CHAPTER 500 INSTALLATION OF STORMWATER FACILITIES

SECTION 501 GENERAL

501.01 Pipe Cover, Grade, and Separation from Sanitary Sewers

Uniform slopes shall be maintained between inlets, manholes and inlets to manholes. Final grade shall be set with full consideration of the capacity required, sedimentation problems, and other design parameters. A minimum of 2.0 feet of vertical separation between storm sewers and sanitary sewers shall be required. When this is not possible, the sanitary sewer must be encased in concrete or ductile steel within 5 feet, each side, of the crossing centerline. There should be no less than 2.5 feet of cover along any part of the pipe from final pavement elevation or final ground surface elevation to the top of the pipe. Reinforced concrete pipe storm sewer minimum cover heights which are less than those described shall be evaluated on a case by case condition and approved only with written permission by the City Engineer.

A set of standard detail drawings is included on the City's website that provides guidance on the design and installation of various hydraulic structures that may not have been covered in this chapter. Adherence to the noted standard details shall be required in addition to other requirements in this chapter. In case of discrepancy, the most restrictive requirement shall apply.

501.02 Alignment

Storm sewers shall be straight between manholes and/or inlets. Storm sewers that cross existing or proposed streets shall cross perpendicular to the centerline and the length of the crossing shall be minimized.

501.03 Manholes/Inlets

All Manholes and Inlets must be pre-stamped with an appropriate message per Hamilton County Standard Detail Drawings, which can be found on the City's website. Manholes and/or inlets shall be installed to provide human access to continuous underground storm sewers for the purpose of inspection and maintenance. The casting access minimum inside diameter shall be no less than 22 inches or a rectangular opening of no less than 22 inches by 22 inches. Manholes shall be provided at the following locations:

1. Where two or more storm sewers converge.
2. Where pipe size or the pipe material changes.
3. Where a change in horizontal alignment occurs.
4. Where a change in pipe slope occurs.

The maximum allowed distance between inlets shall be 300-feet unless gutter spread calculations demonstrate that a greater spacing will still provide a 10-foot lane of traffic in accordance with Section 305.05. Under no circumstances shall inlets be spaced greater than 400-feet. If a spacing less than 300-feet is required based on gutter spread calculations in accordance with 305.05, the lesser spacing shall be provided.

In addition to the above requirements, a minimum drop of 0.1 foot through manholes and inlet structures should be provided. When changing pipe size, match crowns of pipes, unless detailed modeling of hydraulic grade line shows that another arrangement would be as effective. Pipe slope should not be so steep that inlets surcharge (i.e. hydraulic grade line should remain below rim elevation).

Manhole/inlet inside sizing shall be according to the Hamilton County Standard Detail Drawings, which can be found on the City's website. Note that the City of Carmel will require 2 foot sumps

in the last structure before the detention facility or wet pond, with the structure placed within 15 feet of the back of curb of a roadway. If the last structure does not meet this criterion, then the structure must be moved up the pipe run until this requirement is satisfied. Also, if this structure is a curb inlet and the structure sizing chart would allow this to be a 2' x 2' box, it must be upsized to a 48" manhole because of the 2' sump. Under no circumstances shall the depth form the top of casting to the bottom of the sump of an inlet exceed 5-feet. If the depth exceeds 5-feet, the structure shall be a manhole.

501.04 Installation and Workmanship

Bedding and haunching for all reinforced concrete pipe installations shall be #8 stone meeting the material requirements of the INDOT. The material shall be approved by the City of Carmel Department of Engineering at time of installation. Bedding shall be placed in the trench bottom such that after the pipe is installed to grade and line, there remains a 4-inch minimum depth of material below the pipe barrel and a minimum of 3-inches below the bell. For pipe sizes 66-inches and larger, the minimum depth of material below the pipe barrel shall be 6-inches.

Bedding shall be placed to be uniform as possible, but shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe. If the underlying soils of the trench bottom are soft or yielding, the soil shall be undercut to such a depth that when repaired with #2 stone it will produce a uniform and stable foundation along the entire length of the pipe. Haunching shall be compacted in 8-inch maximum lifts to not less than 90% Standard Proctor Density for the entire depth of the material placed. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Haunching shall extend to the springline of the pipe. Minimum trench width shall be the outside diameter of the pipe plus 18-inches.

Final backfill for all reinforced concrete pipe installations under and within 5-feet of pavement or sidewalk or other paved areas and for all installations within City right-of-way shall be B-Borrow for Structure Backfill meeting the material requirements of the INDOT. The material shall be approved by the City of Carmel Department of Engineering at time of installation. Final backfill shall be compacted in 6-inch maximum lifts to not less than 95% Standard Proctor Density for the entire depth of the material placed. The backfill for the top 6-inches of the excavation below the start of the aggregate sub-base of the pavement shall be No. 53 Stone meeting the material requirements of the INDOT and shall be compacted to not less than 95% Standard Proctor Density. Final Backfill for all reinforced concrete pipe installations greater than 5-feet of pavement shall be clean fill material free of rocks larger than 6-inches in diameter, frozen lumps of soil, wood or other extraneous material, compacted in 12-inch maximum lifts to not less than 90% Standard Proctor Density for the entire depth of the excavation. The final 6-inches of the excavation shall consist of topsoil.

The specifications for the construction of storm sewers and sub-drains not maintained by the City or are located outside of City right-of-way shall be per the manufacturer's recommendations

Dips/sags on newly installed storm systems, private or public, will not be allowed. Also, infiltration from cracks, missing pieces, and joints shall not be allowed. Variations from these standards must be justified and receive written acceptance from the City of Carmel. All structures and piping shall require inspection prior to backfill.

501.05 Special Hydraulic Structures

Special hydraulic structures required to control the flow of water in storm runoff drainage systems include junction chambers, drop manholes, stilling basins, and other special structures. The use of these structures shall be limited to those locations justified by prudent planning and by careful and thorough hydraulic engineering analysis. Certification of special structures by a certified Structural Engineer may also be required.

The use of Stormwater lift stations are not allowed within the City of Carmel.

501.06 Connections to Storm Sewer System

To allow any connections to the storm sewer system, provisions for the connections shall be shown in the drainage calculations for the system. Specific language shall be provided in the protective covenants, on the record plat, or with the parcel deed of record, noting the ability or inability of the system to accommodate any permitted connections, for example, sump pumps and footing drains.

1. **Sump pumps** installed to receive and discharge groundwater or other stormwater shall be connected to storm sewer manholes or curb inlets or rear yard subsurface drains. When such a connection to the storm sewer is not possible, discharge into other designated storm drainage facilities may be considered, if approved by the City of Carmel. Under no circumstances shall they be connected to the sanitary sewer.

2. **Footing drains and foundation or other perimeter drains** shall be connected to Manholes or Curb inlets or rear yard subsurface drains. When such a connection is not possible, they shall be discharged into designated storm drainage channels/swales, as a Legal Discharge, in accordance with the City of Carmel Property Maintenance Code. Under no circumstances shall they be connected to the sanitary sewers.

3. All **roof downspouts**, roof drains, or roof drainage piping shall discharge onto the ground, as a Legal Discharge, or directly connected to the storm drainage system as a Legal Connection or Legal Discharge as defined in the City of Carmel Property Maintenance Code. No downspouts or roof drains shall be connected to the sanitary sewers.

4. **Interior floor drains, garage drains, Basement floor drains, and water softener discharge** shall not be discharged to the storm sewers.

5. **Swimming Pool drains** shall not be connected to the storm sewers unless the water is dechlorinated prior to being connected to the storm sewer. However, water generated from filter backwash shall be directed to the sanitary sewer system.

6. Under no circumstances shall a system conveying sanitary or other waste or pollutants be connected to the storm sewer system.

Under no circumstances shall any of the above mentioned devices be connected to any street underdrains.

501.07 Construction Inspection and Approval

Once constructed, all storm sewer pipes and manholes shall be soil tight. The Contractor shall repair to the satisfaction of the City of Carmel all visible points of possible bedding and/or backfill infiltration into the system. The method of repair shall be per the approval of the City of Carmel. When necessary, the Contractor shall remove and reconstruct as much of the work as is necessary to obtain a system that passes the minimum tests prescribed herein.

A. Mandrel Test for Plastic Pipes and Sub-Surface Drains

No sooner than 30-days after installation, all gravity flow storm sewers constructed of flexible pipe (PVC and HDPE) 33-inch in diameter or smaller and all Sub-Surface Drains

(SSD) shall be mandrel tested. A representative of the City of Carmel shall be present on-site during all mandrel tests. The City of Carmel shall be given written notification of the proposed testing times and locations at least 48 hours prior to the intended time for beginning of the tests. Arrangements for the cost and supply of all equipment necessary to perform mandrel tests shall be the responsibility of the Contractor and Owner.

Mandrel tests shall be conducted under the supervision of the City of Carmel or the City of Carmel's Observer.

A seven and one-half (7-1/2) percent "GO/NO-GO" Mandrel Deflection Test shall be performed on all PVC and HDPE gravity storm sewer pipe.

These pipes shall be mandrel led with a rigid device sized to pass seven and one-half (7-1/2) percent or less deflection (OR deformation) of the base inside diameter of the pipe. The mandrel test shall be conducted no earlier than 30-days after reaching final trench backfill grade.

The mandrel (GO/NO-GO) device shall be cylindrical in shape and constructed with nine (9) or ten (10) evenly spaced arms or prongs. Variations of mandrel diameter dimensions due to pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the diameter dimension of the mandrel but shall be counted as par of the 7-1/2% or lesser deflection allowance. Each pipe material/type required to be Mandrel tested shall be tested with a mandrel approved by the City of Carmel and meeting the requirements of this chapter. The mandrel diameter dimension shall carry a minimum tolerance of 0.01 inches.

The mandrel shall be hand pulled through all sewer lines and any section of sewer not passing the mandrel shall be uncovered, replaced or repaired, and retested.

The contact length (L) shall be measured between points of contact on the mandrel arm.

The Contractor shall provide proving rings to check the mandrel. Drawings of mandrels with complete dimensions shall be furnished by the Contractor to the City of Carmel upon request for each diameter and specification of pipe.

PVC or HDPE pipes that are 36-inch in diameter or larger shall be inspected through visual recordings (via closed circuit television) as well as a walk through (visual survey) inspection with the contractor, developer, and a representative from the City of Carmel. Copies of televised inspections shall be provided to the City of Carmel.

B. CMP and RCP Inspections

All reinforced concrete and corrugated metal storm sewer pipes that are 36-inch in diameter or larger shall be inspected through a walk through (visual survey) inspection with the contractor, developer, and a representative from the City of Carmel.

All reinforced concrete and corrugated metal storm sewer pipes 33-inch in diameter or smaller are required to be inspected through closed circuit television viewing (CCTV) at the developer's or contractor's expense by the City of Carmel's representative as described herein. In those instances where CCTV is a required part of the stormwater permits approval, this televised viewing shall be completed in conformance with these minimum guidelines. The inspection between manholes shall be conducted as follows:

1. A camera equipped with remote control devices to adjust the light intensity and one thousand (1,000) lineal feet of cable shall be provided. The camera shall be

able to transmit a continuous image to the television monitor as it is being pulled though the pipe. The image shall be clear enough to enable the City of Carmel to easily evaluate the interior condition of the pipe. The camera should have a digital display for lineal footage and project number and an audio voice-over shall be made during the inspection identifying any problems.

2. The pipe shall be thoroughly cleaned before the camera is installed and televising is commenced. Cleaning of the pipe shall be the responsibility of the owner.

3. The CD – Digital format, as directed by the City of Carmel, of the entire storm sewer line and reproduction map indicating the pipe segment numbers of all the pipe that has been televised shall be submitted to the department for review and placement in their permanent file. The pipe should be flooded with clear water just prior to video recording to show any bellies or sags in the pipe.

These inspections shall be required in order to identify, as examples, excessive sedimentation, joint failures, excessive deflections (CMP), damaged coatings or pavings (CMP), structural defects misalignments, sags, or other system defects which have the potential of affecting the hydraulic performance, durability, or structural integrity of the line segment. Reference should be made to Chapter 400 of this manual for guidance on criteria sufficient to warrant rejection of the installed storm sewer system.

Excessive deflection of CMPs shall be considered to exist under the following conditions: variations from a straight centerline; elliptical shape in a pipe intended to be round; dents or bends in the metal. Metallic or bituminous coatings that have been scratched, scraped, bruised, or otherwise broken shall be considered acceptable criteria for rejection of the installed system.

Any pipe and/or joint found to be defective as a result of the televised viewing shall be required to be repaired or replaced to the satisfaction and approval of the City of Carmel. A re-televising of that portion of the storm sewer line identified as needing repair or replacement shall be required.

C. Manhole and Box Inlet Inspection

Each manhole and/or box inlet structure within all storm sewer line segments shall be visually inspected by a representative of the City of Carmel prior to backfill to ensure seams are sealed, pipes have concrete collars, and structure is watertight. A secondary inspection by a representative of the City of Carmel shall be required to check for excessive leakage, backfill infiltration, or improper workmanship and materials. Manholes or box inlet structures which fail to meet minimum construction standards shall be repaired or, if necessary, replaced, and re-inspected.

501.08 Roadway Subsurface Drain Tile

Roadway subsurface drain tiles shall not exceed 800-feet in length before discharging to a storm sewer structure. All roadways, alleys, and drives with inverted crowns shall be provided with a subsurface drain under the inverted crown.

TABLE 501-1

Typical Values of Manning's "n"		
Material	*Manning's "n"*	*Maximum Velocities (feet/second)*
Closed Conduits		
Concrete	0.013	10
Vitrified Clay	0.013	10
HDPE	0.012	10
PVC	0.011	10
Circular CMP, Annular Corrugations, 2 2/3 x ½ inch		
Unpaved	0.024	7
25% Paved	0.021	7
50% Paved	0.018	7
100% Paved	0.013	7
Concrete Culverts	0.013	10
HDPE or PVC	0.012	10
Open Channels		
Concrete, Trowel Finish	0.013	10
Concrete, Broom Finish	0.015	10
Gunite	0.018	10
Riprap Placed	0.030	10
Riprap Dumped	0.035	10
Gabion	0.028	10
New Earth **(1)**	0.025	4
Existing Earth **(2)**	0.030	4
Dense Growth of Weeds	0.040	4
Dense Weeds and Brush	0.040	4
Swale with Grass	0.035	4

Source of manning "n" values: HERPICC Stormwater Drainage Manual, July 1995.

(1) New earth (uniform, sodded, clay soil)

(2) Existing earth (fairly uniform, with some weeds).

FIGURE 501-1
Bedding and Backfill Standards for Storm Sewers