directed. Joints must be thoroughly brushed with a wire brush to remove all loose rust or foreign material. Soapy water must be brushed over the joint surfaces and over the gasket. Bolts shall be tightened uniformly, using only torque-limiting wrenches to avoid over stressing the bolts. Bolt heads, nuts and other unpainted surfaces shall be coated with two (2) heavy applications of black asphaltum varnish.

All pipe shall be laid in accordance with approved details. Where concrete cradles are used to support the pipe, foundation material will not be required. No solid blocking will be permitted under pipe. Joints shall be made in accordance with the recommendations of the manufacturer

VIII. MATERIAL TESTING. Ductile iron pipe shall be hydrostatically tested at the point of manufacture to 500 psi for duration of one minute. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture of pipe wall. Certified test certificates shall be furnished in duplicate to FTSA prior to time of shipment. All ductile iron pipe and ductile iron fittings shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to FTSA sworn certificates that all tests and inspections required by the Specifications under which the pipe is manufactured have been satisfied.

For plastic pipe, sand box tests shall be run on the same number of lengths as specified above. Test loads shall be equal to twice the maximum trench load.

VIII. GRAVITY PIPE LINE TESTING. The Authority reserves the right to retest and reinspect any construction at any time prior to final acceptance at the end of the maintenance period. The Developer shall be required to correct any defects found in such latter inspections even if said defects had existed, but was not reported, during a previous inspection. The Developer shall bear the cost of all pipe testing

After installation and inspection has completed, all new sewers shall be flushed to remove all foreign material. Pipe shall be inspected and tested for alignment, freedom from obstruction, and lack of structural damage a minimum of 90 days after installation using closed circuit television and mandrels. A mandrel rated at 5% deflection shall be passed through all new PVC sewers after 90 days has elapsed since backfilling has completed. Not withstanding satisfactory testing, any

flexible pipe deflected more than 5.0% within 90 days of installation or the date of testing, whichever is later, shall be replaced at the Applicant's expense

Sewer segments shall then be pressure-tested with air utilizing ASTM C828. Internal air pressure in pipe lines shall never exceed 8 psi. After each segment is pressurized to 4 psi, at least two minutes shall be allowed for stabilization, prior to disconnecting air supply from the test control panel. The time required for the pressure in the section to decrease from 3.5 to 2.5 psi shall not be less than shown in the following table.

**Minimum Test Time for Various Pipe Sizes**

| Nominal Pipe Size (In.) | T (time) min/100 ft | Nominal Pipe Size (In.) | T (time) min/100 ft. |
|---|---|---|---|
| 3 | 0.2 | 21 | 3 |
| 4 | 0.3 | 24 | 3.6 |
| 6 | 0.7 | 27 | 4.2 |
| 8 | 1.2 | 30 | 4.8 |
| 10 | 1.5 | 33 | 5.4 |
| 12 | 1.8 | 36 | 6 |
| 15 | 2.1 | 39 | 6.6 |
| 18 | 2.4 | 42 | 7.3 |

All new sewer segments shall be inspected with closed circuit T.V. using a pan and tilt camera to allow inspection of all lateral fittings. Inspection shall be done in the presence of FTSA. T.V. tapes shall be turned over to FTSA.

IX. PRESSURE PIPE LINE TESTING. Pressure pipe for force mains shall be tested for leakage by the Developer. He shall provide the necessary facilities, water, bulkheads, and labor therefor. Leaks at joints shall be corrected and made tight. Pressure pipe shall be tested under a constant hydrostatic pressure of 75 psi or twice the rated working pressure unless the Engineer approves less. The duration of each test shall be no less than four hours and an accurate pressure gauge shall be installed at an approved, convenient point in the line for observation. The acceptable leakage shall be in accordance with AWWA C-600 or the latest revision of AWWA.

E MANHOLES

I. CONSTRUCTION. All manholes shall be constructed of precast, reinforced concrete riser sections, an eccentric conical or flat slab top section, and a base section as shown or required. Where required, eccentric reducing sections shall be used to join riser sections of different diameters.

Precast manhole sections shall be manufactured in accordance with ASTM Designation C478-61T. Manholes shall be manufactured by the "wet" process and

shall be cured in the forms for several hours. The minimum compressive strength of the concrete for all sections shall be 4000 lbs. per sq. in. The maximum allowable absorption of the concrete shall not exceed 8% of the dry weight. Tests shall be similar to those described in ASTM C-76. The circumferential reinforcement in the walls of all sections shall be a minimum of 0.12 sq. in. per linear ft. for inside diameters up to and including 54 in., and 0.17 sq. in. per linear ft. for the larger sizes. Reinforcement in flat slab top sections shall be designed for the load to be supported. Additional reinforcement shall be provided at all openings larger than 6 inches.

Joints of the sections shall be formed entirely of concrete in accordance with ASTM Designation C361-61 and shall be made with a rubber gasket installed in accordance with the manufacturer's recommendations. Joints shall be self-centering and water tight against internal and external hydrostatic pressure with the gasket utilized as the sealing element and external seams grouted. Grout shall be of water proof non-shrink type manufactured by Five Star Waterproofing, Inc. 425 Stillson Rd., Fairfield, CT, or an approved equal.

Base sections shall be furnished by the manufacturer with either a compressible rubber ring equal to the Omega manhole, or with a flexible sleeve equal to the Interpace flexible manhole sleeve. Waterways shall be constructed by a qualified mason in the field after the manhole has been installed. The shape and size of waterways shall conform to the shape and size of connecting pipes as shown or ordered. Special care shall be taken to form channels with curved shapes that will provide the best hydraulic conditions for smooth flow. Benches shall be sloped to drain to the waterways. Concrete used in forming waterways shall be a stiff, rich mix, and shall be given a steel trowel finish.

Foundation material under manholes shall be crushed stone. Excavation and earthwork shall be as previously specified.

Height adjustment between manhole concrete and cast iron manhole frame shall be constructed of the necessary combination of grade rings and unit masonry as shown on the drawings. Masonry units shall conform to ASTM C32 grade MS or ASTM C139. Grade rings and masonry shall be set with a mortar mix using 1:2 ratio of cement to sand with equal quantities of masonry cement and portland cement. No more than two courses of masonry units shall be used. Masonry shall be laid in running bond on a full bed of mortar and full head joints. The inside and outside faces of the masonry shall be rubbed with burlap and coated with a wash coat of neat cement applied with a stiff bristle brush. The outside face of the masonry shall be finished with a minimum of two coats of bitumastic to a minimum total thickness of 24 mils.

II. MANHOLE APPURTENANCES. Appurtenances shall include manhole frames and covers, manhole rungs, and manhole encapsulation.

Manhole frames and covers shall be of the best quality close grained grey iron castings conforming to the requirements of ASTM Designation A 48, Class No. 30. Seating surfaces of manhole frame and covers shall be machined to insure a non-chattering fit. Manhole frames and covers shall be properly cleaned and coated with a waterproof asphaltum applied by immersion, while the castings are hot.

Watertight manhole frames and covers shall be required in all areas that are located below the 100 year flood level, where adverse drainage conditions exist, or as ordered. Watertight manhole frames and covers shall be Campbell Foundry 6545 or equal.

Unless otherwise indicated, manhole frames and covers shall be of the circular flared type frame with round flange equal to Catalog No. 1203 as manufactured by Campbell Foundry Company.

Locking manhole frames and covers equal to Campbell No. 1487 shall be provided on all manholes located in easements. Locking type covers shall also be provided with a single recessed lifting handle as shown. Lifting handle shall be equal to that shown for Campbell No. 1268. A key shall be supplied with each locking type unit.

Frames and covers equal to those specified above as manufactured by the Neenah Foundry Co. or Flockhart Foundry Co., will be acceptable.

All covers shall be cast with the identifying letters as specified on the Standard Details. Letters shall be 2 in. high and embossed against a recessed background.

Manhole rungs shall be steel reinforced, copolymer polypropylene conforming to ASTM D4101, Classification PP200 B33450 Z02. Steel reinforcing shall be □-inch diameter, conforming to ASTM A615, Grade 60 and shall be continuous throughout the rung. Rungs shall be cast in the vertical sides of the manhole sections on 12 in. centers.

Special details are provided for drop manholes with invert differences exceeding two (2) feet, and for shallow manholes where the grade-to-invert depth is less than 5'6".

Between manholes, pipe shall be straight and at uniform grade. Any deviation from uniform grade shall be grounds for rejection of that portion of the sewer system and the Developer shall be required to excavate and reconstruct the said portion to the required grade. Spacing between manholes shall not exceed 400 feet.

The Contractor shall modify existing manholes by core drilling the masonry to the specified size and installing a Kor and Seal Kit or equal. The waterways shall be

chipped and roughened and then finished with five star waterproofing non-shrink grout or equivalent to provide the best hydraulic conditions for smooth flow.

Flexible joints shall be placed at the manhole wall, and within four feet of the wall, as shown on the Standard Details.

All new manholes shall be provided with a flexible manhole frame encapsulation system that seals the frame to the top most barrel or cone section and prevents seepage over the life of the structure. The sleeve shall be made from materials that provide high electrical resistivity, resistance to corrosive environments, low water absorption, low moisture permeability and shall effectively bond to steel, concrete and common coatings.

Interior and exterior of manholes shall receive a high build polyamide coal tar epoxy coating. Exterior manhole coating shall be Coal Tar Epoxy C-200 by Sherwin Williams, or approved equal. Interior manhole coating shall be Epoxide 33/34 by Sherwin Williams, or approved equal. Joints between precast manholes sections must be patched with cement mortar and field coated with interior and exterior coating.

III. MANHOLE TESTING. All new manholes shall be vacuum-tested prior to being placed into service using test procedures detailed in ASTM C1244. After the manhole is prepared, a vacuum of 10 inches mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 inches mercury. The manhole shall pass if the time meets or exceeds the values indicated in the following table.

**Minimum Test Times For Various Manhole Diameters**

| Depth, (Ft.) | | | Diameter, (In.) | | |
|---|---|---|---|---|---|
| | 48 | 54 | 60 | 66 | 72 |
| | | | Time, (s.) | | |
| 8 | 20 | 23 | 26 | 29 | 33 |
| 10 | 25 | 29 | 33 | 36 | 41 |
| 12 | 30 | 35 | 39 | 43 | 49 |
| 14 | 35 | 41 | 48 | 51 | 57 |
| 16 | 40 | 46 | 52 | 58 | 67 |
| 18 | 45 | 52 | 59 | 65 | 73 |
| 20 | 50 | 53 | 65 | 72 | 81 |
| 22 | 55 | 64 | 72 | 79 | 89 |
| 24 | 59 | 64 | 78 | 87 | 97 |
| 26 | 64 | 75 | 85 | 94 | 105 |
| 28 | 69 | 81 | 91 | 101 | 113 |
| 30 | 74 | 87 | 98 | 108 | 121 |

F HOUSE CONNECTIONS

I. MATERIALS. From the street to the curb, the Developer has the option of furnishing the following types of house connections:

4 inch PVC pipe, schedule 40
4 inch ductile iron pipe - Class 52
4 inch cast iron soil pipe - extra heavy

Wye connections shall be used at the junction of the house connection and street sewer. Tee-wye clean-outs shall be installed at the curb line (see details).

Water-tight plugs or caps shall be furnished at all dead ends.

Bends in house connection lines shall be made using standard, flexible fittings. A riser with a clean-out at grade shall be used for any off-street bend 45 degrees or greater.

Flexible, water-tight joints shall be used throughout, with round rubber rings or rubber gaskets as the seal.

II. INSTALLATION. Slopes of house connections shall, in general, be 1/4 inch per foot. For critical conditions, a minimum slope of 1/8 inch per foot may be approved.

Where "dry sewers," or "dry house connections" are installed, the upstream end of the house connection shall extend to within two feet of the approved ultimate point of connection.

The Developer shall mark the curb or pavement opposite the end of each house connection, in a suitable and approved permanent manner; by scoring curbs or pavements, or be well-marked permanent stakes elsewhere. Exact location and depth, referenced to a permanent marker shall be shown on as-built drawings for any temporary dead end. Each location shall be checked by the Engineer, and the final as-built drawings shall be submitted to the Engineer for approval prior to final acceptance.

For house connections more than 8 feet below grade, a riser pipe shall be installed at a slope of not more than 45 degrees (see details).

House connections shall meet the same standard of allowable leakage as main line sewers.

G SPECIAL STRUCTURES

No one shall be permitted to construct a sewage treatment plant in the Township of Franklin. Industries may construct pretreatment systems that may discharge to the FTSA system, if needed, subject to review and approval by the Authority.

Information on pumping stations, stream crossing, or other special structures shall be submitted for approval in preliminary form, before detailed drawings are prepared, or equipment is ordered. Grease traps, sand traps, or other special appurtenances may be required for special conditions. Advance approval of the State Department of Environmental Protection may be required.

The Authority reserves the right to inspect any pretreatment system to ensure that it is operating properly.

## H SEWAGE PUMPING STATIONS - GENERAL REQUIREMENTS

I. FLOODING. Sewage pumping station structures and electrical and mechanical equipment shall be protected from physical damage by the one hundred (100) year flood, or the flood hazard line, if one has been established by NJDEP. Sewage pumping stations should remain fully operational and accessible during the one hundred (100) year flood.

II. ACCESSIBILITY. The pumping station shall be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys.

III. GRIT. Where it is necessary to pump sewage prior to grit removal, the design of the wet well and pump station piping shall receive special consideration to avoid operational problems from the accumulation of grit.

## I SEWAGE PUMPING STATIONS - DESIGN

I. TYPE. Sewage pumping stations shall generally conform to the following standards. Other types as set forth elsewhere in this section may be approved where circumstances justify their use.

| Motor Horsepower | Pump Type | Building Required |
|---|---|---|
| 5 or less | Submersible grinder | YES |
| 5-10 | Wet well submersible | YES |
| Greater than 10 | Dry well pumps | YES |

II. STRUCTURES. Dry wells, including their superstructure, may utilize common wall construction, but in any event shall be physically separated from the wet well. Below grade dry wells and wet wells shall be constructed of reinforced concrete. Provisions shall be made to facilitate removal of pumps, motors, and other mechanical and electrical equipment.

Wet wells shall incorporate two channels. The primary channel shall include a parshall flume for flow metering and comminution equipment. The secondary or bypass channel shall utilize a bar rack for sewage screening.

Suitable and safe means of access shall be provided to dry wells, and to wet wells, containing either bar screens or mechanical equipment requiring inspection or maintenance.

For all pump stations, building code compliant stairways with rest landings shall be provided at vertical intervals not to exceed 12 feet. Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent an individual from falling past the intermediate landing to a lower level. Mechanical man lifts shall not be used.

Reference should be made to state and federal safety codes, which, if they are more stringent, shall govern.

Due consideration shall be given to the selection of materials because of the presence of hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in sewage.

III. ARCHITECTURE. Pumping stations shall utilize cavity wall masonry construction, with rigid insulation in the cavity. Roof system shall be 30-year asphalt shingles, 5/12 pitch minimum. Aluminum doors and windows are required. If windows are used, a one-inch double pane insulated glass system shall be provided. Handrails shall be aluminum, designed to OSHA requirements. Aluminum gutters and down spouts with PVDF finish are required. All interior surfaces shall be epoxy painted. All colors and final treatments shall be selected by FTSA.

IV. PUMPS AND PNEUMATIC EJECTORS. At least 2 pumps or pneumatic ejectors shall be provided. A minimum of 3 pumps should be provided for stations handling flows greater than 1 MGD. When all pumps are running, the total flow shall increase to 125% of the station design flow.

If only 2 units are provided, they should have the same capacity. Each shall be capable of handling peak flow. Where 3 or more units are provided, they should be designed to fit actual flow conditions and must be of such capacity that, with any one unit out of service, the remaining units will have capacity to handle maximum sewage flows.

The pump shall be so placed that, under normal operating conditions, it will operate under a positive suction head.

Electrical systems and components (e.g., motors, lights, cables, conduits, switch boxes, control circuits, etc.) in raw sewage wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall comply with the National Electrical Code requirements for Class I Group D, Division I locations. In addition, equipment located in the wet

well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with watertight seal and separate strain relief. A fused disconnect switch, located above ground, shall be provided for all pumping stations. When such equipment is exposed to weather, it shall meet the requirements of weatherproof equipment (NEMA 3R).

Each pump should have an individual intake. Wet well design should be such as to avoid turbulence near the intake. Intake piping should be as straight and short as possible.

A separate sump pump equipped with horizontally installed, dual check valves shall be provided in the dry wells to remove leakage or drainage, with the discharge located as high as possible. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump.

The pumps and controls of main pumping stations should be selected to operate at varying delivery rates to permit discharging sewage at approximately its rate of delivery to the pump station.

V. CONTROLS. Control systems shall be of the air bubbler type or the encapsulated float type. Float-tube control systems on existing stations being upgraded may be approved. The electrical equipment shall comply with the National Electrical Code requirements for Class I, Group D, Division I locations.

The control system shall be located away from the turbulence of incoming flow and pump suction.

In all stations, provisions shall be made to automatically alternate the pumps in use.

Instrument loop diagrams shall be submitted for approval, drawn to the conventions published in ISA Standard 5.4 - Standard Instrument Loop Diagrams. The Instrument Society of America (ISA) operates under the International Society for Measurement and Control.

Parshall flumes with strip chart recorders and totalizers shall be provided to meter incoming flow to all stations with pumps 10 HP or greater. Magnetic flow meters, located in a meter vault with piping bypass and isolation valves shall be provided on smaller stations.

VI. VALVES. Suitable shutoff valves shall be placed on the suction line of each pump, except on submersible and vacuum-primed pumps.

Suitable isolation gate valves (solid wedge or resilient seated) and buffered swing check valves shall be placed on the discharge line of each pump. The check valve shall be located between the shutoff valve and the pump. Check valves shall be suitable for the material being handled. Check valves shall not be placed on the vertical portion of discharge piping. Valves shall be capable of withstanding normal pressure and water hammer.

Where limited pump backspin will not damage the pump and low discharge head conditions exist, short individual force mains for each pump may be considered in lieu of discharge valves.

Valves shall not be located in wet wells. For submersible stations, they shall be located in a valve pit, with valves installed just below the frost line so they are readily accessible from grade.

VII. PLUMBING. Toilet facilities are required for all stations. Minimum facilities shall include a water closet, service sink and a suitably sized water heater.

Wash hose stations are required where directed by FTSA, with 1 □-inch and 3/4-inch hose end outlet valves for wash down purposes. Water meters and back flow prevention devices shall be provided, designed in accordance with applicable codes.

All pumping stations shall have a source of clean water. There shall be no physical connection between any potable water supply and a sewage pumping station, which, under any conditions, might cause contamination of the potable water supply. If a potable water supply is brought to the station, it should comply with Franklin Township Water Company's rules and regulations.

VIII. WET WELL. The wet well size and control setting shall be appropriate to avoid heat buildup in the pump motor due to frequent starting and to avoid septic conditions due to excessive detention time.

The wet well floor shall have a minimum slope of one to one to the hopper bottom. The horizontal area of the hopper bottom shall be not greater than necessary for proper installation and function of the inlet.

For stations with dry pit pumps, wet wells shall be divided into multiple sections, properly interconnected, to facilitate repairs and cleaning.

VIII. VENTILATION. Pumping station ventilation shall be designed to be compliant with NFPA Article 820 and applicable provisions of Recommended Standards For Wastewater Facilities, current edition, published by the Great Lakes-Upper

Mississippi River Board of State and Provincial Public Health and Environmental Managers.

IX. ALARM SYSTEMS. Alarm systems shall be provided for pumping stations. The alarm shall be activated in cases of power failure, pump failure, use of the lag pump, unauthorized entry, or any cause of pump station malfunction. Pumping station alarms shall be telemetered, including identification of the alarm condition, to the Authority's system. The work shall be coordinated with the alarm system vendor. Audio-visual alarm systems, with a self-contained power supply, may be acceptable in some cases in lieu of the telemetering system outlined above, depending upon location, station holding capacity and inspection frequency.

X. EMERGENCY OPERATION. Pumping stations and collection systems shall be designed to prevent or minimize bypassing of raw sewage. All pumping stations shall have emergency stand-by generators with automatic transfer switches. Consideration should be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency power generation in order to prevent backup of sewage into basements, or other discharges which may cause severe adverse impacts on public interests, including public health and property damage. Where a high level overflow is utilized, consideration shall also be given to the installation of storage/detention tanks, or basins, which shall be made to drain to the station wet well. Where such overflows affect public water supplies, a storage/detention basin, or tank, shall be provided having 2-hour detention capacity at the anticipated overflow rate.

XI. EQUIPMENT REQUIREMENTS. The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives, or electrical generating equipment.

a. Engine Protection. The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is planned, protective equipment shall be capable of shutting down the engine and activating an alarm on site as provided in "Alarm Systems." Protective equipment shall monitor for conditions of low oil pressure and overheating, except that oil pressure monitoring will not be required for engines with splash lubrication.

b. Size. The engine shall have adequate rated power to start and continuously operate all connected loads.

c. Fuel Type. Diesel fuel or natural gas.

d. Engine Ventilation. The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.

e. Routine Start-up. All emergency equipment shall be provided with instructions indicating the need for regular starting and running of such units at full loads.

f. Protection of Equipment. Emergency equipment shall be protected from damage at the restoration of regular electrical power.

XII. ENGINE-DRIVEN GENERATING EQUIPMENT. Permanently installed or portable engine-driven generating equipment is required. The following requirements, in addition to "Equipment Requirements" above, shall apply.

a. Generating Capacity. Generating unit size shall be adequate to provide power for pump motor starting current and for lighting, ventilation, and other auxiliary equipment necessary for safety and proper operating of the lift station. The operation of only one pump during periods of auxiliary power supply must be justified. Such justification may be made on the basis of maximum anticipated flows relative to single-pump capacity, anticipated length of power outage, and storage capacity. Special sequencing controls shall be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating.

b. Operation. Provisions shall be made for automatic and manual start-up and load transfer. The generator must be protected from operating conditions that would result in damage to equipment. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load.

c. A load bank shall be provided sized such that the generator runs under its design load when normal exercising occurs.

XII. FORCE MAINS. At design average flow, a velocity of at least 2.5 feet per second shall be maintained.

Automatic air relief valves shall be minimized by prudent hydraulic design. Where necessary, they shall be placed at high points in the force main to prevent air locking.

Force mains should enter the gravity sewer system at a point not more than 2 feet above the flow line of the receiving manhole.

The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

Force main construction near streams or used for aerial crossing shall meet the requirements of the applicable sections relating to gravity sewers.

Force mains shall be laid to grade as much as possible to facilitate the use of air injection for odor control. Part of the force main design, shall be an analysis of the impact of various pipe sizes on detention times, odor generation and pumping costs. Multiple force mains or odor control stations may be required.

Force mains shall be made of a minimum of Class 52, ductile iron pipe, with corrosion-resistant interior lining and external encapsulation where the presence of aggressive soils warrant same.

XIV. ENERGY CONSERVATION. Pump Stations shall be designed to provide for energy conservation. Items which may be required by the Authority are as follows:

1. Interlock to prevent an electric unit heater from operating when any pump is running.

2. Roof insulation. 6" thick R-19.

3. Thermostat for heat capable of operating from 45 degree F. to 75 degree F.

4. Phase correction on motors.

5. High efficiency fluorescent lighting.

6. Motor operated louvers which will stay tightly closed when the generator is not operating.

7. Weather stripping on the doors.

8. Provide the highest energy efficient motors and power factor correction capacitors for motors greater than 5 HP

9. Consider the use of VFD's and 2 speed motors when dictated by process or hydraulic requirements. Such requirements require review and approval by the Authority's engineer.