SUSSEX COUNTY
DESIGN STANDARDS

SUSSEX COUNTY
ENGINEERING DEPARTMENT

GEORGETOWN, DELAWARE

January 30, 2023

Sussex County Engineer

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I. Introduction

The Sussex County Engineering Department (SCED) is responsible for all engineering design, construction, operation, and maintenance of public sanitary sewer utilities for unincorporated areas in Sussex County. This includes plan review, approval and installation inspection of public sewer systems and pump stations.

The Sussex County Design Standards manual, herein referred to as the "Manual", is intended to provide design criteria and standard practices applicable to sewer infrastructure under the jurisdiction of Sussex County Council. Technical requirements included herein are intended to assist Land Developers and Engineers when designing and constructing public sanitary sewerage facilities and related site improvements within Sussex County. Both Land Development Projects and County Capital Projects shall conform to the procedures, requirements and criteria provided. The term "Engineer" as used throughout refers to a Developer's Engineer, or an Engineer hired by Sussex County, except where preceded by the word "County", in which case that phrase refers to the Sussex County Engineer.

This document is not intended to restrict the Engineer's opportunity to create innovative, practical, and economical designs. Rather, it is intended to assist the Engineer in implementing projects efficiently within the framework of the design parameters established herein. From time-to-time content in this Manual may require modification to comply with new practices or policies, and as such an updated Sussex County Design Standards manual will be issued. Additionally, the engineering community is encouraged to provide suggested revisions to clarify and/or improve upon manual components by submitting written recommendations to the Sussex County Engineer.

Sanitary Sewer requirements contained in this Manual are applicable to all Land Development and County Capital Projects not yet in construction as of the published Manual date, unless otherwise approved by SCED. For design standards related to community street and road networks, refer to *Sussex County Code § 99 Article III*.

II. General Requirements

1. General

1.1 Manual Outline

This Manual was created by SCED to provide the minimum standard criteria for Engineers to prepare designs and related documentation for public sanitary sewerage utilities proposed to be constructed, operated and maintained within Sussex County.

The Manual is a guideline for use in conjunction with Sussex County Standard Details where referenced and as may be applicable.

1.2 Waivers

If the Engineer for any reason finds it necessary or desirable to use procedures, standards, or criteria other than those set forth in this Manual, the Engineer must apply to SCED for a waiver of a design requirement or any other part of the County Standards. The written waiver request is to be addressed to the Sussex County Engineer and shall, at a minimum, contain a narrative indicating the design objective and the justification for the request.

1.3 Responsibility of the Engineer

While the requirements described in this Manual for various aspects of design include and cover most conditions encountered, there is no intention to relieve the Engineer's responsibility to recognize when conditions are not favorable for the application of published design standards. In the preparation of the Construction Documents, the Engineer shall consider such factors as environmental impact, maintenance of pedestrian and vehicular traffic, maintenance of existing and proposed utility services, constructability and system maintenance, and shall produce the overall most cost-effective design in consideration of minimizing system maintenance and operation requirements.

1.4 Limitation of Manual

It is not possible to include in this Manual all features of design and drafting necessary to produce comprehensive Construction Documents for all projects. The topics addressed are limited to those that will assist the Engineer perform most tasks in an efficient manner and comply with County standard practices. Although the Engineer's responsibility is to exercise professional judgment in the acceptance or use of the standards or features of design included herein, the Engineer shall recognize that they are provided to assist in the development of the project in the manner preferred by Sussex County. All deviations from the design standards must be brought to the attention of the SCED. Waivers from the Sussex County Standards must be justified to SCED as noted herein from an engineering evaluation standpoint that includes consideration of material availability, method of installation, life cycle costs and ease of maintenance.

1.5 Conflicts

If an apparent conflict is identified between any part of the Manual and/or any other County document or specification the SCED shall interpret, clarify, and resolve the same, and its decision shall be final.

2. Plan Review and Implementation Process

2.1 Utility Planning Division Approval

As part of the Concept Development phase for a project that involves connection to the County sewer system, the Engineer, Developer, or property owner is required to submit a Sewer Service Concept Evaluation (SSCE) to the

Utility Planning Division for review. Once all required information and associated fee has been received and reviewed, a division representative will provide an official SSCE response including identification of system connection point(s), potential service to off-site parcels, sewer district status, and necessity of a Use of Existing Infrastructure Agreement. SSCE requirements can be found here: https://sussexcountyde.gov/sewer-service-concept-evaluation-requirements

Applicants are referred to *Sussex County Code § 110* for requirements related to use of County sewer collection and/or transmission capacity and associated infrastructure agreements.

2.2 Engineering Approval Process

Upon Preliminary Approval of the proposed project from Planning & Zoning, if applicable, and completion of SSCE, the Developer's Engineer shall submit to Utility Planning & Design Review all required project materials along with a completed Sussex County Engineering Plan Submission Form summarizing the applicable project information. The submission shall also include all review fees as outlined in the most current Submission Form.

Under no circumstance shall there be a submission of Construction Documents to Utility Planning and Design Review without an approved SSCE within the Sussex County Unified District and Planning Area.

3. Preparation of Sewer Construction Plans

3.1 General Requirements

Contract Documents for construction projects in Sussex County are commonly comprised of construction plans and construction specifications. Taken together, these documents form the basis for the construction contract between the Developer or County and the Contractor. Contract Documents are prepared by the Engineer, who is responsible for a complete description of all work to be performed, in accordance with information in this Manual and other applicable County Standards. The Engineer is responsible for adequately designing, detailing, and specifying all contract-related materials and methods of construction required to complete the project.

3.2 Purpose

The primary purpose of construction plans is to show the size, horizontal and vertical location and type of materials and structures to be installed as part of a proposed new or modified sewer system. The construction plans must be developed in sufficient detail to depict the improvements and their spatial relationship with both existing conditions and planned future system improvements. Future system improvements will be identified by the County as part of the SSCE and/or Engineering Approval Process.

3.3 Topographic Mapping

Unless otherwise directed by SCED, project mapping will be referenced to the Delaware State Plane Coordinates North American Datum (NAD 83/91) and the North American Datum 1988 (NAVD 88). A minimum of two (2) project traverse points/benchmarks with identified horizontal and vertical control shall be provided within the limits of the project. The established control shall be on or within 1000 feet of the site and used for reference during construction. Benchmarks shall be established by Real Time Kinematic (RTK) Global Positioning Systems (GPS) and have horizontal accuracies of 2 centimeters and Vertical accuracies of 3 centimeters or better. Conventional traverses shall have a minimum closure ratio of 1:15000. GPS control points shall be established in accordance with the specifications and requirements of the Federal Geodetic Control Committee (FGCC) for using GPS relative positioning techniques as amended.

All control points shall be referenced in detail on the plans to permanently fixed objects that will not be disturbed during construction of the proposed project or other projects. Traverse points shall be clearly identified, and coordinates of each point shall be either shown at the traverse point in a neat manner, or in tabulation form on each plan sheet for which the traverse points occur.

Topographic mapping shall at a minimum include the locations, spot elevations, inverts, type, size and depth for the following items:

- All existing site features, such as curbing, driveways, sidewalks, buildings, pavement, light standard bases, concrete pads, trees, monuments, wells, valve boxes, manhole covers, cleanouts, electrical equipment, mailboxes, fences, etc.

- All surface and subsurface drainage features, natural or man-made, such as curb and gutter, pipes, catch basins, swales, streams, wetlands, ditches, storm drains, etc. Additional spot elevations beyond the site should be included to depict existing drainage patterns and/or waterways.

- Additional features and information should be shown including existing underground utilities such as well lines, water lines, water valves, fire hydrants, sewer lines, septic systems, drains, electric lines, communication/cable lines, etc.

- Delineations of floodplains and wetlands, including U.S. Army Corp. of Engineers 404 and State of Delaware wetlands should be included on the mapping. The wetland delineation shall be performed by a qualified professional with experience in wetlands delineation, and a signed statement shall be included on the drawing that verifies the accuracy of the delineation.

- Delineations of existing wood lines and any other pertinent existing physical features including limits and type of various surface materials such as streets and property access points.

- Existing and proposed contours at one (1) foot vertical intervals with spot elevations, except at 0.5 foot intervals where necessary to depict grades and predominant drainage patterns.

4. Permits and Approvals

4.1 General Requirements

Upon completion of the plans and specifications for a project and before a construction Notice-to-Proceed can be issued, authorization and approval must be received from all agencies that have jurisdiction over the project. These approvals are often granted in the form of a permit.

Permits issued by an agency are often contingent upon construction details and conformance with design features and working conditions that may require modifications to the normal plans and specifications. The Engineer is responsible for coordinating all such requirements within the construction plans and details for the project.

4.2 Federal and State Agencies

When grants and loans for project construction are involved through Federal and/or State agencies, such as the Delaware Department of Natural Resource and Environmental Control (DNREC) and USDA's Rural Utilities Services (RUS) section, these agencies exercise a separate right of approval over the construction documents.

4.3 Typical Permits

A description of typical permits and approvals that may apply to the various project types defined within the Manual is outlined below. All applicable permits and approvals, whether listed in this section or not, must be obtained prior to project construction.

4.3.1 Soil Erosion and Sediment Control: Construction plans must be reviewed and approved by the Sussex Conservation District (SCD) as applicable for compliance with the Delaware Standards and Specifications for Soil Erosion and Sediment Control.

4.3.2 Storm Water Management: Construction plans must be reviewed and approved by SCD, including all applicable Storm Water Management plans, details, and construction and inspection requirements.

4.3.3 Wetlands, Waterways and Floodplains: Projects involving impacts to the 100-year floodplain as defined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMS) will require review and approval by DNREC's Watershed Stewardship Division. depending on project impacts, a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR) may be required to be issued by FEMA in conjunction with associated revision to the applicable Flood Insurance Rate Map (FIRM).

Projects impacting waterways, streams, waters of the United States, tidal and non-tidal wetlands must be authorized by the U.S. Army Corps of Engineers and/or DNREC as may be applicable.

Wetlands must be delineated and reported in accordance with all Sussex County Code and Land Development Regulations. To satisfy all wetland permits, the wetlands must be delineated in the field and validated by the involved permitting agency.

4.3.4 Non-Point Pollutant Discharge Elimination System: Projects involving "construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale" must file a Notice of Intent (NOI) form to DNREC.

4.3.5 Construction Permit Applications: A wastewater construction permit from DNREC is required for all wastewater projects.

If a project or part thereof occurs within or across a Delaware Department of Transportation (DelDOT) right-of-way or easement, a utility construction or safety permit is required from DelDOT South District.

4.3.6 Other Permits: Project approval may require other permits or approvals not listed above. All required permits and approvals must be obtained by Developer and/or Engineer and submitted to SCED before construction can be authorized.

III. Sewer Design Standards

This section applies to the components of sanitary sewer systems and pumping stations proposed for construction under the jurisdiction of Sussex County. It addresses the selection and use of criteria and practices applicable to the design of sewer and force main projects in conjunction with *Sussex County Code § 110*. The subject matter includes the layout of piping systems, the selection and employment of materials, and the use of sewer appurtenances.

It shall be a responsibility of the Engineer to recognize when conditions are not favorable for application of a Sussex County Standard and to apply for a waiver (or modification) of a requirement when necessary, as previously outlined in the Manual.

1. General Requirements

1.1 Purpose

Sewer collection and transmission systems are designed to provide flow conveyance with total containment. New systems, extensions, or replacements not designed to provide total containment for the design period are not be permitted. Under no circumstances shall there be any unapproved discharge from a source to the sanitary sewer system without approval from the County Engineer. Refer to the specific requirements of *Sussex County Code § 110*.

1.2 Wastewater Flow Criteria

Unless specifically approved by the SCED, all components of a collection and transmission system shall be sized to handle the estimated build-out conditions based on zoning with applicable allowance(s) as defined by *Sussex County Code § 110*. The approved service area of the sewer system will be confirmed in conjunction with the SSCE process, including provisions for extending service to adjoining parcels and/or connections with existing sewer systems.

All peak design flow equivalents established for sanitary sewer systems and pumping stations shall be based on *Sussex County Code § 110*.

1.3 Design Computations & Engineer Reports

Design computations shall be developed for all features of the proposed sewer system and shall be in sufficient detail to enable the SCED to perform a comprehensive review of the methods and criteria employed and the corresponding results obtained.

The Engineer shall provide calculations for the sanitary sewer system using the wastewater flow criteria (on-site and off-site for both existing and proposed conditions as required) as defined relative to the proposed point(s) of connection to the County's sanitary sewer system in accordance with an approved SSCE. SCED staff will provide final determination for adequacy of the receiving

sanitary sewer system following satisfactory review of all design computations associated with the proposed improvements.

Proposed pump stations and/or existing station modifications shall include a detailed system analysis by the Engineer to address at a minimum the following:

A. Existing and future pumping capacity requirements

B. Upgrade of capacities and capabilities

C. Standby emergency power requirements

D. Suitability of location with respect to human activities

E. Pump size and power requirements, balanced by economical equipment and pipe sizes

The Engineer shall provide a description of design criteria utilized for the pump station, preliminary flow computations, design calculations and calculated system and proposed pump curves, along with identification of any land acquisition or easement requirements.

Computations and information may be provided directly on the applicable construction drawings or submitted with applications as a Design Engineer Report sealed by a Delaware licensed professional engineer. SCED reserves the right to request a stand-alone Design Engineer Report for projects as determined necessary. Refer to Section III.3 for specific design guidelines for pump stations.

2. Sewer System Guidelines

2.1 General

All sewer systems shall be designed based on the guidelines and criteria outlined in this Manual and applicable sections of Sussex County Code.

2.2 Gravity Sewer Design

2.2.1 Hydraulic Requirements

A. The Manning Equation shall be used to determine the hydraulic capacity for all gravity systems with “n” coefficients as provided in **Table 1**.

Table 1: Manning "n" Coefficients

Pipe Material	"n" Coefficient
Polyvinyl Chloride (PVC)	0.012
Ductile Iron Pipe (DIP) (Cement Line)	0.013
Ductile Iron Pipe (DIP) (401 Protecto) Epoxy Coated	0.012

B. The minimum size for a collector sewer main is eight (8) inches. The required sizes of sewer mains will vary with the character and size of the development and service area, and design of the conveyance system.

C. Specifying and increase in the pipe diameter for the purpose of decreasing installation grades and minimizing excavation depths is not an acceptable design practice.

D. The size of the sanitary sewer conveyance system shall be sufficient to carry the design flow rate, with the hydraulic gradient below the crown of the pipe at all locations.

E. All sewer sizes shall continually increase progressing downstream as required based on design flows.

F. Gravity sewers shall be designed and constructed to yield mean velocities, under theoretical flow full conditions, of not less than 2.0 feet per second based on Manning Equation analysis.

G. Minimum slopes for gravity sewer pipes are provided in **Table 2** and are based on approximate flow and EDU capacities of pipe sizes in accordance with the County design criteria.

2.2.2 Horizontal Pipeline Alignment

The horizontal alignment of sewer shall consider the following general guidelines.

A. In general, sewer mains shall be located within the paved roadway sections, and wherever possible in the centerline of the travel lanes such that manhole locations are outside of normal wheel paths. For sewer mains located outside of paved roadways, the entire pipeline must be accessible for future maintenance or repair. SCED may require additional paved areas along sewer mains outside paved roadways for access purposes.

B. Where sewer mains in residential developments are to be installed between or across property lot lines, the centerline of the pipe shall be located on the side lot line, or along the rear lot line. Under no circumstances shall sewers or easements cut across building envelopes. Sewer easements shall be provided as defined in Section III.2.6.

C. If a utility easement is required to be extended to the limits of the property being developed to provide future service to an adjacent property, that easement shall be cleared of trees and the pipe installed to the edge of easement at the terminus of said easement.

D. Sewer mains shall be designed to minimize disruption to environmental features. The Engineer shall consider all existing environmental factors and avoid disturbance of sensitive areas, whenever possible. Alternate Installation Technologies such as directional drilling, tunneling and boring methods may be accepted by the County within or adjacent to environmentally sensitive areas. Refer to Section III.5.3.

E. Sewers and related appurtenances, and their required easements, shall not be placed within nor encroach upon an existing or proposed stormwater management facility and related features.

F. All sewers shall be installed a minimum of 10’ from permanent improvements such as buildings foundations. In no case shall a sewer pipe be located such that a theoretical 1:1 slope excavation from the bottom of pipe would result in encroachment on an adjacent structural foundation.

G. Pipes entering manholes shall be designed to be at a 90-degree angle from the wall unless a waiver is granted by the County Engineer**.**

H. Refer to all applicable DelDOT requirements related to utility locations within state-maintained roadways.

2.2.3 Vertical Pipeline Alignment

The vertical alignment of sewer shall consider the following general guidelines.

A. All sanitary sewers shall be designed on a continuous grade between connecting manholes.

B. Where possible, pipe slopes should be increased above minimum slope in locations where pipes will carry fractional flow, especially

where the design does not affect the critical depth of the system.

C. **Table 2** indicates the minimum allowable slopes permitted for gravity pipelines.

Table 2: Minimum Allowable Slope of Gravity Sewer Pipelines

Pipe Diameter In Inches	Minimum Slope in Feet per 100 Feet	Design Capacity (MGD)
8”	0.28	0.4476
10”	0.22	0.7194
12”	0.17	1.0284
15”	0.12	1.5666
18”	0.10	2.3255
21”	0.10	3.5078
24”	0.10	5.0082

D. All 8” terminal sewers shall have a minimum slope of 0.4%, unless designated as a future development connection point.

E. The maximum allowable pipe slope of main line shall be 4 feet vertical per 100 feet in length or the allowable pipe deflection at the receiving structure.

F. Carrier pipe which is to be placed within a casing pipe for jack and bore installations shall use a minimum slope of 0.3 feet per 100 feet of pipe. Regardless of the pipe length and size, a minimum drop of 0.3 feet is required in this application.

G. General design practice shall result in collector sewers being located at a sufficient depth to provide gravity sewer service to the lowest floor level of all buildings/dwellings within the proposed service area or to the basement level if topography permits, unless otherwise directed and/or approved by SCED.

H. Minimum design depth of mainline sewer shall be:

1. Minimum design depth for mainline sewer shall be four (4) feet as measured from top of pipe to finished grade. Minimum cover over top of mainline sewer pipe shall be three (3) feet at points of reduced cover such as at a ditch crossing.
2. Any mainline sewer not having a minimum of 3 feet of cover shall be epoxy coated (Protecto 401 or approved equal) Ductile Iron Pipe (DIP) Class 52.

3. Any mainline sewer which does not allow a connecting sewer lateral to have a cover of 30 inches from the top of lateral pipe to finished grade at any point along the sewer line shall be lowered to an appropriate invert grade to allow the required cover over the lateral pipe.
4. The minimum cover over any sewer lateral within the street right-of-way shall be 30 inches at points of reduced cover such as a ditch crossing. Any sewer lateral not having a minimum of 30 inches of cover shall be epoxy coated ductile iron pipe. Refer to Section III.2.5 for specific sewer lateral requirements.
5. Unimproved Lots (Residential): On vacant lots, it shall be assumed that any future building will be constructed so that gravity sewer service will be available to the most distant part of the lot or property within the building envelope.
6. Unimproved Lots (Commercial/Industrial): For commercial and industrial sites, the Engineer shall determine a reasonable sewer service elevation. Unless specific information is available regarding future development plans, it should be assumed that a large structure may occupy the lot with the building located at the most distant part of the lot within the building envelope.
7. New Developments: In new developments, when subdivision plans include lot grading and building elevations, the sewer shall be designed to serve the basement (if proposed) or lowest floor level of each structure.

2.2.4 Gravity Sewer Materials

The various pipe materials acceptable to Sussex County for collector and transmission sewer installation are summarized in **Table 3**. All materials shall be supplied and installed in conformance with the applicable Sussex County Standard Details and applicable specifications.

Table 3: Gravity Sewer Pipe Materials

Pipe Material (abbreviation)	Pipe Diameters	Depth
Polyvinyl Chloride (PVC) SDR 35	8” – 36”	3’ – 12’
Polyvinyl Chloride (PVC) SDR 26	8” – 36”	12’ - 20’
AWWA C-900 – DR-18	8” – 48”	20’ or greater
DIP Sewer (Epoxy lined)	8” – 18”	<3’ or as approved by SCED

Note: Information in Table 3 applies to open trench installation only

2.3 Sewer Crossings and Separations

The design of sewers shall consider the following general guidelines:

2.3.1 Where a sewer parallels a drainage feature (stream, swale, tax ditch, etc.), the Engineer shall ensure that the proposed sewer depth will be adequate to facilitate future crossings of the feature while maintaining a minimum 3 feet of cover over sewer pipe, unless otherwise governed by other approval agencies.

2.3.2 Where sewer pipes cross drainage features, the crossing angle shall be as near to 90 degrees as possible, and the crossing pipe shall be set at an elevation to provide a minimum of 3 feet of cover over the pipe unless governed by other approval agencies.

2.3.3 Sewers and sewer manholes shall be laid at least 10 feet horizontally from any existing or proposed water mains. The distance shall be measured outside edge to outside edge of pipe. In cases where it is not practical to maintain a 10-foot separation, the Delaware Public Health Department may allow deviation on a case-by-case basis, if supported by data and reasonable justification from the Engineer. In all cases of less than 10-foot separation between sewer and water utility pipes, a written approval from the Public Health Department shall be required.

2.3.4 Sewers crossing water mains shall be laid to provide a minimum vertical clear distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is situated either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistance and as far as possible from the water main joints.

2.3.5 Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent possible damage to the underlying water main. When it is not possible to obtain proper separation, the water line shall be centered at the crossing and concrete encased to include the joints.

2.3.6 Sewers shall be offset 5 feet minimum horizontally from any other existing or proposed utility mains and/or structures. The distance shall be measured outside edge of sewer pipe to outside edge of pipe/utility structure.

2.3.7 Sewers crossing other utilities shall have a minimum vertical distance of 12 inches between the outside of the utility and the outside of the sewer pipe. Refer to Sussex County Standard Details for required crossing

configuration of sewer pipes and drainage pipes with less than 12 inches of cover.

2.4 Sewer Manholes and Appurtenances

2.4.1 Manholes structures shall be incorporated into the sewer system design per requirements outlined in this Manual. Refer to the applicable Sussex County Standard Details for sewer manhole configurations and related appurtenances.

2.4.2 Inverts shall be formed within the manhole to receive future flows when the direction and grade of future connections are identified during the design process, either by the Engineer or SCED. When a future extension from the manhole is to be provided, a formed invert channel and a minimum 5-foot long stubbed connection shall be provided from the manhole in the direction of future sewer service. If the receiving manhole has a concrete collar, the stubbed connection shall be a minimum of 8 feet in length.

2.4.3 Manholes shall not be incorporated into the sewer system design where access and maintenance activities may be difficult such as in areas with curbs, gutters, ditches, parking areas (when possible), athletic and playing fields, and in close proximity to buildings and structures.

2.4.4 The top of manholes placed in unpaved areas shall have an approved concrete collar installed. Refer to DelDOT requirements for manholes located within state roadway right-of-way.

2.4.5 Location and Spacing

Manholes shall be incorporated within the designed sewer system to meet or exceed the following requirements:

A. Change in horizontal direction or vertical grade.

B. Change in pipe size.

C. Change in pipe material.

D. Pipeline junctions.

E. Intersections of mains.

F. Locations along the sewer where future extensions are planned.

G. Manhole spacing within sewer system shall not exceed 450 feet.

2.4.6 Size

Manhole structures shall be sized as follows:

A. Minimum diameter of manholes shall be 48-inches for pipes less than 18” in size.

B. For 18” – 24” pipeline sizes, and for all drop manholes, the minimum diameter of manholes shall be 60 inches.

C. For pipes larger than 24”, coordinate with SCED for required manhole size.

D. Unless otherwise approved by SCED, the first manhole directly upstream of a pump station wet well shall be 5 feet in diameter and located within the designated pump station site.

2.4.7 Flow Channels

The flow channel through manholes shall be made to conform to the shape and slope of the connecting sewer pipes. Channel width shall match inside diameter of connecting pipes, and shall have a uniform width transition if pipe diameters are different. The top of the flow channel (i.e. bench) shall be at the same elevation as the crown of the main sewer line entering the manhole. Precast concrete channels of an acceptable quality may be provided in lieu of brick channels.

Whether the pipe sizes entering and exiting manholes are the same or different, the minimum drop between invert in and invert out shall be 0.10 feet for all sewers 8 inches diameter, and 0.05 feet for sewers greater than 8 inches in diameter.

When varying pipe sizes connect to a single manhole, the design shall have the crowns of the pipes match.

No lateral sewer, service connection or drop manhole pipe is to discharge directly onto the surface of the bench.

2.4.8 Linings

The receiving manhole immediately downstream of a force main discharge shall have its entire interior surface coated per the Standard Details to protect against hydrogen sulfide gas.

2.4.9 Terminal Cleanouts

Terminal cleanouts may be provided at the end of a main line sewer run when less than 150 feet from the last manhole structure.

2.4.10 Drop Manholes

All drop manholes shall have a minimum diameter of 5 feet. No more than one drop pipe per manhole shall be allowed, unless a 6-foot diameter or greater manhole is provided in conjunction with SCED approval. Only inside style drop connections are permitted.

Every effort shall be made by the Engineer to adjust system design parameters including pipe slopes and inverts to avoid pipe connections at between 12 and 36 vertical inches between incoming sewer and manhole invert.

A. A drop pipe shall be provided for a sewer pipe entering a manhole at an vertical distance of 36 inches or more above the effluent manhole invert.

B. Where the vertical difference between the incoming sewer pipe and manhole invert is 12 inches or less, the invert flow channel shall be shaped to provide a fillet or “sliding board” transition to achieve proper flow characteristics to prevent solids deposition

2.4.11 Connection to an Existing System

All connections into the existing County sewer system are subject to approval by SCED. The following guidelines shall be followed in designing the sewer tie-in:

A. Designs shall prioritize having a connecting pipe at or above the spring line of receiving downstream sewer pipe.

B. Match existing pipe material when connecting to an existing manhole where the manhole has a connection stub. If the existing manhole does not have an opening or knockout for a connection, the manhole shall be cored, the invert channel removed and reformed as needed, and a sand collar or link seal installed to connect the new sewer pipe to the existing manhole.

C. Designs must include details and a sequence of construction to address how flows will be consistently maintained in existing system. Any proposed bypass pumping operation must be approved by SCED in advance of set-up and operation.

D. Connections into an existing sewer main at non-manhole locations may be made with a “doghouse” manhole constructed over an existing sewer – refer to Sussex County Standard Details. Alternate doghouse manhole configurations may be used based on specific site conditions, subject to SCED approval. Final determination of

methods for connecting to an existing system rest solely with the direction of SCED.

2.5 Sewer Laterals

2.5.1 Sewer laterals shall be provided to make connections to the collector sewer main in conformance with this Manual. Refer to Sussex County Standard Details for different sewer lateral configurations depending on project design conditions.

2.5.2 Locations
All applicable parcels shall be provided with a cleanout and a 5-foot long stub capped/plugged at the property line or edge of easement. Cleanouts shall be located 1 foot inside ROW, easement or fee simple line, unless otherwise approved by SCED.

2.5.3 In developments where an easement is required between two adjacent lots for the extension of a sewer lateral, the lateral shall be constructed within the easement between the adjacent lots as part of the development. The sewer lateral shall extend along the full length of the easement between the lots.

2.5.4 In general, installation of sewer laterals shall conform to the following requirements unless otherwise directed by SCED:

A. Each individual building/dwelling/lot, except for condominiums**,** shall have an individual lateral connection with cleanout installed, of six (6) inches minimum diameter.

B. Condominiums up to four (4) units per cluster may use a six (6) inch diameter sewer lateral.

C. Commercial uses shall have a lateral connection with cleanout installed of minimum eight (8) inches diameter.

2.5.5 Grades
The preferred minimum grade for a sewer lateral is 2.0% between mainline sewer and the county-maintained cleanout. If site conditions and design constraints warrant a shallower slope, a 1.5% minimum sewer lateral slope is acceptable.

2.5.6 Depth
Sewer laterals shall be installed at depths such that gravity service can be provided to each lot/property served, in conformance with the Vertical Pipeline Alignment guidelines of this Manual. The *minimum* cover over any sewer lateral within the street right-of-way shall be 30

inches at points of reduced cover such as at a ditch crossing.

2.5.7 Type
All sewer laterals shall be of the single or dual service type depending on required service to adjacent properties. A standard depth sewer lateral with cleanout is the preferred configuration per Detail S-2.01 in Sussex County Standard Details. A deep sewer lateral cleanout shall be provided when the depth of the lateral at the right of way/property line is greater than 5-feet as required to avoid utility conflicts. Transition of sewer lateral at the connection point to the sewer main is based on depth of main as shown in the Standard Details.

2.5.8 Cleanouts
Cleanouts located at the property line are required for use with all laterals unless a written wavier is received from SCED. Size of cleanout risers and stub pipes shall match sewer lateral in all cases. Cleanouts shall not be located within the primary flow area of drainage swales. Refer to Sussex County Standard Details for additional requirements.

2.5.9 Materials
Refer to Sussex County Standard Details and/or the applicable project plans and specifications for required sewer lateral materials.

2.5.10 Refer to Sussex County's **Technical Bulletin for Building Sewer and Water Service** for sewer lateral requirements for private properties.

2.6 Sewer Easements

2.6.1 The minimum widths required for Permanent Easements (PE) and Temporary Construction Easements (TCE) are provided in **Table 4**. PE widths shall be centered along the sewer main alignment, and TCE widths shall be applied along and adjacent to the PE to accommodate sewer installation and related construction activities.

2.6.2 Easement widths indicated are minimum requirements for a single pipe. The easement width shall increase by a minimum of five (5) feet with a multiple sewer line configuration, and ten (10) feet with a water main and sewer main along the same alignment.

2.6.3 Smaller diameter pipelines, including force mains, shall have a minimum twenty (20) foot easement unless otherwise directed or approved by SCED.

2.6.4 All PE's shall be maintained free and clear of any above or below grade permanent improvements and obstructions.

Table 4: Minimum Easement Widths

Pipe Diameter	Min. Width of Permanent Easement (PE)	Min. Width of Temporary Construction Easement (TCE)
Up to 24” with installation depths less than 15 feet	20 feet	10 feet
Up to 24” with installation depths of 15 feet or greater	30 feet	20 feet
Greater than 24" regardless of installation depth	30 feet	20 feet

2.7 Temporary Holding Tanks

The use of temporary holding tanks shall not be permitted for new home construction except where occupancy of a home is permitted while the sewage treatment system is under construction. The following are the specific requirements for use of these temporary holding tanks:

2.7.1 A valid signed on-site construction permit, obtained from the office of DNREC.

2.7.2 Construction is underway and will be completed prior to the expiration of the permit.

2.7.3 The SCED reserves the right to determine the number of EDUs to be served by the tank under the permit.

2.7.4 Tank size shall be based upon five days design flow and shall meet the same construction requirements as a septic tank except that the holding tank shall not have an active outlet.

2.7.5 Holding tanks must be equipped with an approved visual and audible alarm system that indicates when the tank is 90% full.

2.7.6 Holding tanks are not permitted for use longer than 12 months and must accompany a signed contract between the property owner and the pump and haul contractor.

2.7.7 Commercial facilities engaged in business of food preparation, car wash and automotive services shall install a grease trap, grease interceptor and/or oil/water separator. For size and type of device required refer to Sussex County’s **Technical Bulletin for Building Sewer and Water**

Service.

3. Pump Station Guidelines

3.1 General

Standards for wastewater pump stations shall meet the requirements and operational responsibilities of SCED and Sussex County Department of Environmental Services (SCDES). The criteria and guidelines included in this Manual are for general design of most wastewater pump stations within the Sussex County public sewer system. The Engineer shall review each project individually and specifically and coordinate with SCED/SCDES for final requirements for all proposed facilities.

3.2 Hydraulic Criteria

Wastewater pump station flow rates shall be designed for the build-out conditions and wastewater flow criteria defined by this Manual and *Sussex County Code § 110*. Should the Engineer demonstrate that adverse operation and maintenance conditions will occur as a result of this approach, SCED may approve a minimum 20-year design flow rate for pump station equipment. In all cases, pump station equipment including wet well structure and associated valve vault components shall be designed for the established flow criteria.

Computations and information for systems with proposed pump stations and/or existing station modifications shall be provided as noted in this Manual and required by SCED/SCDES.

3.3 Tier Classification

Pump stations are classified by Tier Ratings that summarize range of station capacity and other basic operational components. **Table 5** provides a summary of the four different Tier Ratings utilized by Sussex County for pump station classification.

The standards of this Manual apply primarily to Tier 1-Tier 3 pump stations; Tier 4 stations typically require greater project specific design and are only partially covered in the Manual. The SCED/SCDES will make the final determination on tier classification of pump station as well as final criteria for each project application.

Table 5: Pump Station Classification

OPERATIONAL COMPONENT	TIER			
	1	2	3	4
Design Capacity	< 80 GPM	80 – 1,000 GPM	1,000 – 4,000 GPM	> 4,000 GPM

Pump Size	Pump Horsepower as required by Hydraulic Design Parameters and Power Availability			
Wet Well	Precast Concrete	Precast Concrete	Precast or cast in place concrete	Cast in place concrete
Mechanically Ventilated Wet Well	Yes	Yes	Yes	Yes
Pump Type	Grinder/ Submersible Centrifugal	Submersible Centrifugal	Submersible Centrifugal	Submersible Centrifugal
Number of Pumps	2	2	2	3 to 4
Utility Power Requirements[4]	3-Phase or Single Phase 240 V	3-Phase 240 V or 3-Phase 480 V	3-Phase 480 V	3-Phase 480 V
Isolation Valves	Outside of Wet Well	Valve Vault	Valve Vault	Valve Vault
Check Valves	Interior of Wet Well	Valve Vault	Valve Vault	Valve Vault
Bypass Connection	Yes	Yes	Yes	Yes
Exterior Station Lighting	Yes	Yes	Yes	Yes
Concrete Maintenance Pad	No	Yes	Yes	Yes
Safety Grate with Access Hatch	Yes (for non-grinder pump stations	Yes	Yes	Yes
Standby Generator	Yes	Yes	Yes	Yes
SCADA System	Yes	Yes	Yes	Yes
VFD's	No[3]	No[3]	Yes[2]	Yes
Controls Building or Super - Structure	No	No	Yes[1]	Yes[1]
Pump Monorail	No	No	Yes[1]	Yes

Notes: 1) Examined on a case-by-case basis.
2) VFDs shall be provided for all pump station 15 HP and above.
3) All pump motors shall be 3-phase. Where extending 3-phase is cost prohibitive, SCED will consider allowing a VFD to convert single-phase, 240 Volts to 3-phase for pump motors.
4) Coordinate with power company for available electrical service to pump station.

3.4 Regulations

Each wastewater pump station shall be designed and constructed in accordance with all applicable codes, DNREC and utility regulations, the

provisions of this Manual and all applicable County Codes and Ordinances. In addition to Permits and Approvals outlined in this Manual, the Engineer shall obtain all applicable building permits associated with any proposed above ground pump station structures prior to any construction or receiving of official bids.

3.5 General Considerations

Wastewater pump stations shall be engineered to meet the requirements of these guidelines, as well as any supplemental guidelines provided by the SCED on a project specific basis. Refer also to the applicable Sussex County Standard Details.

3.5.1 Location

Pump stations shall be located as far as possible from populated areas. Natural screening and remoteness of the site shall be primary elements of site selection wherever possible. Predominant wind direction for potential odor dispersion and building aspects, such as generator exhaust and ventilation fan noises shall be considered. Distance offsets from a pump station to adjacent populated areas shall be in accordance with the Sussex County Standard Details and related requirements.

3.5.2 Land Acquisition

Land required for pump stations shall be owned in fee simple by Sussex County, unless otherwise approved by SCED. Parcel size shall be a minimum of 50 feet by 50 feet, but in all cases shall be established to accommodate all required pump station components. As part of the land acquisition process, a boundary survey of the property is required together with a record plat and metes and bounds description of the parcel. Concrete monuments shall be set at each property corner of the pump station site.

3.5.3 Site Plan

All plans applicable to the site (site improvements, grading, landscaping, sediment control, etc.) shall be prepared on a 1 inch=20 feet scale plans. All components of the proposed pump station facility along with their corresponding survey coordinate locations shall be provided on the plans. Adequate spot elevations must be provided so all paved and non-paved areas within pump station site can be properly constructed.

3.5.4 Topography

Existing contours and other topography shall be shown for the entire site, including a 100-foot minimum width outside of the proposed property boundary. Contour interval shall be one-foot, unless otherwise approved by the SCED.

3.5.5 Floodplain

Wastewater pump stations shall be sited to remain operational and accessible during a 100-year return frequency flood. Elevations of all pump station structures and associated buildings, access roads and parking, and electrical equipment shall be set a minimum of one-foot above the 100-year floodplain elevation unless otherwise directed by SCED.

3.5.6 Site Surface

The finished surface within the pump station "top slab" footprint shall be portland cement concrete. The preferred finished surface within the remaining area of the pump station site shall be stone aggregate over fabric, unless an alternate surface treatment is approved by SCED. Entrance drives into the pump station site shall be either concrete or bituminous pavement. Type, thickness and configuration of pavement and surface treatment materials within pump stations and at entrances from public or private roads shall be in accordance with the Sussex County Standard Details. Entrance pavement within public right-of-way shall conform to DelDOT requirements as may be applicable.

3.5.7 Grading/Drainage

Grading within pump station sites shall be designed to prevent ponding and provide positive drainage away from all structures. Surface elevations along the top slab footprint shall be designed to be flush with adjacent areas so as to not constitute a tripping hazard. Grades for entrance drive into pump station site shall be a maximum of six (6) percent, unless site conditions warrant a steeper slope per approval by SCED.

Land grading outside of the wastewater pump station perimeter fence shall not exceed a 3 to 1 slope; 4 to 1 slope maximums are desirable and shall be compatible with known slope stability characteristics of on-site soils. Slope stabilization measures shall be appropriate for the designed slope steepness and soil conditions. The use of retaining walls on or adjacent to the wastewater pump station site is not permitted unless warranted by specific site conditions and approved by SCED.

Proposed grading and drainage conditions for a pump station site shall not result in adverse impacts to adjacent or downstream properties. If required by SCED, a Drainage Assessment Report shall be prepared to demonstrate adequate maintenance of drainage conveyances per *Sussex County Code §115-193F*.

3.5.8 Fencing

Fencing requirements around the perimeter of pump station sites, including materials, configuration, and access gates, shall be in accordance with the Sussex County Standard Details.

3.5.9 Test Borings

A minimum of one (1) test boring shall be taken at the wet well location to determine soil types, water table elevations, soil bearing values, etc. Borings shall be taken to a depth of not less than fifteen (15) feet below the bottom of the proposed structure. Borings shall be taken deeper as necessary, depending on soil conditions.

3.5.10 Paintings & Coatings

Wastewater structures and associated piping, valves and fittings shall be painted in accordance with SCED requirements and/or the project specifications. All exposed piping, pump equipment and appurtenances shall be painted with epoxy coating, with paint color selected by Sussex County. All pump station control rooms shall be painted. Wet wells shall be coated as specified in the project documents. All pump station floors shall incorporate floor hardeners for enhanced durability.

3.5.11 Water Supply

There shall be no physical connection between any potable water supply and a wastewater pump station which under any conditions might cause contamination of the potable water supply. If a public water service is available, a yard hydrant with approved backflow preventer shall be supplied for Tier 3 pump stations and above.

3.5.12 Structures

Wastewater structures including wet wells and valve vaults shall be designed and constructed to be as hazard free as possible, with corrosion-resistant materials used throughout.

All below grade structures shall be designed and submitted with a minimum safety factor rating of 1.5 against floatation under the following assumed conditions:

A. The water surface at finished grade

B. A dry unit weight for soil of 100 lb/cu ft

C. A unit weight for concrete of 150 lb/cu ft

D. An empty structure

A submittal to the County including buoyancy calculations with the wet well design must be provided by the Engineer or manufacturer as part of the project shop drawings.

3.6 Design Criteria and Drawings

Wastewater pump stations shall be engineered to meet the requirements of the guidelines contained in this Manual, as well as any supplemental guidelines provided by the SCED on a project specific basis.

3.6.1 Pumps and Motors

Pump stations shall be submersible pump and motor wet well configurations designed for raw wastewater use meeting requirements of the National Electrical Code, with an effective method to detect shaft seal failure provided.

3.6.2 Number of Pumps

Wastewater pump stations shall be equipped with a minimum of two (2) pumps and designed to pump the design flow rate assuming the largest capacity single pump is out of service.

3.6.3 Hydraulic Analysis

Wastewater pump stations must satisfy the defined hydraulic conditions of the system. The Engineer shall perform a complete hydraulic analysis of each wastewater pump station.

When a pump station will add to the existing sewer system, the hydraulic analysis shall consider potential impacts on existing force mains, gravity sewers and pump stations.

System curve (Head vs. Flow) characteristics shall be determined by the Hazen-Williams formula for piping head loss. Pump system curves shall be shown on the plans for single pump operation, as well as for multiple pump operation in stations having three or more pumps. The pump/system curve shall show the following information at a minimum:

A. Static Head

B. Pipe Friction Losses

C. Pump Curve

D. Pump Horsepower, Efficiency and RPM

The static head shall be based on the difference in vertical elevation between the lowest “normal pump stop” level in the wet well and the crown elevation of the force main where it discharges into the gravity sewer.

The pipe friction losses used in evaluating pump and system curves shall be based upon Hazen-Williams "C" factors provided under Force Main Guidelines in this Manual. The Hazen-Williams factors indicated are representative of long-term design values for the system. The Engineer shall check all pump station and force main selections for the anticipated lower head losses (higher “C” value) that are typical of newer pipelines to ensure the satisfactory operation throughout the design life of the system. All minor losses for force main and pump station piping shall be accounted for in accordance with Hydraulic Institute Standards.

Continuous uphill pumping is preferred for a force main exiting a pump station, with the force main discharge point to gravity sewer at a higher elevation than the rest of the system to keep the force main full and static head constant. In the event this cannot be accomplished, the Engineer shall evaluate all intermediate highpoints where the force main will be higher (i.e static head is greater) than the discharge elevation. This evaluation shall be performed to confirm the pumps can overcome the higher static head. However, the static head as defined above shall control the pump station design. If there are multiple intermediate highpoints, each high point shall be checked. System curves for the intermediate high point with greatest Total Dynamic Head (TDH) along with the terminal discharge shall be indicated on the plans.

3.6.4 Total Dynamic Head (TDH)

Wastewater pump stations shall be designed to operate at the appropriate calculated discharge head and flow rate, with total dynamic head generally maintained at less than 100 feet.

3.6.5 Water Hammer

The potential impacts of water hammer on the piping system shall be evaluated for all Tier 4 stations. Hydraulically operated, time-adjustable, pump check service valves shall be provided for Tier 4 pump stations. Unless requested by the SCED, a system surge analysis and inclusion of corresponding surge relief valves shall not be required for Tier 1 through Tier 3 pump stations.

3.6.6 NPSHA and Other Pump Selection Factors

The Engineer shall perform a Net Positive Suction Head available (NPSHA) analysis and include this information in the pump specification. The NPSHA shall be calculated in accordance with the Hydraulic Institute Standards, for the expected design flows, and shall exceed the pump manufacturer's requirements by an added margin of safety of not less than five (5) feet. Other pump selection factors are as follows:

A. Pumps shall be selected to have their maximum efficiency at the operating point.

B. Under no circumstances shall a pump be specified to operate outside of its published recommended range. Examples would be pumps operating at very low flows and high heads, near shutoff heads, or "runout" conditions (maximum possible flow rate of the pump). These conditions can result in excessive hydraulic loading or cavitation damage to impellers, casings and shafts, rapid bearing and mechanical seal wear, and high vibration.

C. The Engineer shall avoid the selection of pumps whose curves are flat (i.e., small changes in head resulting in large changes in flow rate).

D. For conditions where there are intermediate high points in the discharge system, the pump selection shall be evaluated for both intermediate and terminal hydraulic conditions to ensure the pump will operate effectively under all potential flow conditions.

E. At no place on the pump curve shall the horsepower rating of the pump motor be exceeded.

F. The worst case "C" factor shall be anticipated over the life of the pump station and used so that the pump power rating is adequate.

G. Pump types are to be determined by the required force main size. Force mains with a 4” minimum diameter and larger shall have non-clog pumps. Force mains less than 4” in diameter shall have grinder pumps.

3.6.7 Pump Station Drawings

At a minimum, the following information shall be included with the pump station project drawings:

A. Pump station design flow and wet well sizing calculations.

B. Pump station system and pump curves with corresponding pump design point identified. Provide multiple system curves when conditions require.

C. Pump station section view(s) indicating required pump control levels, hatch sizes, piping and valves.

D. Pump station plans showing location of equipment, lighting, antennas, generator, etc.

E. Electrical one-line diagram and panel board schedule.

F. Electrical cabinet, grounding, and instrumentation details if different than that reflected in the County standard Details.

G. Site plan layout, 100-year floodplain, wetlands, grading, paving, entrance, drainage and sediment and erosion control measures.

H. Project specific construction details in addition to SCED Standard Details shall be shown.

3.7 Wet Wells and Valve Vaults

3.7.1 Wet wells shall be considered a hazardous environment, classified as National Electric Code (NEC) Class I, Division I & 2 for explosive gases. All materials and equipment used in wet wells shall meet NEC Class I, Division 1 standards. It shall be the Engineer's responsibility to determine if the valve vault is considered a hazardous environment, and specify materials and equipment on the Drawings accordingly. Refer to Sussex County Standard Details for conduit configuration between the wet well and exterior cabinet.

3.7.2 Wet well and valve vault access shall be through a top slab opening with an aluminum hatch cover and frame with safety grate in accordance with the project specifications and/or Sussex County Standard Details. Hatch cover and frame shall have a minimum H-20 load rating.

3.7.3 Wastewater pump station wet wells and valve vaults shall be constructed of precast or cast-in-place reinforced concrete.

3.7.4 The bottom of the wet well shall be constructed and grouted to a minimum slope of 45 degrees toward the pump suction inlet.

3.7.5 Wet well size and depth shall be as required to accommodate the influent sewer and design flow, as well as pump suction submergence as recommended by Hydraulic Institute Standards. The required working volume and preferred intervals between influent sewer and control elevations shall be designed for a minimum pump cycle time of 6 minutes as defined by the below formula. In all cases, a minimum of 4 exchanges per hour shall be achieved under ultimate design buildout conditions:

$$T = 4V/Q$$

Where:
T = Pump Cycle Time (time between pump starts) in minutes
V = Volume of wet well between the lead pump start and pump stop elevations, in gallons
Q = Pump rate of the lead pump, in gallons per minute (gpm)

3.8 Ventilation

Pump station wet wells and valve vaults shall be provided with a separate permanent mechanical ventilating system, sized to provide the air changes specified herein. Dampers shall not be used on exhaust or fresh air ducts and fine screens or other obstructions in air ducts should be avoided to prevent clogging, except as necessary to provide bird screening. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Air shall be exhausted from the wet well rather than forced into the wet well.

3.9 Valves & Piping

Each wastewater pump shall have isolation valves on the discharge side to permit the removal or maintenance of the pumps and a check valve with isolation ring to prevent backflow through inoperative pumps. The check valve shall be located between the shutoff valve and the pump, but not placed on the vertical portion of the piping. Valves shall be capable of withstanding normal pressure and water hammer.

All wet well and valve vault (if applicable) wastewater piping for Tier 2 through 4 stations shall be minimum 4-inch DIP Class 52, with flanged fittings. Pump suction and discharge piping for Tier 1 stations shall be schedule 80 PVC and shall be at least 1.5 inches. All interior piping shall be designed for a velocity between 5 to 7 feet per second.

3.10 Pump Station Bypass

Wastewater pump stations shall be provided with an auxiliary force main connection downstream of the station to enable the station wet well to be taken off-line for periodic maintenance or repairs.

3.11 Pressure Gauges

Pressure gauges for direct reading of line condition shall be placed on the discharge of each pump for Tier 3 and 4 stations, and Tier 2 stations if directed by SCED, and shall be removable by use of an isolation valve. Pressure gauges shall have a range such that the normal operating pressure is near the middle of the gauge.

3.12 Flow Metering

low metering shall only be incorporated at the specific direction of SCED, and only on pump stations that pump wastewater flow directly to a treatment plant.

Where implemented, flow metering shall adhere to the following requirements:

3.12.1 Meter installation distance from fitting shall be in accordance with manufacturer recommendations, subject to SCED approval.

3.12.2 Meter vaults within manhole shall have positive vertical drainage or have an open bottom. Meter vault manholes shall be a minimum 60-inch in diameter.

3.12.3 Flow meter may be located within valve vault if approved by SCED.

3.13 Electrical and Controls

3.13.1 For electrical services that are supplied from a third-party power company that require crossings of roads or rights-of-ways, the electrical cabling shall be installed in PVC conduit unless a different material is required by DelDOT for public road crossings. An additional empty conduit system of the same size and quantity shall also be installed within or in close proximity to the cabled conduit. The empty conduit shall be for emergency use as needed and shall contain a tracer wire and pull string. This applies for all pump station tier levels.

3.13.2 Electrical Design

All electrical designs and components shall be in strict accordance with all applicable National Codes, County and/or electric utility requirements. Electrical design shall be such that phase-out protection shall be provided so that the power will automatically switch off in the event of a loss of any one phase. Incoming electrical service shall be underground with electric meters installed inside the pump station building or outside of power cabinet.

The electrical plans shall include at a minimum the following information, data and design elements:

A. Complete plan layout indicating all conduit, wire sizes and equipment locations, including lighting and other appurtenances. Incoming electrical service on the pump station site shall be underground.

B. Single line diagrams incorporating all electrical components required for operation of the facility

C. Complete lighting schedule noting model, size, location and installation data as well as appurtenances.

D. Complete control and telemetry diagrams.

E. Elevation of control panels with equipment and mounting dimensions and notes identifying each component.

F. Complete circuit breaker schedule indicating size and identifying each circuit.

G. Line and load reactors shall be incorporated as required based on electrical service parameters.

H. Ventilation schedule noting fan size, operating conditions, location, model, installation data, etc. If applicable, the ventilation schedule shall also outline louver data including size, material, fixed or motorized.

I. Open air transition.

J. Antenna pole details. In lieu of an antenna pole, cellular-based communications may be incorporated as directed by SCED.

K. Provide ARC flash labels for all equipment being installed. Labels shall indicate hazard level and PPE requirements as required by NFPA 70E & IEEE 1584 and as further described in the project specifications and/or per the manufacturer's recommendations.

L. Badging – Include requirements for Tags/Labels to be affixed to cabinets or other equipment to identify the various levels of electrical and controls design parameters.

M. Provide a legend of all symbols used related to the above information.

3.13.3 Lightning and Surge Protection

Lightning and Surge Protection shall be utilized on all pumping station electrical systems. Type 1 and Type 2 Surge Protection Devices (SPD), UL listed and approved for such use, shall be installed at the Main Distribution Panel. Short Circuit Protection and Disconnection means shall be provided. Each SPD shall be rated for the voltage and poles of the incoming utility service. All SPD's shall be properly grounded to the specified Grounding Electrode System.

AC Data Products, or approved equal, with a 10–year Module Replacement Warranty, shall be used for Type 1 and Type 2 SPD's. A Type 3 SPD shall be used ahead of all sensitive electronics of the Pumping Station Controller, (PLC, Radios, Flow Meters, Transducers, etc.). The Lightning and Surge Suppression System shall comply with the latest edition of NEC/NFPA 70 and IEEE Standards.

3.13.4 Backup Power

All wastewater pump stations shall be provided with an emergency generator. Emergency generators shall be sized to maintain full station operation. Emergency generators shall be diesel driven with fuel storage on the underside of the generator in a belly tank. Fuel spillage protection shall be provided. Minimal tank size shall be suitable for 24 hours of continuous generator operation at 80% load – preference is to have a standard (i.e., non-custom) tank generator. Generators shall be located at sides of pump station site with the exhaust sides facing the farthest from adjacent residential housing.

3.13.5 Controls and Alarms

The pumps shall be controlled by means of a pressure transducer with intrinsically safe float control back-up. For Tier 1, 2 and 3 Stations, the following levels shall be specified on the Drawings per the following requirements:

A. High-Water Alarm: Minimum 1-foot below lowest sewer invert into wet well

B. Start Lag 1 (2^{nd} pump on): Minimum 1-foot below high-water alarm

C. Start Lead (first pump on): Minimum 1-foot below step start lag

D. Pump Off: Minimum 2-feet below pump start or greater to provide required pump cycle time

E. Low-Water Alarm: Minimum level to achieve full pump submersion.

3.13.6 Telemetry

Refer to Sussex County Standard Details for the required inputs and outputs for the telemetry system. Final telemetry requirements shall be coordinated with and approved by SCDES.

3.14 Odor Control

Tier 3 and Tier 4 pump stations with a Peak Design Flow (Q_p) of 1,500 GPM or greater shall incorporate a permanent odor control system which shall be detailed on the Plans. Tier 2 pump stations shall incorporate and odor control system only if directed by SCED. Odor control shall be a Bio Air system or approved equal.

4. Force Main Guidelines

4.1 General

The design of a wastewater force main piping network must be coordinated with the design of the connected wastewater pump stations. The proposed horizontal alignment of the force main shall generally follow the Horizontal Pipeline Alignment guidelines for gravity sewer contained in Section III.2.2.2. The vertical profile of the force main shall be designed to achieve a minimum of four (4) feet of cover from existing/proposed groundline to top of pipe, while minimizing the addition of Air Release Valve manholes (see Section III.4.5). The design profile for the force main shall depict all changes in force main elevation with pipe invert data provided at appropriate stations along the pipe.

4.2 Hydraulic Criteria

The Hazen-Williams (HW) equation shall be used to estimate friction losses in force mains. Minor losses at transitions and bends shall also be added in the determination of the total energy losses. The HW roughness coefficient ("C" factors) for force mains shall be as follows:

Pipe Material	"C" Factor
Ductile Iron Pipe (Cement Lined)	100 *(existing pipe)*
Ductile Iron Pipe (Epoxy Coated)	140
HDPE	140
PVC / FUSIBLE PVC (FPVC)	140

Force main size shall be based on the required pipe's maximum carrying capacity to convey the design flow rate at permissible velocities, while minimizing friction losses and corresponding life cycle costs.

To optimize the sewerage system, SCED prefers the use of non-clog pumps versus grinder pumps whenever possible. Force main sizes on non-clog pump stations shall not be less than four (4) inches. Force main sizes on grinder pump stations shall not be less than 1-1/2 inches.

The formula to be used to determine the minimum inside diameter of the force main is:

$$D = 0.175 \sqrt{(Q_p \times 0.1334 \times C / 2.5)}$$

Where:
D = Diameter of force main in inches
Q_p = Peak Design Flow in gallons per minute
C = Hazen Williams Coefficient Factor

Design velocities in force mains shall be between 2.5 to 5 feet per second (fps), with 3 fps being most desirable.

If the diameter of the force main is known, the following equation can be used to determine if the required velocity is achieved:

$$V = Q_p \times 0.32 / A_{cs}$$

Where:
V = Velocity in feet per second
Q_p = Peak Design Flow in gallons per minute
A_{cs} = Cross-sectional inside diameter area of the pipe in square inches

4.3 Pipeline Materials

Force main materials for standard sewer projects shall be PVC (C900/C905), DR 18 class 200 with epoxy coated DIP fittings. HDPE and Fusible PVC (FPVC) for directional drill installations may be considered subject to County approval. Epoxy Coated Ductile Iron Pipe shall be used in low cover conditions. All force main pipes shall incorporate continuous toning wire per the Sussex County Standard Details.

4.4 Thrust Restraint Design

Thrust restraint is required for all pressurized wastewater mains where plugs, tees, bends or reducers are incorporated, as well as at transitions between HDPE and non-HDPE pipe. Thrust restraint is also required for directionally drilled pipe depending on design configuration.

4.4.1 Concrete Buttresses

Concrete buttress details are provided in the Sussex County Standard Details and are to be employed in all cases compatible with the design conditions. The Engineer is responsible for verifying that the standard buttress details apply to the particular project and shall prepare calculations as appropriate based on internal hydraulic and surge pressures.

4.4.2 Restrained Joints

Restrained joints may be used in place of concrete buttressing for thrust restraint design (SCED may require the use of both buttressing and restrained joints in certain applications). All design of restrained joint systems shall be in accordance with the Ductile Iron Pipe Research Association (DIPRA) Thrust Restraint Design for Ductile Iron Pipe (latest addition). Restrained joint designs shall have a factor of safety of 1.5.

All design parameters for restrained joint designs shall be based on actual field conditions including soil types, groundwater conditions, design depths, and the testing pressure required for the pipeline. For PVC piping, restrained lengths shall be calculated assuming polyethylene encased Ductile Iron Pipe.

4.5 Automatic Combination Air and Vacuum Valves

Force mains shall ideally be designed to rise continuously in profile from pumping station to the ultimate point of discharge. To minimize installation and maintenance costs, the Engineer shall evaluate the feasibility of eliminating intermediate high points by installing the sewer main deeper below grade in specific areas to achieve a constant profile grade. Where not practical, the Engineer shall include automatic combination air and vacuum valves at the intermediate high points to expel accumulated air under pressure, allow air into force mains to prevent vacuum conditions, and expel larger quantities of air when the sewer mains are filled.

Air Release Valves on wastewater force mains shall be specifically manufactured for wastewater service and sized according to manufacturer's recommendations. The following guidelines shall be used to locate combination air and vacuum valves within the force main system:

4.5.1 Peaks in pipeline profiles

4.5.2 Abrupt increases in downward slopes, such as directional drills

4.5.3 Abrupt decreases in upward slopes

4.5.4 Long ascents or long descents – 1,500 ft. to 3,000 ft. intervals

4.6 Isolation Valves

Isolation valves shall be incorporated at points along a force main run as needed based on County testing, maintenance and operation requirements.

4.7 Toning Wire Boxes

The force main toning wire shall be turned up into all isolation valves, as well as into separate adjacent toning wire boxes where combination air and vacuum valves are installed. In general, access to the toning wire along the force main piping shall be provided at maximum intervals of 1,500 feet. If this distance criteria is exceeded based on installation of other surface access structures, independent toning wire boxes shall be added along the force main to meet the required 1,500' maximum distance between toning wire access points. Toning wire boxes shall be located outside of roadway travel lanes, and in locations to provide convenient direct access.

4.8 Discharge Manholes

The connection between a force main system and gravity sewer shall incorporate a lined force main discharge manhole. There shall be no sewer lateral connections at a discharge manhole.

The connection from the force main system to a discharge manhole shall be made with a diffuser pipe sized in accordance with data provided in the Sussex County Standard Details.

4.9 Low Pressure Sewer *(future)*

5. Sewer Installation and Construction Guidelines

5.1 General Requirements

Installation of all sewerage facilities shall be in accordance with SCED standards, specifications and details, including but not limited to pipe, bedding and backfilling, handling, cleaning, testing, tapping, etc. Trenching shall comply with the appropriate OSHA regulations, at widths in conformance with manufacturer installation guidelines and applicable SCED and agency standards.

5.2 Pipeline Abandonment

Sussex County preferred practice is removal of sewer pipelines that are no longer in service or needed. In cases where abandonment of sewer pipes and associated structures are deemed necessary as approved by SCED, abandonment limits and techniques shall be in accordance with the Sussex County Standard Details. The Engineer shall coordinate with SCED for all proposed sewer pipe/structure abandonments.

5.3 Alternate Installation Technologies

In some cases, traditional open cut methods for installation of sewer pipelines are not practical due to excessive cost or disruption to the surrounding environment. Trenchless technologies such as Jacking and Boring and Directional Drilling were developed specifically to address these challenges and should be considered by the Engineer for utility crossings in the following cases:

- Environmentally sensitive areas such as wetlands, waterways or hazardous waste sites.
- Railroads lines.
- Primary or secondary roadways where traffic cannot be disrupted.
- Areas congested with existing utilities or adjacent to buildings where open trenching could undermine existing utilities or foundations.

In general, adequate room space for the drilling/jacking and boring operation should be established with appropriate barriers incorporated for public safety. Temporary construction easements shall be provided to accommodate necessary encroachment onto private property.

5.3.1 Jacking and Boring

A. Pipe crossing for a jacking and boring operation should be located as nearly perpendicular to the roadway or railroad alignment as possible to minimize overall casing length.

B. The minimum casing length beneath a railroad shall match the width of the railroad right-of-way. Refer also to roadway/railroad owner requirements for jacking and boring operation, as well as casing specifications.

C. The casing pipe shall be the appropriate grade steel for a jacking and boring operation. Casing diameters shall be sufficient in size to correctly install the sewer main. Details for carrier pipe spacers and casing pipe end seals shall be appropriate for proposed jacking and boring operation

D. Refer to Sussex County Standard Details for casing and carrier pipe material specifications and installation details.

5.3.2 Directional Drilling

A. Standards
Directional drill method shall be mechanical with fluid assistance. Drill operations shall be designed and implemented in accordance with the following standards:

- ASTM F-1962-99 or latest revision Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings.
- ASCE Manuals and Reports on Engineering Practice No. 89 Pipeline Crossings.
- All applicable manufacturer’s recommendations.
- Sussex County technical requirements and specifications.

B. Work Areas
The Engineer shall ensure that there is adequate space available on the drill entry side for any required bentonite slurry pits and for the drilling rig and any associated equipment. Adequate room must also be available on the drill exit side for any required pipe welding or fusing equipment as well as for the pipeline to be laid out

continuously prior to pull back. Drill entry and exit locations will be determined by the minimum bending radius of the pipeline, the depth of pipeline and available land.

C. Pipe Materials

Typical pipeline materials for directional drilling include fused High-Density Polyethylene (HDPE). The design of pipeline thicknesses shall be based upon the installation loads and stresses that will be experienced during installation as well as the in-use loads such as operating pressure, soil loads, static water loads, surface loads etc.

The preferred pipe wall thickness for a given pipe diameter shall be Standard Dimension Ratio (SDR) 11 for HDPE. The Engineer shall ensure that the maximum pull length for a given pipe material, thickness and installation condition is not exceeded. Pipeline thicknesses shall be increased if engineering calculations indicate that a lower SDR is required due to anticipated service or installation loads. Toning wire shall be specified for all drilled force mains, with the installed location as close as practical to the force main.

5.4 Vacuum Sewer Systems *(future)*