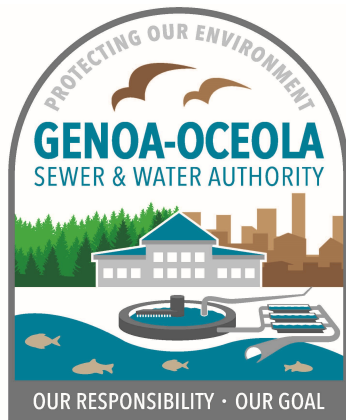


MARION • HOWELL • OCEOLA • GENOA - SEWER AND WATER AUTHORITY
GENOA • OCEOLA - SEWER AND WATER AUTHORITY

Sanitary Sewer and Water

DESIGN STANDARDS

February 2019



NOTE TO USER:

The following design standards apply to water improvements in Marion, Howell, Oceola and Genoa Townships. The sanitary sewer design standards only apply to improvements in Genoa and Oceola Townships.

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PART I – DESIGN STANDARDS

1.0 WATER MAINS

1.01 Water Distribution System Basis of Design

- a) All publicly owned and operated system components require construction plan review and permitting, as outlined in Section 3 of the Connection Manual for Systems Operated by the MHOG Utility Department (Connection Manual). All 8-inch and greater water main, fire hydrants, system valves, and booster stations are considered publically owned. Fire suppression lines can be private if there are no hydrants connected to them. All water main shall be shown in both plan and profile view on the construction plans with a maximum scale of 1" = 50'.
- b) A water distribution system basis of design shall be submitted with construction plans for approval by the Authority's Engineer. The basis of design shall include an area map indicating the areas and zoning district for each area to be served, including any off-site areas. The basis of design will reflect proposed developmental phasing. Developments with proposed usage larger than 100 residential units shall go through the Impact Determination requirements in Section 3 of the Connection Manual.
- c) In general, water distribution systems shall be designed in accordance with the *Recommended Standards for Water Works* by the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers ("Ten States Standards").
- d) Residential developments shall consider a design population of at least 2.6 persons per dwelling unit, with an annual average daily water demand of 100 gallons per capita per day (gpcd).

In non-residential developments, flow estimates shall be based on water use records from similar facilities, as may be provided by petitioner and approved by the Authority's Engineer, or an estimate of proposed water demand in accordance with the residential equivalent user (REU) schedule.

- e) For the purpose of network analysis and water main design, maximum daily demands will be computed as no less than twice the average daily demand. Peak hourly flows will be computed as no less than four times the average daily demand.

- f) Water main shall be designed to provide fire protection (rates and durations) based on the recommendations of the Insurance Services Office (ISO) for projected land use and building types.
- g) Water main shall be sized to meet peak hourly demands and to meet maximum daily demands plus fire flow. The Authority Engineer shall model the distribution network. The petitioner is responsible for providing the onsite size, layout and necessary information for model development.
- h) All municipal water distribution mains shall be a minimum of 8-inch in diameter. Transmission mains of greater diameter may be required if future area development plans or the impact determination process dictate such sizing.
- g) Where improvement or grading is to be done over existing utilities a profile of existing utilities should be included in the construction plans.

1.02 Water Main Layout

- a) All sites developing an on-site water main network shall be serviced by two sources of water or shall be planned for service from an adjacent site by extending the water main to one or more property lines. The impact determination process will determine if looping of the water main is required. Looping of the water main may be required to increase the pressure or fire flow. Looping also provides the benefit of redundancy and for end users in which water is critical to operation looping may be required for redundancy.
- b) All water mains shall be carried to the limits of the development for future extension by neighboring properties. Water main in excess of 1,600 lineal feet between interconnections may be required to be oversized at the developer's expense. The Township and/or Authority may also require water main oversizing or additional water main improvements based on the impact determination process.
- c) Dead-end mains may not exceed 600 feet in a single-family, residential neighborhood, nor 500 feet in a multiple-family, residential neighborhood. Valves shall not be left on a dead-end line, unless there are plans for a subsequent phase, as outlined in subsection (t) below. Dead-ends shall be terminated with a hydrant at the end of the water main for adequate flushing and maintenance of the main.

- d) Hydrants shall be a maximum of 500 feet on center along the water main on a dedicated street or approved fire lane. Additional hydrants may be required at locations selected by the Fire Marshal. A reduction in this standard must be approved by the Authority Engineer or Utility Director.
- e) Hydrant assemblies less than 25 feet from the main may be connected to the water main with 6-inch pipe. Hydrant assemblies greater than 25 feet from the main shall be connected with 8-inch pipe. This 8-inch pipe may be reduced down to a 6-inch pipe within 25 feet from the hydrant.
- f) Buildings shall be covered within a 250-foot radius of a hydrant. No hydrant shall be placed within 40 feet of a building/structure. In single-family, residential areas, the hydrant coverage may be increased to 350-foot radius with the approval of the Fire Marshal and Authority Engineer. The radii of coverage may be reduced in industrial areas at the discretion of the Fire Marshal.
- g) Fire hydrants and valves shall be placed in such a way that no more than two hydrants and valves in total have to be put out of service when isolating a section of water main.
- h) Valves shall be placed at each junction of water main, and in such a way that no more than three valves have to be closed to isolate a branch of water main. Water mains 16-inch and greater shall use butterfly valves, rather than gate valves. Butterfly valves shall be placed in gate wells. Gate valves located outside of paved areas shall be installed with concrete aprons. The maximum distance between valves shall be 800 feet. This distance can be exceeded for transmission lines or rural areas with the approval of the Utility Director and/or Engineer.
- i) Service lead locations shall be approved by MHOG during the construction plan review process. All curb stops shall be adjusted to final grade. Curb stops within any driveways, walkways or cement sidewalks shall be placed in a valve box as outlined in 22 11 13. Curb stops shall be placed no closer than 10 feet from a building footing. Stainless steel riser rods affixed with stainless steel cotter pins shall be installed on all curb stops, regardless of size.
- j) All unnecessary utility crossings shall be avoided. A minimum 10-foot horizontal and 18-inch vertical clearance shall be maintained from sanitary and storm sewers. If less than 18-inches of clearance is requested, contractor shall install a full length of pipe centered on the crossing to ensure the joints are as far from the crossing as possible.

- k) Water main shall be placed in the right-of-way and outside the roadway surface where possible, in general accordance with approved typical street cross-sections (see Details). Water main may be placed in easements if approved by the Authority Engineer. Where placement in easements is approved, a minimum 25-foot-wide permanent easement is required. The petitioner should work with the Township to secure the necessary easements.
- l) All water main shall be profiled in the construction drawings. Top of pipe elevations, rim elevations, final grade elevations, utility crossings, stationing, and backfill requirements shall be shown in the profile view.
- m) Building footings must be a minimum of 20-feet from all water mains.
- n) Water main shall be ductile iron pipe. HDPE or PVC pipe may be installed in special situations when approved by the Authority Engineer or Utility Director. Special applications may include:
- Surface water crossings
 - Highway crossings
 - Wetlands
 - Unstable soil areas
 - Areas that would require high restoration costs due to conventional construction
 - Corrosive soils or anode beds.
- o) A valve shall be provided on each side of all critical crossings, such as surface water crossings. Critical crossings may also require additional monitoring, such as pressure gauges.
- p) Where HDPE pipe is used in conjunction with ductile iron pipe, the inside diameter of the HDPE pipe shall be equal or greater than the inside diameter of the ductile iron pipe. HDPE pipe shall be ductile iron pipe sizes (DIPS). HDPE pipe shall be manufactured from high density PE 3408 polyethylene resin, having a dimension ratio (DR) of 11 or less, the DR rating shall be specified on the plans. The DR is calculated as the outside diameter of the pipe divided by the minimum wall thickness.
- q) Tracer wire shall be included on all water main distribution lines. Refer to Section 22 11 13, Water Distribution Piping for details.

- r) Tracing wire systems shall terminate in Rhino TriView Tracing Wire Stations or a tracer wire box located at a hydrant, not a valve. The tracer wire box shall have a concrete housekeeping pad in developed areas.
- s) Valves shall be located a minimum of 5 feet from roadway.
- t) When a residential development is constructed in phases, a valve must be installed between each phase to ensure the subsequent phases can be installed tested during construction without disturbing water service to the existing phases.

1.03 Depth of Water Main

- a) Water main shall be buried with a minimum of 5.5 feet of cover over the pipe, and maximum 8.5 feet of cover. Where water main is installed in undeveloped areas, or areas subject to future grading, probable finished grades will be considered.
- b) Water main shall be buried with a minimum 5.5 feet of cover under roadway.
- c) If water main is constructed in areas where pavement will be constructed in the future, granular backfill shall be used.

1.04 Joint Restraint

- a) All water main or process piping shall be designed with mechanical restraint of joints in accordance with Section 22 11 13 of the Standard Technical Specifications and Details.
- b) Concrete thrust blocks are not permissible.

1.05 Meters

- a) All buildings using Authority water shall be metered. In general, water meters shall be placed in a dedicated closet or room for water meter installation, access and maintenance. Area shall be specifically designated on design drawings and shall be oriented to coincide with water lead locations. Water meters must be in a heated area that is accessible always.
- b) For multiple tenant occupied buildings a dedicated meter area with a meter manifold should be constructed to meter each tenant space individually.
- c) Fire lines (4-inch diameter or greater) may bypass the meter, provided the fire system is alarmed in accordance with applicable building and fire codes.

2.0 SANITARY SEWERS

2.01 Sanitary Sewer Basis of Design

- a) All publicly owned and operated system components require construction plan review and permitting, as outlined in Section 3 of the Connection Manual for Systems Operated by the MHOG Utility Department (Connection Manual). 8-inch gravity sanitary sewer, manholes, force main, air release structures, and pump stations are considered public components of the sanitary sewer system.
- b) A sanitary sewer basis of design shall be submitted with construction plans for approval by the Authority Engineer. The basis of design shall include an area map indicating the areas and zoning district for each area to be served, including any off-site areas. The basis of design will reflect proposed developmental phasing. Developments with proposed usage larger than 100 residential units shall go through the Impact Determination requirements in Section 3 of the Connection Manual.
- c) In general, wastewater collection systems shall be designed in accordance with the Recommended Standards for Wastewater Facilities by the Great Lakes-Upper Mississippi River Board of State Public Health and Environmental Managers (“Ten States Standards”).
- d) Residential developments shall consider a design population of at least 2.6 persons per dwelling unit, with wastewater generation of 100 gallons per capita per day (gpcd).

In non-residential developments, flow estimates shall be based on water use records from similar facilities, as may be provided by petitioner and approved by the Authority Engineer, or an estimate of proposed wastewater generation in accordance with REU Schedule.

- e) Sanitary sewers shall be designed to carry peak flow at their 0.90 capacity line while maintaining scouring velocities at minimum flows. Peak flows shall be calculated in accordance with Ten State Standards.
- f) All sanitary sewer pipe shall be a minimum of 8 inches in diameter.
- g) Minimum design velocity shall be 2 feet/sec for sewers 42 inches and less in diameter and maximum design velocity shall be 10 feet/sec. The allowable pipe slopes are shown in the following table:

Pipe Diameter (Inches)	Minimum Slope (Feet per 100 Feet)	Maximum Slope (Feet per 100 Feet)
8	0.40	10.00
10	0.28	7.00
12	0.22	5.30
15	0.15	3.90
18	0.12	2.90
21	0.10	2.32
24	0.080	1.92
27	0.067	1.64
30	0.058	1.44
36	0.046	1.12
42	0.037	0.92

- h) Proposals for sanitary sewage pumping stations are to be discussed in detail with the Authority Engineer and the Authority prior to submittal of site plans. All alternatives to eliminate a new pump station must be considered.
- i) All sanitary sewer testing shall be in compliance with technical specification section 22 13 13, Sanitary Sewers.
- j) Where improvement or grading is to be done over existing utilities a profile of existing utilities should be included in the construction plans.

2.02 Sewer Location

- a) Sanitary sewers shall be located in general conformance with the approved typical street cross-sections (see Details section). Sewer shall be placed in public street right-of-way whenever practicable. Placement in easements will be permitted upon approvals of Authority Engineer and the Township.
- b) Where sewer placement in easements is approved, a permanent easement will be required, the width of which will be determined by the Authority Engineer. In all cases, the sewer easement shall be maintained as accessible to Authority personnel and equipment for maintenance and repairs. Easement size shall be determined by the following table:

BURIAL DEPTH (ft)	EASEMENT WIDTH (ft)
5 – 7	20
7.1 – 12	30
12.1 – 17	40
> 17.1	50

2.03 *Depth of Sewers*

- a) In general, sanitary sewers shall be installed sufficiently deep to receive wastewater from basements and to prevent freezing. In no case shall sewer be placed with less than four feet of cover to the top of the pipe and five feet of cover under roadway. Where sewer is placed in undeveloped areas or areas subject to future grading, probable future grades will be considered.
- b) Where future development plans call for construction of pavement along or across the sanitary sewer route, granular backfill will be used.
- c) All sanitary sewer 8 inches and greater shall be profiled in the construction drawings. Top of pipe elevations, rim elevations, final grade elevations, utility crossings, stationing, and backfill requirements shall be shown in the profile view. Construction plans shall have a maximum scale of 1" = 50'.

2.04 *Manholes*

- a) Manholes shall generally be placed at intervals not to exceed 400 feet; at every change of grade, direction, and pipe size; and at each junction of sewers.
- b) Exterior drop manhole connections shall be used whenever a sewer enters a manhole at an elevation more than 18 inches above the manhole invert. Interior drop manhole connections may be used as an alternative if approved by the Authority Engineer and/or Utility Director.
- c) When pipe sizes change, the larger sewer shall be dropped so that the 0.8 depth line or the pipes match.
- d) An allowance of at least 0.10 foot shall be made between all inlet and outlet pipes within manholes with a horizontal change in direction of the sewer.
- k) In industrial developments, and as required by the Authority Engineer, a sampling manhole shall be constructed along the on-site sewer. The sampling manhole shall be located along a

straight run of pipe and shall have a vertical drop of six inches from inlet to outlet along a poured flow channel.

- l) All manholes and cleanouts shall be brought up to final grade prior to the authority accepting operational responsibility.
- m) All manholes shall be wrapped with WrapidSeal™.
- n) Interior manhole coating will be required for forcemain discharge into proposed or existing manholes.
- o) When the water table will be above the bottom of the manhole, a doghouse manhole shall not be used.

2.05 *Service Connections*

- a) Sanitary sewer services shall be connected to the sewer through wye fittings. Connections of manholes require approval of the Authority Engineer.
- b) Food service facilities and other buildings, as required by the Authority and their Engineer, shall be serviced by grease traps. Traps shall be located outside of the building below ground and of sufficient size to provide 30-minute detention of the peak wastewater flow. The minimum size is 1,000 gallons and maximum size is 2,000 gallons. Each trap shall contain an interior baffle to prevent grease from reaching the public water system. Grease interceptors shall be constructed of impervious material capable of withstanding abrupt changes in temperature. They shall be of substantial construction, watertight, and equipped with removable covers that are gastight and watertight. The interceptor must be easily accessible for pumping and inspection. A cleanout should be provided on the discharge line downstream of the grease interceptor. The grease interceptor shall be connected to all food service drains including kitchen floor drains, mop sinks, dishwashers, and food prep sinks. All non-food service wastewater drains shall be separated from the grease interceptor and connect to the public sewer lead downstream of the grease interceptor. A low flow, minimum grease producing food service facility may utilize interior “under sink” grease traps if they are protective of all food service drains as listed above and approved by the Authority Engineer and/or Director. See grease interceptor detail.
- c) No footing drains or other storm or groundwater drainage facilities shall be connected to sanitary sewer.

- d) Sanitary sewer laterals shall have a minimum diameter of 6 inches. Multiple connections to a sewer lateral are prohibited.
- e) Cleanouts should be provided at all bends and for every 100 feet of a sanitary service lateral.

2.06 *Submersible Wastewater Pump Stations*

Proposals for sanitary sewage pumping stations are to be reviewed in concept with the Authority Engineer and the Utility Director prior to submittal of site plans. If a new pump station is approved for the site, the municipality shall reserve the right to design the proposed pump station. A project specific specification book will be generated for each proposed pump station or pump station upgrade project. The following design guidelines will be used by the municipality for all future pump station upgrades:

Submersible wastewater pump stations shall be designed to pump the flow generated from the proposed development to which it is located. The flow expected at the pump station shall be shown in a basis of design as determined in Section 2.01 (Sanitary Sewer Basis of Design). The basis of design shall include but not be limited to the following information:

- a) Service area for the proposed pump station, including the lowest invert elevation
- b) Design population, design average flow (gpm), design peak flow (gpm). The design peak flow shall be determined per the requirements stated in the “Ten States Standards.”
- c) Design firm pumping capacity. The firm pumping capacity shall be equal to the pumping capacity of the pump station with the largest pump out of service.
- d) The primary pump control method shall be level transducer. Float switches shall be used as a back-up system.
- e) Maximum and minimum system curves. If the force main is cement-lined ductile iron pipe, the maximum system curve shall use a ‘c’ value of 120, and the minimum system curve shall use a ‘c’ value of 140. If PVC or HDPE force main is used, the ‘c’ values shall be 130 and 160, respectively.
- f) Wet wells shall be sized such that the operational volume allows a maximum filling time during average flow of not greater than 30 minutes. The minimum operational volume of the wet well shall be based on the maximum number of pump cycles (starts/stops) allowed by the pump or motor manufacturer per hour. The maximum number of pump cycles will occur when the

influent sanitary flow is exactly half of the pumping capacity; therefore, the minimum wet well volume may be calculated by the following equation:

$$V_{\min} = (Q_p \times T) / 4$$

Where,

V_{\min} = Minimum Wet Well Volume (gallons)

Q_p = Pump Capacity (gpm)

T = Cycle Time (min) = 60 minutes/maximum # of pump starts

- g) To allow Operators time to respond to emergencies, pumping station wet wells shall be of sufficient size to permit a minimum of two (2) hours of storage, at average design flow, above the high water alarm elevation prior to any basement being flooded or wastewater overflowing from any structure.
- h) All pump stations shall be provided with a stand-by generator (diesel or natural gas) housed in a weather- and vandal-resistant enclosure or masonry building, designed to start and operate sufficient pumps to pump the station design capacity in the event of utility power failure. Power shall transfer to the generator by means of an Automatic Transfer Switch. Each pump station shall also be provided with a manual transfer switch and a generator receptacle to enable a portable generator to be substituted for the permanently installed generator in the event of problems occurring with the generator. Generators shall be manufactured by Kohler, Cummins, Caterpillar or Authority approved alternate, and shall include all safety features, alarm lights, and accessories.
- i) Submersible pump stations for Genoa and Ocala Townships shall be Gorman Rupp or Flygt chopper style pump not impacted by flushable wipes. Submersible pumps are preferred over suction lift pumps.
- j) All pump stations shall be connected to the current dedicated frequency telemetry system that is maintained by the Authority. All SCADA system improvements shall be installed with an uninterruptible power source (UPS) and a backup dialer. At a minimum, the station shall be controlled by PLC and have a digital level controller

Pump stations shall be adaptable to the following generator plug:

- Three Phase, 480, Crouse Hines
APJ-10487-S22, 100A, 3W, 4p

- k) Wetwell coating is required, including epoxy coating of all ductile iron pipes in the wetwell.
- l) All pump stations shall be equipped with a bypass pumping connection, shall be fenced in, have paved access for pump maintenance, and shall be screened from adjacent parcels with appropriate landscaping.
- m) All pump station wetwells and valve vaults shall be furnished with aluminum hatch covers and stainless steel hardware.

2.07 *Pressure Sewers Systems*

Proposals for pressure sewer systems are to be reviewed in concept with the Authority Engineer and Utility Director prior to submittal of site plans. All alternatives to provide a gravity sewer system shall be explored. The following design guidelines should be used for private or public grinder pumps:

- a) Maintain a minimum of 2 feet per second in the force main.
- b) Maximum pump head shall not exceed 104 feet.
- c) Easements shall be dedicated the entire length of the service lateral from the grinder pump to the property line.
- d) Tracer wire shall be included on all low-pressure force mains. Refer to Section 22 13 13, Sanitary Sewers for details.
- e) Valves shall be placed at each junction of force main, and in such a way that no more than two valves have to be closed to isolate a branch of force main for repairs.
- f) All flushing connections and air releases shall be brought up to final grade prior to the authority accepting operational responsibility.
- g) Force main shall be buried with a minimum of 5.5 feet of cover over the pipe, and maximum of 8.5 feet of cover. Where force main is installed in undeveloped areas, or areas subject to future grading, probable finished grades will be considered.
- h) Force main shall be buried with a minimum 5.5 feet of cover under roadway.
- i) Air releases shall not be placed in a residential yard or driveway.

- j) Grinder pumps shall be Environment One. Additional information and details on the acceptable materials for various components of the grinder pump are shown on the Standards Detail sheet.

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SECTION 01 33 00 - SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals, including, but not necessarily limited to, the following:
 - 1. Contractor's Construction Schedule.
 - 2. Shop Drawings.

1.2 SUBMITTALS

- A. Bonds and Insurance Certificates shall be submitted to and approved by Owner and Engineer prior to the initiation of any construction on Site.
- B. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents; correspondence and records established in conjunction with compliance with standards; and regulations bearing upon performance of the Work.

1.3 SUBMITTAL PROCEDURES

- A. Coordination:
 - 1. Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 - 2. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 3. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - 4. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- B. Processing:
 - 1. Allow sufficient review time so that installation shall not be delayed as a result of the time required to process submittals, including time for resubmittals.
 - 2. Engineer will review and return submittals with reasonable promptness, or advise Contractor when a submittal being processed must be delayed for coordination or receipt of additional information by putting the submittal "On Hold" and returning a transmittal identifying the reasons for the delay.
- C. Submittal Preparation:
 - 1. Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

2. Provide a space approximately 4 inches by 5 inches on the label or beside the title block on submittals not originating from Contractor to record Contractor's review and approval markings and the action taken.
3. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
4. Any markings done by Contractor shall be done in a color other than red. Red is reserved for Engineer's marking.
5. The number of copies to be submitted will be determined at the pre-construction conference. Reproducibles may be submitted and will be marked and returned to Contractor. Blue or black line prints shall be submitted in sufficient quantity for distribution to Engineer and Owner recipients.

D. Submittal Transmittal:

1. Package each submittal appropriately for shipping and handling. This shall include an index either on the transmittal or within the submittal itself. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than Contractor will be returned without action. Use separate transmittals for items from different specification sections. Number each submittal consecutively. Resubmittals should have the same number as the original, plus a letter designation for each resubmittal (i.e., 7-A, 7-B, etc.).
2. Indicate on the transmittal relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements. On resubmittal, all changes shall be clearly identified for ease of review. Resubmittals shall be reviewed for the clearly identified changes only. Any changes not clearly identified will not be reviewed and original submittal shall govern.

1.4 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. Shop Drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings. Include the following information:
 1. Dimensions.
 2. Identification of products and materials included.
 3. Compliance with specified standards.
 4. Notation of coordination requirements.
 5. Notation of dimensions established by field measurement.

- C. Shop Drawings shall indicate shop painting requirements to include type of paint and manufacturer.
- D. Manufacturer's catalog sheets, brochures, diagrams, illustrations, and other standard descriptive data shall be clearly marked to identify pertinent materials, products, or models. Delete information which is not applicable to the Work by striking or cross-hatching.
- E. Measurements given on Shop Drawings or standard catalog sheets, as established from Contract Drawings and as approved by Engineer, shall be followed. When it is necessary to verify field measurements, they shall be checked and established by Contractor. The field measurements so established shall be followed by Contractor and by all affected trades.
- F. Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 inches by 11 inches but no larger than 36 inches by 48 inches.
- G. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

1.5 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, Engineer will review each submittal, mark to indicate action taken, and return promptly.
 - 1. Compliance with specified characteristics is Contractor's responsibility.
- B. Action Stamp: Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
 - 1. Final Unrestricted Release: Where submittals are marked "No Exceptions Taken," that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
 - 2. Final-But-Restricted Release: When submittals are marked "Furnish as Corrected," that part of the Work covered by the submittal may proceed, provided it complies with notation or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
 - 3. Returned for Resubmittal: When submittal is marked "Rejected" or "Revise and Resubmit," do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
 - a. Do not permit submittals marked "Rejected" or "Revise and Resubmit" to be used at Site, or elsewhere where Work is in progress.
 - 4. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Acknowledge Receipt."
 - 5. The approval of Engineer shall not relieve Contractor of responsibility for errors on Drawings or submittals as Engineer's checking is intended to cover compliance with Drawings and Specifications and not enter into every detail of the shop work.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01330

SECTION 01 50 00 - TEMPORARY FACILITIES

PART 1 – GENERAL

1.1 SECTION INCLUDES

This Section specifies requirements, traffic control and sedimentation control.

- A. During the progress of the Work, Contractor shall accommodate both vehicular and pedestrian traffic as provided in these Specifications and as indicated on the Drawings. In the absence of specific requirements, Contractor shall maintain such traffic. Access to fire hydrants, water and gas valves shall always be maintained. Contractor's truck and equipment operations on public streets shall be governed by all local traffic ordinances and regulations of the Fire and Police Department and the Department of Public Works. Work within State highway rights-of-way shall be under the jurisdiction of the Michigan Department of Transportation. Contractor shall accommodate, and not disrupt, the schedules for trash collection and mail delivery. Contractor shall notify the local police agency of street obstruction and detours. Contractor shall clean out any storm collection system appurtenances that are impacted via soil erosion sediment that he creates.
- B. In the event of Contractor's failure to comply with the foregoing provisions, the Authority may, with or without notice, issue a stop-work notice; this notice shall in no way release Contractor from Contractor's liability for the safety of the traveling public.
- C. Special Requirements. Special requirements of Authority and MDOT being specified for traffic control on state trunk lines and major arteries due to the magnitude of traffic disruption involved in this Contract.

1.2 REFERENCES

- A. Act 346 of 1972, the Inland Lakes and Streams Act and corresponding general rules.
- B. Act 347 of 1972, the Soil Erosion and Sedimentation Control Act, as amended by Act 197 Public Acts of 1974 of the Michigan Compiled Laws.
- C. Local Soil Erosion Control Ordinance or requirements.
- D. Act 53 of Public Acts of 1974, as amended.
- E. Michigan Manual of Uniform Traffic Control Devices (MMUTCD).
- F. Standards. Comply with NFPA Code 241, "Building Construction and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library, "Temporary Electrical Facilities."
- G. Refer to "Guidelines for Bid Conditions for Temporary Job Utilities and Services," prepared jointly by AGC and ASC, for industry recommendations.

1.3 SUBMITTALS

- A. Traffic Control Plan of Action. Contractor shall submit the Plan of Action for Traffic Control in six copies within 10 days after the Notice to Proceed is issued. Contractor shall not commence Work on any State trunk line or major artery without written approval of the Plan for that portion of the Contract.
- B. Contractor's Plan of Action shall be based upon Authority's requirements for Traffic Control and shall detail specific detour routes including individual sign markings and locations. Contractor shall also propose Contractor's intended method for lane control within the construction Work areas.
- C. Authority and/or MDOT shall approve the proposed Plan of Action. Modifications to the proposed Plan of Action resulting in changes to the Bid quantities shall be adjusted as required during Contractor's submittal of monthly payment estimates.
- D. In addition to the Plan of Action, this Work shall consist of the furnishing, installation, operation, maintenance, and removal of the traffic control devices described in this Section.
- E. The location, type, and wording of warning and guide signs shall be proposed by Contractor as part of Contractor's required Plan of Action for Traffic Control.
- F. The erosion control program prepared by Contractor, as described herein, shall be reviewed and have received at least preliminary concurrence from the local Enforcing Agent before it will be presented and discussed at the preconstruction meeting, at which time final revisions may be made. Copies of the final agreed program shall be made available for Engineer and the local Enforcing Agent.

1.4 QUALITY ASSURANCE

- A. Regulations. Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
 - 1. Building Code requirements.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police, Fire Department and Rescue Squad rules.
 - 5. Environmental protection regulations.
 - 6. State and local soil erosion control regulations.
- B. Inspection. Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.5 PROJECT CONDITIONS

- A. All work site conditions shall comply with Michigan Manual of Uniform Traffic Control Devices.
- B. Security and protection facilities required include, but are not limited to:
 - 1. Soil erosion and sedimentation control measures.
 - 2. Environmental protection.

- C. Soil Erosion and Sedimentation Control Program. Contractor shall prepare a soil erosion and sedimentation control program for submittal to and approval by Local Soil Erosion and Sedimentation Control Agent prior to start of construction, as required in the following paragraphs. Copies of State guidelines "Better Environment through Soil Erosion and Sedimentation Control" and "Protection of Natural Resources" DNR Handbook of Specifications may be obtained at no charge from the Michigan Department of Environmental Quality. The "Michigan Soil Erosion and Sedimentation Control Guidebook" may also be obtained from the Michigan Department of Environmental Quality.

- D. Since it is impractical to identify specific potential soil erosion problems along a utility route, Contractor, after award but prior to the preconstruction conference, together with the local soil erosion Enforcing Agent, shall identify all potential soil erosion problem areas and prepare a detailed soil erosion and sedimentation control program satisfying Contractor's specific method of operation. This program shall include as a minimum, but not necessarily be limited to, the following:
 - 1. Identify on a separate set of plans all soil erosion problem areas.
 - 2. Identify specific control structure using MDEQ United Keying System from the "Michigan Soil Erosion and Sedimentation Control Guidebook" to be placed to control erosion and to prevent soil from entering storm sewers and streams.
 - 3. Indicate timing of placement and removal of structures both in relationship to time of year and to sequence of construction.
 - 4. Indicate timing of completion of cleanup and surface restoration after control structures are removed.

- E. The erosion control program, prepared by Contractor, shall be reviewed and have received at least preliminary concurrence from the local Enforcing Agent before it will be presented and discussed at the preconstruction meeting, at which time final revisions may be made. Copies of the final agreed program shall be made available for the Authority and the local Enforcing Agent. Should the local regulatory agency determine at any time during construction that the construction operation is in violation of the Act and cite Owner, Contractor or Subcontractor shall take immediate action, as directed by Authority, to ensure compliance with the Act.

1.6 SEQUENCING AND SCHEDULING

- A. Contractor shall inform the local Fire Department in advance of Contractor's program of street obstruction and detours, so that the Fire Department can set up plans for servicing the area in case of an emergency. Contractor shall also notify the public agency having jurisdiction over the roads at least one week prior to obstructing any street.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Seed shall be, at least, per acre, 10 pounds Kentucky 31 fescue, three pounds Birdsfoot Trefoil, and three pounds white clover.

- B. Fertilizers shall be, at least, 200 pounds per acre 12:12:12 or equivalent.

- C. Mulches shall be two tons per acre of straw or hay. A chemical mulch or other approved material may be used.
- D. Barricades. When a road or street is closed to all through traffic, movable Type III barricades shall be erected at all points of closures, including cross streets. If barricades are to be left over night, three warning lights shall be provided for each Type III barricade.
- E. Barriers. Whenever the excavation on roads open to through traffic exceeds ten feet below surface grade, portable concrete barriers shall be provided between the open trench and any traffic lanes including barriers at the ends of the trench as necessary. The maximum length of open trench shall be 50 feet.
- F. Signs. Standard sign sizes and colors, as shown in "MMUTCD," shall be used to make the approach to construction areas and to direct motorists on any detour route. All signs shall be reflectorized.
- G. Temporary Pavement Marking. Bituminous surfaces shall be marked with either marking tape or paint after each day's paving or prior to opening to traffic. Temporary marking shall be applied to the leveling course if that section will be open to traffic. Removal of temporary pavement marking will not be required unless markings are improperly applied or incorrectly located by Contractor.
- H. Temporary pavement markings shall be placed as directed by Engineer and shall include the following types of markings:
 - 1. Two-foot dashed pavement marking line.
 - 2. Four-foot dashed pavement marking line.
 - 3. Solid pavement marking line.
- I. All markings shall have a nominal width of four inches. Markings shall be either white or yellow in accordance with the "MMUTCD." Dashed lines shall be spaced not greater than 50 feet, center to center of markings.

2.2 EQUIPMENT

- A. General. Provide new equipment; if acceptable to Engineer, undamaged, previously used equipment in serviceable condition may be used. Provide equipment suitable for use intended.
- B. Lane control shall be accomplished by the use of drums and/or Type II barricades to channel the traffic flow, supplemented by guide signs and/or flag persons as necessary. Lighted arrow panels, Type A, shall be required for lane control on both State trunk lines and all City streets open to through traffic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed, or are replaced by authorized use of completed permanent facilities.
- C. Temporary Paving. Construct and maintain temporary roads and paving to adequately support the indicated loading and to withstand exposure to traffic during the construction period. Locate temporary paving for roads, storage areas and parking where the same permanent facilities will be located. Review proposed modifications to permanent paving with Engineer.
- D. Comply with Section 02513, Asphalt Concrete Paving, for construction and maintenance of temporary paving.
- E. Coordinate temporary paving development with subgrade grading, compaction, installation and stabilization of subbase, and installation of base and finish courses of permanent paving.
- F. Install temporary paving to minimize the need to rework the installations and to result in permanent roads and paved areas that are without damage or deterioration when occupied by Owner.
- G. Delay installation of the final course of permanent asphalt concrete paving until immediately before Substantial Completion. Coordinate with weather conditions to avoid unsatisfactory results.
- H. Extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration and supervision.
- I. Dewatering Facilities and Drains. For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Division 2 Sections. Where feasible, utilize the same facilities. Maintain the site, excavations and construction free of water.
- J. Collection and Disposal of Waste. Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than seven days during normal weather or three days when the temperature is expected to rise above 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material in a lawful manner.
- K. Barricades, Warning Signs and Lights. Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics and

warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.

- L. Environmental Protection. Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near the site.
- M. Control of Noise. Contractor shall eliminate noise to as great an extent as possible at all times. Air compressors shall be equipped with silencers, and the exhaust of all gasoline motors and other power equipment shall be provided with mufflers. In the vicinity of hospitals, libraries and schools, special precautions shall be taken to avoid noise and other nuisance, and Contractor shall require strict observances of all pertinent ordinances and regulations. Any blasting permitted in such locations shall be done with reduced charges.
- N. Dust Control. Contractor shall take all steps necessary for the alleviation or prevention of dust nuisance caused by or resulting from Contractor's operations and shall apply water or dust palliative, or both, as required. No direct payment will be made for any such work performed or materials used to control dust from this Contract.
- O. Maintenance of Traffic. During the progress of the Work, Contractor shall accommodate both vehicular and pedestrian traffic as provided in these specifications and as indicated on the Drawings. In the absence of specific requirements, Contractor shall maintain such traffic. Access to fire hydrants, water and gas valves shall always be maintained. Contractor's truck and equipment operations on public streets shall be governed by all local traffic ordinances and regulations of the Fire and Police Departments and the Livingston County Road Commission.
- P. Small street openings necessary for manholes, alignment holes, pipe connections, etc., will be permitted. Such holes shall not be open longer than necessary and shall be protected in accordance with the requirements of the local agency having jurisdiction, and any traffic detouring necessary shall be done to the satisfaction of the Agency. Whenever possible, small openings shall be covered with steel plates at pavement level and secured in place at the time that Work is being performed.
- Q. Where streets are partially obstructed, Contractor shall place and maintain temporary driveways, ramps, bridges and crossings which, in the opinion of Engineer, are necessary to accommodate the public. As part of the Work under this Contract, Contractor shall be responsible for providing and maintaining flag persons, warning lights, signs and/or barricades, including necessary detour signs outside the Project limits as required to direct and protect vehicular and pedestrian traffic. In the event of Contractor's failure to comply with the foregoing provisions, Owner may, with or without notice, cause the same to be done and deduct the cost of such Work from any monies due or to become due Contractor under this Contract; but the performance of such Work by Owner, or at Owner's insistence, shall serve in no way to release Contractor from Contractor's liability for the safety of the traveling public.
- R. Contractor shall inform the local Fire Department in advance of Contractor's program of street obstruction and detours, so that the Fire Department can set up plans for servicing

- the area in case of an emergency. Contractor shall also notify the public agency having jurisdiction over the roads at least one week prior to obstructing a road.
- S. Complete all Work as required, such as pipe stubs to connecting mains or utility service replacements, while constructing mains, so the street will only be closed once.
 - T. Complete new or restored roadways along a street during the same construction season as the trench work. Coordinate traffic rerouting with road work by others so as to minimize the disruption of traffic.
 - U. Markings shall be applied so that they adhere adequately to the surface. Paint shall be applied at a rate of 15 gallons per mile of 4-inch solid line and reflectorized by applying glass beads on the wet paint at a rate of six pounds per gallon. Markings which do not function properly as temporary pavement marking shall be replaced and the application methods revised as directed by Engineer.
 - V. Shaft locations shall be selected at points where they will interfere with traffic as little as possible and their working site arrangements shall meet the approval of Engineer. Detouring of traffic shall be done in accordance with the requirements of the public agencies having jurisdiction over the roads.
 - W. Crossing Railroad Tracks. Owner will obtain the necessary rights-of-way from the railroad company for crossing under its tracks. Contractor shall conduct Contractor's Work in strict accordance with all provisions of the right-of-way agreement thus obtained. Contractor shall make all necessary arrangements with the railroad company as to time of construction, watchpersons, warnings, etc., and all such costs shall be borne by Contractor.
 - X. Soil Erosion and Sedimentation Control. Contractor shall take all precautions necessary to prevent soil erosion of areas disturbed by the construction and shall ensure that all soil erosion be contained within the construction site. Contractor shall provide temporary slope protection, temporary dikes, etc., as required to prevent eroded materials from entering any sewers or natural watercourses.
 - Y. Contractor shall comply with the soil erosion and sedimentation control requirements of Act No. 347 of the Public Acts of 1972 as amended by Act 197, Public Acts of 1974 of the Michigan Compiled Laws and local city or county soil erosion control programs.

3.2 INSTALLATION

- A. Dewatering Trenches and Disposal of Excess Excavated Material. For dewatering requirements, refer to Section 02140, Dewatering. For disposal of excess excavated material, refer to Section 02210, Excavation and Backfill (Sewers and Water Main).
- B. Stream Bank Protection. The banks of streams shall not be left unprotected for more than one day where possible, but never more than seven days after the stream crossing is completed. Replacing of bank plug and grading of stream banks within 50 feet of the stream shall be accomplished immediately following pipe laying. Construction will not be allowed to continue at the expense of not providing stream bank protection.
- C. All disturbed stream banks shall be finished with a slope not steeper than 2: 1 (two horizontal to one vertical). The 2: 1 slope shall be graded up and back to the high water line. If the top of

the natural bank is more than three feet above the high-water line, a 10-foot (minimum) berm shall be constructed at this level, and the remaining slope constructed upward parallel with or on a flatter slope than the original natural bank, provided sufficient adjoining property is available. If such property is not available, permanent riprap shall be placed to the top of the bank. Permanent riprap material shall be placed from the bed of the channel to three feet above the normal high-water line or to the top of the bank. If riprap is placed to the top of the bank, a berm will not be required. Permanent riprap shall be five to one mix of sand to cement in burlap or canvas bags, "Sacrete," broken concrete, man-sized rock, or other material approved by Engineer. "Sacrete," where used, shall be transferred to burlap or canvas bags. All raw soil exposed above the riprap shall be either sodded or seeded, fertilized and mulched. On slopes greater than 10 percent, sod shall be pegged for stability.

- D. Slope Protection - Adjacent to Stream Crossings. In clearing and grubbing of right-of-way, a 20-foot-deep strip of natural vegetation the full width of the right-of-way shall be left on both sides of the streams or drains to be crossed. Deflection dikes consisting of gravel or other suitable material, reinforced by one row of sandbags, shall be used to divert runoff from steep slopes adjacent to water crossing, where contributing runoff could be great enough to cause slope erosion and resulting sedimentation at the stream crossing. Diversion berms, filter berms, diversion ditches or terracing may be appropriate. On slopes greater than 20 percent, such diversion structures shall be placed at the top of said slopes and at 100-foot intervals or less on the slope face. Similar diversion structures shall be placed along the top of the stream bank where the entire slope is not protected with riprap. Water shall be diverted to undisturbed areas adjacent to the right-of-way.
- E. A pipe trench excavation shall stop some distance from the stream to leave a protective plug of 10 to 20 feet of unexcavated material at each bank. The plugs shall be left in place until the pipe laying operation across the stream has begun. Bypassing of water in the trench to the side by diversion ditches or by pumping may be required. The water shall be diverted to undisturbed areas adjacent to the right-of-way. Replacing of bank plug and grading of stream banks within 50 feet of the stream shall be accomplished immediately following pipe laying. Clearing and the removal of protective vegetation shall be kept at a minimum distance ahead of the trenching unit.
- F. Slope Protection. On slopes greater than 20 percent, but not immediately adjacent to stream crossing, mulch shall be anchored with a spray of asphalt, Type SS-IS emulsion mixed with an equal amount of water at a rate of 200 gal/acre. A chemical self-adhering mulch may be used. Mulch shall be anchored on slopes greater than 10 percent if immediately adjacent to stream crossings. Mulch may also be held in place by discing with a farm disc. If mulch materials such as netting or excelsior blankets are used, they may have to be pegged.
- G. Protection. When final topography has been established, all bared soil shall be seeded, fertilized and mulched in an effort to restore to a protected condition, except in flat, active farm fields. Critical areas shall be sodded as specified under Section 31 20 00 Earth Moving.
- H. The permanent protection measures shall be in effect not more than 30 days after the earth change is completed, except at tie-in areas at both sides of the stream where temporary measures will be installed within three days following a pipeline crossing. Temporary measures may include a row of sand bags at the top of the bank, a row of pegged bales of straw, or an earth berm or diversion ditch. These temporary measures shall be maintained until permanent measures are installed.

- I. Where construction involves placing pipes in roadways or under other impervious materials, special care shall be provided by Contractor.
- J. Provide control measures at all storm sewer catch basins by providing straw or other types of filters or construct sediment traps adjacent to inlets.
- K. If a roadway has a grass ditch area, minimize disturbance and provide filter berms (straw or gravel) or sediment traps as appropriate.
- L. Provide proper down drain structures to control increased runoff to streams and drains.
- M. Stabilize the roadway as soon as possible after placement of the utility. Temporary erosion control measures shall be instituted until final paving is complete. Such measures may include a subbase surfacing application or gravel surfacing. Compaction of soil may suffice if other control measures are effected.

3.3 FIELD QUALITY CONTROL

- A. Any unforeseen situations that may be encountered during the course of construction that may cause accelerated erosion and deposition of sediment into waterways and/or lakes shall be controlled by methods that may include sediment traps, sediment basins, or holding ponds. Any slope failures or development of gullies after construction has been completed shall be corrected immediately.
- B. Should the local regulatory agency determine at any time during construction that the construction operation is in violation of Act 346 and cite Owner, Contractor or Subcontractor shall take immediate action, as directed by Owner, to ensure compliance with the Act.
- C. Public roadway surfaces shall not be used as a work platform. Any disruption to the existing surface must be repaired at the Contractor's expense.

END OF SECTION 01 50 00

SECTION 03 30 53 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
 - 1. Section 32 13 13 Concrete Paving for concrete pavement and walks.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture.

1.3 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. Comply with the following sections of ACI 301 unless modified by requirements in the Contract Documents:
 - 1. "General Requirements."
 - 2. "Formwork and Formwork Accessories."
 - 3. "Reinforcement and Reinforcement Supports."
 - 4. "Concrete Mixtures."
 - 5. "Handling, Placing, and Constructing."
 - 6. "Lightweight Concrete."
- B. Comply with ACI 117.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

2.3 CONCRETE MATERIALS

- A. Normal-Weight Aggregate: ASTM C 33/C 33M, 1-1/2-inch nominal maximum aggregate size.
- B. Lightweight Aggregate: ASTM C 330/C 330M, 1-inch nominal maximum aggregate size.
- C. Air-Entraining Admixture: ASTM C 260/C 260M.
- D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- E. Water: ASTM C 94/C 94M.

2.4 FIBER REINFORCEMENT

- A. Synthetic Micro-Fiber: Monofilament or fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

2.5 RELATED MATERIALS

- A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.
- B. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.7 CONCRETE MIXTURES

A. Classes

1. Class A: All concrete not otherwise indicated.
2. Class C: Fill within manholes, mud mats, fill under structures, encasement for piping below or adjacent to structures and encasement for floor drains, sewer inlets and similar items.

Concrete Class	A	C
28-day Compressive Strength, psi* Laboratory Trial Batch for Selecting Concrete Proportions, average 28-day	4,000	2,000
Compressive Strength, psi, design mix	4,700	2,600
Cement Content per cubic yard of concrete, sacks minimum **	6	4
Water/Cement Ratio by weight, maximum	0.44	0.75
Air Content, percent by volume	5+1	NA
Slump at point of placement, inches ***	2-4	3-6

* 7-day compressive strength for high-early strength concrete

** For concrete with fly ash, values are total of cement plus fly ash (except Class F)

*** For concrete containing HRWR admixture (superplasticizer), slump shall not exceed 8 inches after addition of HWRW to verified 2-4 inches slump concrete.

3. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.
4. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than a rate of 1.0 lb/cu. yd.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is above 85 deg F, reduce mixing and delivery time to 45 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT INSTALLATION

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

3.5 CONCRETE PLACEMENT

- A. Comply with ACI 301 for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Do not add water to concrete during delivery, at Project site, or during placement. Forms shall be moist when concrete is placed. Concrete is to be handled to maintain its consistency and not to permit the ingredients to separate. Place concrete in layers not over 18 inches deep.
- D. Consolidate concrete with mechanical vibrating equipment according to ACI 301.
- E. Discharge concrete at Work within 1-1/2 hours after the cement has been added to the water or the aggregates.
- F. When depositing concrete on the ground for slabs and footings, place the concrete on undisturbed or compacted granular base moistened but free from standing water, mud, frost and ice.

3.6 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding 1/2 inch.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch.

3.7 FINISHING UNFORMED SURFACES

- A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
- C. Do not further disturb surfaces before starting finishing operations.
- D. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- E. Slip-Resistive Broom Finish: Apply a slip-resistive finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.8 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screening, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.

- c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections to determine that the concrete complies with the compressive strength and consistency requirements.
- B. Tests: Perform according to ACI 301.
 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 2. Engineer will witness the preparation of test cylinders. Provide concrete for (4) test cylinders in each set. Make, handle, and store test specimens. Pack and ship specimens in substantial packages to prevent damage during transit. Contractor shall bear expenses of shipment and testing specimens by an approved, independent testing laboratory.

END OF SECTION 03 30 00

SECTION 22 11 13 - WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for combined water service and fire service mains.
- B. Section includes the following:
 - 1. Provide all labor, materials, and equipment necessary for fabrication and production of the items specified in this Section and as shown on Drawings or listed on Schedule.
 - 2. Dismantling of existing piping and supports, where required or shown or noted on Drawings; piping connections to existing piping, structures, valves, gates, measuring devices, pumps and other equipment, including equipment erected under other Contracts, are included in Work of this Section. Piping shall contain necessary unions or companion flanges to allow ease of equipment removal.
 - 3. Complete all the demolition work and repair thereof to existing walls and slabs as required for the installation of this Work including grouting of all sleeves and castings. Provide all necessary joint and coupling materials, including bolts, nuts and gaskets, wall castings or sleeves, and standard or special fittings. Furnish hangers, supports, anchors, blocking, harnesses, and other necessary closure pipe sections and special fittings. Provide and secure in proper alignment, all sleeve and casting openings in existing walls and slabs, including repair thereof.
 - 4. Provide all shop-applied interior and exterior pipe linings and coatings. Provide plugs in open ends of pipe, temporary bulkheads, protection of surface and subsurface improvements, cleaning, painting, testing, and disinfection, as required to accomplish Work as specified and shown on Drawings.

1.2 DEFINITIONS

- A. DIP: Ductile Iron Pipe
- B. HDPE: High Density Polyethylene Pipe
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.3 REFERENCE STANDARDS

- A. Where noted in these specifications, all referenced standards refer to the latest revisions to the following specifications.
 - 1. AWWA meaning the American Water Works Association.
 - 2. ASTM meaning the American Society for Testing and Materials.
 - 3. ANSI meaning the American National Standards Institute.
 - 4. UNI - BELL meaning the Uni-Bell PVC Pipe Association.

5. Recommended Standards for Water Works (Ten States Standard) Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.
6. PPI meaning the Plastic Pipe Institute, Inc.
7. NSF meaning the National Sanitation Foundation
8. Environmental Protection Agency Safe Drinking Water Act (SDWA)

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Submit in accordance with Section 01 33 00 Submittals covering the items included under this Section. Shop Drawing submittals shall include:
 1. Shop Drawings shall be fully dimensioned Drawings showing the piping in full detail with exact locations, dimensions, and schedules of all pipe, fittings, hangers, supports, and appurtenances. They shall be made in accordance with the general information shown on Drawing and special information furnished by the several manufacturers of equipment. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.
 2. Design details of joints and joint restraint shall be submitted to Engineer for Engineer's consideration and approval before ordering any pipe.
- C. Record Drawings: At Project closeout, submit Record Drawings of installed products, in accordance with requirements of MHOG Standards.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
 1. Comply with standards requirements of MHOG for potable-water-service piping, including materials, installation, testing, and disinfection.
 2. Comply with standards requirements of local Fire Department (Marion, Howell, Ocoola or Genoa Township) for building-related fire suppression water service piping, including materials, hose threads, installation, and testing.
 3. Comply with the Recommended Standards for Water Works (Ten States Standard) Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

- D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire service main piping for fire suppression.
- E. NSF Compliance:
 - 1. DIP shall comply with NSF372 and NSF 61 Annex G for materials for water-service piping and specialties for domestic water.
- F. All Work under this Section shall be done in accordance with standard practices as recommended by manufacturer and AWWA.
- G. Codes, Ordinances, and Standards: Manufacture, storage, and erection of equipment under this Contract shall be in accordance with current ASA (ANSI), AWWA, and ASTM Standards. Standards and Specifications referenced herein shall be the current published edition. The manufacturer of the pipe and fittings shall furnish Engineer a certified statement that all pipe and fittings furnished by manufacturer meet the material requirements and have been inspected and tested in accordance with the applicable Specification and Standard.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.
- H. Disinfection compounds shall be stored in well-ventilated areas protected from moisture and fire.

1.9 PROJECT CONDITIONS

- A. Interruption of Existing Water Distribution Service: Contractor is not to operate any MHOG water distribution valves. All water system shut downs are to be coordinated with MHOG a minimum of 48 hours before the planned shutdown. All valves to be closed as part of the shutdown are to be operated by MHOG staff.
- B. Existing Conditions: The Drawings are not intended to show every detail of construction or location of piping or equipment. Where existing conditions make it necessary or advisable to change location of piping or equipment, Contractor shall so inform Engineer for Engineer's approval. Engineer shall be allowed 48 hours to respond to any discrepancy without being responsible for any delay in the Work.

PART 2 - PRODUCTS

Refer to Design Standards Part IV - Approved Procedures for a list of all approved materials.

2.1 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 - 2. Copper, Pressure-Seal Fittings:
 - a. NPS 2 and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - b. NPS 2-1/2 to NPS 4: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- C. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. All ductile iron water main pipe shall conform to ANSI/AWWA C151/A21.51-02 and contain a cement mortar lining which shall conform to ANSI/AWWA C104/A21.4-95. All ductile iron water main pipe with a nominal inside diameter of sixteen inches (16") or smaller shall be Pressure Class 350 or Thickness Class 52.
- B. Fittings; All bends, tees, wyes and other special fittings used on water main pipe shall be ductile iron Thickness Class 52, or Pressure Class 350 which shall conform to ANSI/AWWA C153/A21.53-00 and contain a cement mortar lining which shall conform to ANSI/AWWA C104/A21.4-95. All ductile iron water main pipe fitting joints shall be the push-on type and shall conform to ANSI/AWWA C111/A21.11-00.
- C. Mechanical-Joint, Ductile-Iron Pipe: with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Approved Products: Refer to Part IV - Approved Procedures for a list of all approved products.
 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts. Gasket material for contaminated areas shall be specified for resistance to the specific chemical contamination.
 3. Flanged joints shall not be used on ground-buried pipe.
- D. Push-on-Joint, Ductile-Iron Pipe: with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Approved Products: Refer to Part IV - Approved Procedures for a list of all approved products.
 2. Gaskets: ANSI/AWWA C111/A21.11-00, rubber.
 3. Flanged joints shall not be used on ground-buried pipe.
- E. Flanges: ASME 16.1, Class 125, cast iron.
- F. Fasteners: Type 316 stainless steel.
- G. All ductile iron piping shall comply with the requirements NSF/ANSI 372.
- H. All ductile iron pipe to be buried shall be wrapped in polyethylene encasement per manufacturer's recommendations.

2.3 PVC PIPE AND FITTINGS

- A. Use of PVC pipe must be approved by Authority Engineer.
- B. Water main shall be ductile iron pipe. PVC pipe may be installed in special situations when approved by the Authority Engineer or Utility Director. Special applications may include:
- Surface water crossings
 - Highway crossings
 - Wetlands
 - Unstable soil areas
 - Areas that would require high restoration costs due to conventional construction
 - Corrosive soils or anode beds.
- C. Pipe Sizes 12-inches or Less in diameter: PVC, AWWA Pipe: AWWA C900 and shall meet the requirements of ASTM-2241-00 and ASTM D1784-03, minimum working Pressure Class 235 (DR 18), with bell end with gasket, and with spigot end. The Authority Engineer must approve use of PVC pipe in any water main project.

- D. Pipe Sizes 14 inches through 48 inches in diameter: PVC, AWWA Pipe: AWWA C905 and shall meeting the requirements of ASTM-12454 and ASTM D1784-03, Pressure Class 235 (DR 18) with bell end with gasket, and with spigot end. Wall thickness in the bell section shall conform to the requirements of ASTM D3139, “Standard Specification for Joint for Plastic Pressure Pipes Using Flexible Elastomeric Seals.”
- E. General:
1. Comply with NSF Standard 14. ANSI/NSF Standard 14 meets the requirements of ANSI/NSF Standard 61 and be stamped “NSF-pw” on the exterior pipe wall.
 2. Pipe shall have an integral wall-thickened bell end designed for joint assembly using a factory installed elastomeric gasket conforming to ASTM F477 to affect the pressure seal.
 3. Pipe shall be designed for direct connection into ductile iron pipe and fittings.
 4. Each piece of pipe and fitting shall be clearly labeled to identify its size, pressure class and manufacture date.
 5. Pipe joints shall meet the requirements of ASTM D-3212-9 for push-on joints.
 6. Gaskets shall meet the requirements of ASTM F-77-02 regarding elastomeric seals for joining plastic pipe.
 7. PVC pipe shall have the same outside diameter as ductile iron water main pipe. The internal diameters of the proposed PVC pipe shall be equivalent to the comparable ductile iron internal diameters.
 8. All bends, wyes and other fittings for PVC water main pipe shall be ductile iron.
 9. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 - b. Approved Manufacturer: Refer to Part IV - Approved Procedures for a list of all approved products.
 10. PVC pipe shall be provided in standard 20 foot lengths, unless otherwise specified, detailed or required on the approved construction plans. Shorter lengths up to 10 feet, will be permitted when authorized by the Authority. Field cut lengths of pipe used as closures may not be shorter than 2 feet in length and must be approved by the Authority.
 11. All PVC pipe entering or exiting a fitting shall be a minimum length of 10 feet.
- F. Solid Sleeves; Contractor shall provide bolted solid sleeves manufactured of ductile iron with a restraint designed for PVC water main pipe. The nuts and bolts for the solid sleeves shall be low carbon steel and conform to ASTM A307, Grade B.
- G. Joint Restraint; Refer to Part IV - Approved Procedures for a list of all approved products.

2.4 HDPE PIPE AND FITTINGS

- A. HDPE pipe must be approved by Authority Engineer.
- B. Water main shall be ductile iron pipe. HDPE pipe may be installed in special situations when approved by the Authority Engineer or Utility Director. Special applications may include:
- Surface water crossings

- Highway crossings
 - Wetlands
 - Unstable soil areas
 - Areas that would require high restoration costs due to conventional construction
 - Corrosive soils or anode beds.
- C. High density polyethylene pipe conforming to ASTM D1598 and D3350, AWWA C906 and ANSI/NSF-14 and 61, material shall be comprised of PE 3408 Resin with a cell classification of PE334434C. All pipe shall be stamped “NSF-pw” on the exterior pipe wall.
1. Product shall be from one of the following manufacturers or an approved equal: Refer to Part IV - Approved Procedures for a list of all approved products. No installations shall exceed ten feet (10') of cover unless approved by the Engineer or as directed by the plans and specifications. The Authority Engineer must approve the use of HDPE pipe in any water main project.
 2. Pipe shall have a wall thickness of DR-11 and a working pressure rating of 160 psi, with approval of Utility Director and/or Authority Engineer.
 3. Materials and workmanship shall be as required by AWWA M55, PE Pipe Design and Installation Manual and ASTM F714 Manufacturing requirements.
 4. HDPE pipe, appurtenances, and installation methods shall conform to the latest addition of AWWA C906. The AWWA Standard Code C906 identification must appear on the exterior wall print line of the HDPE pipe proposed for potable use and installation. All HDPE materials must be listed and approved for use with potable water under ANSI/NSF Standard 14. ANSI/NSF Standard 14 meets the requirements of ANSI/NSD Standard 61. The exterior wall print lines of all HDPE pipe proposed for installation and potable use must bear the NSF-pw identification.
 5. Pipe shall be furnished in ductile iron pipe sizes (DIPs).
 6. Pipe shall be handled and installed in accordance with manufacturer's recommendations.
 7. Pipe shall be furnished with continuous, permanent print line identifying pipe size, pressure rating, trade name, material classification, ASTM and NSF standards, pipe test category, plant location and shift, date of manufacture, operator and extruder numbers, and supplier of raw materials.
 8. Exterior wall print line must bear NSF – PW identification.
- D. Fittings and Couplings: Fittings and specials shall be of the same construction and design as the pipe. The manufacturer of the pipe shall be the same as the manufacturer of the fittings and other fabrications.
- E. Joints: Joints shall be thermally butt-fused according to the recommendations of the manufacturer.

2.5 JOINING MATERIALS

- A. Refer to Section 33 05 00 Common Work Results for Utilities for commonly used joining materials.
- B. Mechanical Joint Restraints: Shall be provided at all valves, reducer fittings and as noted on the Standard Water Main Details and Notes sheets. Restrainers must accommodate the full

working pressure ratings and associated safety factor of the specified class of pipe and must be UL or FM approved. Mechanical joint restraints shall meet and or exceed the specification requirements of the pipe material specifications as previously stated. Refer to Part IV - Approved Procedures for a list of all approved products. In addition to certification, a copy of manufacturer's recommendations for installation must be supplied to the Authority Engineer. Restrained mechanical joints shall be provided at all main line valves, all hydrant branch pipe joints and/or as called out in the construction plans.

C. HDPE Restraint Methods;

1. Restrained joints include butt fusions, electro-fusions, socket fusions, bolted flange connections, MJ Adapter connections or other restrained mechanical connections.
2. Provide joint restraints on long string of butt fused HDPE to bell and spigot or mechanical sleeve joint.
 - a. Wall Anchor;
 - 1) Restrain the transition connection by butt fusing a Wall Anchor in the HDPE pipeline close to the connection and pouring a concrete anchor around it as shown in Details. Refer to the pipe manufacturer's recommendations on anchor size and pull out loads.
 - b. Mechanical Joint.
 - 1) Restrain the transition connection and several non-PE bell and spigot joints down line from the transition connection.
 - 2) Distance of pipe restraint needs to be identified on the drawings and noted in the HDPE to DIP Connection Detail. At minimum the Contractor shall provide pipe restraint per the requirements of a "Dead End" pipe as noted in the "Pipe Restraint Schedule" or 3 Pipe Lengths, whichever is greater.

D. HDPE to DIP and DIP Fittings;

1. MJ (mechanical joint) Adapters are to be used to connect polyethylene pipe to mechanical joint fittings and appurtenances that meet AWWA C111/ANSI A21.11.
2. Slip the Gland Ring over the pipe end and then butt fuse the HDPE MJ Adapter to the end of the pipe using the PPI Generic Butt Fusion Joining Procedure TR-33. Install the Gasket over the MJ Adapter and align the fitting with the socket hub of the ductile iron fitting. Lubricate the gasket, the end of the MJ adapter, and the inside of the socket hub with an approved pipe lubricant meeting AWWA C111. Do not use soapy water.
3. Insert the MJ Adapter into the socket hub. Make sure it is evenly and completely seated in the socket hub. The MJ Adapter and the socket hub must be aligned straight into each other. Insert the gland bolts, and run the nuts up finger tight. Tighten the gland bolts evenly to the fitting manufacturer's recommended procedures.
4. When connecting to a valve with an MJ connection, longer T-bolts may be required. If the T-bolts that come with the kit are not long enough for the assembly, use a coupling nut and Grade 5 all thread to make up the length required.

E. HDPE Flanged Connection to DI Fittings:

1. Flanged joints can be used to attach HDPE pipe to valves or DI fittings using HDPE Flange Adapter, Back-Up Ring, Gaskets and Bolts, Nuts and Washers.
2. Connection is made by sliding the Back-Up Ring over the pipe end and then butt fusing the HDPE Flange Adapter to the end of the pipe using the PPI Generic Butt Fusion Joining Procedure TR-33. Align the flanges and back-up rings and follow the fitting manufacturer's recommended procedures for bolting the flanges together. The service pressure rating for the back-up ring should meet or exceed the service pressure in the pipe.

3. Gaskets are required for connections between polyethylene and non-polyethylene flanges. The gasket manufacturer should recommend the gasket to use with polyethylene pipe. This is considered a “fully restrained joint” and typically does not need external restraint devices.
- F. Solid DI Sleeve Connections to HDPE pipe:
1. Solid Sleeves are ductile iron fittings designed to connect DI/PVC pipe to other piping materials including HDPE pipe. The solid sleeve is to have a flange or MJ hub to attach to the HDPE pipe. On the ductile iron pipe side, a Megalug flange is attached to the pipe and a gasket is installed over the pipe and into the sleeve before bolting the Megalug to the Sleeve flange. A standard HDPE MJ Adapter kit is used on the HDPE pipe side to complete the assembly.
 2. Contractor is to follow manufacturer’s recommended procedures for this assembly.
- G. HDPE Pipe Connection to DI or PVC Bell End:
1. Flex restraint pieces are electro-fused to the HDPE pipe to achieve the proper stab depth in the PVC or DI bell and the restraint harness plate is attached behind them. The opposite end of the restraint harness is attached behind the DI /PVC hub.
 2. Install the HDPE pipe in the PVC/DI bell until it bottoms out on the flex restraints and tighten the tie rods to prevent the assembly from pulling apart.
 3. A stiffener is to be installed in the HDPE pipe end.
 4. Contractor is to follow manufacturer’s recommended procedures for this assembly
- H. Mechanical Connection – HDPE to PVC:
1. Provide coupling on plain-end PVC pipe to plain-end HDPE pipe without special adapters.
 2. When connecting HDPE pipe to a mechanical coupling, the fitting unless otherwise stated by the coupling manufacturer.

2.6 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tracer wire is to be installed on all water main distribution lines and service lines.
1. For directional bores tracer wire shall be:
 - a. Directionally drilled tracer wire to be Copperhead ‘Soloshot’ Extra High Strength Directional Drill Wire 1150# Break Load or equal.
 2. For conventional open cut construction tracer wire shall be:
 - a. Direct bury tracer wire to be Copperhead 10 CCS High Strength 600# Break Load or equal.
 3. Tracer wire shall be installed in a continuous fashion. Install tracer wire on top of pressure process piping and secure to main every five (5) feet with tape.
 4. The wire shall be brought to the surface at bore pits, valves, fittings or manholes through utility markers or tracer wire terminal boxes which may serve as access points. Trace wire shall be brought to the surface at least every five hundred (500) feet unless noted by the Owner. Care should be taken not to damage the wire coating. If wire coating is damaged, the Contractor shall repair the damaged coating with electrical tape.
 5. Tracer wire shall terminate in boxes when at paved surfaces. Refer to Part IV - Approved Procedures for a list of all approved products.

6. Tracer wire systems in rural areas shall terminate in tracing wire stations. Terminals shall be external and colored blue for water distribution systems. Terminals should be located at least every one thousand (1,000) feet or as shown on the drawings. Refer to Part IV - Approved Procedures for a list of all approved products.
 7. Contractor shall test the locator system for continuity upon completed installation. Should tracer wires fail to test for continuity then the test shall be considered a failure.
 8. Failure of the tracer wire shall result in the installation of utility markers at no additional cost to Owner.
- C. Bolts, Nuts and Washers
1. All bolts, nuts and washers used by the manufacturer to fabricate and assemble hydrants, tapping sleeves, resilient seated gate valves and butterfly valves shall be #316 stainless steel. All portions of these fasteners exposed after installation must be field coated with rust preservative spray paint (bituminous base non-toxic undercoat spray paint), which is approved by the Authority.
 2. Refer to Part IV - Approved Procedures for a list of all approved products. All bolts, nuts and washers used for the installation of sleeves, couplings, and mechanical joint fittings shall be COR-BLUE approved equal.

2.7 CORROSION-PROTECTION PIPING ENCASEMENT

- A. Standards: AWWA C105
- B. High-density, crosslaminated PE film of 0.004-inch minimum thickness, colored black.

2.8 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 1. Nonrising-Stem, Resilient-Seated Gate Valves, for water main pipe sixteen inches (16") and smaller in diameter:
 - a. Description: Gray or ductile iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut. Gate valve stems shall be high tensile strength, non-rising type with double O-Ring stem seals. The gate valve wedge shall be ductile iron encased in an EPDM rubber covering which shall form the sealing surface and provide sealing in either direction.
 - 1) Standard: AWWA C515-01.
 - 2) Minimum Working Pressure Rating: 250 psig.
 - 3) End Connections: Mechanical joint.
 - 4) Operating Nut: 2-inch
 - 5) Interior Coating: Complying with AWWA C550.
 - 6) All nuts, bolts and washers for installation on sleeves, couplings and mechanical joint connections shall be Cor-Blue or approved equal.
 - 7) All nuts, bolts and washers used by manufacturer to fabricate and assemble gate valves shall be #316 stainless steel and exposed portions shall be field coated with pipe mastic or an approved corrosion protective spray.
 - 8) Provide one operating wrench of suitable length.
 - b. Direction of Open: Open valve by turning operating nut to left or counterclockwise.
 - c. Refer to Part IV - Approved Procedures for a list of all approved products including gate valves.

2.9 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies:
1. Valve
 - a. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.
 - b. All nuts, bolts and washers for installation on sleeves, couplings and mechanical joint connections shall be Cor-Blue or approved equal.
 - c. All nuts, bolts and washers used by manufacturer to fabricate and assemble gate valves shall be #316 stainless steel and exposed portions shall be field coated with pipe mastic or an approved corrosion protective spray.
 - d. All tapping-sleeve valve assemblies shall use a well instead of a valve box.
 2. Pressure Tapping Sleeve
 - a. All pressure tapping sleeves shall be installed in an appropriately sized valve manhole. All pressure tapping sleeves shall be push on restrained joints by flanged outlet, stainless steel or ductile iron built in two (2) parts.
 - b. Refer to Part IV - Approved Procedures for a list of all approved products including approved mechanical joint sleeves.
 - c. No live taps will be allowed where the outlet is the same size as the main without consultation with the Authority Engineer.
 - d. There shall be no direct taps on PVC or HDPE watermain. Saddles must be used for all tapping operations. When tapping pressurized PVC watermain, the Contractor is to use a heavy protective blanket 4 foot by 6 foot with a hole for the tapping machine or a tapping shield. System pressures shall be reduced during tapping. Contractor assumes all liability relative to the safety and injury resulting from tapping PVC Pipe.
 - e. All pressure tapping-sleeve assemblies shall use a well.
- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
1. Provide #6 base with valves 8-inches or less.
 2. Provide #8 base with valves greater than 8-inches.
 3. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.10 CHECK VALVES

- A. AWWA Check Valves:
1. Refer to Part IV - Approved Procedures for a list of all approved check valves
 2. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
 - a. Standard: AWWA C508.
 - b. Pressure Rating: 175 psig.

2.11 BUTTERFLY VALVES

- A. AWWA Butterfly Valves:
1. Description: Rubber seated.
 - a. Standard: AWWA C504.

- b. Body: Cast or ductile iron.
 - c. Body Type: Wafer.
 - d. Pressure Rating: 150 psig.
2. Refer to Part IV - Approved Procedures for a list of all approved Butterfly Valves.

2.12 PLUG VALVES

- A. Plug Valves:
- 1. Description: Resilient-seated eccentric.
 - a. Standard: MSS SP-108.
 - b. Body: Cast iron.
 - c. Pressure Rating: 175-psig minimum CWP.
 - d. Seat Material: Suitable for potable-water service.
 - 2. Refer to Part IV - Approved Procedures for a list of all approved Plug Valves.

2.13 CORPORATION VALVES AND CURB VALVES

- A. Manufacturers:
- 1. Refer to Part IV - Approved Procedures for a list of all approved corporation stops, curb stops, and curb boxes.
 - 2. All corporation valve, curb valves, and fittings shall contain no lead in compliance with Safe Drinking Water Act amendment 1417 of 2011 and NSF 61 Annex G.
- B. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material. The minimum size of curb valves shall be 1-inch.
- C. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
- 1. Service Box Rods: Steel, stem of length to operate deepest buried valve, curved to have top centered in box with slotted end matching curb valve. Rods are not to be used on valve boxes with an access way greater than 1-inch.

2.14 WATER METERS

- A. Water meters will be furnished by MHOG at the Contractor's expense.

2.15 FIRE HYDRANTS

- A. Fire Hydrants:
- 1. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron or ductile-iron body, compression-type valve opening against pressure and closing with pressure. Hydrants shall have a 6-foot bury depth.

- a. Refer to Part IV – Approved Procedures for approved fire hydrants and accessories.
- b. Fittings: 5-inch Storz Nozzle and Cap integral with fire hydrant assembly.
- c. Bibs: Two (2) 2- 1/2 –inch National Thread Standard (NTS)
- d. Standard: AWWA C502.
- e. Pressure Rating: 250 psig.
- f. All nuts, bolts and washers for installation on sleeves, couplings and mechanical joint connections shall be Cor-Blue or approved equal.
- g. All nuts, bolts and washers used by manufacturer to fabricate and assemble gate valves shall be #316 stainless steel and exposed portions shall be field coated with pipe mastic or an approved corrosion protective spray.
- h. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
- i. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
- j. Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
- k. Hydrant flag: Hydrant markers shall be heavy-duty galvanized spring steel hydrant markers 6' high with flat mounting bracket and spring.

2.16 PRESSURE-REDUCING VALVES

- A. Water Control Valves:
 - 1. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
 - a. Pressure Rating: Initial pressure of 150 psig minimum.
 - b. Main Valve Body: Cast-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - 1) Size: See Drawings.
 - 2) Pattern: Angle or Globe-valve design as required by design.
 - 3) Trim: Stainless steel.
 - c. Design Flow Rate: See Drawings.
 - d. Design Inlet Pressure: See Drawings.
 - e. Design Outlet Pressure Setting: See Drawings.
 - f. End Connections: ANSI 125 lb. flanged connections.

2.17 PLUGGING DEAD ENDS

- A. Standard plugs shall be inserted into the bells of all dead ends of pipes, tees or crosses, and spigot ends shall be capped. Plugs or caps shall be joined to the pipe or fitting in the manner specified and shall be secured with mechanical joint restraints.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 31 20 00 Earth Moving, for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 1 to NPS 3 shall be any of the following:
 - 1. Soft copper tube, ASTM B 88, Type K; copper, pressure-seal fittings; and pressure-sealed joints.
- F. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 shall be any of the following:
 - 1. Ductile iron, mechanical joint pipe; ductile iron, mechanical joint fittings; and mechanical.
 - 2. PVC, AWWA Class 200 pipe listed for fire protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, high-pressure, resilient-seated gate valves with valve box.
 - 2. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising stem.
 - b. Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.
 - c. Check Valves: AWWA C508, swing type.
 - 3. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
 - 4. Relief Valves: Use for water-service piping in vaults and aboveground.
 - a. Air-Release Valves: To release accumulated air.
 - b. Combination Air Valves: To release or admit air.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Section 33 05 00 Common Work Results for Utilities for piping-system common requirements.

3.5 PIPING INSTALLATION

- A. Water-Main Connection: Must notify MHOG a minimum 48 hours prior to making any water main connections or taps of any size.
- B. Make connections larger than NPS 2 with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
 - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- C. Make connections NPS 2 and smaller with drilling machine according to the following:
 - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
 - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 - 4. Install corporation valves into service-saddle assemblies.
 - 5. Install manifold for multiple taps in water main.
 - 6. Install curb valve in water-service piping with head pointing up and with service box.
- D. Comply with NFPA 24 for fire-service-main piping materials and installation.
 - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
 - 2. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- F. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- G. Install PVC, AWWA pipe according to AWWA C605 and AWWA M23.
- H. Bury piping with depth of cover over top at least 5.5 feet and no greater than 7.5 feet below finished grade.
- I. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- J. To prevent unwanted water intrusion, open ends of pipe shall be closed temporarily with a watertight bulkhead.
- K. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

- L. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- M. Copper service piping gooseneck shall be pre-formed prior to connection to the corporation. Bending of copper service after connection to main line is prohibited.

3.6 JOINT CONSTRUCTION

- A. See Section 33 05 00 Common Work Results for Utilities, for basic piping joint construction.
- B. Make pipe joints according to the following:
 - 1. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
 - 2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 - 3. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
 - 4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
- C. Joint Harnessing
 - 1. Pipe and fittings that require harnessing shall be provided with standard lugs ASTM A 283, Grade B, or A 285, Grade C, or equal, meeting the requirements of AWWA Specification C111 or AWWA Manual M11, unless otherwise noted.
 - 2. Harness tie rods and nuts shall be mild steel meeting the requirements of ASTM A 193, Grade B7, or A 307, Grade B, or equal with American Standard threads. The nuts shall seat on steel plate washers. The rod, washers, and nuts shall be hot-dip galvanized ASTM A 153.

3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Locking mechanical joints.
 - 2. Set-screw mechanical retainer glands.
 - 3. Bolted flanged joints.
 - 4. Heat-fused joints.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
 - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
 - 3. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box if in yard. In pavement, install in protective valve box. Curb stop box top access way opening threads shall be greased with synthetic food grade grease in compliance with NSF 60.
- D. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves
- E. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.9 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
- B. AWWA Fire Hydrants: Comply with AWWA M17.
- C. Each fire hydrant shall be tagged with its distinguishing mark letter and number. Mark letter and number and tag as provided by MHOG.
- D. Each hydrant assembly shall be tested by CONTRACTOR; the test shall consist of flushing the hydrant for a minimum of ten minutes. During the test period, the 6-inch gate valve shall be closed and opened. CONTRACTOR shall furnish hoses for the proper disposal of OWNER-furnished water.
- E. Contractor shall plug hydrant weep holes prior to installation.

3.10 CONNECTIONS TO EXISTING FACILITIES

- A. Where shown on the drawings, connections to existing mains shall be done only after the new mains are shown to be disinfected by the results of the bacteriological analysis. Care should be taken to prevent debris from entering water main during cutting and connection work.

3.11 CLEANING

- A. All mains shall be cleaned using a poly-pig cleaning system. All equipment and temporary piping materials shall be provided by the Contractor. Prior to connecting to any existing valves, the Contractor shall check that the existing valve doesn't leak and if so, must notify the Owner immediately prior to making any connections. The pig shall be inserted into the first segment of pipe installed at the existing or proposed valve as described in the locations listed below. At the end of the segment of pipe to be cleaned, prior to pressure testing and chlorination, the Contractor shall install a 45-degree bend and a segment of pipe to accommodate flushing of the pig. The main shall be filled with water by means other than

opening the valve prior to flushing the pig. Once the water main is full the existing or proposed valve may be opened until the pig is retrieved from the end of the line. After the pig has been removed from the line, the contractor shall remove the 45-degree bend and terminate the portion of the water main for other testing. Contractor shall propose pigging/testing locations to the Engineer for acceptance prior to capping and filling the pipe. Below are the recommended segments of pipeline to be pigged; any changes to the following locations shall be submitted to the Engineer for approval prior to beginning pipe construction:

1. At point of connection to existing water main.
2. At any tees or crosses.
3. Other locations as recommended by MHOG based on the proposed water main layout.

3.12 CLOSING ABANDONDED WATERMAIN SYSTEMS

- A. Close open ends of abandoned underground piping indicated to remain in place. Fill abandoned pipe with grout. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads, grouted in place.
 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Backfill to grade according to Section 31 20 00 Earth Moving.

3.13 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests after all pipe has been backfilled. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Flushing: Water main flushing shall be conducted at a rate of 3.0 ft/sec to achieve adequate scour flushing in the main. Contractor shall coordinate with MHOG for completion of flushing.
- C. After completion, each run of pipe shall be tested by Contractor in the presence of Engineer. All appurtenances such as service connections, corporation stops, and curb stops shall be tested with the run of pipe.
 1. Any leaks shall be made tight.
 2. Under this Work, Contractor shall furnish all piping, bulkheads, pumps or compressors, gauge, and other equipment required for the test. When possible, Contractor to request MHOG to furnish water for testing. Any water used for testing will require use of a reduced-pressure zone backflow preventer and meter.
 3. The section of pipe to be tested shall be cleaned and isolated by valves or plugs, and shall not exceed 2,000 feet for any individual test. Such valves or plugs shall be designed to hold against the test pressure. Sections of pipe shall have an opening through which air or water can be introduced. The supply line shall be fitted with suitable control valves and a pressure gauge for continually measuring the pressure. The pressure gauge shall have a minimum diameter of 3-1/2 inches and a range compatible with the test pressure. Pipelines that cannot be closed for a direct pressure test shall be tested by filling the tanks to which they are connected to the highest operating level or installing temporary test bulkheads. After completion of tests, all

pipes shall be drained. Buried pipelines shall be pressure tested with all pipe joints exposed for visual inspection unless otherwise directed by Engineer.

4. If requested by Engineer, Contractor shall furnish proposed test procedures for approval including pipe identification, test pressure and a description of the method of testing.
 5. In the event that the leakage exceeds the specified amount, the joints in the line shall be carefully inspected for leaks and repaired where necessary. Any pipes or special castings found to be cracked shall be removed and replaced with new pieces by Contractor. After this Work has been done, the test shall be repeated. Final acceptance of the lines will not be made until satisfactory tests have been passed.
- D. All PVC pipe shall be in accordance with ASTM D1599.
1. The manufacturer of each shipment of pipe may be required to supply a statement certifying that each lot or load of pipe has been subjected to the tests specified for PVC pipe and has been found to meet all the requirements of AWWA C909 and AWWA C905 as applicable.
 2. PVC pipe which has been gouged shall not be used. Any scratch or gouge in the pipe that is measured as 10% or more of the wall thickness shall be cause for rejection of that pipe. This shall be monitored by the owner during all phases of construction. PVC pipe which has received minor scratches during handling may be used solely at the discretion of the Authority. PVC pipe shall not be rolled off delivery trucks or other transporting vehicles.
 3. Contractor to install PVC water main in strict accordance with the manufacturer's installation guide, AWWA C605 and AWWA M23 latest revisions thereof. If any of these documents are found to conflict, the most restrictive of the requirements shall be met.
 4. Do not install any PVC pipe contaminated with a petroleum product (inside or out). Do not install any PVC pipe that shows evidence⁴ of exposure to sunlight, age, surface deterioration or other physical damage.
 5. PVC pipe shall be supported uniformly will be stored and not stacked with weight on the bells. All pipe shall be stored in such a way to protect it from exposure from direct sunlight. The pipe may be covered with an opaque material will permitting adequate air circulation above and around the pipe. Gaskets shall be stored in a cold, dark place out of the direct rays of the sun. No pipe showing evidence of sun burning shall be installed.
- E. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure.
1. Hydrostatic Testing (except HDPE): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes.
 - a. The test period shall start immediately after initial pressurization. The line shall be maintained under the test pressure for a continuous 2-hour period.

- b. The section of pipe to be tested shall hold the test pressure with no more than a 5 percent loss in pressure over the test period or the leakage per hour under the conditions of test shall not exceed values determined by the following equation:

$$L = \frac{SD\sqrt{P}}{148,000}$$

Where L = allowable leakage per hour (gallons)
S = length of pipe in test (feet)
D = nominal diameter of pipe (inches)
P = average test pressure (psi, gauge)

- c. Piping with flanged, grooved coupling, screwed, socket type, and welded joints shall be completely tight at the designated test pressure.
- d. The test pressure shall not vary by more than 5 psi throughout the entire test period.
2. Hydrostatic Testing of HDPE Pipe: The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes. To compensate for expansion after initial pressurization, sufficient make-up water shall be added into the pipe system at hourly intervals for 3 hours to raise the pressure back up to the test pressure.
- a. After completion of this initial phase, approximately 4 hours after start of the testing procedure, the actual test shall begin.
- b. The system shall be pressurized up to the test pressure and by make-up water held continuously at the test pressure for at least 1 hour, but no more than 3 hours.
- c. The make-up water used during the test shall be measured and shall not exceed the allowance given in the table below.
3. The Contractor shall not pressure test against a closed valve unless the new main has already been disinfected and the bacteriological samples have passed.
4. All water used during testing shall be metered.

ALLOWANCE FOR EXPANSION OF HDPE PIPE UNDER TEST PRESSURE

Allowance for Expansion
(U.S. Gallons per 100 Feet of Pipe)

Nominal Pipe Size (In.)	1-Hour Test	2-Hour Test	3-Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	11.1	16.8
28	5.5	11.1	16.8
32	7.0	14.3	21.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
48	15.0	27.0	43.0
54	22.0	35.0	55.0

- a. If there are no visible leaks or pressure drops greater than 5 psi during the actual test period, the system passes the test. If leakage is revealed, however, the defect shall be corrected and a retest shall be made after a 24-hour minimum depressurized recuperation period.
- 5. Pneumatic Testing: The section of pipe to be tested shall be filled with air and pumped up to test pressure.
 - a. Sufficient time shall be allowed for the air pressures to stabilize at the test pressure. After the stabilization period, the air control valve shall be closed and the test period started. The section of pipe shall be maintained under the test pressure for a continuous 4-hour period with no more than a 10 percent loss in pressure over the entire test period.
 - b. Pneumatic testing of HDPE pipe shall not be allowed.
- 6. Each valve assembly shall be tested by Contractor; the test shall consist of opening and closing the valve.
- 7. Each hydrant assembly shall be tested by Contractor; the test shall consist of flushing the hydrant for a minimum of ten minutes. During the test period the 6-inch gate valve shall be closed and opened. Contractor shall furnish necessary hoses for the disposal of Owner-furnished water.

F. Prepare reports of testing activities.

3.14 IDENTIFICATION

- A. Install continuous underground electronic detectable tracer wire during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly on top of the piping. Tracer wire requirements are specified in this section.

3.15 DISINFECTION

- A. Disinfection Products:
 - 1. Liquid Chlorine shall not be allowed.
 - 2. Use NSF 60 certified granular chlorine for disinfection.
- B. Clean and disinfect water-distribution piping according to procedures detailed in Design Standards Part IV – Approved Procedures.

END OF SECTION 22 11 13

SECTION 22 13 13 - SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Nonpressure and pressure couplings.
 - 3. Expansion joints and deflection fittings.
 - 4. Cleanouts.
 - 5. Encasement for piping.
 - 6. Manholes.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Expansion joints and deflection fittings.
- B. Shop Drawings: Submit in accordance with Section 01 33 00 Submittals covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. For manholes. Include plans, elevations, sections, details, and frames and covers.
 - 2. Shop Drawings shall be fully dimensioned Drawings showing the piping in full detail with exact locations, dimensions, and schedules of all pipe, fittings, hangers, supports, and appurtenances. They shall be made in accordance with the general information shown on Drawing and special information furnished by the several manufacturers of equipment. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.
 - 3. Each pipe section, special fitting, casting, sleeve, and appurtenance shall be identified on Drawings by its respective erection mark.
- C. Record Drawings: At Project closeout, submit record Drawings of installed products, in accordance with requirements of MHOG Standards.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:

1. Comply with the Recommended Standards for Wastewater Facilities (Ten States Standard) Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight. Flexible pipe shall be stored on a flat surface so that barrel is evenly supported. Pipe shall not be stored in piles higher than 4 feet.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. The drawings are not intended to show every detail of construction or location of piping or equipment. Where existing conditions make it necessary or advisable to change location of piping or equipment, Contractor shall inform Engineer for Engineer's approval. Engineer shall be allowed 48 hours to respond to any discrepancy without being responsible for any delay in the Work.

B. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by public or private facilities unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Do not proceed with interruption of service without the written permission of the Authority.

PART 2 - PRODUCTS

Refer to Part IV- Approved Procedures for a list of all approved products and materials.

2.1 REQUIRED MANUFACTURERS

A. Adapter Flange Coupling (AFC): Shall be the product of one of the following manufacturers, or equal:

1. Uni-Flange
2. Victaulic Co.
3. Smith-Blair, Inc.

B. Bolted Flexible Coupling (BFC): Shall be the product of one of the following manufacturers, or equal:

1. Dresser Industries, Inc.
2. Smith-Blair, Inc.

C. Equipment Connections: Shall be the product of one of the following manufacturers, or equal:

1. Garlock
2. Metra Flex
3. Mercer Rubber Co.
4. Redflex
5. Atlantic Metal Hose Co (Vibra-flexor)

6. Allied Metal Hose Co.
7. Universal Oil Products

D. Hangers and Supports: Shall be the product of one of the following manufacturers, or equal:

1. Grinnel
2. Elcen

E. Mechanical Sleeve Seals: Shall be the product of one of the following manufacturers, or equal:

1. Thunderline Corp.

2.2 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Push-on-Joint Piping:

1. Pipe: AWWA C151 (NPS 3 to NPS 64). Thickness class 52 or Pressure class 350.
2. Standard Fittings: AWWA C110, ductile or gray iron (NPS 3 to NPS 48).
3. Compact Fittings: AWWA C153 (NPS 3 to NPS 64).
4. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:

1. Pipe: AWWA C151, with bolt holes in bell (NPS 3 to NPS 48).
2. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell (NPS 3 to NPS 48).
3. Compact Fittings: AWWA C153, with bolt holes in bells (NPS 3 to NPS 48).
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.
6. All buried ductile iron pipe shall be encased in polyethylene wrap.

2.3 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 26, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Gravity Sewer Piping (NPS 18 to NPS 36):

1. Pipe and Fittings: ASTM F 679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

C. PVC Pressure Piping:

1. Pipe: AWWA C900, Class 200 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 200 PVC pipe with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.
4. Fusible PVCP shall be manufactured of PVC resin compounds Class 12454 A or B conforming to ASTM D 1784 in accordance with ASTM D 2241. PVCP shall have a pressure rating of 200 psi (14 DR). Joints shall be fused.

2.4 HDPE PIPE AND FITTINGS

- A. High density polyethylene pipe conforming to ASTM D3350-02 and AWWA C906-90, material shall be comprised of PE 3408. Product shall be from one of the following manufacturers or an approved equal: Drisco Pipe, Performance Pipe, or Plexico.
1. Pipe shall have a minimum wall thickness of DR-11 or less as directed by the Authority and a working pressure rating of 160 psi or more.
 2. Materials and workmanship shall be as required by AWWA M55, PE Pipe Design and Installation Manual and ASTM F714 Manufacturing requirements.
 3. HDPE pipe, appurtenances, and installation methods shall conform to the latest addition of AWWA C906.
 4. Pipe shall be furnished in ductile iron pipe sizes (DIPs).
 5. Pipe shall be handled and installed in accordance with manufacturer's recommendations.
 6. Pipe shall be furnished with continuous, permanent print line identifying pipe size, pressure rating, trade name, material classification, ASTM and NSF standards, pipe test category, plant location and shift, date of manufacture, operator and extruder numbers, and supplier of raw materials.
 7. Exterior wall shall be permanently color coded to provide service identification. Stripes along the entire length of the pipe, 120 degrees apart, shall be made by co-extrusion or impregnation. Stripes for sanitary force mains shall be green.
 8. No installations shall exceed ten feet (10') of cover unless approved by the Engineer or as directed by the plans and specifications.
- B. Fittings and Couplings: Fittings and specials shall be of the same construction and design as the pipe. The manufacturer of the pipe shall be the same as the manufacturer of the fittings and other fabrications.
- C. Joints: Joints shall be thermally butt-fused according to the recommendations of the manufacturer.
- D. HDPE Restraint Methods:
1. Restrained joints include butt fusions, electro-fusions, socket fusions, bolted flange connections, MJ Adapter connections or other restrained mechanical connections.
 2. Provide joint restraints on long string of butt-fused HDPE to bell and spigot or mechanical sleeve joint.
 - a. Wall Anchor:
 - 1) Restrain the transition connection by butt fusing a wall anchor in the HDPE pipeline close to the connection and pouring a concrete anchor around it as shown in Details. Refer to the pipe manufacturer's recommendations on anchor size and pull out loads.
 - b. Mechanical Joint.
 - 1) Restrain the transition connection and several non-PE bell and spigot joints down line from the transition connection.
 - 2) Distance of pipe restraint needs to be identified on the drawings and noted in the HDPE to DIP Connection Detail. At minimum the Contractor shall provide pipe restraint per the requirements of a "Dead End" pipe as noted in the "Pipe Restraint Schedule" or 3 pipe lengths, whichever is greater.
- E. HDPE to DIP and DIP Fittings:
1. MJ (mechanical joint) Adapters are to be used to connect polyethylene pipe to mechanical joint fittings and appurtenances that meet AWWA C111/ANSI A21.11.

2. Slip the Gland Ring over the pipe end and then butt fuse the HDPE MJ Adapter to the end of the pipe using the PPI Generic Butt Fusion Joining Procedure TR-33. Install the Gasket over the MJ Adapter and align the fitting with the socket hub of the ductile iron fitting. Lubricate the gasket, the end of the MJ adapter, and the inside of the socket hub with an approved pipe lubricant meeting AWWA C111. Do not use soapy water.
 3. Insert the MJ Adapter into the socket hub. Make sure it is evenly and completely seated in the socket hub. The MJ Adapter and the socket hub must be aligned straight into each other. Insert the gland bolts, and run the nuts up finger-tight. Tighten the gland bolts evenly to the fitting manufacturer's recommended procedures.
 4. When connecting to a valve with an MJ connection, longer T-bolts may be required. If the T-bolts that come with the kit are not long enough for the assembly, use a coupling nut and Grade 5 all thread to make up the length required.
- F. HDPE Flanged Connection to DI Fittings:
1. Flanged joints can be used to attach HDPE pipe to valves or DI fittings using HDPE Flange Adapter, Back-Up Ring, Gaskets and Bolts, Nuts and Washers.
 2. Connection is made by sliding the Back-Up Ring over the pipe end and then butt fusing the HDPE Flange Adapter to the end of the pipe using the PPI Generic Butt Fusion Joining Procedure TR-33. Align the flanges and back-up rings and follow the fitting manufacturer's recommended procedures for bolting the flanges together. The service pressure rating for the back-up ring should meet or exceed the service pressure in the pipe.
 3. Gaskets are required for connections between polyethylene and non-polyethylene flanges. The gasket manufacturer should recommend the gasket to use with polyethylene pipe. This is considered a "fully restrained joint" and typically does not need external restraint devices.
- G. Solid DI Sleeve Connections to HDPE pipe:
1. Solid Sleeves are ductile iron fittings designed to connect DI / PVC pipe to other piping materials including HDPE pipe. The solid sleeve is to have a flange or MJ hub to attach to the HDPE pipe. On the ductile iron pipe side, a Megalug flange is attached to the pipe and a gasket is installed over the pipe and into the sleeve before bolting the Megalug to the Sleeve flange. A standard HDPE MJ Adapter kit is used on the HDPE pipe side to complete the assembly.
 2. Contractor is to follow manufacturer's recommended procedures for this assembly.
- H. HDPE Pipe Connection to DI or PVC Bell End:
1. Flex restraint pieces are electro-fused to the HDPE pipe to achieve the proper stab depth in the PVC or DI bell and the restraint harness plate is attached behind them. The opposite end of the restraint harness is attached behind the DI /PVC hub.
 2. Install the HDPE pipe in the PVC/DI bell until it bottoms out on the flex restraints and tighten the tie rods to prevent the assembly from pulling apart.
 3. A stiffener is to be installed in the HDPE pipe end.
 4. Contractor is to follow manufacturer's recommended procedures for this assembly.
- I. Mechanical Connection – HDPE to PVC:
1. Provide coupling on plain-end PVC pipe to plain-end HDPE pipe without special adapters.
 2. When connecting HDPE pipe to a mechanical coupling, the fitting unless otherwise stated by the coupling manufacturer.

2.5 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end. Couplings shall be Logan LCP Coupling, or Fernco Series 1001-66 or approved equal.
- B. Sleeve Materials:
 - 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Ring-Type, Flexible Couplings:
 - 1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.6 EXPANSION JOINTS AND DEFLECTION FITTINGS

- A. Ductile-Iron, Flexible Expansion Joints:
 - 1. Joints for Ductile Iron Pipe to be Tyton, Bell Tite, Fast Tite or equal.
 - 2. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.
- B. Cleanouts
 - 1. PVC Cleanouts:
 - a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
 - b. Cleanout to be constructed as noted in the Genoa - Oceola Sanitary Sewer Standard Details.
 - c. PVC to meet ASTM D-3034.
 - d. Cleanout lid to be heavy duty, EJIW 1574 Solid Cover or equal. Lid to be cast within concrete pad.

2.7 MANHOLES

- A. Standard Precast Concrete Manholes:
 - 1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Diameter: 48 inches minimum unless otherwise indicated.
 - 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
 - 5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
 - 6. Top Section: Eccentric-cone.
 - 7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection. Resilient Pipe Connector to be Kor-N-Seal or approved equal.
9. Steps: Individual steel-reinforced plastic steps; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step, minimum 10-inches wide. Cast or anchor steps into sidewalls at 16-inch intervals.
10. Grade Rings: Reinforced-concrete rings, 3- to 8-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
11. Provide interior manhole coating where manhole used for force main discharge. Coating shall be SpectraShield or approved equal.
12. All manholes shall be wrapped with Wrapid Seal joint wrap or equal.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch minimum-width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.
3. Frame and Cover manufacturer make and model required for the Authority is noted in the Standard Details.

C. Manhole Adjustment

1. Precast concrete grade rings, 2" to 6" thick may be installed above the manhole cone to provide the adjustment of 3" to 8" according to standard details.
2. Where manholes require more adjustment than 8", the existing cone section of the manhole is to be removed and precast sections installed.
3. Adjusted manholes shall be grouted on the interior and exterior of the adjustment rings.

2.8 PLUG VALVES

A. Plug Valves:

1. Description: Resilient-seated 100% Port Eccentric.
 - a. Standard: MSS SP-108, with 100% port opening.
 - b. Body: Cast iron.
 - c. Pressure Rating: 175-psig minimum CWP.
 - d. Seat Material: Suitable for raw sewage service.
2. Plug Valves shall be Clow, Dezurik, Homestead, or Pratt, or GO SWATH approved equal.

2.9 RELIEF VALVES

A. Combination Air Valves:

1. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
 - a. Standard: AWWA C512.
 - b. Pressure Rating: 300 psig.
 - c. Body Material: Cast iron.
 - d. Trim Material: Stainless steel.
 - e. Inlet and Outlet Size: Per Drawings Specifications
 - f. Orifice Size: Per Drawings Specifications

- g. Design Air Capacity: Per Drawings Specifications
- 2. Combination Air Valves shall be APCO, ARI model D-025 2" threaded inlet match detail, Crispin, or GO SWATH approved equal.

2.10 CONCRETE

- A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi (minimum, with 0.45 maximum water/cementitious materials ratio).
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.11 UTILITY MARKERS

- A. All sanitary sewer leads shall have an electronic marker system furnished and installed complete with marker locator.
 - 1. Markers shall be installed in a horizontal position 3 to 4 feet below the ground surface at the end of the lead or at the property line.
 - 2. Utility markers to be Rhino FiberCurve and colored green for sanitary sewer systems.
- B. Tracer wire is to be installed on all non-ferrous/metallic service lines and sanitary sewer pumping mains.
 - 1. For directional bores tracer wire shall be:
 - a. Directionally Drilled tracer wire to be Copperhead 'Soloshot' Extra High Strength Directional Drill Wire 1150# Break Load or equal.
 - 2. For conventional open cut construction tracer wire shall be:
 - a. Direct bury tracer wire to be Copperhead 10 CCS High Strength 600# Break Load or equal.
 - 3. Tracer wire shall be installed in a continuous fashion. Install trace wire on top of pressure process piping and secure to main every five (5) feet with tape.

4. The wire shall be brought to the surface at bore pits, valves, fittings or manholes through utility markers or tracer wire terminal boxes which may serve as access points. Trace wire shall be brought to the surface at least every five hundred (500) feet unless noted by the Owner. Care should be taken not to damage the wire coating. If wire coating is damaged, the Contractor shall repair the damaged coating with electrical tape.
5. Tracer wire shall terminate in boxes when at paved surfaces. Copperhead brand boxes shall be used. Model RB14*TP shall be used in asphalt installations and model CD14*TP shall be used for all other installations.
6. Tracer wire systems in rural areas shall terminate in Rhino Triview Tracing wire stations. Terminals shall be external and colored green for sanitary sewer systems. Terminals should be located at least every one thousand (1,000) feet, or as shown on the drawings.
7. Contractor shall test the locator system for continuity upon completed installation. Should tracer wires fail to test for continuity then the test shall be considered a failure.
8. Failure of the tracer wire shall result in the installation of utility markers at no additional cost to Owner.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 20 00 Earth Moving.

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling. Casing pipes may be required for certain crossings and to maintain accurate line and grade. Horizontal directional drilling is allowable for pressure mains.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 3. Install piping with 66 inch minimum cover.
 4. Install ductile-iron, gravity sewer piping according to ASTM A 746.
 5. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
 6. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
 7. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
 2. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
 3. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 4. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 5. Join dissimilar pipe materials with nonpressure-type, flexible couplings.
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.
- E. Pipe to manhole connections shall be provided by the manufacturer or cored in the field. In no instance shall new holes be sledgehammered out.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts, and use PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block as shown in the Genoa – Ocoola Sanitary Sewer Standard Details.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

- A. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 16.
 - a. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - b. Core existing pipe and install a tapping saddle such as the Romac “CB” Sewer Saddle or approved equal.
 - 3. Make branch connections from side into existing piping, NPS 18 or larger, using an Inserta-Tee of approved equal.
 - 4. Connections to existing sanitary sewer manholes will only be allowed through coring the structure and installing a flexible connector such as Kor-n-Seal or approved equal.
 - 5. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Fill abandoned pipe with grout. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads, grouted in place.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
 - 1. Remove manhole and close open ends of remaining piping.
 - 2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section 31 20 00 Earth Moving.

3.9 FIELD QUALITY CONTROL

- A. Conduct acceptance tests for tightness on nonpressure sanitary sewers and laterals. In areas where live leads have to be connected as the Work progresses, then only a television inspection will be required. Do not enclose, cover, or put into service before acceptance tests have been passed unless approved by the Engineer.

Test sewers NPS 24 and smaller using low pressure air. Also test sewers for infiltration where groundwater is above the sewer invert. In areas where groundwater is more than 5 feet above the sewer invert, air test with dewatering system in operation or use infiltration test when dewatering is turned off and has returned to normal level. Make provisions for determining groundwater levels prior to testing.

Test sewers NPS greater than 24 using infiltration or exfiltration tests, as directed by the Engineer.

1. Schedule tests and inspections with the Authority with at least 24 hours' advance notice.
 2. Submit a separate report for each test performed.
 3. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 4. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 5. Reinspect and repeat procedure until results are satisfactory.
 6. Leaks and loss in test pressure constitute defects that must be repaired.
 7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- B. Low Pressure Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
1. Option: Test plastic gravity sewer piping according to ASTM F 1417.
 2. Option: Test concrete gravity sewer piping according to ASTM C 924.
 3. Testing procedure:
 - a. Add air to line until internal pressure of 4 psig is obtained, allow for stabilization. Once 4.0 psig is held, allow the pressure to decrease to 3.5 psig, at which time, begin a stopwatch to determine the total time required for internal pressure to drop to 2.5 psig.
 - b. Adjust pressure by adding 0.433 psi pressure for each foot of groundwater above the invert of the pipe being tested.
 - c. Do not allow persons to be in the manhole during air testing.
 - d. Do not allow internal pipe pressure to rise above 5.0 psi.
 - e. Determine rate of air loss—check time for pipe to drop 1.0 psi and compare to allowable time listed in Low Pressure Air Test Tables included in this specification.

LOW PRESSURE AIR TEST TABLES
 TIME REQUIRED FOR 1.0 PSIG PRESSURE DROP
 WHEN TESTING ONE PIPE DIAMETER ONLY FOR SIZE AND LENGTH OF PIPE INDICATED.

TABLE FOR PVC, PVCP, ABS AND DI PIPE

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft.)	4 Time for Longer Length (sec.)	Test Time for Length (L) Shown (min:sec)								
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.	
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31	
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33	
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48	
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15	
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46	

TABLE FOR VCP AND CONCRETE PIPE

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft.)	4 Time for Longer Length	Test Time for Length (L) Shown (min:sec)								
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.	
4	1:53	597	0.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12	
8	3:47	298	0.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42	
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54	
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:48	11:24	12:50	
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51	
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	
24	11:20	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54	
30	14:10	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07	
36	17:00	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23	
42	19:50	57	20.939L	34:54	52:21	69:48	87:15	104:42	122:09	139:36	157:03	

Note: When testing two sizes of pipe simultaneously, time shall be computed by ratio of lengths involved.
 Example: 400 feet of 8-inch PVC pipe and 150 feet of 6-inch VCP pipe.

$$\begin{aligned}
 \text{Time} &= \frac{\text{Length1} \times \text{Time1} + \text{Length2} \times \text{Time2}}{\text{Length1} + \text{Length2}} \\
 &= \frac{400 \times 10:08 + 150 \times 2:50}{400 + 150} \\
 &= \frac{400 \times 608 + 150 \times 170}{400 + 150} \\
 &= 489 \text{ seconds} = 8:09 \text{ (min:sec)}.
 \end{aligned}$$

C. Hydrostatic Test (Gravity Sewer except HDPE): Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

1. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
2. Close openings in system and fill with water.
3. Purge air and refill with water.
4. Disconnect water supply.
5. Test and inspect joints for leaks.

D. Hydrostatic Testing (Pressure Pipe except HDPE): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes.

1. The test period shall start immediately after initial pressurization. The line shall be maintained under the test pressure for a continuous 2-hour period.
2. The section of pipe to be tested shall hold the test pressure with no more than a 5 percent loss in pressure over the test period or the leakage per hour under the conditions of test shall not exceed values determined by the following equation:

$$L = \frac{SD\sqrt{P}}{148,000}$$

Where L = allowable leakage per hour (gallons)
 S = length of pipe in test (feet)
 D = nominal diameter of pipe (inches)
 P = average test pressure (psi, gauge)

3. Piping with flanged, grooved coupling, screwed, socket type, and welded joints shall be completely tight at the designated test pressure.
4. The test pressure shall not vary by more than 5 psi throughout the entire test period.
5. Test Pressures: Pipelines shall be tested at 1-1/2 times their working pressure.

E. Hydrostatic Test (HDPE Pipe): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes. To compensate for expansion after initial pressurization, sufficient make-up water shall be added into the pipe system at hourly intervals for 3 hours to raise the pressure back up to the test pressure.

1. After completion of this initial phase, approximately 4 hours after start of the testing procedure, the actual test shall begin.
2. The system shall be pressurized up to the test pressure and by make-up water held continuously at the test pressure for at least 1 hour, but no more than 3 hours.
3. The make-up water used during the test shall be measured and shall not exceed the allowance given in the following table.

ALLOWANCE FOR EXPANSION OF HDPE PIPE UNDER TEST PRESSURE

Allowance for Expansion
(U.S. Gallons per 100 Feet of Pipe)

Nominal Pipe Size (In.)	1-Hour Test	2-Hour Test	3-Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	11.1	16.8
28	5.5	11.1	16.8
32	7.0	14.3	21.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
48	15.0	27.0	43.0
54	22.0	35.0	55.0

4. If there are no visible leaks or pressure drops greater than 5 psi during the actual test period, the system passes the test. If leakage is revealed, however, the defect shall be corrected and a retest shall be made after a 24-hour minimum depressurized recuperation period.
- F. Ring deflection testing: A minimum of 30 days after the sewer has been installed, ring deflection testing shall be performed on all flexible pipe. Any pipe with deflection of 5 percent or greater will require replacement at no cost to the Owner.
- G. Television inspection: Furnish materials, labor, and equipment for television inspection of all new sanitary sewers. Included will be necessary cleaning and pumping of sewage. Television inspection shall not take place until a maximum of 30 days after installation.
1. Engineer's representative shall directly supervise televising and view recordings.
 2. Record sewer interior on video DVD which shall be turned over to Owner. Make recording on continuous running audio video DVD.
 3. The inspection shall involve visual observation by closed circuit television. Perform inspection at rate of speed which will allow examination of all points of infiltration, cracked or crushed pipe, defective joints, misalignment in line or grade, location of wye openings and other defects. Precisely locate and describe by detailed statement of condition any item which in opinion of Engineer requires repair.

4. As part of television inspection, note precise location of each wye in relation to downstream manhole. Record this location on wye location sheets supplied by CONTRACTOR.
 5. If camera encounters dip in sewer such that water is standing above springline of sewer pipe, and if camera lens becomes submerged because of this condition, withdraw camera rig from sewer and insert from other end as far as possible. Prevent back flooding into reach from adjacent section.
 6. Provide two copies of notes, wye locations and other pertinent information as part of television inspection report. Turn over one set of this information to ENGINEER upon completion of inspection of each line. Hold second copy of information until completion of Project, at which time assemble and turn it over to ENGINEER
- H. Manholes: Perform hydraulic test according to ASTM C 969 or low-pressure vacuum air testing in accordance with ASTM C 1244-05ae1, and below.
1. All pipes must be connected to the manhole prior to testing, and the manhole must be backfilled and compacted above all joints and connections to be tested.
 2. The trench shall be maintained in a dewatered condition such that no standing water is above any joint to be tested. Contractor shall provide a method for measuring the groundwater elevation adjacent to the manhole to be inspected.
 3. Permanently plug all lift holes prior to air testing. All piping must be temporarily plugged, with the plug placed inside the pipe so that the connection between the boot and the manhole is tested.
 4. A vacuum of 10 inches of 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 of mercury.
 5. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the time as indicated in Table 1. Time shall be measured using a digital or analog stopwatch.
 6. If the manhole fails the air test, the Contractor shall make all repairs by methods approved by the Engineer. The manhole shall then be retested until a satisfactory test is obtained.
 7. The Engineer may require the reconstruction of any manhole that does not pass acceptance test at no additional cost to the Owner.

TABLE 1
 SANITARY MANHOLE AIR TEST TABLE
 MINIMUM TIME REQUIRED FOR 1.0 IN MERCURY PRESSURE DROP

Depth, ft	Diameter, in								
	30	33	36	42	48	54	60	66	72
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

1. Time given is in seconds
2. The depth of the manhole is measured from the top of the manhole cover to the floor of the manhole. If the depth of the manhole is not listed, the next higher value shall be used.
3. The largest diameter section of the manhole shall be used to determine time required.

3.10 CLEANING

- A. Clean dirt and superfluous material from interior of piping.

END OF SECTION 22 13 13

SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Removing existing vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Stripping and stockpiling rock.
 - 6. Removing above- and below-grade site improvements.
 - 7. Disconnecting, capping or sealing and removing site utilities or abandoning site utilities in place.
 - 8. Temporary erosion and sedimentation control.

1.2 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
- D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.3 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by MHOG or the Township.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify Miss Dig for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Michigan Department of Transportation (MDOT) Specifications.
 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
 1. Restore damaged improvements to their original condition, as acceptable to the Authority.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
- B. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- C. Interrupting Existing Utilities: Do not interrupt utilities serving any public or private facilities, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 1. Notify the facility owner and MHOG not less than five (5) days, unless otherwise approved, in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without MHOG's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 3. Use only hand methods or air spade for grubbing within protection zones.
 4. Chip removed tree branches and stockpile in areas approved by MHOG or dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
 1. Limit height of topsoil stockpiles to 72 inches.
 2. Do not stockpile topsoil within protection zones.
 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them.

END OF SECTION 31 10 00

SECTION 31 20 00 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses.
 - 2. Drainage course for concrete slabs-on-grade.
 - 3. Subbase course for concrete walks and pavements.
 - 4. Subbase course and base course for asphalt paving.
 - 5. Surface course for gravel and stone driveways.
 - 6. Excavating and backfilling for utility trenches.

1.2 SUBMITTALS

- A. Test and Inspection Reports: Written reports shall be submitted to Engineer, with copy to Contractor, documenting testing and/or inspection results. Tests shall include:
 - 1. Test reports on borrow material.
 - 2. Gradation analysis for granular backfill and subbase materials.
 - 3. Field reports; in-place soil density tests will be performed by a representative of Owner.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction. Construct subbase in accordance to MDOT Standard Specifications for Construction.
- B. Testing and Inspection Service: Owner will employ and pay for a qualified independent geotechnical testing and inspection laboratory to perform soil testing and inspection service during earthwork operations.

1.4 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated in drawings.
- G. Fill: Soil materials used to raise existing grades.

- H. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- J. Gravel/Stone Driveway: Any residential or commercial driveway approach that consists of a gravel or stone surface between the edge of roadway and the right-of-way.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 PROJECT CONDITIONS

- A. Groundwater is anticipated to be encountered during excavation. Dewatering requirements are specified in Section 31 23 19 Dewatering.
- B. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
- C. Contractor shall notify MISS-DIG, Utility Communications System, three working days prior to starting any excavation with power equipment.
 - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing utilities serving facilities occupied by Owner or others during occupied hours except when permitted in writing by Engineer, and then only after acceptable temporary utility services have been provided.
 - 3. Provide minimum of 2 working days notice to Engineer and receive written notice to proceed before interrupting any utility.
 - 4. Demolish and completely remove from Site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
- D. Use of explosives is not permitted.
- E. Protection of Persons and Property: Barricade open excavations occurring as part of this Work and post with warning lights.
 - 1. Operate warning lights as recommended by authorities having jurisdiction.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - 3. Perform excavation by hand within drip line of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. Contractor shall provide verification that materials brought on site for use as fill are environmentally clean and free of known contaminants.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 1. Liquid Limit: Shall not exceed 35 percent when tested in accordance with ASTM D 4318.
 - 2. Plasticity Index: Shall not be greater than 12 percent when tested in accordance with ASTM D 4318, and not more than 35 percent by weight shall be finer than No. 200 sieve when tested in accordance with ASTM D 1140.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
 - 2. Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills, trash, refuse, backfills from previous construction, and material classified as satisfactory which contains root and other organic matter or frozen material.
 - 3. The Authority shall be notified of any contaminated materials.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
 - 1. MDOT Specifications - Granular Materials Class II is acceptable.
- E. Granular Fill: Granular fill shall be defined as sharp sand, gravel, or crushed stone, free from lumps of clay, soft or flaky material.
 - 1. Shall conform to MDOT Specification, "Granular Materials - Class III."
- F. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- G. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- H. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
 - 1. MDOT Specification Granular Material 6A or Class I, except 100 percent must pass 1 1/2 inch sieve.
 - 2. Bedding for Thermoplastic Pipe, 6-inch Diameter or Less: Granular material with 100 percent passing the 1/2-inch sieve and less than 50 percent passing the No. 200 sieve.
- I. Stone Refill: MDOT 6A Coarse Aggregate.
- J. Gravel or dirt driveways shall be MDOT 22A Aggregate. Stone driveways shall be replaced with washed stone, pea stone, or limestone of type and thickness that matches existing

surface. Road gravel (22A) shall not be used to replace stone drives unless authorized by the Owner and the Engineer.

- K. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 4 sieve.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.4 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe.
 - 2. Bottom of trench in granular material shall be loosened to a depth of 3 inches below bottom of pipe.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.
 - 2. At least the bottom half of the pipe shall be laid in bedding. Bedding in haunch area shall be compacted in layers not to exceed 6 inches in depth to 95 percent of its maximum unit weight.

- D. Length of Trench Opening: In excavating for pipelines, the excavation shall at all times be finished to the required grade for an adequate distance in advance of the completed pipeline. Unless otherwise permitted by the Engineer, not more than 50 feet of trench in advance of the pipe and 200 feet of total trench shall be open at one time. The length of street which may be occupied by the construction work at any one time will be based on the requirements of use of the street by the public. No more than 600 consecutive feet of length of the street shall be occupied at one time, and vehicle traffic through the street shall not be entirely stopped without the permission of the Engineer.
- E. Stability of Excavations: Comply with local codes, ordinances, and requirements of agencies having jurisdiction. Slope sides of excavations where space allows, or shore and brace where sloping is not possible. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- F. Trenches in Tree- and Plant-Protection Zones:
 - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.5 SUBGRADE INSPECTION

- A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities.

3.6 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
 - 2. Dispose of excess excavated soil material not acceptable for use as backfill or fill.

3.7 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Roadways: All trenches in paved streets, shoulders, traveled roadways, parking areas and driveways shall be backfilled with job-excavated backfill or granular backfill, as shown on the Drawings, from the level one foot above the top of the pipe to the specified road surface subgrade. The material shall be placed in not more than 6-inch layers and thoroughly and uniformly compacted 95 percent of maximum unit weight. With the approval of the Engineer, water jetting on granular backfill may be acceptable in lieu of mechanical tamping in 6-inch layers.
- D. All trenches not in paved streets, shoulders, traveled roadways, parking areas and driveways shall be backfilled from the level one foot above the top of the pipe to the ground surface

with job-excavated backfill and shall not require tamping other than that required to prevent trench settlement, unless otherwise noted on the drawings.

- E. Wherever gas mains, water mains, sewers, etc., are located in the trench area, granular fill shall be used for backfill from the bottom of the trench up to the spring line of these pipes. Granular fill shall be placed full trench width with two horizontal to 1 vertical side slopes and compacted in 6-inch layers to 95 percent of its maximum unit weight so as to thoroughly support the pipe within the trench area. Granular fill so required shall be considered included in the unit prices bid for other items of the Work. When directed by the Engineer, dry mix Class C concrete will be substituted for granular fill. The installation of any dry mix Class C concrete shall be considered a change in the Work.
- F. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in "Miscellaneous Cast-in-Place Concrete".
- G. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- H. Place and compact final backfill of satisfactory soil to final subgrade elevation.

3.8 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.

3.9 STONE REFILL

- A. In locations where the soil at the bottom of the trench is unstable, when ordered by the Engineer, Contractor shall excavate below the trench bottom and refill with crushed stone, slag or crushed gravel equivalent in grading to MDOT 6A.

3.10 GRAVEL AND STONE DRIVEWAYS

- A. Gravel and stone driveways are to match the existing section thickness, but not to be less than 6 inches thick.

3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - 1. Under pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 - 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
 - 4. Gravel/Stone Driveways, compact material at 95 percent.

3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1 inch.
 - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 - 1. Shape subbase course and base course to required crown elevations and cross-slope grades.
 - 2. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 ROADSIDE DITCHES AND CULVERTS

- A. All roadside ditches and driveway culverts shall be cleaned, repaired and replaced to the same condition, or better, as existed before trenching operations commenced. Repair and/or replacement costs shall be included in other portions of the Work unless otherwise noted on the Drawings.

3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Authority.
- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off site.

END OF SECTION 31 20 00

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes construction dewatering.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades. Control of surface and subsurface water, ice and snow are part of dewatering requirements.
- B. Contractor shall reduce hydrostatic head in the water-bearing strata below structure foundations, drains, sewers and other excavations to extent that water level and piezometric water levels in construction areas are below prevailing excavation surface.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Provide temporary grading to facilitate dewatering and control of surface water.
- B. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 31 10 00 Site Clearing, during dewatering operations.
- C. Contractor shall, prior to excavation below groundwater level, place system into operation to lower water levels as required and then operate it continuously 24 hour a day, 7 days a week until water mains, sewers and structures have been constructed, including placement of fill materials, and until dewatering is no longer needed.
- D. Contractor shall dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of the work under construction or completed, including work being performed by adjacent project(s). Dispose of water in a manner to avoid inconvenience to others engaged on the site, including work being performed by adjacent project(s). Provide sumps, sedimentation tanks, and other flow control devices as necessary. Effluent water from dewatering methods shall be sediment free or be discharged through a sediment entrapment basin approved by the contracting officer.
- E. Contractor shall provide standby equipment on site, installed and available, for immediate operation if required to maintain dewatering on a continuous basis in event any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to

inadequacy or failure of dewatering system, perform work as may be required to restore damaged structures and foundations soils at no additional expense.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
 - 1. Space well points or wells at intervals required to provide sufficient dewatering.
 - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
 - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

3.4 FIELD QUALITY CONTROL

- A. Survey Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

END OF SECTION 31 23 19

SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Hot-mix asphalt paving.
- B. Related Requirements:
 - 1. Section 31 20 00 Earth Moving for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each paving material.
- B. Bituminous Mix Design: Provide mix design documentation that shall include, at a minimum, the asphalt content, compacted mixture specific gravity theoretical maximum specific gravity, air voids, voids filled with asphalt (VFA), voids mineral aggregate (VMA), mix proportions, stability, flow, aggregate gradation, crush content, and job mix formula. Mix design shall be provided a minimum 72 hours prior to placement to allow time for review and approval.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the Michigan Department of Transportation (MDOT).
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the Michigan Department of Transportation (MDOT) for asphalt paving work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 SITE CONDITIONS

- A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50 degrees F (10 degrees C), and when temperature has not been below 35 degrees F (1 degree C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excessive amount of moisture.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- B. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320, PG 64-22 for Base and intermediate course and PG 70-22 for surface course.
- B. Tack Coat: ASTM D 977 Type AE-T, AE-PMT, SS1h.

2.3 MIXES

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes meeting MDOT specifications and complying with the following requirements:
 - 1. Base Course: MDOT 13A.
 - 2. Surface Course: MDOT 36A.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.03 to 0.08 gal/sq yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.2 PLACING HOT-MIX ASPHALT

- A. Spread mix at a minimum temperature of 300 +/- 9 deg F for dense graded mixtures and 260 +/- 9 deg F for open graded mixtures. Asphalt material shall not be applied on a wet surface, when the ambient temperature is below 50 deg F, or when other unsuitable conditions exist.
- B. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- C. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

- D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.3 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.4 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch.

2. Surface Course: Plus 1/4 inch, no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
1. Base Course: 1/4 inch.
 2. Surface Course: 1/8 inch.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Replace and compact hot-mix asphalt where core tests were taken.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes Concrete Paving, including the following:
 - 1. Driveways.
 - 2. Roadways.
 - 3. Parking lots.
 - 4. Curbs and gutters.
 - 5. Walks.
- B. Related Requirements:
 - 1. Section 31 20 00 Earth Moving for subbase preparation.
 - 2. Section 03 30 53 Miscellaneous Cast-in-Place Concrete for general building applications of concrete.

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Includes concrete, joint filler, curing compound and detectable warning devices.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified installer of stamped or embedded detectable warnings.

1.5 QUALITY ASSURANCE

- A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Comply with Michigan Department of Transportation (MDOT) Standard Specifications for Construction, most recent edition.

1.6 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.
- B. Michigan Department of Transportation (MDOT): Materials for form, steel reinforcement, joint materials, and curing materials shall comply with current MDOT Specifications, if not specified in this section or in Section 03 30 00 Cast-In-Place Concrete.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.
 - 2. Check completed formwork for grade and alignment to the following tolerances:
 - i. Top of forms not more than 1/8 inch in 10 feet.
 - ii. Vertical face on longitudinal axis, not more than 1/4 inch in 10 feet.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.
- C. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
- D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.
- F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.
- G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 deformed bars; assembled with clips.
- H. Plain-Steel Wire: ASTM A 1064/A 1064M, as drawn.
- I. Deformed-Steel Wire: ASTM A 1064/A 1064M.
- J. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- K. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 plain-steel bars.
- L. Tie Bars: ASTM A 615/A 615M, Grade 60; deformed.
- M. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- N. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- O. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- P. Zinc Repair Material: ASTM A 780/A 780M.

2.4 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150/C 150M, portland cement Type I.
 - 2. Fly Ash: ASTM C 618, Class F.
 - 3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, uniformly graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
 - 1. Aggregate Sizes: 3/4 to 1 inch nominal.
- D. Air-Entraining Admixture: ASTM C 260/C 260M.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- F. Water: Potable and complying with ASTM C 94/C 94M.

2.5 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches long.

2.6 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz/sq yd dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.7 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements.
- E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.
- F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of Portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
- G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

2.8 DETECTABLE WARNING MATERIALS

- A. Embedded Detectable Warning:
 - 1. Rigid, cast-in-place embedded detectable warnings with the ability to replace the surface are to be used. Furnished by Access Tile or approval equal.
- B. Stamped Detectable Warning: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
 - 1. Detectable Warning Stamp to meet current MDOT standards.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 and MDOT Specifications for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in MDOT Specifications.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- F. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.
- G. Screed paving surface with a straightedge and strike off.
- H. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- I. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- J. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.5 DETECTABLE WARNING INSTALLATION

- A. Embedded Detectable Warnings: Install embedded detectable warning plaques during the concrete placement and finishing stages and according to manufacturer's written instructions.
- B. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
 - 1. Before using stamp mats, verify that the vent holes are unobstructed.
 - 2. Apply liquid release agent to the concrete surface and the stamp mat.
 - 3. Stamping: After application and final floating of pigmented mineral dry-shake hardener, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
 - 4. Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.
 - 5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint

patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.6 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection and MDOT specifications.

3.7 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and MDOT specifications.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing to meet requirements of MDOT Specifications.

3.9 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.
- B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 92 00 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Hydroseeding.
 - 3. Sodding.
 - 4. Erosion-control material(s).

1.2 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.3 INFORMATIONAL SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- B. Product Certificates: For fertilizers, from manufacturer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Pesticide Applicator: State licensed, commercial.
 - 3. Seeding, Mulching, Sodding and Weed Control shall comply with Michigan Department of Transportation (MDOT), most recent edition.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.6 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances and MDOT Specifications for Turf Establishment.
- B. Seed Species:
 - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
 - 2. For shoulders, slope area, or flat field: MDOT roadside mixture.
 - 3. For flat lawn area, MDOT Class A mixture.

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Sodding to comply with MDOT specifications for Turf Establishment.

2.3 MULCHES

- A. Mulches to comply with MDOT specifications for Turf Establishment.

2.4 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by the Authority.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.
- C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 4-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to MDOT Specifications.
- B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.
 - 1. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Authority's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion-control mat with planting soil and compact before planting.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

- B. Sow seed at a total rate per MDOT specifications.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal/1,000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.
- G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

3.6 HYDROSEEDING

- A. Hydroseeding shall comply with MDOT Specifications.

3.7 SODDING

- A. Sodding shall comply with MDOT Specifications

3.8 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches, if required by Authority.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

3.9 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Engineer:
 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with the Authority's operations and others in proximity to the Work. Notify MHOG before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 33 05 00 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping joining materials.
 - 2. Sleeves.
 - 3. Identification devices.
 - 4. Grout.
 - 5. Piping system common requirements.
 - 6. Equipment installation common requirements.
 - 7. Concrete bases.
 - 8. Metal supports and anchorages.

1.2 QUALITY ASSURANCE

- A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

- A. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.2 SLEEVES

- A. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

- D. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.3 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Install piping according to the following requirements and utilities Sections specifying piping systems.
- B. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- C. Install piping at indicated slopes.
- D. Install piping free of sags and bends.
- E. Install fittings for changes in direction and branch connections.
- F. Select system components with pressure rating equal to or greater than system operating pressure.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- F. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- G. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
- H. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
- I. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End PE Pipe and Fittings: Use butt fusion.
 - 2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
- M. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.4 GROUTING

- A. Clean surfaces that will come into contact with grout.
- B. Provide forms as required for placement of grout.
- C. Avoid air entrapment during placement of grout.
- D. Place grout, completely filling equipment bases.
- E. Place grout on concrete bases and provide smooth bearing surface for equipment.
- F. Place grout around anchors.
- G. Cure placed grout.

END OF SECTION 33 05 00

SECTION 33 05 23 – TRENCHLESS UTILITY INSTALLATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Providing casing pipes in the locations shown and according to details shown on Drawings.
- B. Products Installed but not Furnished under this Section:
 - 1. The carrier pipe shall be as specified under:
 - a. Section 22 11 13 Water Distribution Piping
 - b. Section 22 13 13 Sanitary Sewers

1.2 REFERENCES

- A. Reference Standards:
 - 1. AASTHO:
 - a. M167 Bituminous Coating.
 - b. M190 Bituminous Coating.
 - 2. American Railway Engineering (AREA):
 - a. Part 5, Pipelines.
 - 3. ASTM:
 - a. A 53, Grade B Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - b. A 106 Seamless Carbon Steel Pipe for High-Temperature Service.
 - c. A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. A 449 Quenched and Tempered Steel Bolts and Studs.
 - e. A 569 Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality.
 - f. C 76 Reinforced Concrete Sewer Pipe.
 - 4. Michigan Department of Transportation:
 - a. MDOT 8.08.03 Reinforcing Steel.

1.3 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01 33 00 Submittals, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. CONTRACTOR shall submit complete plans and details of the boring installation, including:
 - a. Arrangement of cutter head.
 - b. Location and size of jacking and receiving pits.
 - c. Shoring/Sheeting of jacking and receiving pits.
 - d. Method of grouting.

1.4 SCHEDULING

- A. CONTRACTOR shall notify MHOG at least 5 working days before beginning Work under this Section.

- B. CONTRACTOR shall notify the Livingston County Road Commission 5 days prior to beginning Work under this Section.
- C. CONTRACTOR shall notify ENGINEER 4 working days prior to beginning on any railway property. ENGINEER will notify Railroad on behalf of OWNER.

1.5 PROJECT CONDITIONS

- A. Safety Requirements: All operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of roadways, or damage, destroy, or endanger the integrity of roadway.
- B. At all times when Work is being progressed, a field supervisor for Work with no less than 12 months experience in the operation of the equipment being used shall be present. If boring equipment or similar machines are being used, the machine operator also shall have no less than 12 months experience in the operation of the equipment being used.

PART 2 - PRODUCTS

2.1 STEEL PIPE FOR USE UNDER ROADWAYS

- A. Steel pipe shall meet the requirements of MDOT. Pipe shall be ASTM A 53, Type E or S, Grade B, or ASTM A 160, Grade B or C, with a minimum yield strength of 35,000 psi.
- B. Steel pipe casing shall be smooth steel pipe fabricated in sections in accordance with AWWA C201. Lengths shall be as long as practical for site conditions.
- C. Joints shall conform to the requirements of AWWA C206. Joints between sections shall be completely welded to the preceding sections. Prior to welding joints, the Contractor shall ensure that both ends of the casing sections being welded are square.
- D. The ends of the steel pipe to be jacked shall be prepared for field welding at joints.
- E. The nominal outside diameter and wall thickness, in inches, for steel pipe shall be as shown below.

<u>Nominal Size</u>	<u>Wall Thickness</u>
12	0.188
14	0.250
16	0.250
18	0.250
20	0.250
24	0.250
30	0.312
36	0.312
42	0.438
48	0.500
54	0.563

2.2 STEEL PIPE FOR USE UNDER RAILROAD TRACKS

- A. Steel pipe shall meet the requirements of The American Railway Engineering Association. Pipe shall be ASTM A 53, Type E or S, Grade B, or ASTM A 160, Grade B or C, with a minimum yield strength of 35,000 psi.
- B. Minimal wall thickness for steel casing pipe based on a Cooper E80 shall be as shown below (in inches).

<u>Nominal Size</u>	<u>Wall Thickness</u>
12	0.188
14	0.250
16	0.281
18	0.312
20	0.344
24	0.407
30	0.469
36	0.531
42	0.625
48	0.688
54	0.781

2.3 CONCRETE PIPE

- A. Concrete jacking pipe shall be reinforced concrete pipe meeting the requirements of AASHTO M 170M, Class IV pipe, as specified in MDOT Standard Specifications 909.04.
- B. Joints in reinforced concrete pipe used for jacking shall be tongue and groove, jointed with cold mastic and inside tuck-pointing.
- C. A cushioning material, similar to Celotex or hardboard, shall be placed in the joint shoulder between pipe sections to uniformly distribute the jacking pressures.
- D. After the jacking operation is complete, the joints in pipe 36 inches and larger shall be pointed on the inside by removing any existing materials to a depth of 1/2-inch and cementing this space by pointing with cement mortar composed of 1 part cement and 2 parts sand.

2.4 CARRIER PIPE SUPPORT

- A. Casing spacers are required for all carrier pipes. Casing spacers shall be plastic, fiberglass, stainless steel or carbon steel.
- B. Provide steel assemblies fabricated of steel beams, angles, and small-diameter pipe to guide and support large carrier pipe at required grade.
- C. Provide casing pipe spacers equivalent to INs manufactured by or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. CONTRACTOR shall excavate and dispose of material of any nature required to carry out Work. All tunnel and shaft excavation shall be performed in accordance with any paragraphs under Division 2 which may apply. All excavated material, except that needed for backfill, shall be promptly removed and disposed of.
- B. Drainage: CONTRACTOR shall provide and maintain all facilities for collecting, conveying, and disposing of water in tunnels and shafts until the completion of Work as required in Section 31 23 19 Dewatering. CONTRACTOR shall have on hand at all times sufficient machinery for all emergencies that are likely to arise on Work of this character, and such machinery shall be kept in good working order. The pumping and power supply to the pumps shall be under the direct charge of competent mechanics, constantly attended on a 24-hour basis.
- C. Effective and continuous control of water during the placing of concrete shall be required. CONTRACTOR shall maintain the groundwater table to a level 2 feet below the casing invert during construction.
- D. Protection of Drainage Facilities: If, in the course of construction, it may be necessary to block a ditch, pipe or other drainage facility, temporary pipes, ditches or other drainage facilities shall be installed to maintain adequate drainage, as approved by the owner of the facility being crossed. Upon completion of Work, the temporary facilities shall be removed and the permanent facilities restored.
- E. Power and Lighting: All power machinery and tools used shall be operated by electricity or compressed air. No electric voltage in excess of 440 volts will be permitted. Transformers, if used, shall be mounted on platforms or in an approved enclosure. The use of gasoline in power is prohibited.
 - 1. All machinery and equipment used in tunnel headings or shafts under gaseous conditions shall bear the approval plate of the United States Bureau of Mines.
 - 2. Work shall be lighted with electricity at the expense of CONTRACTOR. A sufficient number of lights shall be provided to illuminate properly all parts of Work. All lighting circuits shall be thoroughly insulated and kept separate from power circuits. In gaseous conditions, all lamps shall be mounted in protected gas- and vapor-proof fixtures.

3.2 INSTALLATION

- A. Casing pipe is to extend a minimum of 10 feet from the back of curb or edge of pavement when jacking under roadways unless otherwise noted by jurisdictional authority.
- B. Ventilation: CONTRACTOR shall keep the tunnel air in a condition suitable for the health of the workers and clear enough for the surveying operations. Provisions shall be made for quick removal of gases. Whenever a 24-hour tunneling operation exists, CONTRACTOR shall have attainable, within 1 hour's time, any spare piece of equipment or material vital to the tunnel operation.
- C. Jacking and Boring Pipe: Jacking and receiving pits shall be completely sheeted to provide proper support for the banks and adequate support for reaction blocks. Jacking shaft shall be constructed long enough to provide room for jacking head frame, reaction blocks and two sections of pipe. The

width shall be sufficient to allow ample working room. The backstops or reaction blocks shall be placed absolutely perpendicular in all directions to axis of the pipe and the guide timbers carefully installed to the proper line and grade.

1. Prior to jacking the pipe out of the shaft, the outside surface may be coated with bentonite or other suitable lubricant. Bentonite, or other suitable lubricant, may be applied at the front face of the lead pipe simultaneously with the jacking operation. A lubricant sill plank may be required in the heading to maintain vertical alignment.
 2. The front of the pipe shall be provided with mechanical arrangements or devices that will positively prevent the auger from leading the pipe so that there will be no unsupported excavation ahead of the pipe.
 3. The auger and cutting head arrangement shall be removable from within the pipe in the event an obstruction is encountered. If the obstruction cannot be removed without excavation in advance of the pipe, the casing pipe shall be filled with grout and abandoned unless otherwise directed by ENGINEER.
 4. Jacking pressure must be applied by a pushing frame at right angles to the line to avoid breaking the pipe or forcing it out of alignment. A positive stop boring arrangement to prevent excavation ahead of the pipe shall be provided. Excavation ahead of the pipe shall not be permitted.
 5. When excavating, voids outside the pipe and disturbances of the surrounding material shall not exceed 1/2 inch. Excessive voids shall be filled immediately with sand or other suitable material and thoroughly compacted.
 6. The jacking operating shall be continuous insofar as possible to prevent seizure of the pipe. However, if the operation is discontinued for any time, the excavation shall be safely supported with wood bulkhead and adequate blocking.
- D. Grouting Casing Pipe: All voids around the outside of the jacked pipe shall be filled by means of pressure grouting with approved material as specified in MDOT Standard Specification 702. Grouting shall be completed within 48 hours of completing the bore.
1. Where voids are suspected, a sufficient number of grout holes shall be provided in the casing pipe to ensure complete grouting of the space between the casing and the surrounding soil. Grouting pressure shall be sufficiently high to fill all voids.
 2. Following satisfactory pipe grouting operations, the grout pipe shall be removed from the grout hole after the grout has taken its initial set. The space occupied by the grout pipe shall be completely filled with stiff mortar and troweled smooth at the inner face or a threaded plug installed.
- E. Grouting Tunnel under Plates: Grouting shall start at the lowest hole in each grout panel and proceed upwards simultaneously on both sides. A threaded plug shall be installed in each grout hole as the grouting is completed at that hole. Grouting shall be kept as close to the headings as possible, using grout stops behind the liner plates as necessary. Grouting shall proceed as directed by ENGINEER, but in no event shall more than six lineal feet of tunnel be progressed beyond the grouting.
1. Grouting pressure shall be sufficiently high to fill all voids. Necessary grouting holes shall be installed as required to ensure complete filling of void spaces. A grout pipe with a control valve attached to the grout hole shall be inserted and securely caulked to the grout hole with a half coupling welded to the casing pipe. Grout shall consist of a mixture of Portland cement thoroughly mixed with mortar sand, with sufficient water to permit steady flow through the grout pipes. The mix shall be 2 parts of sand to 1 part of cement. If necessary to speed up setting of grout, approved admixtures of quick-setting cement shall be used as directed by ENGINEER.

2. Following satisfactory pipe grouting operations, the grout pipe shall be removed from the grout hole after the grout has taken its initial set. The space occupied by the grout pipe shall be pitted with a threaded plug.

3.3 CARRIER PIPE INSTALLATION

- A. Carrier pipes shall be installed as specified under:
 1. Section 22 11 13 Water Distribution Piping
 2. Section 22 13 13 Sanitary Sewers
- B. Pipe shall be the type and class as shown on Drawings. Joint restraint, where required, shall be provided.
- C. Pipe Placed in Casings: Under this Section, CONTRACTOR shall install tracer wire per 22 11 13, place the carrier pipe, fill the annular space between the casing and carrier pipe with flowable grout fill, place bulkheads, and complete all backfilling. All necessary skidding materials required to protect the carrier pipe shall be provided.
- D. Carrier Pipe Support: Place pipe spacers, wood skids, or steel frames so as to prevent contact between carrier and casing pipe and to guide carrier pipe, without damage, into the casing pipe to its required grade. Place pipe spacers or wood skids within 12 inches of casing pipe ends, at each carrier pipe joint, and at intervals to prevent pipe deflection. Maximum distance between supports shall be 7 feet. If grout is to be used to fill annular space between carrier and casing pipes, place support at top of carrier pipe to prevent flotation.
- E. Casing Pipe under State (MDOT) or County Roads: All void spaces between the casing pipe and carrier pipe shall be filled with flowable grout fill. CONTRACTOR shall furnish grout fill holes as required to ensure complete filling of all void spaces. Grout pressure shall be controlled to prevent damage to the carrier pipe in accordance with AWWA C600 and shall not exceed 100 psi.
- F. Casing Pipe under Railroads: The void space shall be filled to the springline of the carrier pipe with flowable grout fill as specified above.
- G. Sealing Casing Pipe Ends:
 1. Casing ends seals shall be synthetic neoprene rubber pull-on type end seals with stainless steel bands, as manufactured by Pipeline Seal and Insulator, Inc., or approved equal.
 2. The annular space at ends of casing pipe shall be bulkheaded with a minimum 12-inch-thick solid masonry with a 1-inch fiberboard cushion between the masonry and carrier pipe.

3.4 FIELD QUALITY CONTROL

- A. CONTRACTOR shall provide all survey equipment and personnel necessary to maintain the casing or tunnel on correct alignment and grade during construction. ENGINEER shall provide reference points for use by CONTRACTOR.

END OF SECTION 33 05 23

SECTION 33 05 23.13 – UTILITY HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Specifications for installation of pipelines by horizontal directional drilling where called for on Drawings or chosen by CONTRACTOR.
 - 1. Work shall include piping connections to existing piping or to pipes installed by other methods.
 - a. For potable water mains, Work shall include pressure testing, cleaning and disinfection as required in Section 22 11 13 Water Distribution Piping.
 - b. For pumping mains, Work shall include all testing as required in Section 22 13 13 Sanitary Sewers.
- B. Products Installed But Not Supplied Under This Section:
 - 1. Unless otherwise noted on Drawings, or stated in this Section, all piping shall be furnished under the below sections and installed under this section.
 - 1) Section 22 11 13 Water Distribution Piping
 - 2) Section 22 13 13 Sanitary Sewers
 - 2. All necessary joint and coupling materials, including bolts, nuts, gaskets, wall castings or sleeves, supports, anchors, blocking harnesses and other necessary closure pipe sections, and standard or special fittings shall be furnished under the Specification for the piping type.
 - 1) Section 22 11 13 Water Distribution Piping
 - 2) Section 22 13 13 Sanitary Sewers
 - 3) Section 33 05 00 Common Works

1.2 SCHEDULING

- A. CONTRACTOR shall notify MHOG at least 5 working days before beginning Work under this Section.
- B. CONTRACTOR shall notify the Livingston County Road Commission 5 days prior to beginning Work under this Section when working on County Roadways.

1.3 PROJECT CONDITIONS

- A. Safety Requirements: All operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of roadways, or damage, destroy, or endanger the integrity of roadway.
- B. At all times when Work is being progressed, a field supervisor for Work with no less than 12 months experience in the operation of the equipment being used shall be present. The machine operator also shall have no less than 12 months experience in the operation of the equipment being used.

1.4 ACTION SUBMITTALS

- A. Pipe Logs: The requirements for the necessary pipe location logs are found in detail under Field Quality Control. Submit a written report to ENGINEER documenting location and depth of pipe.
 - 1. Submit logs and summary of stresses on pipe during installation

- B. Equipment Data: Furnish data on tracking systems that will be used. Data shall include depth and accuracy capabilities of equipment.
- C. Drilling Fluids: Submit manufacturer's data.
- D. Pipe Design: Submit design calculations.
- E. Pipe: Submit the proposed pipe material including method to be used for joining the pipe segments.

1.5 REFERENCES

- A. Reference Standards:
 - 1. Driscopipe, Inc., "Technical Note #41," dated September 1993, may be used as a guideline for HDPE pipe design.

PART 2 - PRODUCTS

2.1 DRILLING FLUID

- A. Drilling fluid shall be bentonite clay mixture. CONTRACTOR may use a polymer additive at CONTRACTOR's option.

2.2 PIPE

- A. Pipe shall be DIP or HDPE as specified in Section 22 11 13 Water Distribution Piping and Section 22 13 13 Sanitary Sewers.
 - 1. Ductile iron pipe shall be pressure class 350 or greater with joints designed specifically for directionally drilling applications.
 - 2. HDPE pipe shall be provided to meet the design system pressures, match ductile iron pipe size, and be sized to provide an equal or greater than flow capacity.
- B. CONTRACTOR shall determine the pipe SDR required based on the proposed installation procedures, and the following analysis:
 - 1. Tensile pull load: (Based on pipe weight, pipe friction on the ground, pipe friction in the bore hole, flotation loads, and submersion load; tensile load shall be calculated for a minimum of three conditions: When the pipe enters the borehole, midway through insertion, and as the pipe leaves the ream hole.) Limit tensile stress to 1,600 psi.
 - 2. Bending stress on pipe sidewalls during installation.
 - 3. Net longitudinal compressive stress, based on bending stresses.
 - 4. Total longitudinal axial stress from sustained loads.
 - 5. External differential pressure collapse/buckling resistance.
 - 6. Earth load on pipe following installation at maximum depth.
- C. Summarize results in a tabular format including values used for pipe physical properties.
- D. Include sketches to show critical installation dimensions.

- E. The SDR used shall be the lower of that specified by ENGINEER in 22 11 13 Water Distribution Piping and Section 22 13 13 Sanitary Sewers, or that required by the above analysis.
- F. DIP pipe shall be manufactured by US Pipe with TR Flex joints, Clow with Super-Lock joints, or approved equal.
- G. HDPE pipe shall be manufactured from high density PE 3408 polyethylene resin, having a dimension ratio (DR) of 11 or less. The DR is calculated as the outside diameter of the pipe divided by the minimum wall thickness.

2.3 UTILITY MARKERS

- A. Tracer wire is to be installed on all water main distribution lines and sanitary sewer pumping mains.
 - 1. For directional bores tracer wire shall be:
 - a. Directionally Drilled tracer wire to be Copperhead 'Soloshot' Extra High Strength Directional Drill Wire 1150# Break Load or equal.
 - 2. For conventional open cut construction tracer wire shall be:
 - a. Direct bury tracer wire to be Copperhead 10 CCS High Strength 600# Break Load or equal.
 - 3. Tracer wire shall be installed in a continuous fashion. Install tracer wire on top of pressure process piping and secure to main every five (5) feet with tape.
 - 4. The wire shall be brought to the surface at bore pits, valves, fittings or manholes through utility markers or tracer wire terminal boxes which may serve as access points. Tracer wire shall be brought to the surface at least every five hundred (500) feet unless noted by the OWNER. Care should be taken not to damage the wire coating. If wire coating is damaged, the CONTRACTOR shall repair the damaged coating with electrical tape.
 - 5. Tracer wire shall terminate in boxes when at paved surfaces. Copperhead brand boxes shall be used. Model RB14*TP shall be used in asphalt installations and model CD14*TP shall be used for all other installations.
 - 6. Tracer wire systems in rural areas shall terminate in Rhino Triview Tracing wire stations. Terminals shall be external and colored green for sanitary sewer systems and blue for water distribution systems. Terminals should be located at least every one thousand (1,000) feet or as shown on the drawings.
 - 7. CONTRACTOR shall test the locator system for continuity upon completed installation. Should tracer wires fail to test for continuity then the test shall be considered a failure.
 - 8. Failure of the tracer wire shall result in the installation of utility markers at no additional cost to OWNER.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

- A. CONTRACTOR shall examine the site(s) indicated. The limits of surface excavation are shown on Drawings. CONTRACTOR shall be responsible for locating the borehole and receiving hole sufficiently back from the limits of excavation to allow connection to the horizontally drilled pipe.

3.2 PROTECTION

- A. Provide all required sediment and erosion control measurements to prevent drilling fluid or borehole cuttings from entering the wetlands areas or surface waters.

3.3 INSTALLATION

- A. Pilot hole shall establish the horizontal plane of the pipeline. A plot of length versus elevation versus left/right variance will dictate the actual as-built plan and profile of the pipeline. Data feedback and electronic guidance systems are supplemental surface tracking systems and shall be used to provide confirmation of position.
 - 1. Minimum depths are indicated on Drawings. Pipe may be installed at greater depths to facilitate the installation if the proposed greater depth is reviewed and approved by ENGINEER before installation.
- B. Reaming shall consist of using an appropriate tool to open the pilot hole to a slightly larger diameter than the carrier pipeline. The percentage over size shall depend on soil types, soil stabilities, depth, drilling fluid hydrostatic pressure, etc. Normal over sizing shall be from 120 to 150 percent of the carrier pipe diameter. Drilling fluid shall be forced down the hole to stabilize the hole and to remove soil cuttings.
- C. Pull back the entire pipeline length in one segment back through the drilling fluid along the reamed hole pathway. Proper pipe handling, cradling, bending minimization, surface force readings, constant insertion velocity, drilling fluid flow circulation/exit rate, and footage length installed shall be recorded. The pull-back speed shall be within the pipe manufacturer's recommendations.
- D. The as-built Drawings are finalized based on the final course followed by the reamer and the installed pipeline. The gravity forces may have caused the reamer to go slightly deeper than the pilot hole and the buoyant pipe may be resting on the crown of the reamed hole.
 - 1. Any bits, drills, reamers, or other tools lost or stuck in the hole shall be removed at CONTRACTOR's expense. If tools cannot be readily removed, CONTRACTOR may at CONTRACTOR's option abandon the hole. No payment shall be made for any lost equipment, material, or work on abandoned holes.
- E. Allowable Tolerances in Pipe Grade: A variation greater than 6 inches from the horizontal plan or designated grade is sufficient reason for rejection of the pipe, and pipe shall be re-bored to proper grade if so directed by ENGINEER at no cost to OWNER.
- F. Drilling Fluid: Drilling fluid to be used to facilitate installation of the pipe shall be adjusted within acceptable limits such that ground heaving and subsurface cavity formation through erosion are prevented.

3.4 CLEAN UP AND RESTORATION

- A. Spent drilling fluid and cuttings shall be confined to vicinity of drilling rig.
 - 1. Any drilling fluid which enters the pipe shall be removed by flushing or other suitable means.
 - 2. CONTRACTOR shall be responsible for clean up and restoration should the bore hole blow out due to excessive pressure in the drilling fluid. No additional payment shall be made for clean up costs required by OWNER, ENGINEER, or regulatory agencies due to a loss of drilling fluid. This includes all requirements of any MDEQ required frac-out plan.

- B. Restoration: Pits excavated to permit connection of bored pipe shall be backfilled, and disturbed surface shall be restored as described in the Township Standards.

3.5 FIELD QUALITY CONTROL

- A. Pipe Logs: Logs shall be kept giving the horizontal and vertical position of the transmission main or force main at 25-foot intervals along the pipe points to confirm its conformance to specified depth and line and grade shown on Drawings. No payment for any length pipe shall be made without a log accompanying it.

END OF SECTION 33 05 23.13

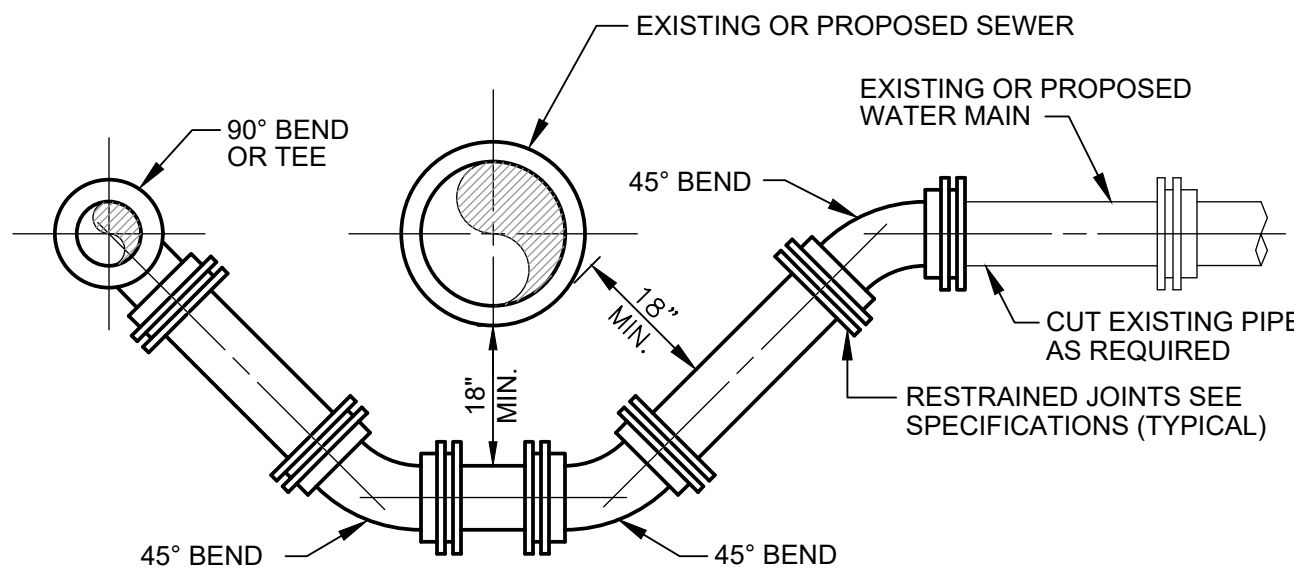
PART III – STANDARD DETAILS

PIPE RESTRAINT SCHEDULE

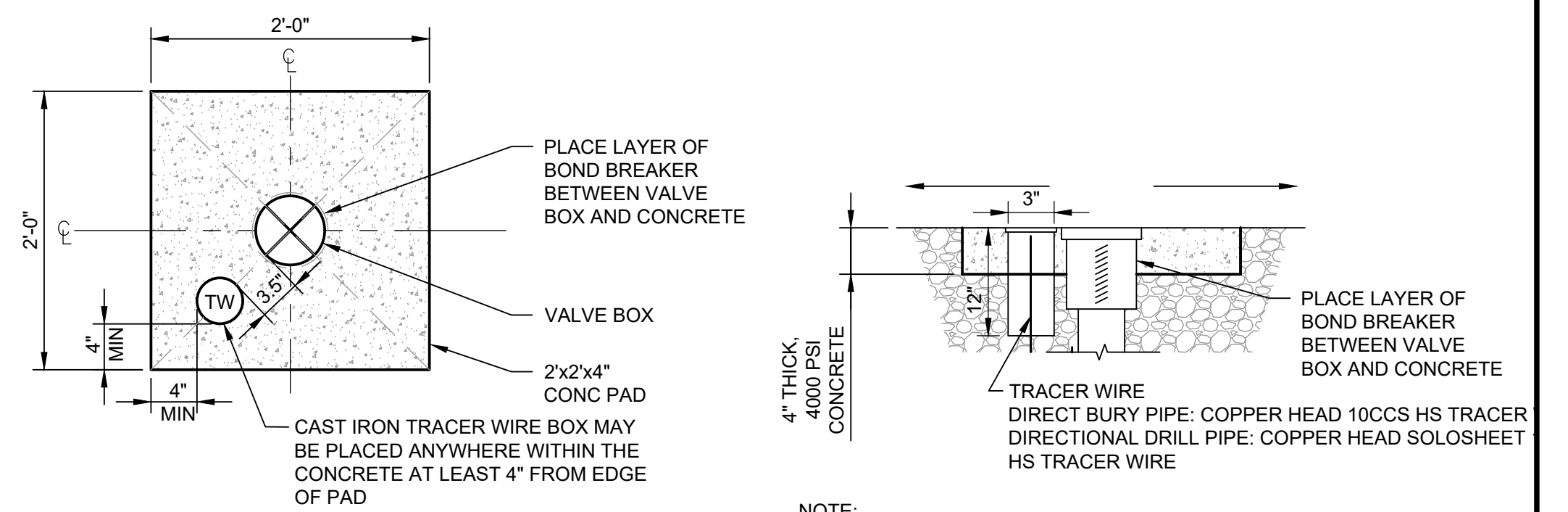
GROUND BURIED PRESSURE PIPE - POLYETHYLENE ENCASED DUCTILE IRON PIPE

PIPE DIAMETER	TEES, 90° BENDS	45° BENDS	22-1/2° BENDS	11-1/4° BENDS	DEAD ENDS	REDUCERS (ONE SIZE REDUCTION)*	REDUCERS (TWO SIZE REDUCTION)*
4	13	5	3	1	40	--	--
6	19	8	4	2	58	31	--
8	24	10	5	2	75	30	70
12	34	14	7	3	107	57	116
16	43	18	9	4	139	59	137
20	52	22	10	5	169	59	134
24	61	25	12	6	199	60	132
30	73	30	15	7	242	85	168
36	84	35	17	8	281	84	168

- LENGTHS OF PIPE RESTRAINT ARE GIVEN IN FEET.
 - IF REQUIRED PIPE DIAMETER IS NOT LISTED IN THIS TABLE, THE NEXT LARGEST PIPE DIAMETER SHALL BE USED.
 - THIS TABLE IS BASED ON A TEST PRESSURE OF 180 PSI (OPERATING PRESSURE PLUS WATER HAMMER. FOR OTHER TEST PRESSURES, ALL VALUES TO BE INCREASED OR DECREASED PROPORTIONALLY.
 - THE VALUES PROVIDED OF RESTRAINT LENGTH ARE IN EACH DIRECTION FROM THE POINT OF DEFLECTION OR TERMINATION EXCEPT FOR TEES, AT WHICH ONLY THE BRANCH IN THE DIRECTION OF THE STEM.
 - IF THE RODS ARE USED, USE FOUR RODS MINIMUM AND ADD 1/8-INCH TO BAR DIAMETER AS CORROSION ALLOWANCE.
- * SIZE REDUCTION IS BASED UPON THE PIPE DIAMETER SHOWN IN THIS TABLE.
- BASED UPON: INTERNAL PRESSURE: 180
PIPE DEPTH: 5
BEDDING CLASS: TYPE 4
SOIL TYPE: GOOD SAND
SAFETY FACTOR: 2



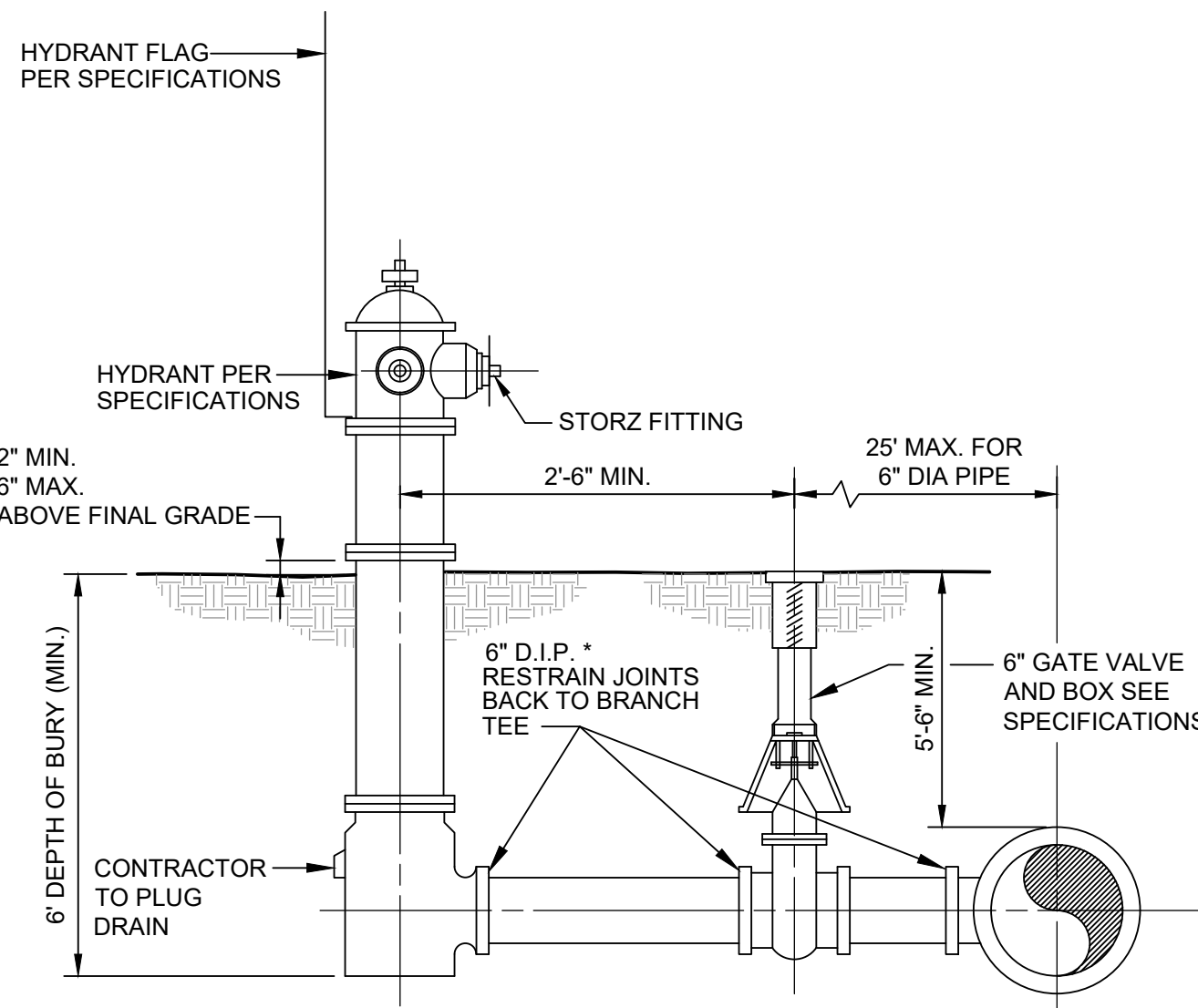
WATER MAIN UTILITY OFFSET



NOTE: ALL BOXES & ADJOINING TW BOXES SHALL BE ENCASED IN A CONC. PAD UNLESS OTHERWISE DETERMINED BY MHOG.

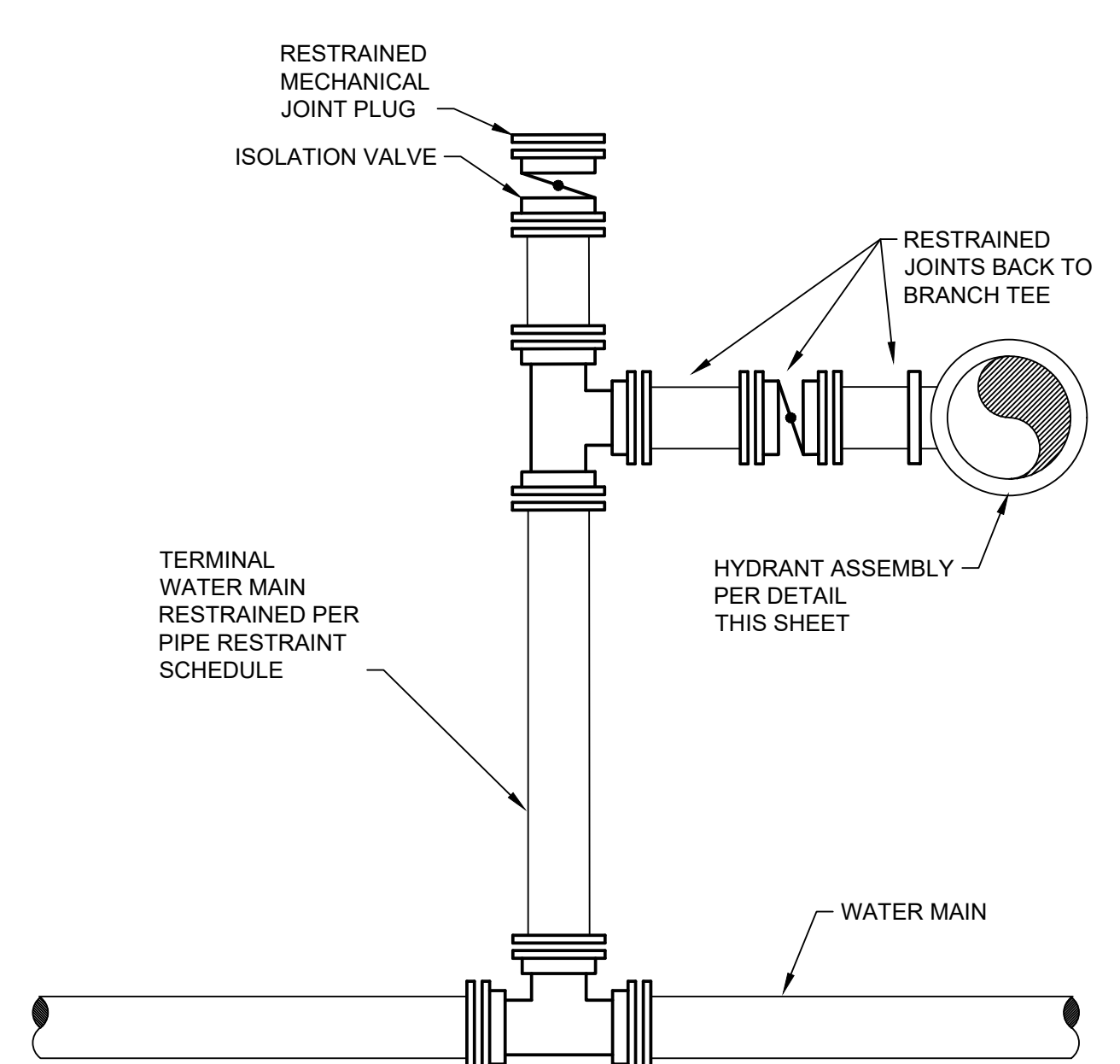
PLAN
VALVE/TRACER WIRE BOX IN CONCRETE DETAIL
NO SCALE

- SECTION**
- TRACER WIRE BOXES LOCATED WITHOUT A VALVE BOX ONLY REQUIRE AN 18" X 18" CONCRETE PAD.
 - TRACER WIRE BOX SHALL HAVE A LOCKING LID W/STANDARD AWWA PENTAGON KEY.
 - TRACER WIRE BOX SHALL BE COPPERHEAD RB14"TP IN ASPHALT INSTALLATIONS AND CD14"TP FOR ALL OTHER INSTALLATIONS.

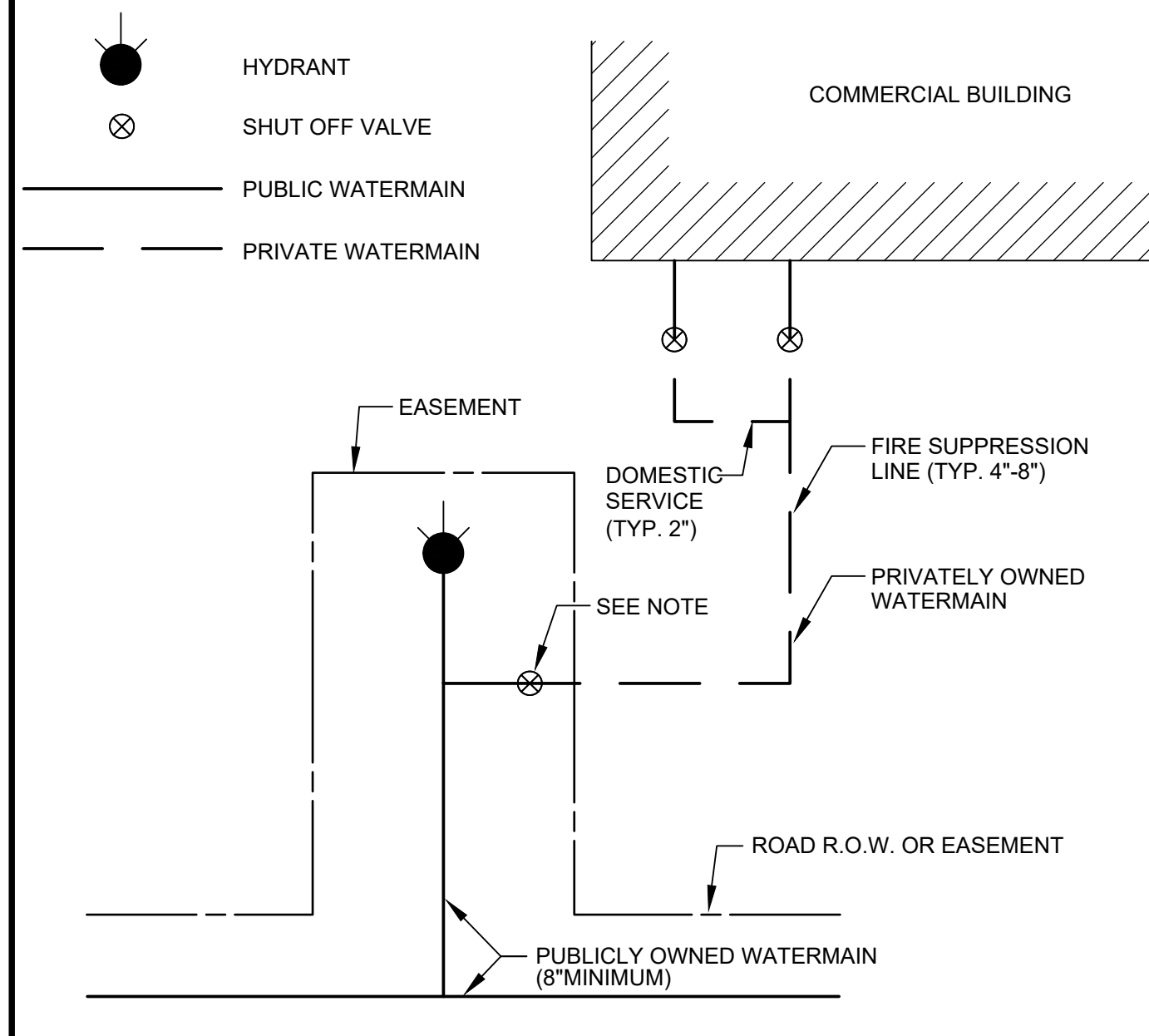


* THE LENGTH OF 6" PIPE FROM THE MAIN TO THE HYDRANT ASSEMBLY CANNOT EXCEED 25'. ANY PIPE OVER 25 FEET SHALL BE 8" DIAMETER MINIMUM AND DESIGNED PER MHOG SPECIFICATIONS.

FIRE HYDRANT ASSEMBLY

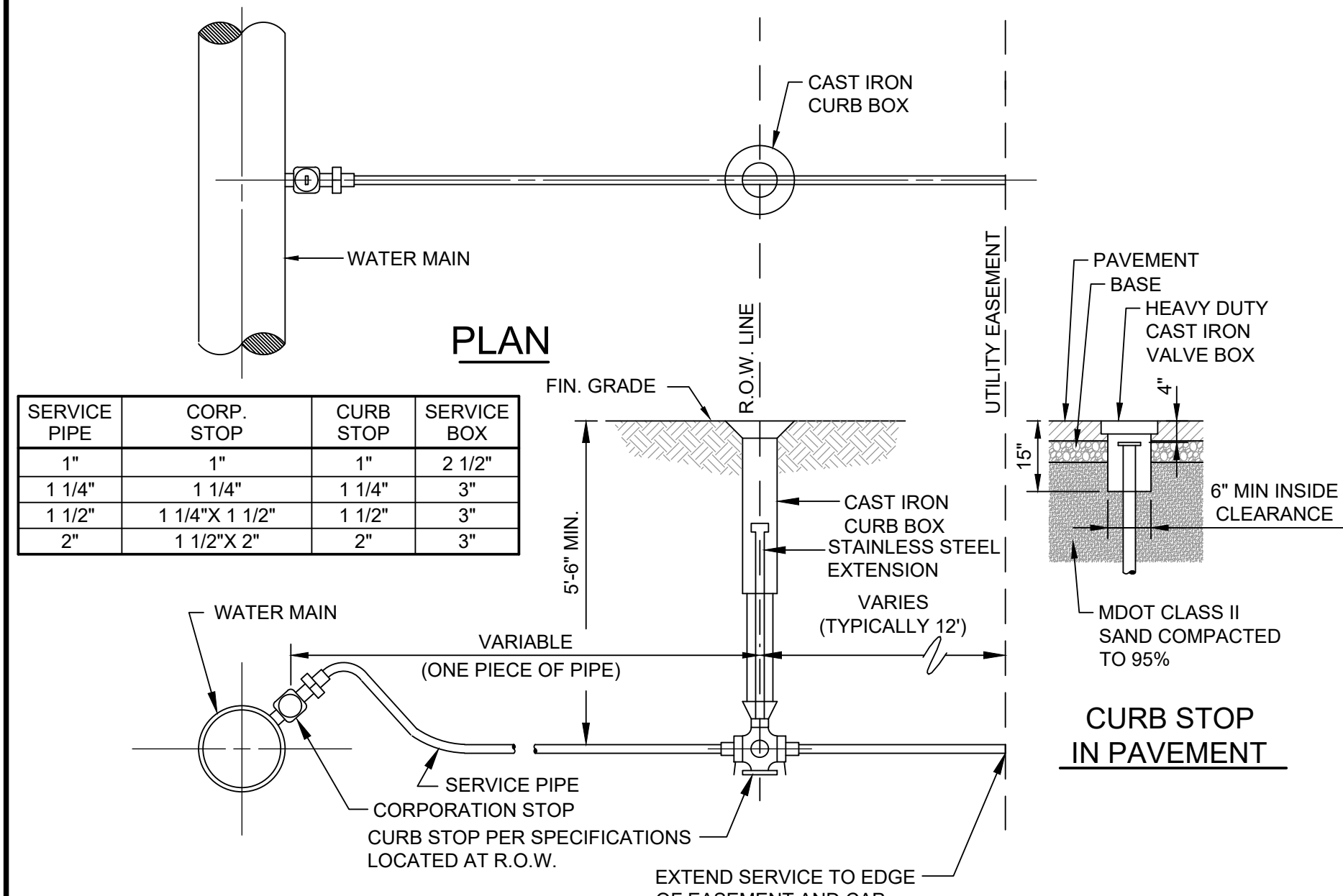


TERMINAL HYDRANT DETAIL

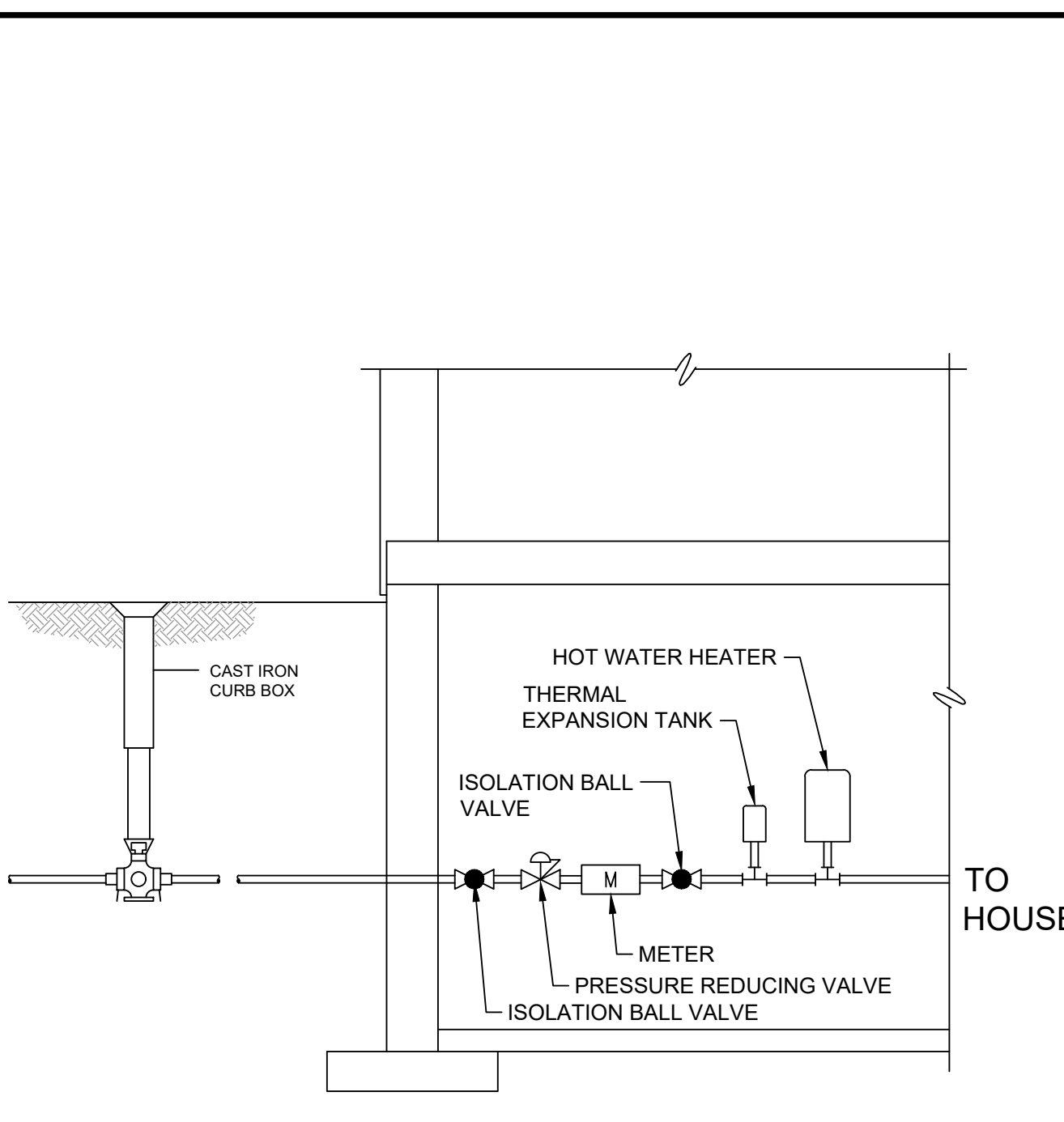


NOTE: PUBLICLY OWNED SHUT OFF VALVE TO BE LOCATED IN EASEMENT.

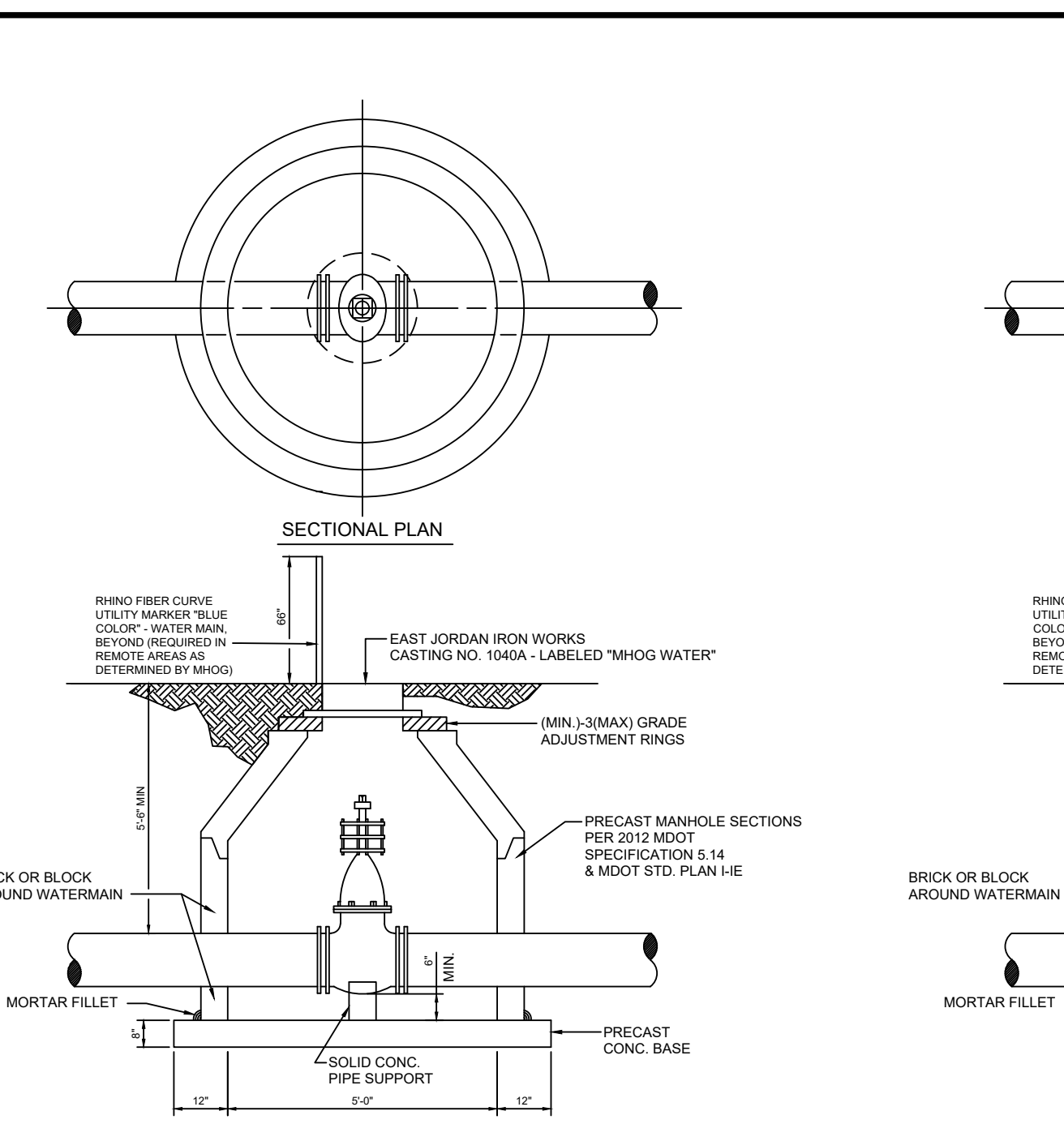
COMMERCIAL BUILDING WATER SERVICE LAYOUT



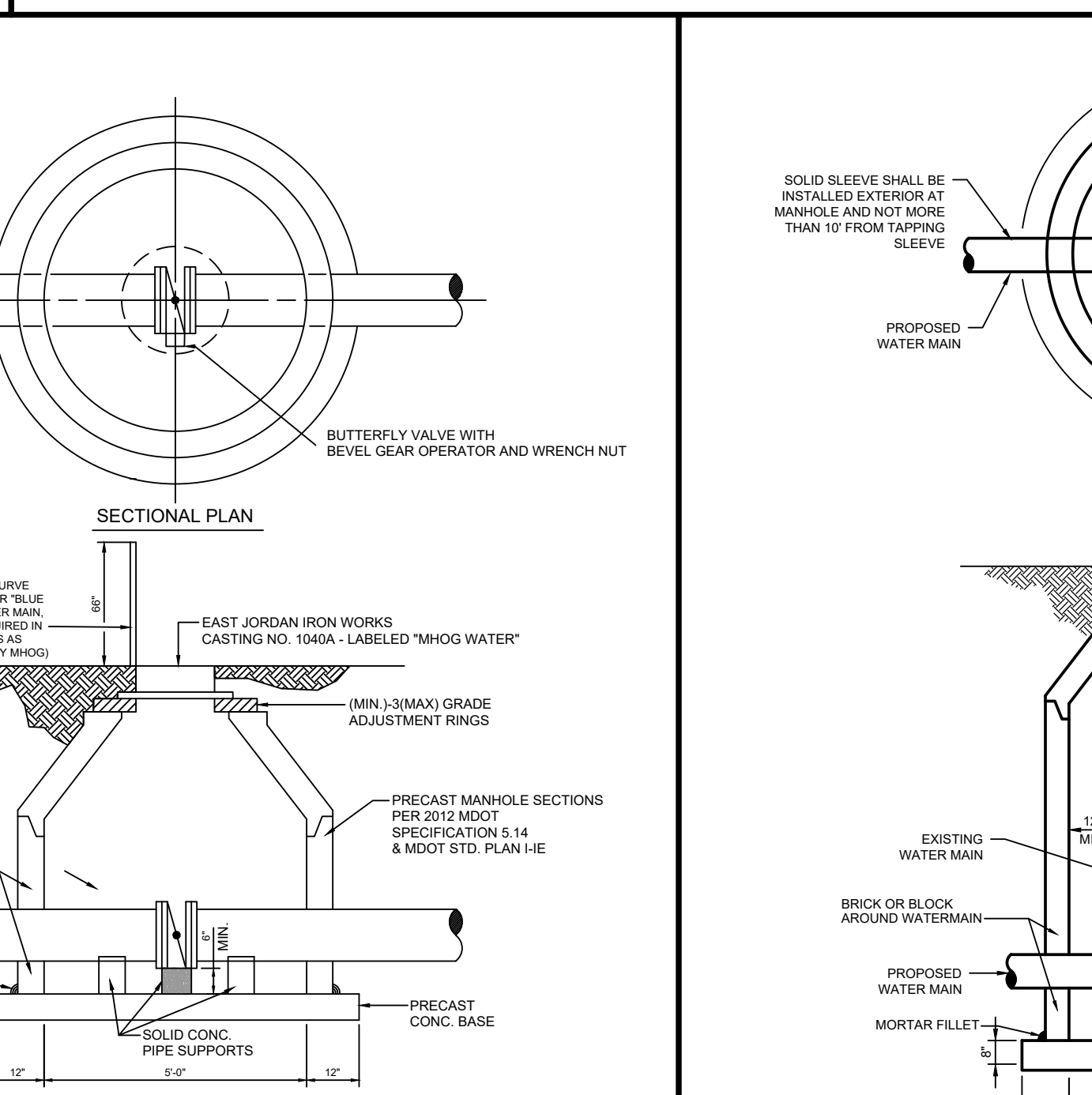
SECTION
WATER SERVICE LATERAL



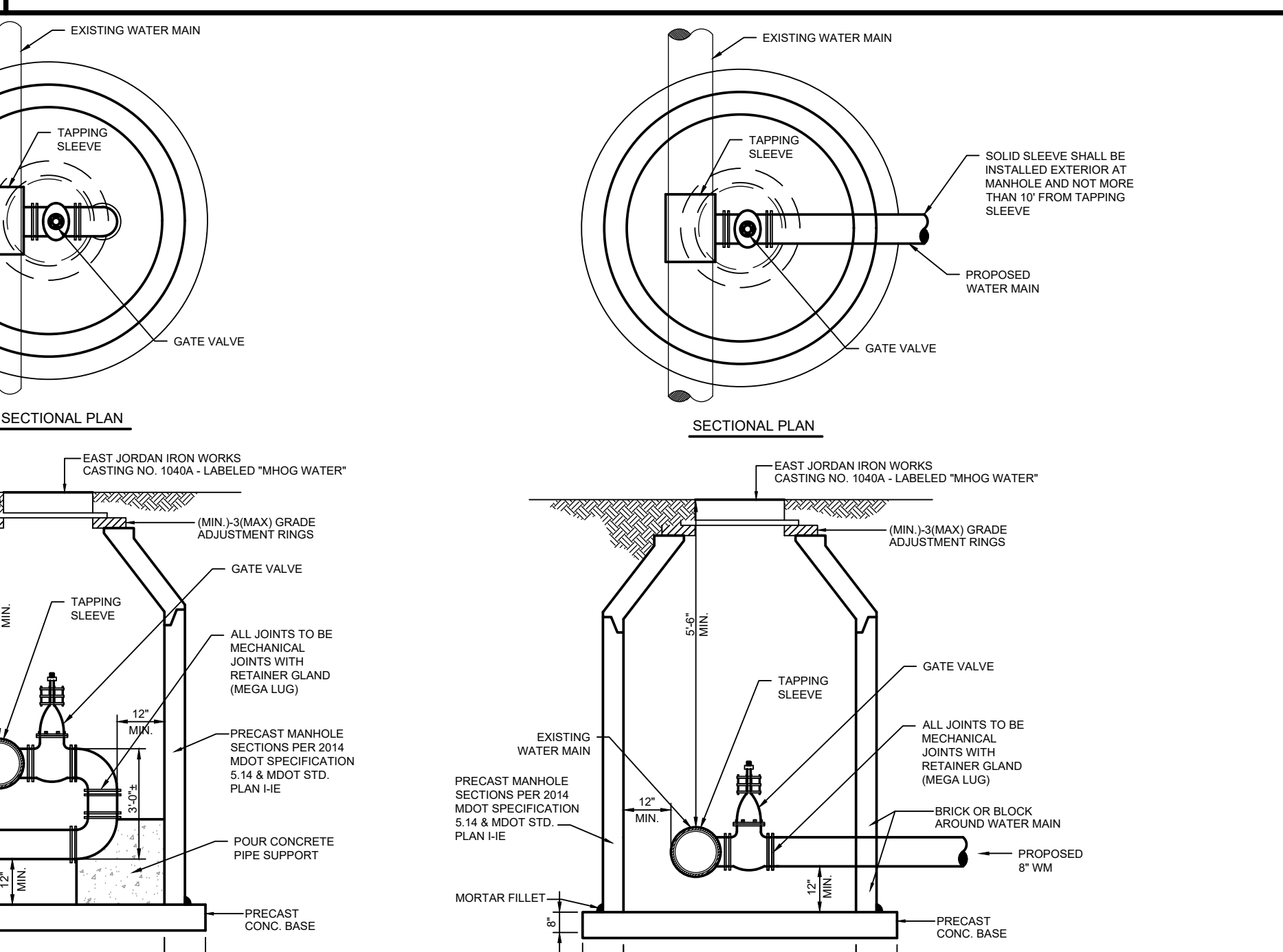
PRIVATE RESIDENCE
PRESSURE REDUCING VALVE (PRV)



VALVE AND GATE WELL



BUTTERFLY VALVE AND WELL



REVERSE TAP GATE WELL

REGULAR TAP GATE WELL



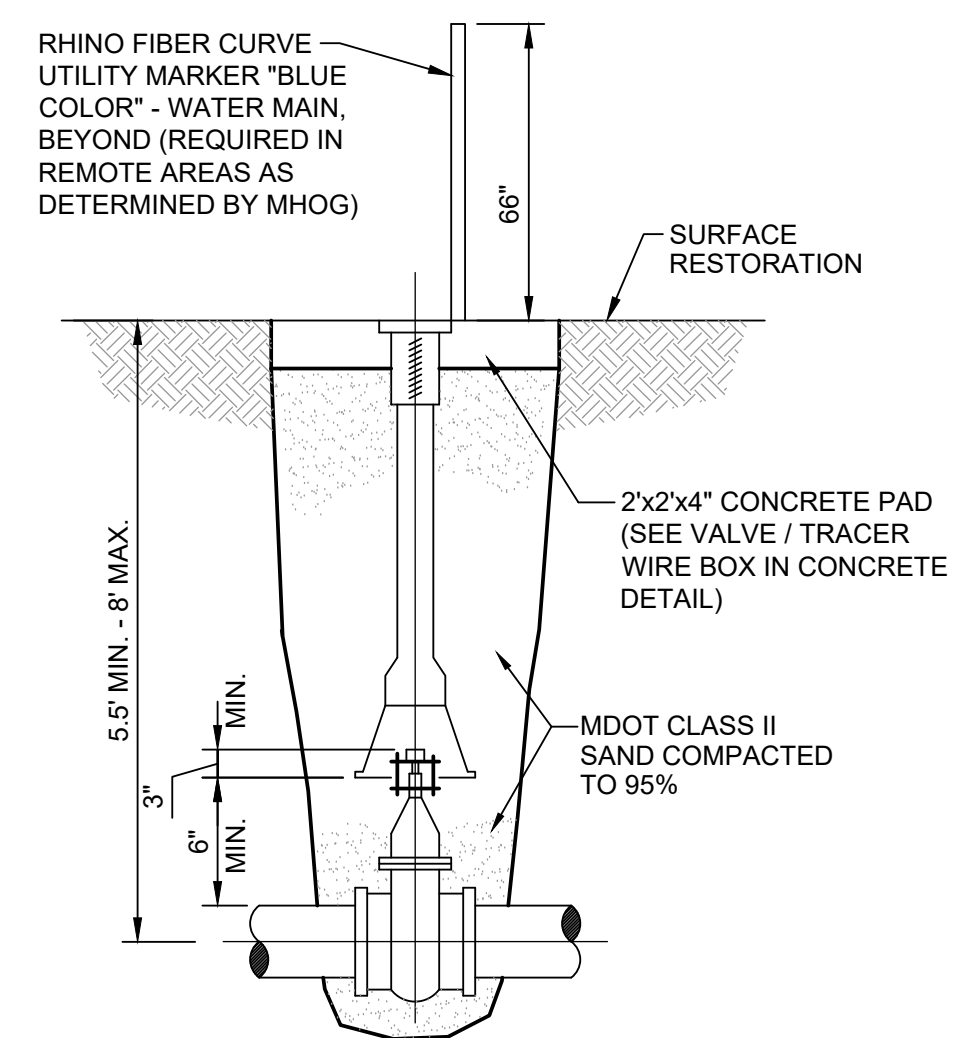
MARION HOWELL OCEOLA GENOA
Sewer and Water Authority

STANDARD DETAILS

Scale: NONE
Issued Date: JANUARY - 2014
UPDATED: MAY 2015
UPDATED: FEBRUARY 2016
UPDATED: APRIL 2016
UPDATED: OCTOBER 2017
UPDATED: FEBRUARY 2019

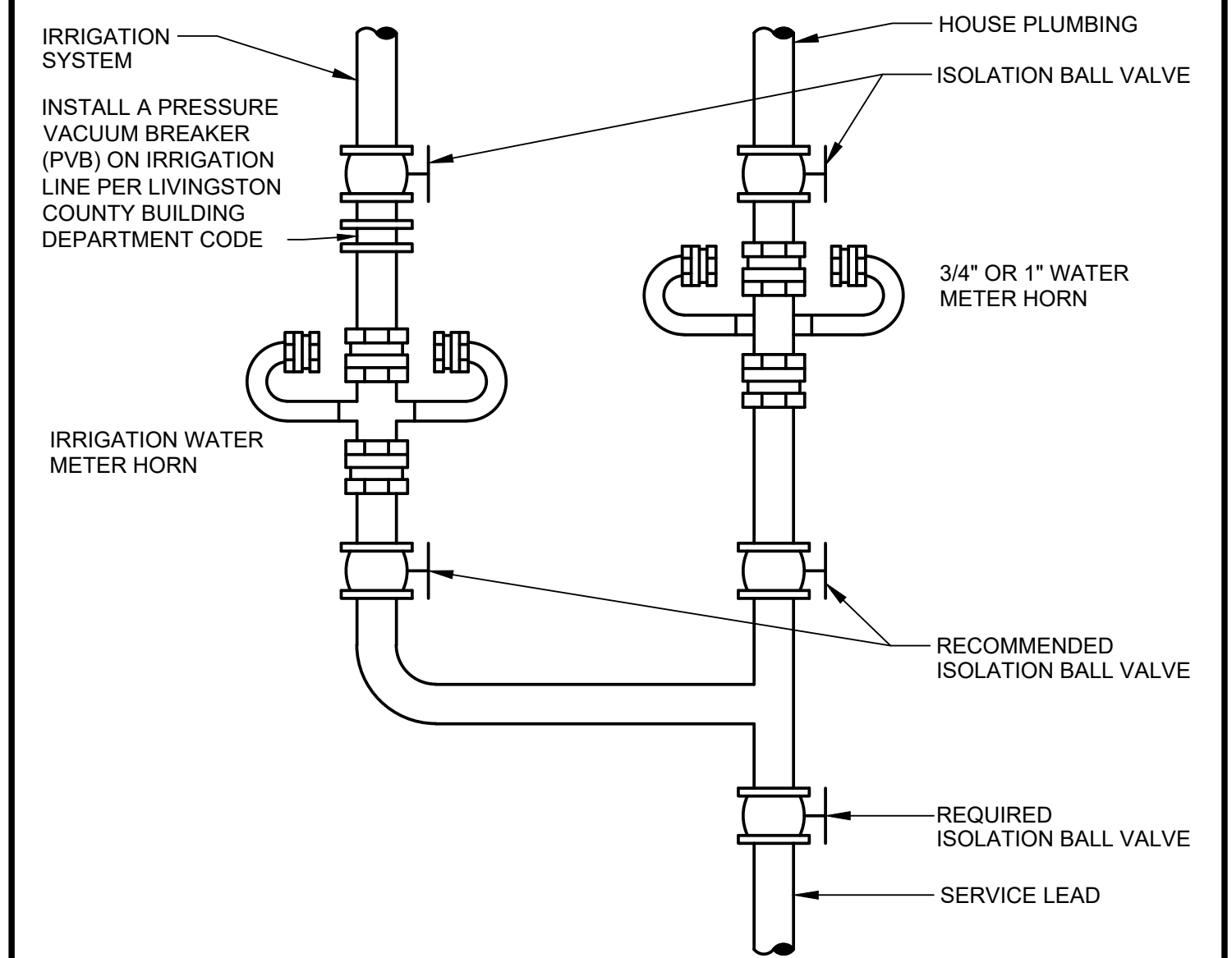
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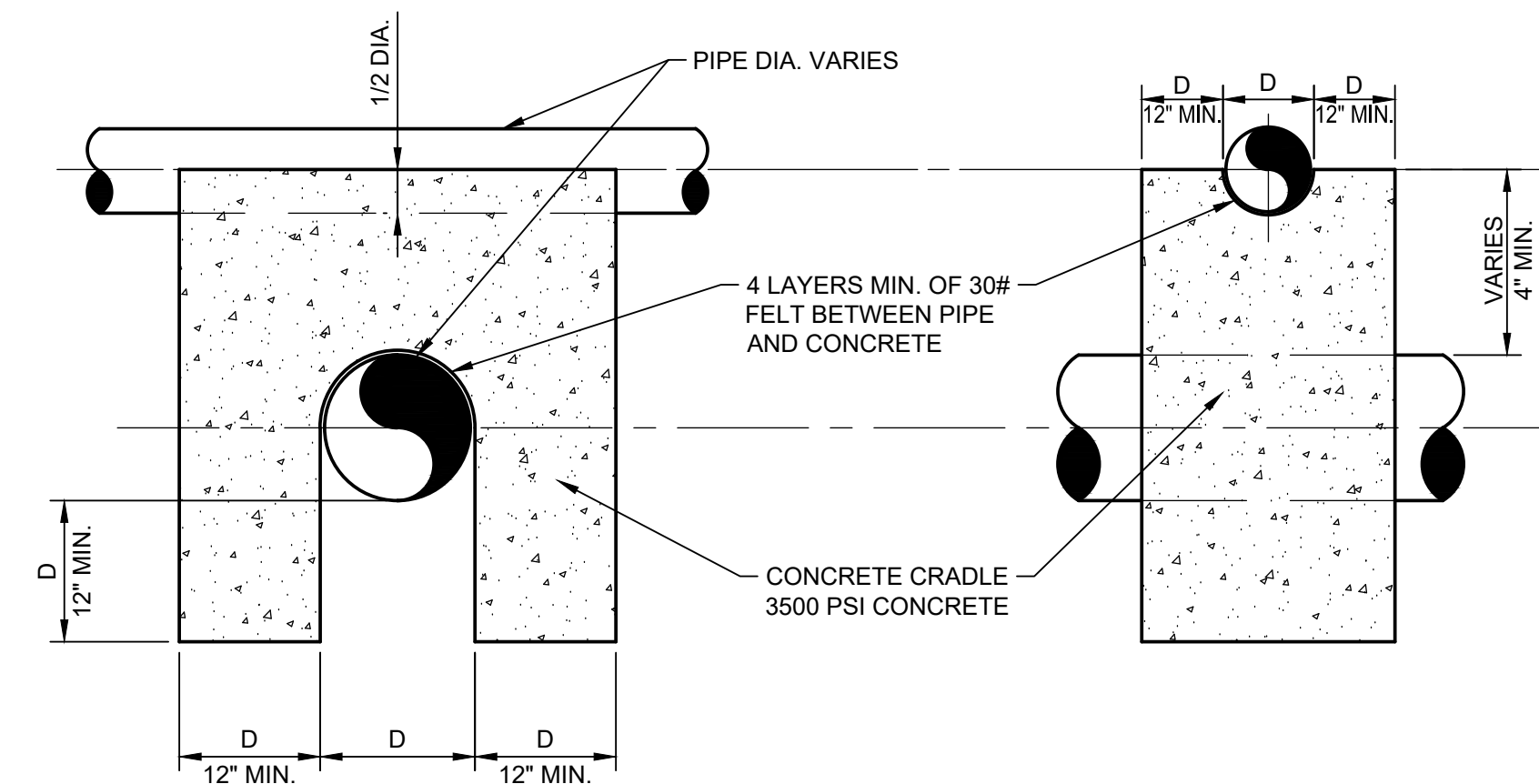
- NOTES:
1. VALVE BOX SHALL NOT REST ON VALVE OR MAIN LINE PIPE.
 2. A VALVE STEM EXTENSION WITH CENTERING RING IS REQUIRED FOR VALVES BURIED DEEPER THAN 6\".

GATE VALVE AND BOX



- NOTES:
1. ALL METERS ARE TO BE INSTALLED HORIZONTALLY IN A DRY, CLEAN, SANITARY LOCATION THAT IS READILY ACCESSIBLE. THIS DRAWING IS NOT TO SCALE & IS ONLY A REPRESENTATION OF HOW THE METERS SHOULD BE INSTALLED. THE SECOND METER IS OPTIONAL FOR IRRIGATION USAGE. METERS SHOULD NOT BE INSTALLED IN LINE (ONE RIGHT AFTER THE OTHER).
 2. PROPERTIES DESIGNATED "HIGH HAZARD" PER THE MHOG CROSS CONNECTION RULES MANUAL WILL REQUIRE THE INSTALLATION OF A REDUCED PRESSURE ZONE (RPZ) BACK FLOW PREVENTION DEVICE.

TYPICAL METER HORN INSTALLATION



CONCRETE CRADLE DETAIL

SCALE: NONE



MHOG CASTING DETAIL

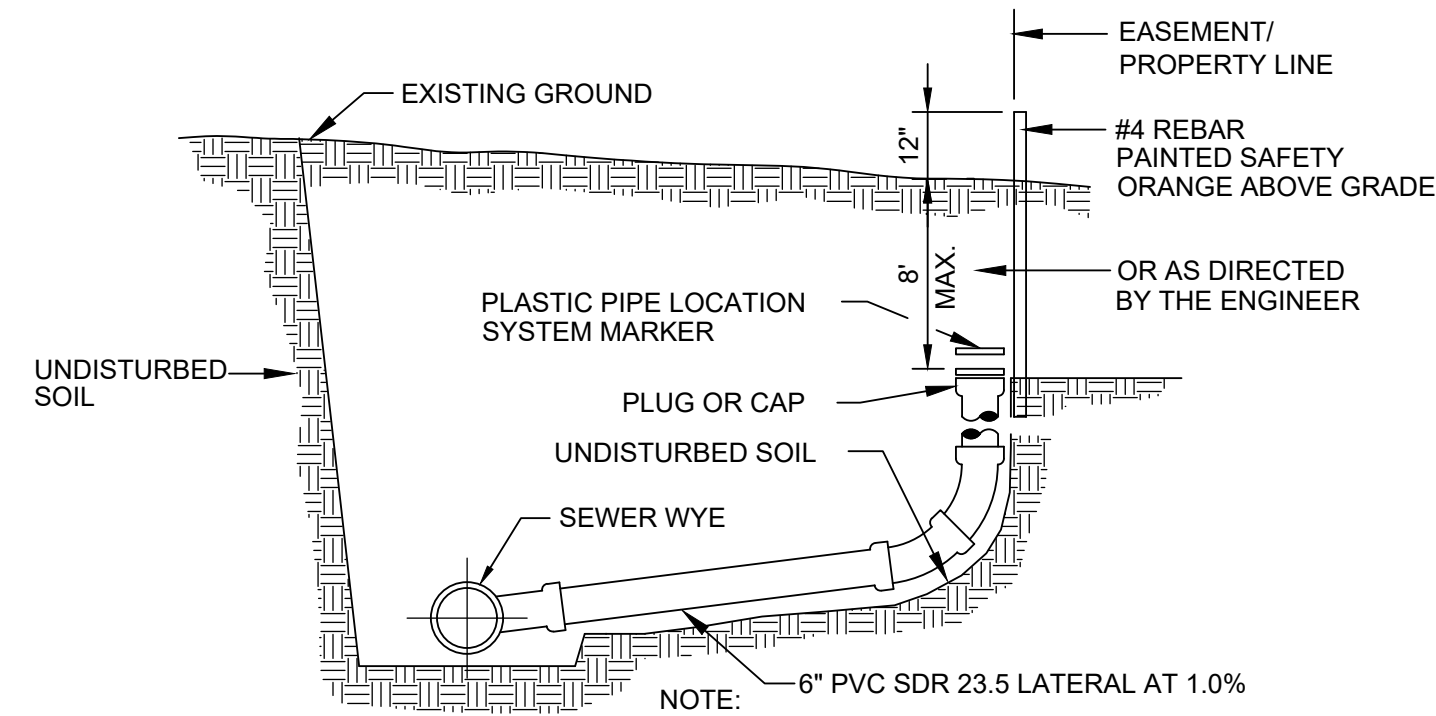
NO SCALE



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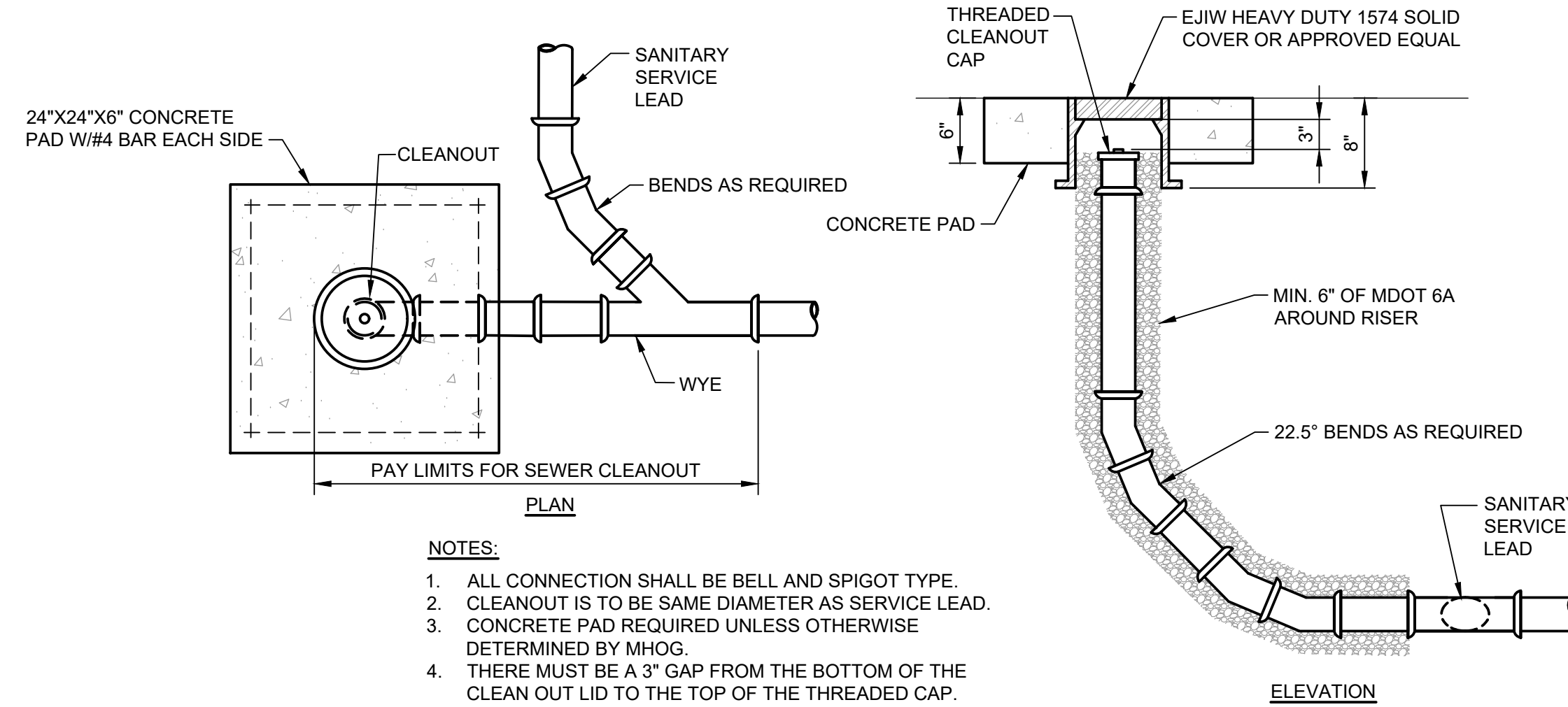
STANDARD DETAILS

Scale: NONE
 Issued Date JANUARY - 2014
 UPDATED: MAY 2015
 UPDATED: FEBRUARY 2016
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 UPDATED: OCTOBER 2017
 UPDATED: FEBRUARY 2019



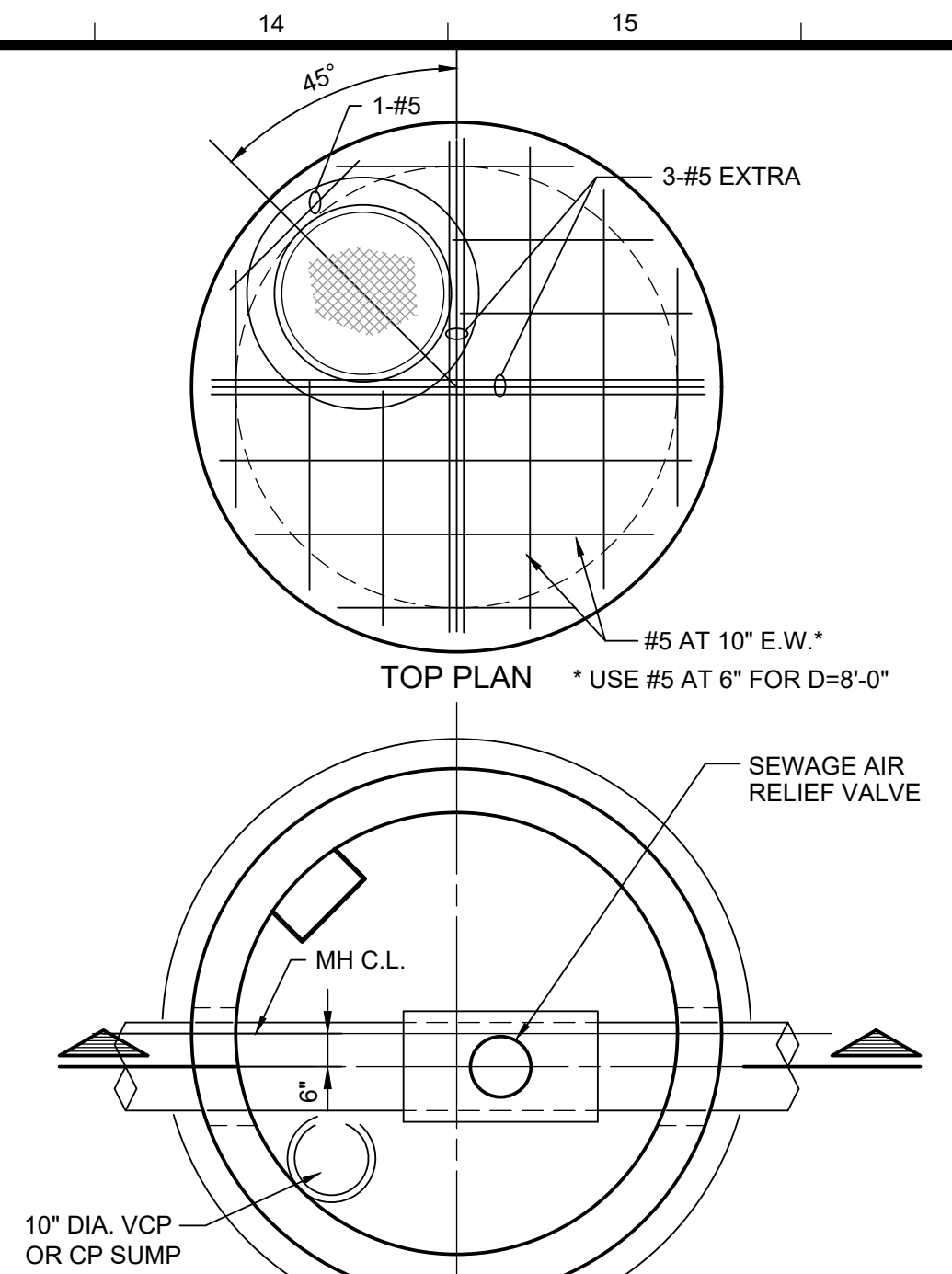
SANITARY SEWER LATERAL

NOTE: 6" PVC SDR 23.5 LATERAL AT 1.0%
 1. RISER PIPE MAY NOT BE REQUIRED FOR SHALLOW SEWERS AS SHOWN.
 2. WHEN CONNECTING TO AN EXISTING SEWER THE AUTHORITY MAY REQUIRE CORING OF THE EXISTING PIPE AND INSTALLATION OF A SEWER SADDLE. SADDLE SHALL BE ROMAC "CB" SEWER SADDLE OR APPROVED EQUAL.

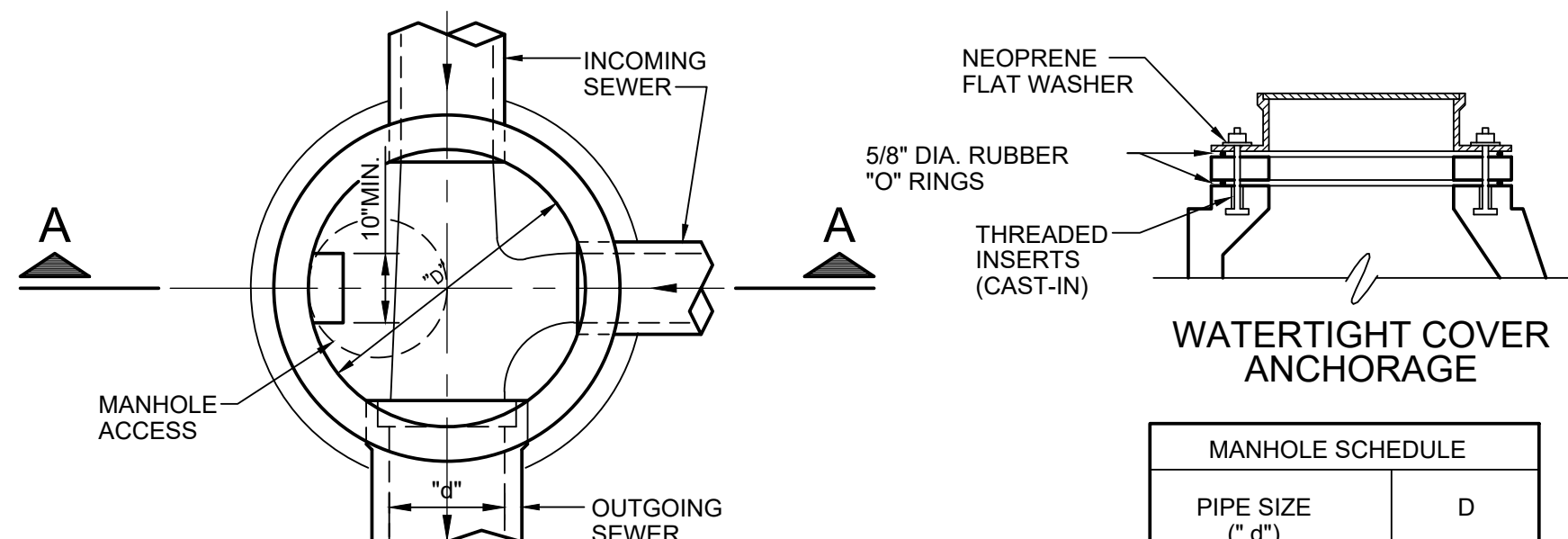


SEWER CLEANOUT DETAIL

NOTES:
 1. ALL CONNECTION SHALL BE BELL AND SPIGOT TYPE.
 2. CLEANOUT IS TO BE SAME DIAMETER AS SERVICE LEAD.
 3. CONCRETE PAD REQUIRED UNLESS OTHERWISE DETERMINED BY MHOG.
 4. THERE MUST BE A 3" GAP FROM THE BOTTOM OF THE CLEAN OUT LID TO THE TOP OF THE THREADED CAP.

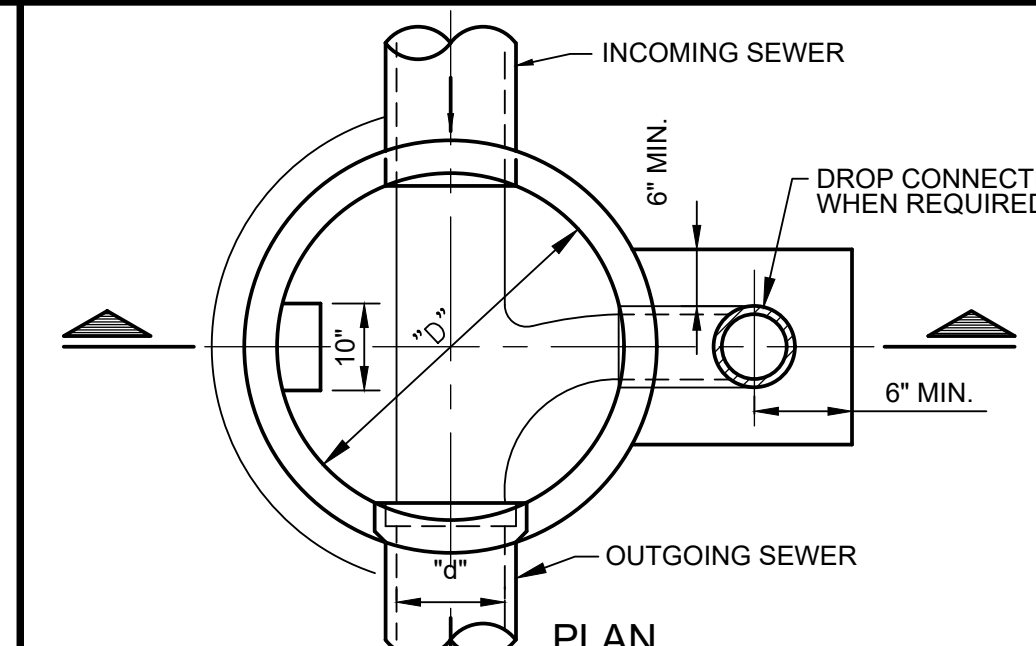


AIR RELIEF STRUCTURE

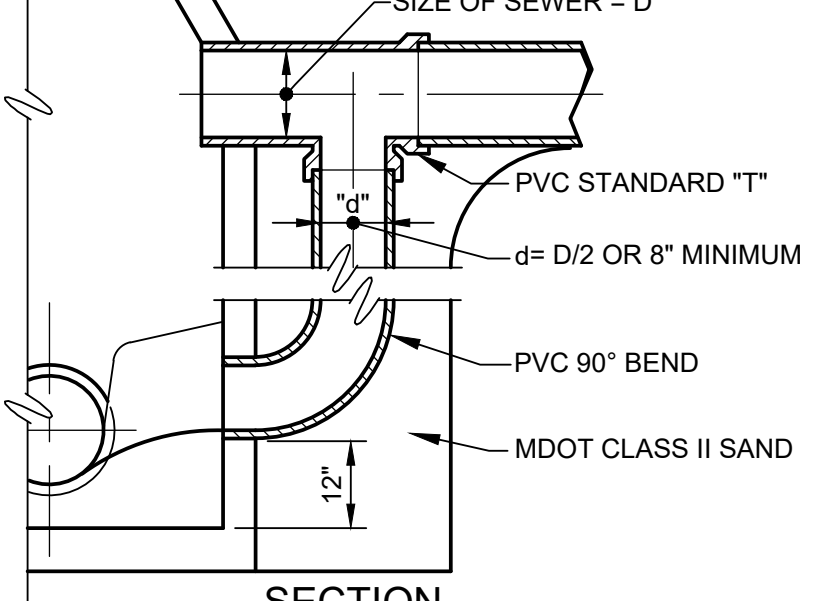


WATERTIGHT COVER ANCHORAGE

MANHOLE SCHEDULE	
PIPE SIZE ("d")	D
8"-24"	48"
27"-36"	60"
42"-48"	72"
54"	84"

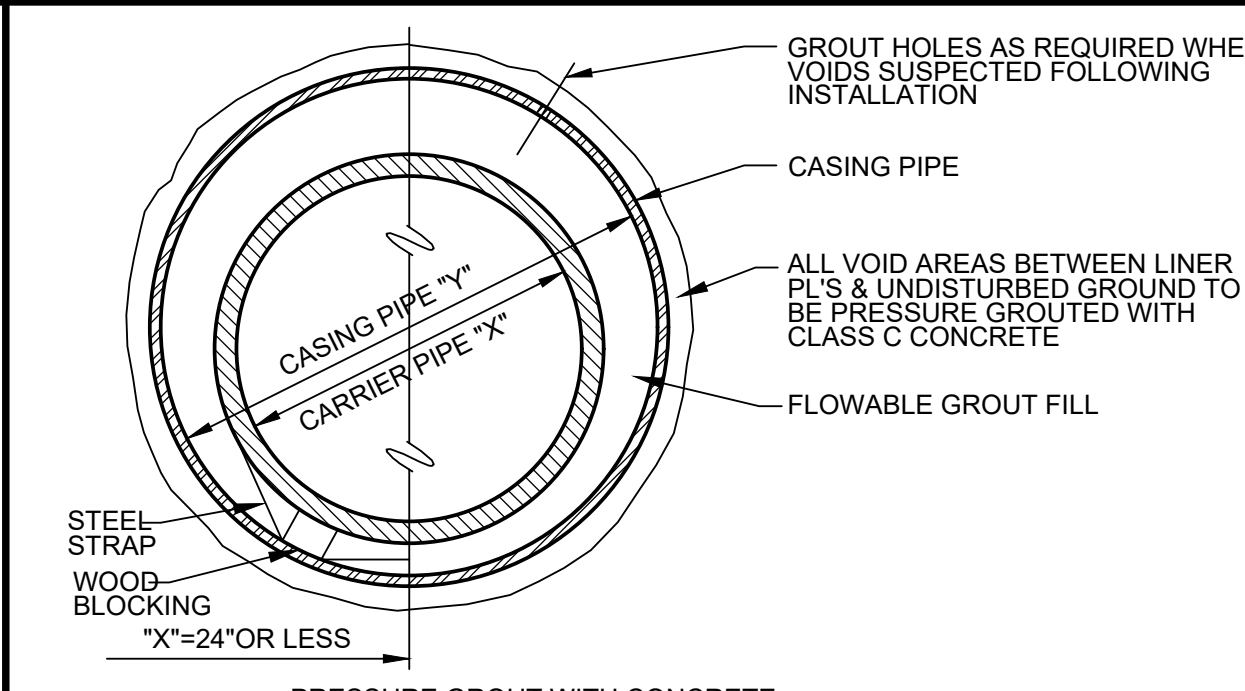


DROP CONNECTION



SECTION

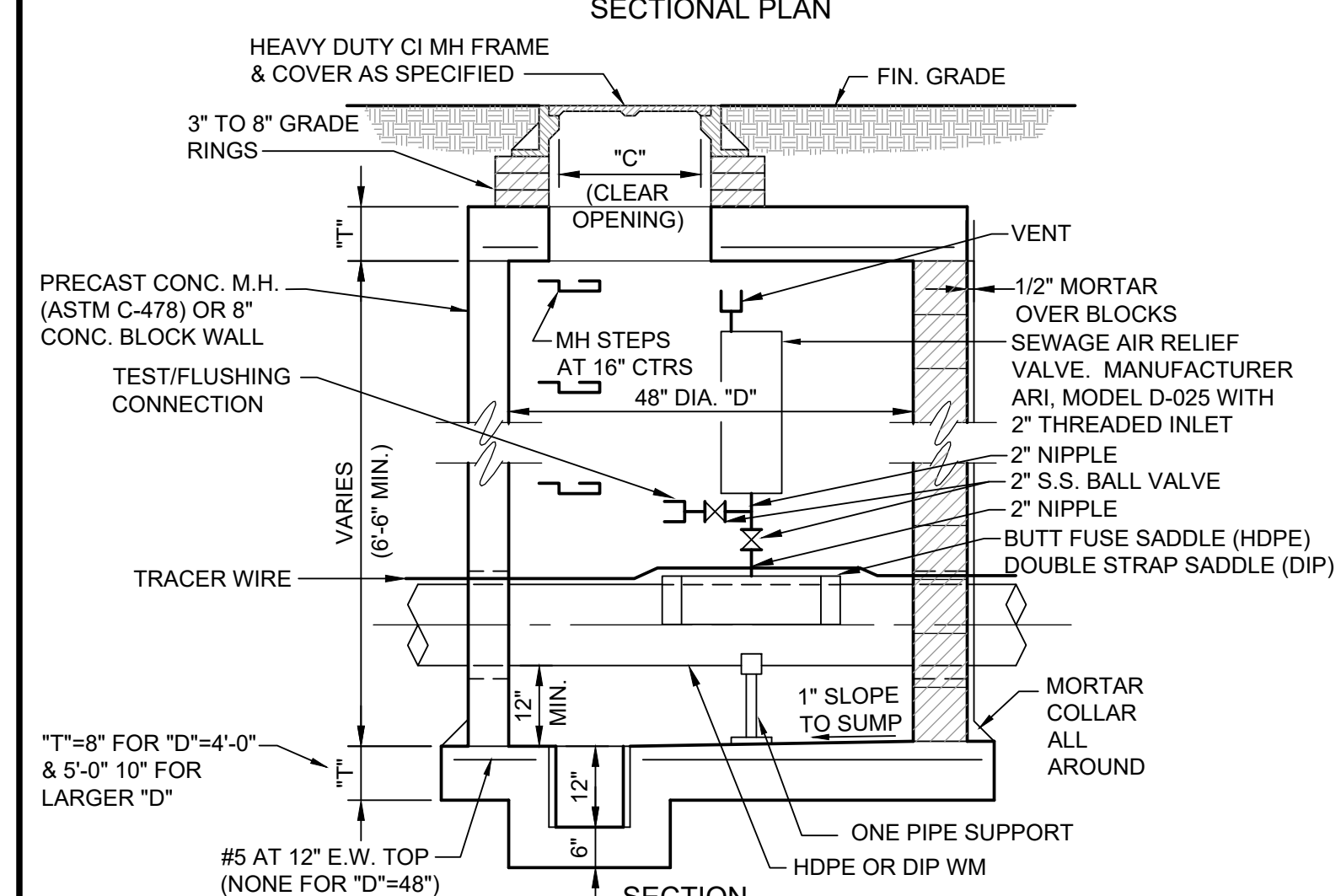
REQUIRED WHEN AN INLET PIPE IS 24" OR MORE ABOVE THE OUTLET PIPE IN A MANHOLE



CASING PIPE

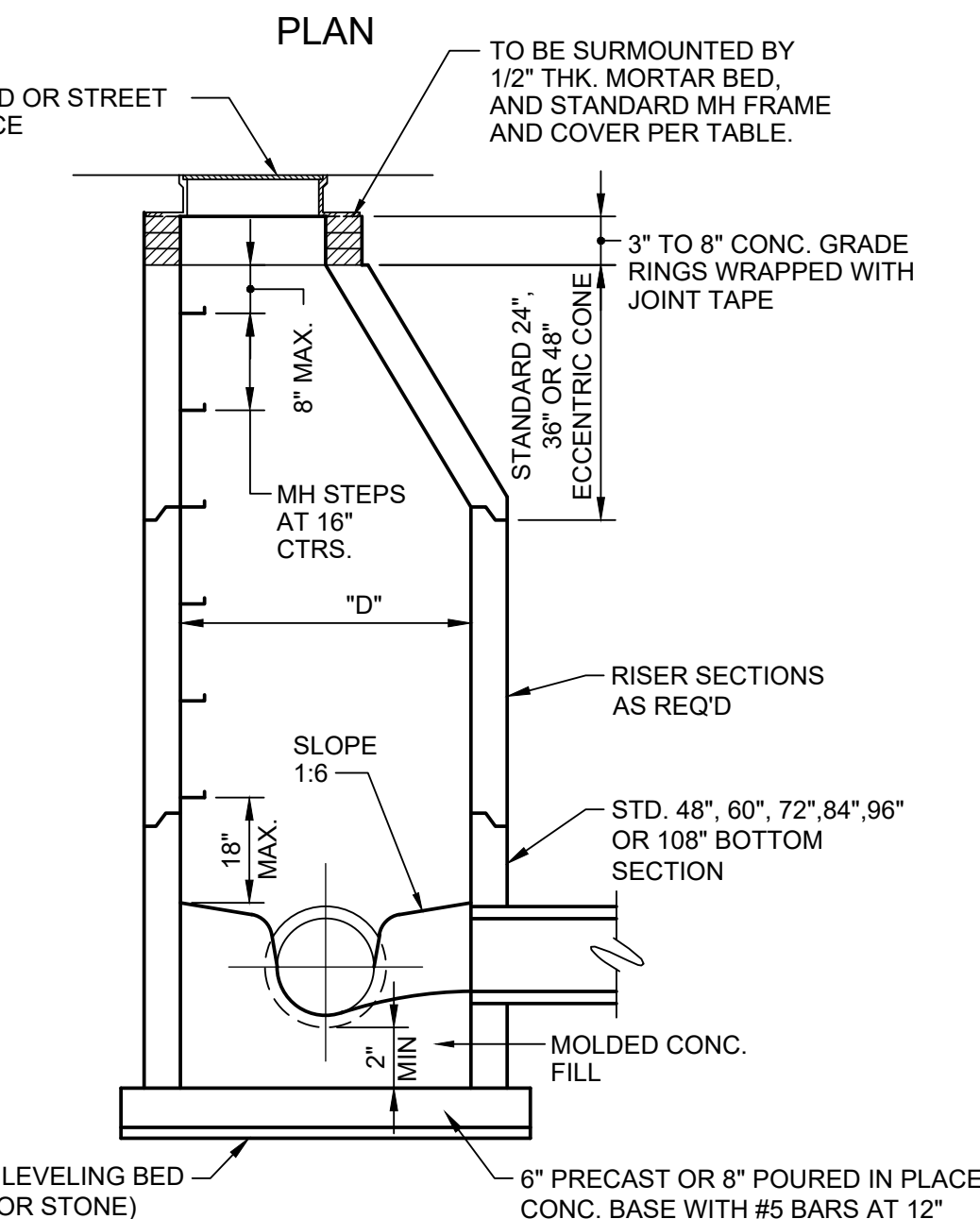
TABLE	
"X"	"Y"(MIN)
6"-8"	20"
10"-12"	24"
14"-15"	30"
18"-21"	36"
24"	42"

NOTE: SEE SPECIFICATIONS FOR ALTERNATE CONST. METHODS



SECTION

NOTE: ALL PLUMBING MATERIALS TO BE NON-CORROSIVE. ALL FITTINGS SHALL BE STAINLESS STEEL.



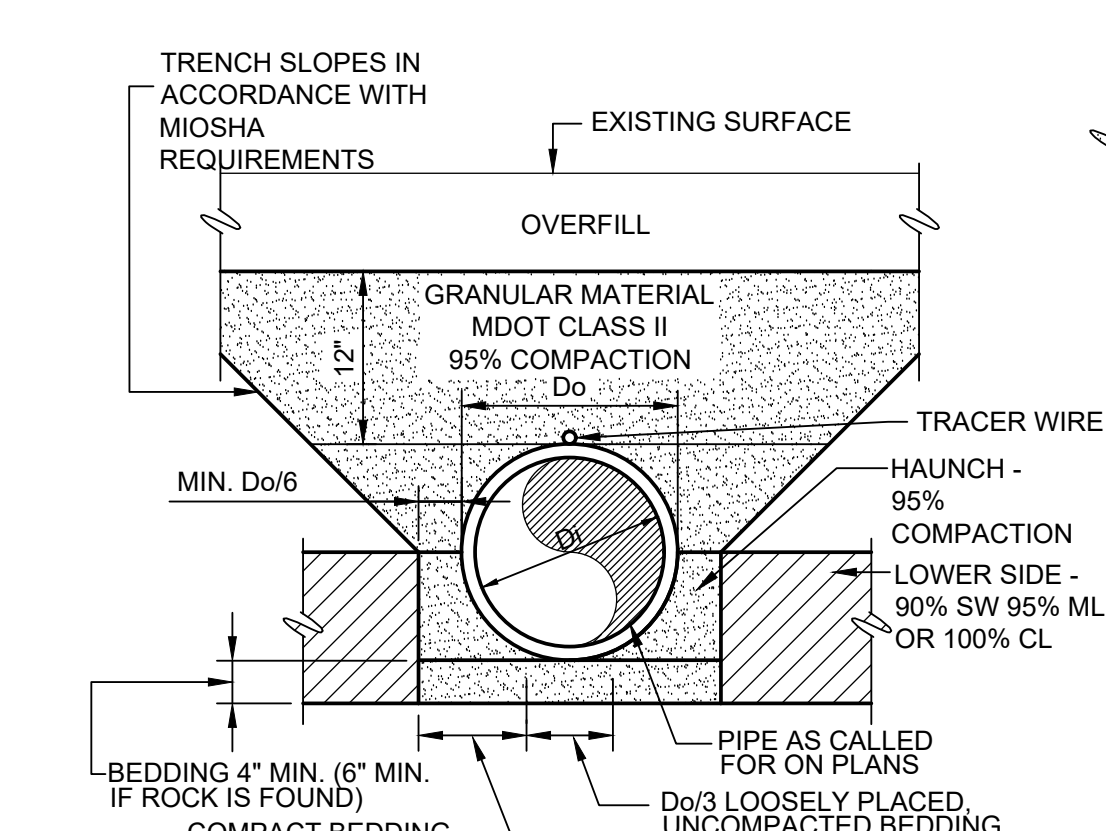
SECTION A-A

NOTES:
 1. ALL SANITARY MANHOLES TO BE PRECAST REINFORCED CONCRETE WITH PREMIUM JOINTS. SEE SPECIFICATIONS FOR BASE SLAB AND PIPE OPENINGS AND CONNECTIONS.
 2. MANHOLE CONES SHALL BE THE ECCENTRIC TYPE.
 3. PROVIDE 6" OF COMPACTED GRANULAR MATERIAL UNDER ALL PRECAST CONCRETE BASE SLVC.
 4. FORCE MAINS CONNECT DIRECTLY TO A MANHOLE SHALL BE INSTALLED SO THAT THE ELEVATION OF THE PIPE CROWNS MATCH. THE FORCE MAIN SHALL BE DIRECTED DOWNWARD INTO THE FLOW CHANNEL.
 5. FOR SANITARY SEWERS ALL PIPES SHALL ENTER MANHOLE THROUGH RUBBER BOOTED CONNECTION.

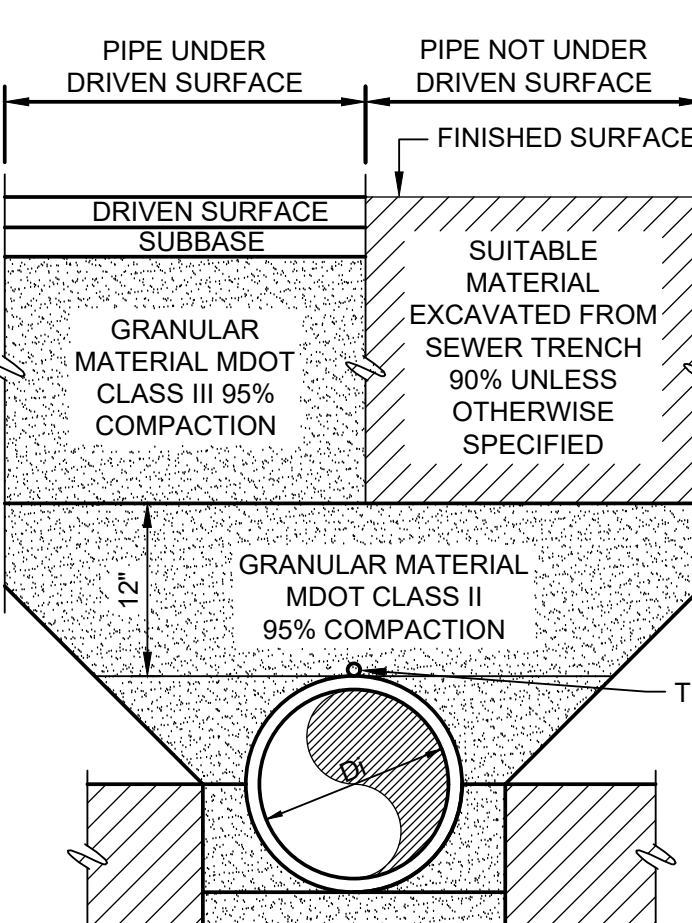
FRAME & COVER FOR SANITARY SEWER MANHOLES			
TYPE	TYPE OF COVER	MANUFACTURER OR EQUAL	
		EAST JORDAN	NEENAH
MH	SANITARY - SOLID SELF-SEALING	1040.0000	R-1642
MH	SANITARY - SOLID WATERTIGHT	1040-APT	R-1916-F
CO	SOLID	1574A	R-1973-A

STANDARD MANHOLE

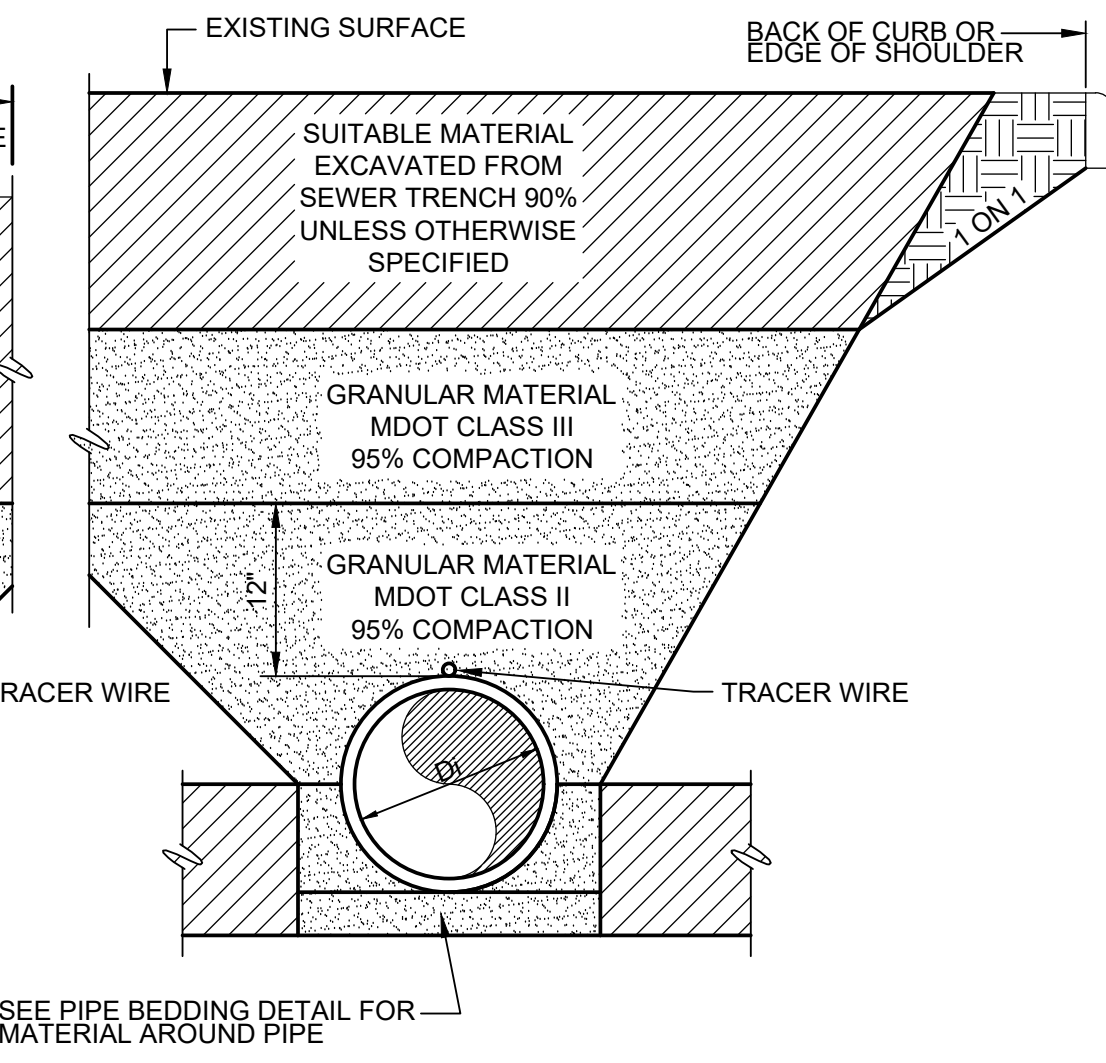
NOTES:
 1. COMPACTION PRESENTED AS MINIMUM STANDARD PROCTOR VALUES.
 2. MATERIALS AROUND THERMOPLASTIC PIPE WITH DIAMETER < 6 INCHES SHALL PASS 0.5 INCH SIEVE, MATERIALS AROUND OTHER PIPES SHALL PASS 1.5 INCH SIEVE.
 3. MATERIALS AROUND HDPE PIPE TO BE MDOT 6A OR 21AA.
 4. DRIVEN SURFACE IS DRIVEWAY, PARKING AREA, ROAD BED OR SHOULDER.
 5. UTILITY TRENCHES LOCATED WITHIN A MDOT ROW SHALL CONFORM TO MDOT STANDARD DETAIL R-83.
 6. TRACER WIRE IS REQUIRED ON FORCE MAIN ONLY AND SHALL BE BROUGHT TO GRADE AT A MINIMUM EVERY 1000 FEET IN A APPROVED CAST IRON TRACER WIRE BOX ENCASED IN CONCRETE OR WITH AN APPROVED GREEN MARKER POST.



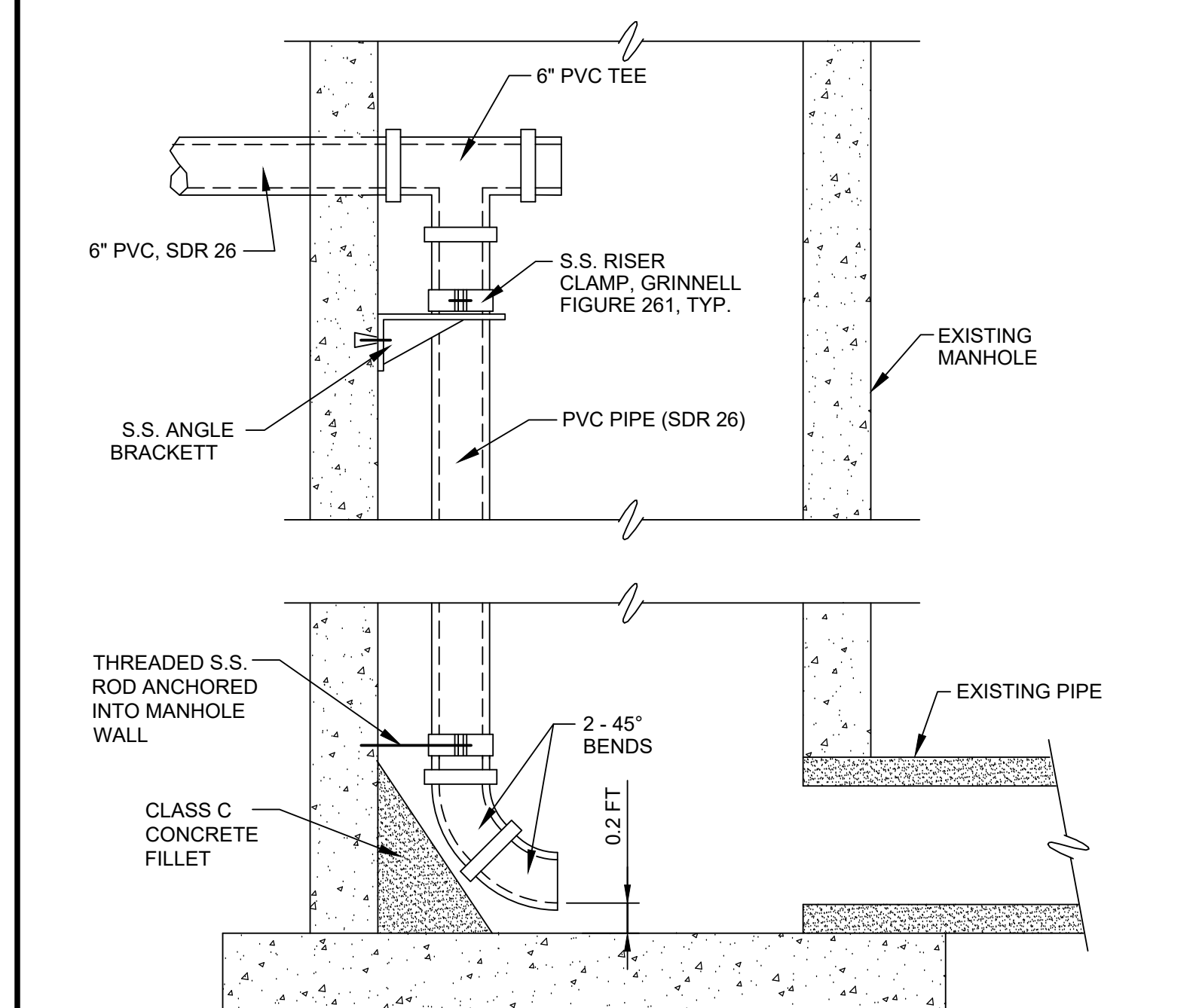
PIPE BEDDING



PIPE UNDER/NOT UNDER DRIVEN SURFACE



PIPE WITHIN INFLUENCE OF DRIVEN SURFACE



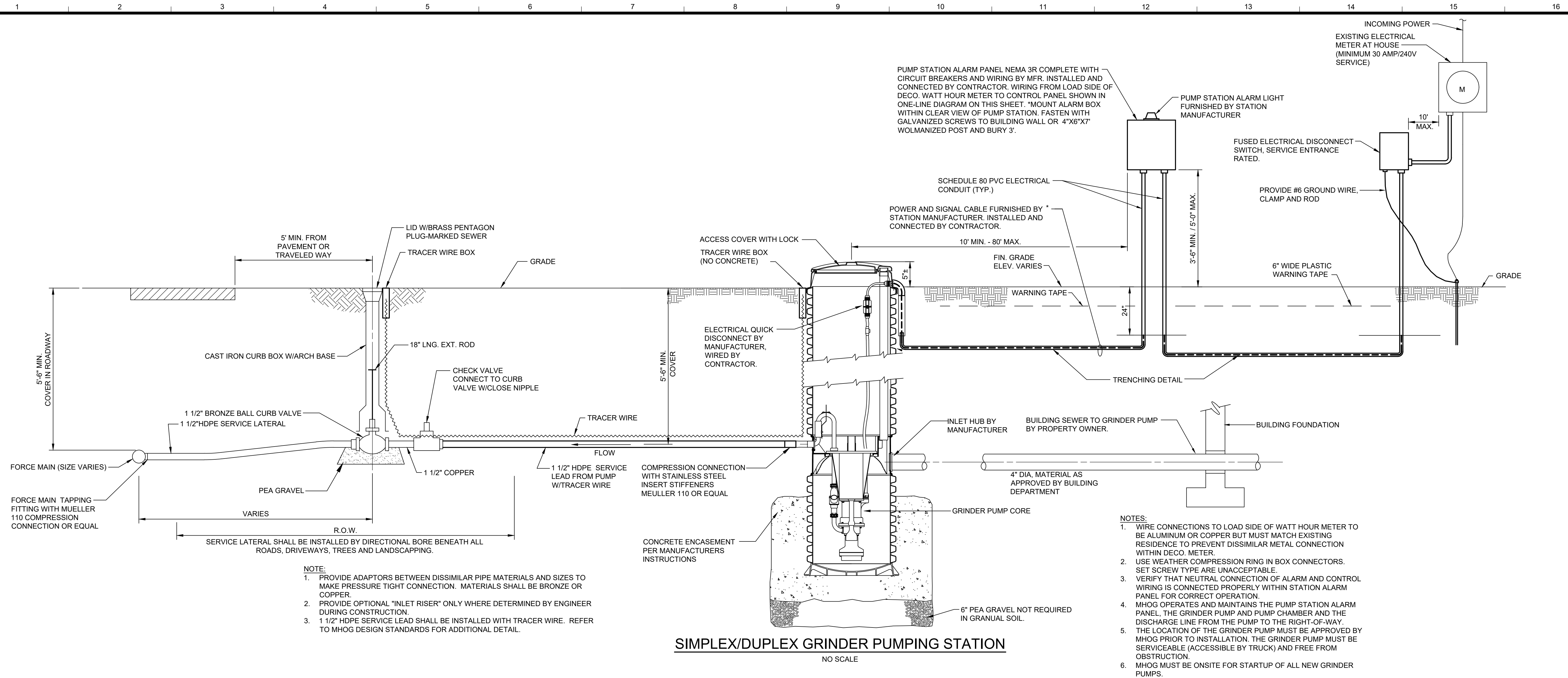
INTERIOR SEWER LATERAL DROP CONNECTION



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 Sewer and Water Authority

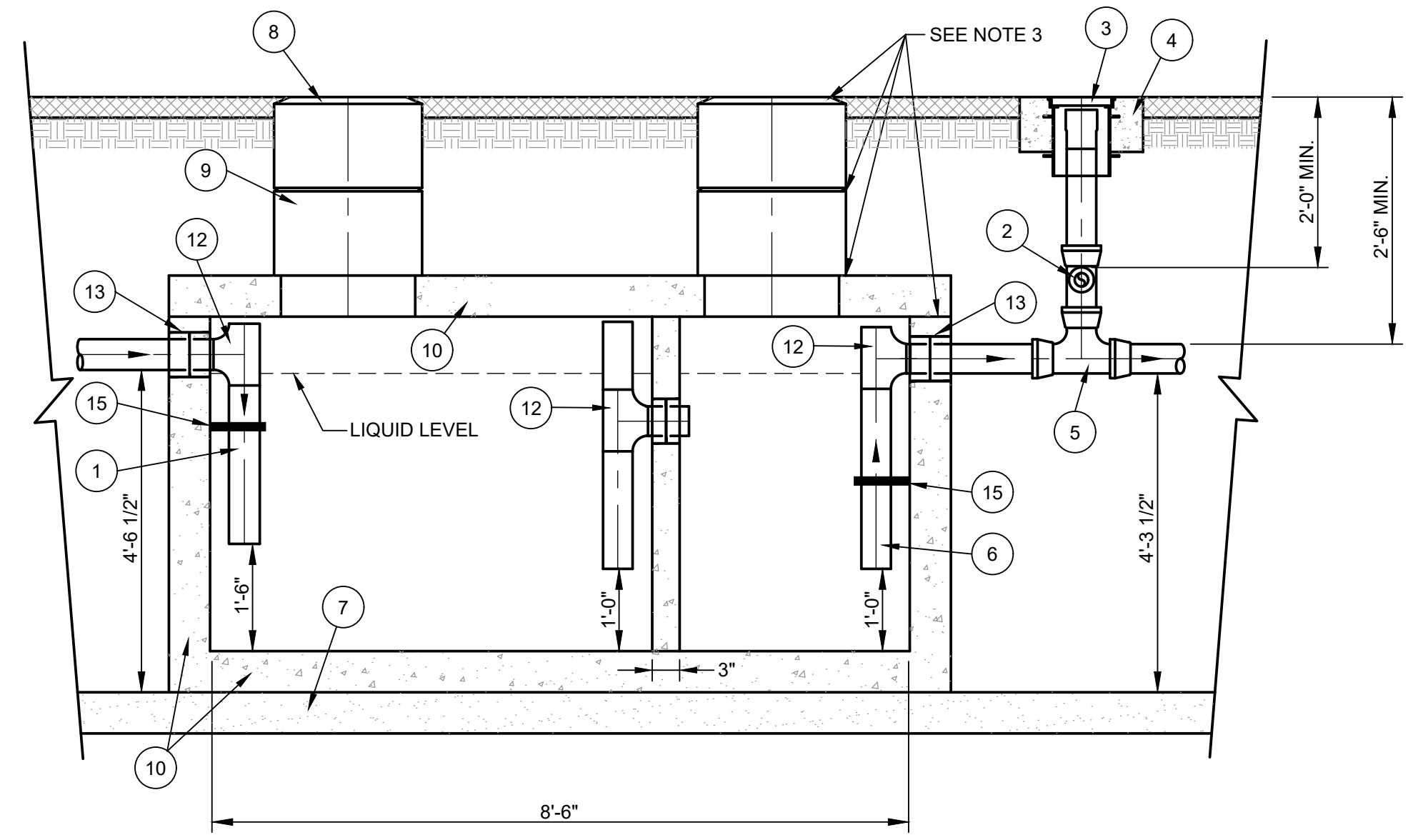
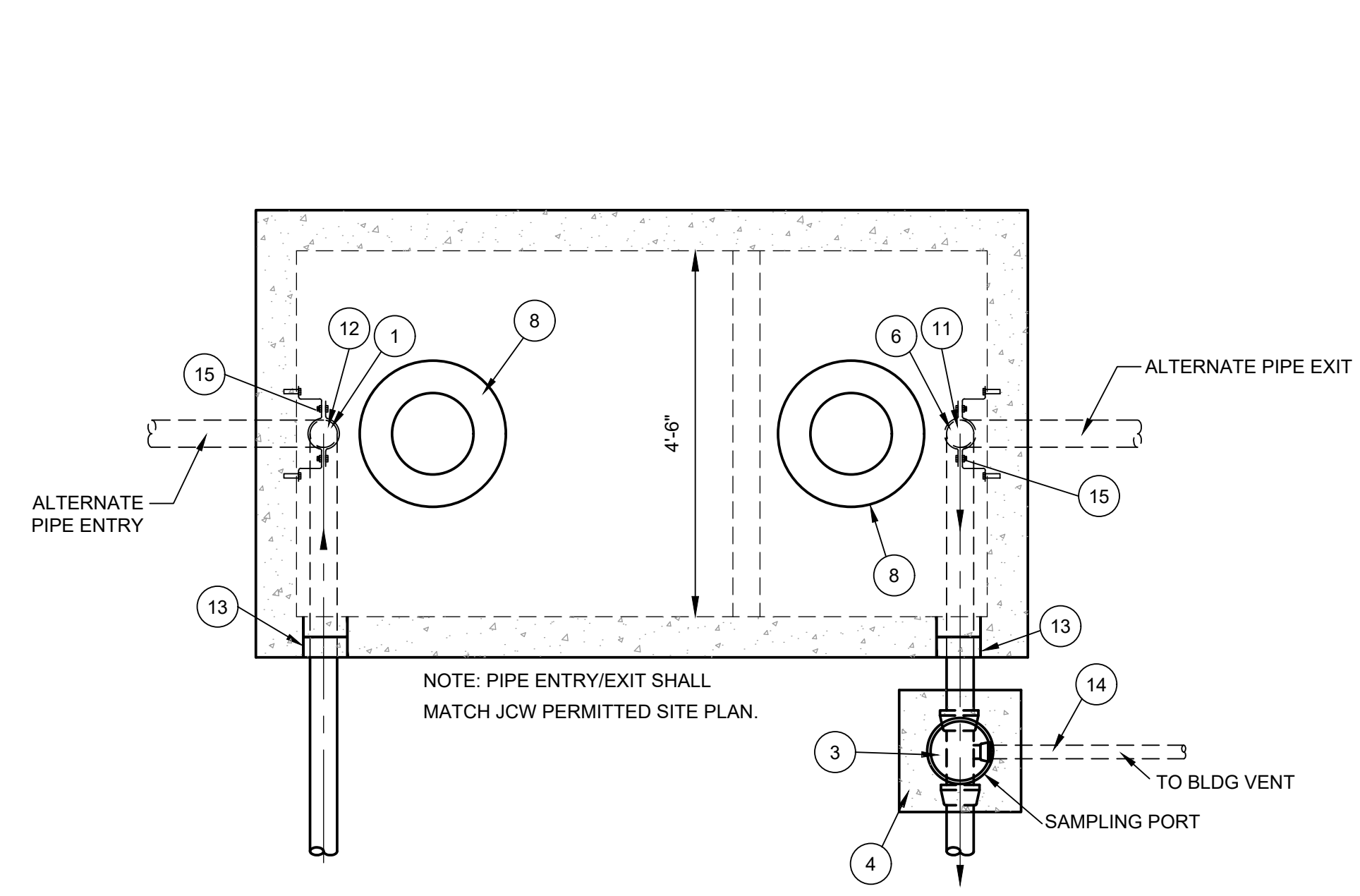
Scale: NONE
 Issued Date: JANUARY - 2014
 UPDATED: MAY 2015
 UPDATED: FEBRUARY 2016
 UPDATED: APRIL 2016
 UPDATED: OCTOBER 2017
 UPDATED: FEBRUARY 2019

STANDARD DETAILS



SIMPLEX/DUPLEX GRINDER PUMPING STATION

NO SCALE



GREASE INTERCEPTOR 1000 GALLON

NO SCALE

ITEM	DESCRIPTION
1	4" PVC INLET PIPE*
2	4"x4"x2" TEE WITH 2" PIPE TO BUILDING VENT*
3	THREADED C/O CAP JOSAM 58860 OR APP EQUAL**
4	CONCRETE PAD
5	4"x4"x4" TWO-WAY CLEANOUT TEE*
6	4" PVC OUTLET*
7	4" - 6" GRAVEL BEDDING
8	HEAVY-DUTY CAST IRON FRAME AND COVER ***
9	CONCRETE ADJUSTMENT RINGS
10	REINFORCE AS REQUIRED FOR SERVICE CONDITIONS
11	4" PVC 90° ELBOW*
12	4" PVC TEE*
13	A-LOK OR PRESS SEAL PSX PIPE/WALL CONNECTOR
14	2" VENT PIPE (IDENTIFY PIPE TYPE, CLASS & JOINT AS REQUIRED FOR PROJECT)
15	STAINLESS STEEL PIPE SUPPORT CLAMP ****

* 6" PIPE MAY BE SUBSTITUTED TO MATCH UPSTREAM PIPE DIAMETER.
 ** REFER TO CLEAN OUT DETAIL(S) ON STANDARD DETAIL SHEET.
 *** CLAY & BAILEY 2008 BV OR EQUAL (FROST PROOF COVERS OPTIONAL)
 **** FM STAINLESS FASTENERS #63 OR EQUAL. 1/2"x2-1/2" SS BRACKET W/ 1/2"x1-1/2" FULLY THREADED SS HEX BOLT WITH 1/2" SS WASHER AND 1/2"x1-3/4" SS ANCHORS. CLAMP TO BE FACTORY INSTALLED.

- NOTES:**
1. THREE COVERS AND RISERS SHOWN. TWO COVERS AND RISERS CENTERED OVER UPPER TWO BAFFLES ARE OPTIONAL.
 2. INTERCEPTOR SIZE - 1000 GAL MINIMUM (REVISE THE SIZE DIMENSIONS, AS NEEDED, FOR LARGER CAPACITY INTERCEPTORS)
 3. ALL JOINTS AT THE FRAME & COVER, CONCRETE ADJUSTMENT RINGS AND THE LID OF THE INTERCEPTOR SHALL BE SEALED WITH A MINIMUM OF TWO (2) ROWS OF 3/4 TO 1 INCH PREFORMED BUTYL JOINT SEALER AND A 6" BUTYL JOINT WRAP AROUND SLEEVE (EZ WRAP). THE ENDS OF THE 6" EZ WRAP SHALL OVERLAP BY 12".
 4. PIPING ON THE INTERIOR OF THE INTERCEPTOR SHALL BE PVC WITH SOLVENT-CEMENTED JOINTS.
 5. GREASE INTERCEPTOR INCLUDING ADJUSTMENT RINGS AND CASTINGS SHALL BE WATER TESTED FOR WATER TIGHTNESS AFTER THE BACKFILL OPERATIONS HAVE BEEN COMPLETED. WATER TESTING SHALL CONSIST OF THE FOLLOWING: 1. SEAL THE TANK. 2. FILL WITH WATER. 3. LET STAND FOR 24 HOURS. 4. REFILL TANK. 5. TANK IS APPROVED IS WATER LEVEL IS HELD FOR 1 HOUR.
 6. ONLY KITCHEN WASTE SHALL BE DIVERTED TO THE GREASE TRAP.



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Sewer and Water Authority

STANDARD DETAILS

Scale: NONE
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PART IV – APPROVED PROCEDURES



MHOG Approved Procedure for Disinfecting Water Main

This Standard Operating Procedure (SOP) is based on the requirements of AWWA Standard C651-14, Disinfecting Water Mains, and describes the essential procedures necessary to ensure sanitary conditions are achieved and documented prior to connection of newly installed main to the existing MHOG Potable Water System.

Pre Chlorination Flushing Procedure:

Prior to disinfection, the main shall be pigged and flushed to remove particulate material from the main that can contain bacteria. Following pigging of the main, the main shall be filled with potable water to eliminate air pockets and remove small size particulate matter remaining after pigging. The flushing velocity in the main shall not be less than 3.0 ft/sec unless site conditions do not allow for discharge to waste at that velocity. The table below shows the required flow and inlet and outlet opening sizes to flush pipelines at 3 ft/sec.

Pipe Diameter (in)	Flow Required to Produce 3 ft / sec (gpm)	Size of Tap Used (in)			Number of Hydrant Outlets	
		1 in	1.5 in	2 in	2.5 in	4.5 in
		Number & Size of Taps Required on Pipe				
4	120	1	-	-	1	1
6	260	-	1	-	1	1
8	470			1	1	1
10	730	MHOG can supply up to a 2-inch hydrant meter. For higher flows, work with the MHOG Utility Dept. to achieve necessary velocity			1	1
12	1,060				2	1
16	1,880				2	1

Please note that during flushing, each hydrant should be opened to fully remove any air pockets from the main starting with the hydrant nearest the tap or connection point first. Potable water can be obtained only by using a temporary hydrant backflow preventer and meter obtained from the MHOG Utility Department or by other means arranged with the MHOG utility Department. Following flushing, the water should run clear and not milky, which indicates the presence of entrained air in the main.

Chlorination Procedure

Only following pigging and flushing of the main, and prior to service lead installation, can chlorination occur. Note that sodium and calcium hypochlorite used for disinfection must conform to ANSI/AWWA B300. Do not use calcium hypochlorite intended for swimming pool disinfection as this material has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time has been achieved.

For main up to 16-inches in diameter, the continuous feed method of chlorination is required. The slug method may be utilized for mains 20-inches in diameter or larger. At the point of beginning of the new main, inject chlorine into the water at a constant rate such that the water will not have less than 25 mg/L of free chlorine. The free chlorine concentration shall be measured at regular time intervals using a chlorine test kit. To determine the amount of chlorine to place into the water main utilize the following formula:

$$\text{Chlorine, lbs} = (\text{Volume of Water, gal})(25 \text{ mg/L})(8.34 \text{ lbs/gal})$$

Chlorine application shall not cease until the entire main is filled with chlorinated water. The chlorinated water shall be retained in the main for at least a 24 hour period, during which time valves and hydrants in the treated section are operated to ensure disinfection of those appurtenances as well.

At the end of the 24 hour period, the treated water shall have a residual of not less than 10mg/L. After the applicable chlorination period of 24 hours, heavily chlorinated water shall not remain in prolonged contact with the pipe. To prevent damage to the pipe, the heavily chlorinated water shall be flushed from the main, fittings, valves, and hydrants until chlorine concentration in the water leaving the main is no longer higher than that generally in the distribution system or below 2ppm (mg/L). Resident Professional Engineer shall be present for all flushing's.

The environment to which the highly chlorinated water is being discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, a neutralizing chemical and dechlorinating device shall be used. If a dechlorinating device is used, then the velocity of flushing shall not exceed the rated capacity of the device.

Note that if MHOG staff is on-site to take samples, and the chlorine residual is higher than 2ppm mg/L), the contractor will be responsible to re-flush the water main until the residual is at the acceptable level. The contractor will also be required to pay a re-trip fee of \$25.00 which must be paid before re-scheduling the sampling.

1. A second sample will be collected 24 hours after the first sample and 48 hours after flushing of the highly chlorinated water. Additional information regarding sampling is presented below.

Other Sampling Notes:

1. MHOG does not obtain samples on the weekend. The contractor must schedule the first sample no later than Wednesday of any given week.
2. MHOG requires a minimum of 24 hour notice to schedule sampling.
3. MHOG will obtain two samples from the same location, 24 hours apart.
4. If the construction job has more than one tap, MHOG will sample all the taps during a single sampling event.
5. MHOG requires one sample site per every 1,500 linear feet of pipe, unless otherwise approved by MHOG.
6. Hydrants can be used as sample points and MHOG will supply the sample tap to attach to the hydrant.

MHOG will notify the site resident project representative when the samples have either passed or failed. If a sample fails, the disinfection procedure outlined above must be performed again.

Scheduling:

To schedule meter and backflow rental or bacteriological sampling; please call the MHOG Utility Department at 810.224.5835.

MHOG Water Distribution Approved Materials List					
Product Type	Material	Applicable Size	Manufacturers / Source	Model # /Type	Additional Requirements
Water Main Including T's and	Ductile Iron Pipe	3-24 inch	All	Pressure CL350; CL52	
	HDPE	3-24 inch	All	DR-11	Directional Drill Only
Water Main Fittings	Mechanical Joint - Restrained	Per Pipe Diameter	EBAA Iron	Mega Lugs 1100T Series	Provide Flouorocarbon T-Bolts
	Restrained Push Joint Gaskets	Per Pipe Diameter	Per Pipe Manufacturer	Per Manufacturer	
	Gaskets	Per Pipe Diameter	Per Pipe Manufacturer	Per Manufacturer	Environmental where specified
	HDPE - Ductile Iron Conversion	Per Pipe Diameter	Per Pipe Manufacturer	Per Manufacturer	Manufactured by same
	Sleeves Cast Iron	Per Pipe Diameter	Tyler Union/EJIW or A/E	Per Manufacturer	
	Bolts	Per Pipe Diameter	Trumbull or A/E	T-Head Bolts	COR-BLUE
Gate Valves	Cast Iron	3-12 inch	Mueller	A-2360	Open left only, coat bolts with undercoating
	Cast Iron	3-12 inch	EJIW	Flowmaster Series	Open left only, coat bolts with undercoating
Butterfly Valves	Cast Iron	16 - 24 inch	Pratt, EJIW, Dezurik	Per Manufacturer	Open left only, gate well required, mechanical operator, coat bolts with undercoating
Tapping Sleeve and Valve	#304 stainless steel minimum	All Sizes	Romac SST, JCM Industries, or A/E	Full Stainless Steel Construction Per Manufacturer	Gate Well required
Check Valve	Cast Iron	All Sizes	Clow, M&H, Kennedy, Rensselaer or A/E	Swing or Ball	Per Plans and Specifications
Fire Hydrants	Ductile Iron/Cast		EJIW	5BR-250 - 6 FT Bury Depth	Storz fitting required on steamer port, red in color, drian plugs fully closed
Corporation Stops	Brass	1 - 2 inch	Ford Meter Box	CCXCOMP B25008	Lead free, brass, compression
	Brass	1 - 2 inch	Mueller Co.	FB1000-x-Q	Lead free, brass, compression
Curb Stops	Brass	1 - 2 inch	Ford Meter Box	B44-XXX-Q-NL - (XXX per size)	Minneapolis Pattern, compression only
	Brass	1 - 2 inch	Mueller Co.	MNP Comp B25155- All sizes	Minneapolis Pattern, compression only
Curb Boxes	Cast Iron	1 - 2 inch	Ford Meter Box	EM2 Series	Grease threads on center nut
	Cast Iron	1 inch	Mueller	H-10300	Grease threads on center nut
	Cast Iron	1.5 - 2 inch	Mueller	H-10302-99005	Grease threads on center nut
Riser Rods	Stainless Steel Rod	1.5-3 feet	Per manufacturer of curb box	Per Manufacturer	Required on all Curb Stops regardless of size, stainless steel pin required
Service Lines	Copper	1-2 inch	All	Type K - Soft	Sand backfill required
	HDPE	1-2 inch	All	DR-11 CTS	Directional drill only, tracer wire required
MH Covers	Cast Iron	26 inch Opening	EJIW	1040 - Water	MHOG Logo
Valve Boxes & Covers	Cast Iron		Tyler Union/EJIW/OE		Must be labeled water on cap
Tracer Wire Boxes			Copperhead	CD14*TP Blue Top	Model RB14*TP for asphalt installations
Tracer Wire			Copperhead	10#CCS - 600# Breakload	Single strand copper
Hydrant Flags	Steel with integral steel coil		USA Bluebook	Part No. 75193	Attach to top flange, reflective
Polyethlyne Pipe Wrap	Polyethlyne	Per Pipe Schedule	Christy's or AE	8 mill thick	Required on all Ductile Iron Pipe

Genoa - Ocoala Wastewater Collection System Approved Materials List

Product Type	Material	Applicable Size	Manufacturers / Source	Model # / Type	Additional Requirements
Gravity Main Pipe	SDR -26	8-18 inches	All	SDR-26 ASTM D3034	Bell and Socket Joint
	F679	18-60 inches	All	PVC Pipe ASTM F679	Bell and Socket Joint
Sanitary Wye Fittings	PVC to match approved mainline pipe material	6 inch			For use in constructed sanitary wye installation
	Ductile Iron, SS, and Butly Rubber	6 inch on 6-18 inch	Romac	Model CB Sewer Saddle	Core in wye installation
Force Main Pipe	Ductile Iron Pipe	2-20 inch	All	Per Manufacturer	Bell and Socket, Megalugs on fittings
	C-900 PVC	2-20 inch	All	Per Manufacturer	Bell and Socket, Megalugs on fittings
	HDPE	2-20 inch	Drisco Pipe, Performance Pipe, or A/E	Per Manufacturer	Manufacturer supplied transition required for HDPE to Ductile
Forcemain Main Fittings	Mechanical Joint - Restrained	Per Pipe Size	Per Pipe Manufacturer	Per Manufacturer	
	Push Joint - Restrained	Per Pipe Size	Per Pipe Manufacturer	Field Lock, TR Flex, Fast Grip	
	Gaskets	Per Pipe Size	Per Pipe Manufacturer	Per Manufacturer	
	HDPE - Ductile Iron Conversion	Per Pipe Size	Per Pipe Manufacturer	Per Manufacturer	
	Sleeves	Per Pipe Size	Per Pipe Manufacturer	Per Manufacturer	Permitted for repairs only
	Bolts	Per Pipe Size	Trumbull	Core-Blue	
Sanitary Valves	Plug Valve - Cast Iron	3-24 inch	DeZurick, Clow, Homestead, Pratt, or AE	Round port design	Mechanical Operator Required
	Check Valve	3-24 inch	DeZurick, Clow, Homestead, Pratt, or AE	Swing Check	Weighted arms required
Manholes	Concrete	48 inch minimum	Northern, Co-pipe, or AE	Precast, Booted, Flow Channel	All new sanitary installations, vaccum test required
	Concrete		Northern, Co-pipe, or AE	Doghouse	Permitted on forcemain installations only
Manhole Lining	Interior Corrosion Protection	All	Spectrashield / Obic		Required on all forcemain to gravity connections
	Exterior Butyl Wrap	All	WrapidSeal or A/E		Required on all joints and adjustment rings
Service Lines	PVC	6 inch	All	SDR-26	Sand backfill required
Manhole Covers	Cast Iron	26 inch opening	EJIW	1040 - Sanitary Sewer	"Sanitary Sewer", rubber gasket
Manhole Grade Rings	Concrete	1-3 inch			No more than 8-inch adjustment, grouted in place
Cleanout Lid	Cast Iron	4 -6 Inch	EJIW	EJIW-1574	Required on all clean out structures in pavement or green belt
Combination Air Vac Valves	Composite	2 inch	ARI	D-025	Valve Centered in Manhole
Combination Air Vac Fittings	#304 Stainless Steel Ball Valve	2 inch	All	Per Manufacturer	
	#304 Stainless Steel Pipe Nipple	2 inch	All	Per Manufacturer	
Tracer Wire	Tracer Wire		Copperhead	Soloshot, 10#CCS - 600# Breakload	Required on directional drilled sewer, single strand copper
	Tracer Wire Box		Copperhead	CD14*TP - Green Top	Model RB14*TP for asphalt installations
Polyethlyne Pipe Wrap	Polyethlyne	Per Pipe Schedule	Christy's or AE	8 mil thick	Required on all Ductile Iron Pipe