SECTION 615 Storm Sewer

615.1 General

The design of a storm sewer system is based on information obtained from a survey conducted before preparation of plans for the project. Generally, time elapses between the initial surveys and the beginning of work. Changes in the surface drainage, existing sewers, underground utilities, and other features may occur during this time. Therefore, the project engineer upon arriving on a project should check the plan and profile sheets, drainage structure sheets, point of connection to existing sewer or point of discharge and all other drainage sheets for discrepancies and deviations from field conditions. Any discrepancies noted should be investigated. Existing field conditions should be provided with proper drainage.

To avoid damage or interference with local utilities or facilities of a municipality, a thorough check is to be made by the contractor of their locations before excavation. Utility location plans should be reviewed, and the utilities should be exposed. Pertinent elevations and other measurements should be taken before attempting any necessary adjustment or redesign of sewers or appurtenances. Check separation distances from existing or proposed watermains, especially if unexpectedly encountered during construction. State and local requirements require horizontal or vertical separation of storm and sanitary sewers from watermain unless protected by special material or joints.

It is very important to remember that any change in sewer grade will affect both flow velocity and capacity and may justify a change in pipe size. A change in horizontal or vertical alignment can affect the class of pipe used. Consult the fill height tables in FDM 13-1-25 to confirm maximum fill heights for the specified materials. Before changes are implemented, a check should be made with the region and the FDM.

The project engineer or inspector should inspect pipe as soon as possible after delivery to the job. The inspection should cover dimensions, soundness, and markings including class, damage incurred during shipment or unloading, or defects overlooked at the plant. Pertinent information concerning any rejected pipe should be recorded in field notebooks. Refer to the Materials Testing and Acceptance Guide in CMM 850 for pipe acceptance conditions.

Pipe delivered to the project site should be handled, and if not immediately installed, stored in a manner to prevent potential damage. Refer to CMM 550.4 for additional guidance regarding the storage and handling of pipe before installation.

The layout for the storm sewer is typically conducted by a staking contractor. The project engineer or inspector should confirm that the staking and storm sewer contractors are aware of any changes to the approved plans before any staking or computation of grades. Although the contractor is responsible for staking, the project engineer or inspector should still spot check grade stakes and verify cut sheets. In addition, a requirement of contractor staking is for the staking contractor to verify that the final elevations of storm sewer pipe outfalls and inlets match the existing field elevations and provide this information to the project engineer at a mutually agreed upon date or least 14 calendar days before ordering inlets, catch basins, manholes, endwalls, and storm sewer pipe. Further details on storm sewer construction staking, including requirements for contractor staking, can be found in CMM 720 and standard spec 650.

Before staking, the location of the stakes relative to the sewer structures should be determined in a conference with the contractor, recognizing the type of operation and construction procedures. A duplication of stake placement can often be eliminated by knowing where the pipe is to be stockpiled, whether the excavated material is to be loaded into trucks or placed along the roadway, and other details regarding the sewer installation procedure.

When laying out sewer structures, it should be noted that the center of the sewer is not necessarily the center of the top opening in the structure. Adjustments in the layout may have to be made to ensure proper location of the frame on the structure. Special care must be taken in the layout process to ensure location and elevation are correct.

615.2 Excavation

Trenches must be carefully examined to ensure bracing and sloping in the excavation are performed in accordance with the WisDOT standard specifications and OSHA regulations. Any trench considered unsafe by the project engineer or inspector should not be entered until necessary corrections have been made. Safety precautions in CMM 135 must be maintained to the highest degree during excavation due to the dangerous nature of this work.

Loads acting upon a pipe increase with the width of the trench as well as with the height of fill above the top of the pipe. To ensure against the occurrence of a greater load upon the pipe than the design load, trench width and trench wall limitations are necessary. Trenches should be wide enough to provide free working space on each side of the pipe. Generally, this space must not exceed 1/2 the nominal diameter of the pipe, and never be less than 6 inches. The required working space depends upon the size of the pipe and the character of the material in the excavation. For concrete pipe, the trench width should be

enough to allow for preparing the foundation, laying the pipe, and placing and compacting backfill, but not exceed the pipe's outside diameter by more than 36 inches. For composite, polyethylene and polypropylene pipe ensure minimum trench width is not less than the greater of either the pipe outside diameter plus 16 inches or the pipe outside diameter times 1.25, plus 12 inches. ASTM D2321 and AASHTO LRFD Bridge Construction Specifications Section 30 provide additional guidance on the installation of polyethylene and polypropylene pipe.

In addition to the trench width limitations stated above, the contractor should excavate the trench below the top of pipe as vertical as possible when the final height of the proposed fill above the top of the pipe will exceed 6 ft. Sliding the trench box or shoring to a new location in the excavation, especially with polyethylene and polypropylene pipe, should be avoided unless special measures are taken to avoid disturbing the pipe and backfill or leaving voids as the shield is advanced. Such measures may include; using a subtrench, lifting the trench box during pipe installation to both conform with OSHA requirements and to properly backfill and compact the soil around the pipe, or other manufacturer approved methods. While following proper worker safety requirements, the trench box or shoring should be properly removed, and the resulting voids backfilled and compacted.

615.3 Forming Foundation

Standard spec 608.3.2 specifies excavating and forming the foundation and bed for storm sewer under public highways. Pipe foundation is the part of the terrain that supports the pipe and the forces of any loads superimposed upon the pipe. Pipe bedding, or foundation backfill as depicted in figure CMM 550-1 is the portion of the foundation in immediate contact with the pipe.

The contractor must excavate for foundation backfill at least 6 inches below the elevation established for the bottom of the pipe unless the project engineer determines that the existing foundation material for this depth conforms to standard spec 608.2.2.2. If rock, hardpan, or fragmented material exists, the trench is to be excavated the greater of 6 inches below the pipe or to a depth equal to 1/2 inch per foot of proposed embankment above the top of the pipe. Additional excavation may be needed for pipe bells. Figure CMM 550-1 depicts trench width, bedding and backfill requirements for storm sewer and pipe culverts.

If the pipe trench bottom is inadvertently over-excavated below intended grade, the over-excavation should be filled with mechanically compacted foundation backfill at no additional cost to the department. Major foundation problems should be brought to the attention of the project engineer and region soils engineer for resolution.

615.4 Laying Sewer

Pipe can be placed by various means, which are acceptable, if damage to the pipe or the foundation bed does not occur. Proper joints are essential in good sewer construction. As preferred installation methods may vary based on material, the contractor should comply with manufacturer's recommendations for assembly of joint components, lubrication, and making of joints. Polyethylene, polypropylene and composite pipe should be handled with great care to prevent damage during installation. These materials should not be handled with chains. Individual lengths of pipe can typically be handled using a nylon sling or cushioned cable secured around the third points of the pipe. Consult the manufacturer data for specific handling and storage requirements or additional information. The directions of the manufacturer should also be followed closely to ensure a tight joint. Standard spec 608.3.4 describes additional requirements for joints.

High grade on the pipe should not be corrected by alternately lifting and dropping the pipe. Care should be exercised to prevent the moving of a previously placed pipe when setting a new pipe. Line and grade should always be checked after the pipe is in final position. When pipe laying is interrupted, the contractor should secure piping against movement and seal open ends to water, mud, or foreign material from entering.

In areas where existing underground utility lines may interfere with proposed storm sewer work, grades for the storm sewer may have to be adjusted to not interfere with the existing utility lines. In these cases, it may be necessary to construct manholes after construction of the sewer line.

Reinforced concrete storm sewer pipes are required to be tied at the joints with joint ties to prevent separation of adjacent pipe sections. This is required at the last 3 sections of the system infalls and outfalls. When using apron endwalls, the endwall and the last 2 sections are tied. No ties are required on storm sewers infalls or outfalls with masonry endwalls unless the plans show otherwise.

Joint ties are not required for thermoplastic pipe where a full (+/- 20 foot) pipe section is utilized from the infall and outfall to the first joint. Where a partial pipe section must be used at the infall or outfall end, it should be restrained with a manufacturer supplied external mechanical coupling, a mastic impregnated geotextile wrap with mechanical fastening bands, or a concrete collar. Apron endwalls must be secured to the pipe. No ties are required on pipes with masonry endwalls unless the plans show otherwise.

Final sewer locations, elevations, and unusual ground conditions should be recorded by the inspector for future reference.

615.5 Backfilling

The backfill material should have a moisture content suitable for acceptable consolidation with the compaction tools used. The material provided should have a liquid limit less than or equal to 25 and a plasticity index less than or equal to 6.

615.5.1 Foundation Backfill

In order that a pipe may successfully support the loading to which it may be subjected without excessive distortion or rupture of the pipe, and to preclude settlement problems, it is essential that adequate lateral support be provided for the pipe by thorough consolidation of the backfill between the pipe and the walls of the trench. To facilitate this, pipes are to be embedded in compacted foundation backfill as defined by standard spec 608.2.2.2 from a minimum 6 inches or more below the bottom of the pipe to 12 inches above the top of pipe. Foundation backfill is virgin material consisting of either sand-sized particles or sand-sized particles mixed with gravel, crushed gravel, or crushed stone. For storm sewer only, the contractor may supply crushed stone chips conforming to standard spec 608.2.2.2. The contractor may use material from the work site only if it meets specifications.

Before pipe placement, the foundation backfill is to be mechanically compacted. After pipe placement, mechanically compacted lifts, not measuring more than 6 inches after compaction, are to be placed to an elevation 12 inches above the top of pipe. To ensure against disturbance of the pipe alignment, each layer of backfill material must be placed, compacted, and brought up uniformly on each side of the pipe.

While compaction is essential and required by specification throughout the foundation backfill zone, special emphasis has been placed on compacting material under the lower portion of the pipe. Backfill material placed in the area under the lower half of the pipe must be thoroughly compacted. In narrow trenches where access and working conditions may be difficult, there may be a tendency to slight this work, particularly in the haunch areas directly under the pipe. Hand work may be required to fill voids under the pipe. Shovel slicing, rodding and hand tamping are an effective means of achieving support in the haunch zone. Adequate compaction of foundation backfill in the haunch zone is important for all pipe materials, but is particularly important for polyethylene, polypropylene, and composite pipes where the pipe and bedding interaction is critical to developing the strength to support vertical loads applied to the pipe.

615.5.2 Trench Backfill

Starting 12 inches above the top of the pipe, the remaining trench, if any, must be backfilled with compacted trench backfill. Trench backfill is to be placed to the top of the subgrade in layers no more than 8 inches thick after compaction. Backfilling details are shown in figure CMM 550-1.

Allowable trench backfill materials for storm sewers are not the same as trench backfill for culvert pipes. Trench backfill material for storm sewer must be either granular backfill meeting standard spec 209.2 or material meeting the requirements for culvert foundation backfill under standard spec 520.2.5.2.

Pipe should be protected from construction traffic after placement. If 2 or more feet of cover is not provided by foundation and trench backfill, it may be necessary to temporarily place a "cushion" of compacted earth embankment over the pipe for at least the trench width. This cushion is to protect the pipe from construction equipment during subsequent operations until such time the roadway pavements can be placed.

Polyethylene, polypropylene and composite pipe can be easily punctured, so care must be used to prevent mechanical equipment from directly contacting the pipe during backfilling.

Foundation and trench backfill are incidental to Storm Sewer.

615.6 Clean Out

According to standard spec 608.3.6 all new or re-laid sewers must be cleaned of silt and debris, and flow-tested with water or other project engineer-approved means before acceptance. All existing sewers must be cleaned by the general contractor of silt and debris accumulated as a result of the contractor's operations. Clean out operations should be done very late in the progress of the project to collect and remove the maximum amount of silt and debris.

615.7 Deflection Testing for Polyethylene and Polypropylene Pipe

Mandrel Testing is required for all polyethylene and polypropylene pipe culverts and storm sewers. Standard spec 608.3.7 and CMM 550.9 describe the requirements for mandrel testing. If deflection testing fails or significant construction issues occur with polyethylene and polypropylene pipe, please notify the statewide drainage engineer in the Central Office Roadway Standards Development Unit.