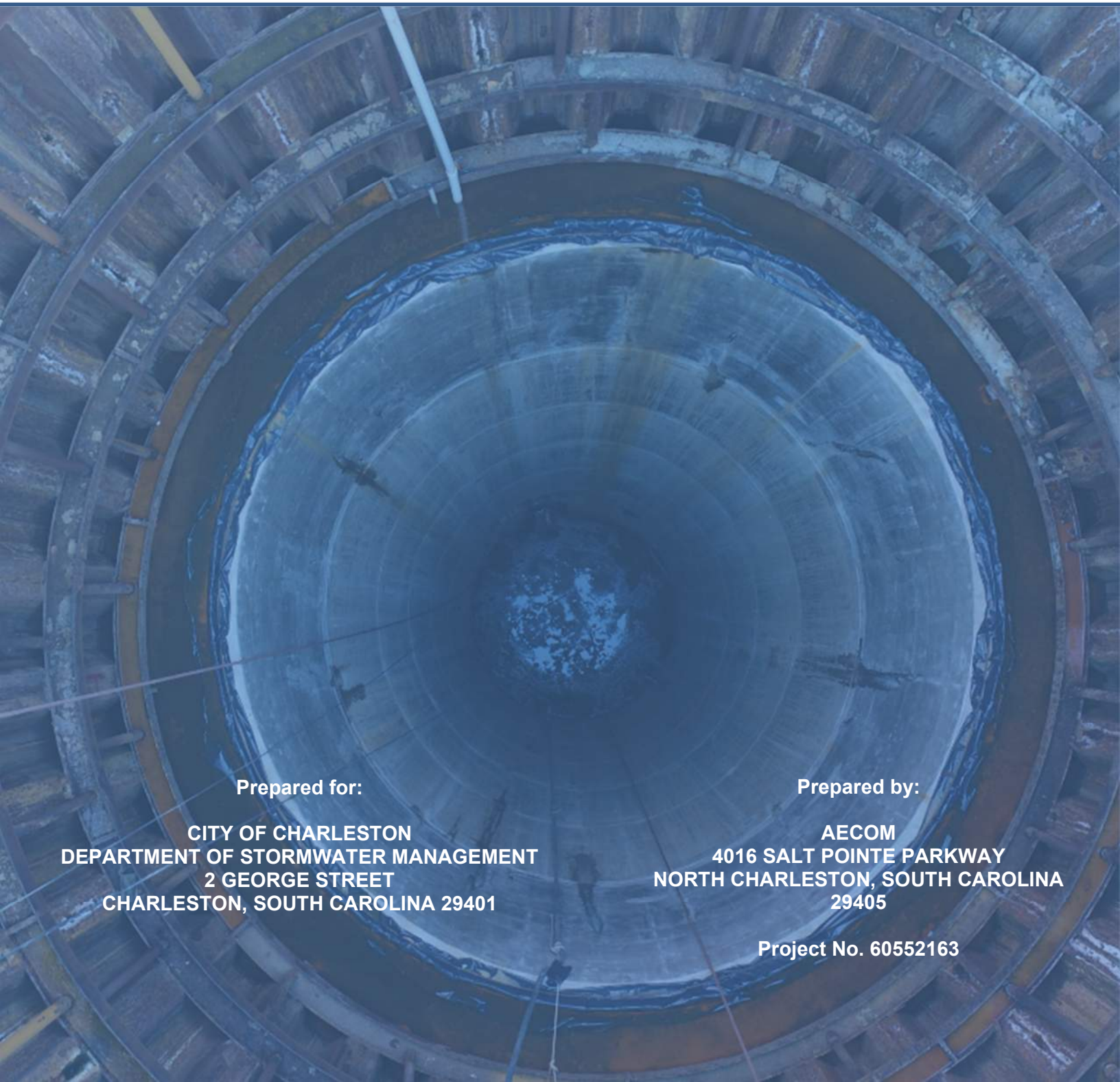
CITY OF CHARLESTON

STORMWATER DESIGN STANDARDS MANUAL



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City of Charleston Signature Page

I hereby certify that I have examined this Stormwater Design Standards Manual and, being familiar with the South Carolina Department of Health and Environmental Control National Pollutant Discharge Elimination System General Permit for Stormwater Discharges from Regulated Small Municipal Separate Storm Sewer Systems (MS4) and the City of Charleston Department of Stormwater Management, attest that this Manual has been prepared in accordance with the applicable MS4 permit requirements. My signature below constitutes authorization for the commitment of resources necessary for implementation of the Manual.

Director, Department of Development Services	Date

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Record of Revisions

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March 2013	Stormwater Design Standards Manual – Updated Final
August 2014	Appendix Update
July 2020	Stormwater Design Standards Manual - Major Revision
September 2025	Stormwater Design Standards Manual – Updated Final

This manual is intended to be a dynamic document with revisions made as new design criteria or technology evolve or it becomes evident that additional measures are needed to ensure the public general welfare. This manual will be amended with City Council's approval. This manual can also be found on the City of Charleston's website at https://www.charleston-sc.gov/351/Stormwater-Design-Standards-Manual.

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
AEP	Annual Exceedance Probability
AO	Administrative Order
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials

BMP	Best Management Practice
CAA	Construction Activity Application
CAP	Citizen Access Portal
CEPSCI	Certified Erosion Prevention and Sediment Control Inspector
CFR	Code of Federal Regulations
CGP	Construction General Permit
City	City of Charleston
COA	Close-Out Application
CPMSF	Covenant for Permanent Maintenance of Stormwater Facilities
C-SWPPP	Comprehensive Stormwater Pollution Prevention Plan
CWA	Clean Water Act
CZC	Coastal Zone Consistency
CZMA	Federal Coastal Zone Management Act of 1972
DO	Dissolved Oxygen
ECB	Erosion Control Blanket
EPA	Environmental Protection Agency
EPSC	Erosion Prevention and Sediment Control
FEMA	Federal Emergency Management Agency
FIPS	Federal Information Processing Standard
fps	feet per second
GIS	Geographic Information System
H:V	Horizontal to Vertical
HEC	Hydrologic Engineering Center
HEC-RAS	Hydrologic Engineering Center’s River Analysis System
HOA	Home Owners Association
HSG	Hydrologic Soil Group
HY8	Culvert Hydraulic Analysis Program
ICPR	Interconnected Channel and Pond Routing
IGP	Industrial General Permit
LCP	Larger Common Plan
LID	Low Impact Development
LOS	Level of Service
MHHW	Mean Higher High Water
MS4	Municipal Separate Storm Sewer System
NAD	North American Datum

NAVD	North American Vertical Datum
NERC	Natural Environment Research Council
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOT	Notice of Termination
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OCRM	Office of Ocean and Coastal Resource Management
OS-SWPPP	On-site Stormwater Pollution Prevention Plan
PDF	Portable Document Format
PE	Polyethylene
PVC	Polyvinyl Chloride
QLP	Qualifying Local Program
RCP	Reinforced Concrete Pipe
SC811	South Carolina 811
SCDHEC	South Carolina Department of Health and Environmental Control
SCDOT	South Carolina Department of Transportation
SCS	Soil Conservation Service
SEDCAD	Sediment Erosion Discharge by Computer Aided Design
SEDPRO	Sediment Erosion Discharge Program
SFHA	Special Flood Hazard Area
SFR	Single Family Residence
SMS4	Small Municipal Separate Storm Sewer System
SMSRA	South Carolina Stormwater Management and Sediment Reduction Act of 1991
SPCC	Spill Prevention, Control, and Countermeasure
SRC	Subdivision Review Committee
SWAT	Soil and Water Assessment Tool
SWDSM	Stormwater Design Standards Manual
SWMM	Stormwater Management Model
SWMP	Stormwater Management Plan or Stormwater Management Program
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TRC	Technical Review Committee
TRM	Turf Reinforced Mat

TSS	Total Suspended Solids
UOS	Uniform Ordinance Summons
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USGS	United States Geological Survey
WQV	Water Quality Volume

Definitions

Words used in this manual shall have customary meanings as determined by the standard dictionary definition except for the following specific words and terms that are herein defined or are otherwise defined in the City of Charleston Ordinance, authorizing regulations listed in **Section 1.5**, or applicable Federal Emergency Management Agency regulations. The Department of Stormwater Management has the right to define or interpret any other word or term contained within this manual.

Accommodate: water elevation not exceeding the crown of the pipe or culvert crossing under a roadway; coming within 12 inches of the top of the ditch or channel for the design storm; or not encroaching on less than one-half of a travel lane for street drainage, curbs, and gutters for the design storm event.

Algal Bloom: the rapid increase in the population of algae in an aquatic system.

Applicant: a person, firm, governmental agency, partnership, limited liability company, or any other entity who seeks to obtain approval under the requirements of Chapter 27 in the City of Charleston Ordinance and who, in addition to the property owner or operator, will be responsible for the land disturbing activity and related maintenance thereof. The Applicant executes the necessary forms to obtain approval for a permit for a land disturbing activity.

Appropriate Plan Approval Authority: South Carolina Department of Health and Environmental Control, local government, or conservation district that is responsible in a jurisdiction for review and approval of Stormwater Management and Erosion Prevention and Sediment Control Plans. This function will be carried out by the City of Charleston.

Backwater: the increase in water surface elevation relative to the elevation occurring under natural channel and floodplain conditions upstream of a stormwater facility.

Bankfull Event: the flow condition where the highest stresses are applied to streambanks, causing streambank erosion and channel enlargement.

Best Management Practice (BMP): any structural or non-structural measure or drainage facility used for the control of stormwater runoff, be it for quantity or quality control. Best management practices also include schedules of activities, prohibitions of practices, maintenance procedures, treatment requirements, operating procedures, and other management practices to control site runoff, spillage or leaks, sludge or waste disposal, drainage from raw material storage, or measures that otherwise prevent or reduce the pollutant loading of receiving water(s). Structural best management practices may be referred to as “Stormwater Control Measure”, as in the case of ASCE language.

Brownfield: a formal industrial or commercial site where future use is affected by environmental contamination.

Building: any structure built for support, shelter, or enclosure for any occupancy or storage.

Certified Erosion Prevention and Sediment Control Inspector (CEPSCI): a person with the responsibility for conducting inspections during construction and maintenance inspections after the land disturbing activity is completed as certified by South Carolina Department of Health and Environmental Control.

Certified Stormwater Plan Reviewer: a person with the responsibility for reviewing Stormwater Management and Erosion Prevention and Sediment Control Plans for the City as certified by South Carolina Department of Health and Environmental Control.

Channel: a stormwater conveyance open to the atmosphere flowing under the influence of gravity, including, but not limited to, natural waterways, canals, ditches, swales, and flumes.

Construction or **Construction Activity**: an activity involving clearing, grading, transporting, filling, or any other activity that causes land to be exposed to the danger of erosion, or that might create an alteration to an existing drainageway or other component of the City's stormwater management system or drainage facility.

Construction Activity Application (CAA): the set of drawings, specifications, design calculations, Stormwater Pollution Prevention Plan, and other documents necessary to apply for a construction activity permit.

Contour: representative line on a topographic map connecting points of equal elevation.

Conveyance System: private and public drainage facilities other than sanitary sewers within the City's municipal separate storm sewer system by which stormwater runoff may be conveyed to receiving waters, and includes but is not limited to roads, streets, constructed channels, storm drains, pipes, street gutters, inlets to storm drains or pipes, catch basins, or pumping systems.

Covenants: the Covenants for Permanent Maintenance of Stormwater Facilities, which is a permanent maintenance agreement between the property Owner and the City of Charleston, for maintenance of permanent stormwater best management practices described in construction plans approved by the City of Charleston, and any other permanent stormwater best management practices thereafter constructed on the Owner's property.

Critical Area: a critical area is defined as coastal waters, tidelands, beaches, and beach/dune system in South Carolina Code of Laws: Title 48 Environmental Protection and Conservation Section 48-39-10. A beach/dune system is the area from the mean high-water mark to the setback line as determined in Section 48-39-280.

Culvert: an enclosed symmetrical channel of comparatively short length installed to convey water from one side of an embankment to the other, typically under a roadway, and mainly used to divert stream or rainfall runoff to prevent erosion or flooding on roadways.

Design Exception: the modification of the minimum stormwater management requirements contained in Chapter 27 of the City of Charleston Ordinance and the Stormwater Management Program for specific circumstances where strict adherence to the requirements would result in unnecessary hardship and not fulfill the intent of Chapter 27 of the City of Charleston Ordinance. This was previously known as a variance.

Detention: the collection and storage of stormwater runoff in a surface or subsurface facility for subsequent controlled discharge to a conveyance system or receiving water.

Detention Structure: a permanent stormwater management structure whose primary purpose is to temporarily store stormwater runoff and release the stored runoff at controlled rates.

Development: any of the following actions undertaken by a person, a firm, a governmental agency, a partnership, a limited liability company, or any other individual or entity, without limitation:

- Division or subdivision of a lot, tract, parcel, or other divisions by plat or deed
- Construction, installation, or alteration of land, a structure, impervious surface, or drainage facility
- Clearing, scraping, grubbing, or otherwise significantly disturbing the soil, vegetation, mud, sand, or rock of a site
- Adding, removing, exposing, excavating, leveling, grading, digging, burrowing, dumping, piling, dredging, or otherwise disturbing the soil, vegetation, mud, sand, or rock of a site

Discharge: when used without a qualifier, refers to “discharge of a pollutant” as defined at South Carolina Regulation 61-9, Water Pollution Control Permits, Section 122.2.

Ditch: a drainage channel in the earth created by natural or artificial means to convey surface and/or subsurface water, flowing continuously or intermittently. Ditches are generally smaller than those conveyances referred to as channels.

Drainage: a general term applied to the removal of surface or subsurface water from an area either by gravity via natural means or by systems constructed to remove water and is commonly applied herein to surface water.

Drainage Area: an area contributing stormwater runoff to a single point. In this document, the term *Drainage Area* is considered synonymous with *Watershed*.

Drainage Easement: the right of access of stormwater runoff from adjacent drainage basins into the drainageway within the defined easement as defined by Section 54-1051(i) Ordinance No. 2018-031 § 11, 4-10-18.

Drainage Facility: any component of the drainage system.

Drainage System: the surface and/or subsurface system that collects and conveys stormwater and surface water, and includes watercourses, waterbodies, receiving waters, and wetlands.

Easement: an authorization by a property owner to the general public, a corporation, or a certain person or persons for the use of any designated part of his property for a specific purpose, as defined by Ordinance No. 2007-158, § 2, 8-21-07; Ordinance No. 2017-110, § 1, 9-13-17). An easement is also defined in the Zoning Ordinance as the right of use for access granted on, above, under, or across a tract of land by the landowner to another person or entity (Section 54-1051(i) Ordinance No. 2018-031 § 11, 4-10-18).

Elevation: height in feet above a known datum, such as NAVD88.

Embankment or **Fill**: a deposit of soil, rock, or other material placed by construction methods.

Equalization Pipe: a pipe that maintains equal water surface elevation in all connected ponds in a closed system.

Erosion: the general process by which soils or rock fragments are detached and moved by the action of wind, water, ice, and gravity.

Erosion Prevention: measures employed to prevent erosion, including soil stabilization practices, limited grading, mulch, temporary or permanent cover, compost application, and construction phasing.

Eutrophication: the process by which a body of water becomes enriched in nutrients that stimulate growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.

Evapotranspiration: the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.

Extended Detention: basin that provides a storage volume above the invert of the lowest outlet, to temporarily detain a portion of stormwater runoff for an extended time period. The basin provides water quality through sedimentation of particulates during the extended time period.

Final Stabilization: having 70 percent or more of the entire site with permanent coverage in good condition.

Flood or **Flooding**: a temporary rise in the level of water that results in the inundation of areas not ordinarily covered by water. The types of flood events that occur in the City of Charleston are:

- ***Coastal (Tidal) Flooding:*** occurs during high tides and is not dependent on weather conditions. Frequency of tidal flooding increases with effects of sea level rise and moon phases.
- ***Extreme Event (Flash) Flooding:*** occurs when intense rainfall makes water rise quickly and flow at a high speed for a short amount of time.
- ***Fluvial (Riverine) Flooding:*** occurs when the capacity of a river's channel is exceeded as a result of intense or sustained rainfall across the catchment.
- ***Groundwater Flooding:*** occurs when the water table rises up to the surface during a prolonged wet period. Low-lying areas, areas near aquifers, and properties with cellars or basements are more likely to experience groundwater flooding.
- ***Surface Flooding:*** occurs when the volume of rainfall is unable to drain away through the drainage systems or infiltrate into the land, and instead flows over land.

Floodplain: an area of low-lying ground that may be submerged by floodwaters.

Grading: the excavating, filling (including hydraulic fill), or stockpiling of earth material, or any combination thereof, including the land in its excavated or filled condition.

Green Infrastructure (GI): an adaptable term used to describe an array of materials, technologies, and practices that use natural systems or engineered systems that mimic natural processes to enhance overall environmental quality and provide utility services. As a general principal, green infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, and/or recycle stormwater runoff. Examples of green infrastructure include green roofs, porous pavement, rain gardens, and vegetated swales.

Green Space: an area of grass, trees, or other vegetation set apart for recreational or aesthetic purposes in an otherwise urban environment.

Hydrologic Soil Group (HSG): a classification of soils based on the soil's runoff potential used by the Natural Resource Conservation Service.

Illicit Discharge or **Illegal Discharge:** any activity that results in a discharge to the City of Charleston stormwater management system or drainage facility or receiving waters that is not composed entirely of stormwater except:

- Discharge pursuant to a National Pollutant Discharge Elimination System permit (other than the National Pollutant Discharge Elimination System permit for discharges from the City of Charleston municipal separate storm sewer system)
- Discharges resulting from fire-fighting activities

Impaired Waters: waterbodies with pollutant load exceeding the Total Maximum Daily Load level established by the State in which it is located and approved by the Environmental Protection Agency.

Impervious Surface: a surface that has been compacted or covered with a layer of material so that it is highly resistant to infiltration by water, including conventionally surfaced streets, roofs, sidewalks, parking lots, and other similar structures.

Infiltration: the passage or movement of water through the soil profile.

King Tide: the highest seasonal tides that occur each year.

Land Disturbing Activity: any use of the land by any person that results in a change in the natural cover or topography that may cause erosion and contribute to sediment and alter the quality and quantity of stormwater runoff.

Larger Common Plan (LCP): broadly defined as any announcement or piece of documentation (including a sign, public notice or hearing, sales pitch, advertisement, drawing, permit application, zoning request, computer design, etc.) or physical demarcation (including boundary signs, lot stakes, surveyor markings, etc.) indicating construction activities may occur on a specific plot. A common plan for development or sale identifies a site where multiple separate and distinct construction activities (areas of disturbance) are occurring on contiguous areas. Such sites may have one operator or owner or several operators and owners. Construction activities may take place at different times on different schedules, in separate stages, in separate phases, in combination with other construction activities. Each Developer, Operator, or Owner for each site or project determined to be a part of a Larger Common Plan is subject to permitting requirements as defined by Chapter 27 in the City of Charleston Ordinance and the City of Charleston Stormwater Design Standards Manual.

Level Spreader: a structure that is designed to uniformly distribute concentrated stormwater runoff over a large area. Level spreaders come in many forms, depending on the peak rate of inflow, duration of use, type of pollutant, and site conditions. All designs follow the same principle:

- Concentrated flow enters the spreader through a pipe, ditch, or swale.
- The flow is retarded, and energy is dissipated.
- The flow is distributed throughout a long linear shallow trench or behind a low berm.
- Water then flows over the berm/ditch along the entire length.

Low Impact Development (LID): a set of principles and design components used to manage stormwater runoff by mimicking natural conditions and limiting pollutant transport through source control.

Maintenance: any action necessary to preserve stormwater system components, including conveyances, facilities, and BMPs, in proper working condition, to serve the intended purposes and to prevent structural failure of such components.

Maximum Extent Practicable: a technology-based control standard used in the municipal stormwater program against which South Carolina Department of Health and Environmental

Control Bureau of Water and permittees assess whether an adequate level of control has been proposed in the Stormwater Management Program.

Municipal Separate Storm Sewer System (MS4): conveyances or system of conveyances (including roads with drainage systems, highways, rights-of-way, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains, detention ponds, and other stormwater facilities) that receives, transports, stores, or treats stormwater runoff and that is:

- Owned or operated by the City of Charleston
- Designed or used for collecting or conveying stormwater
- Not a combined sewer system
- Not a part of a publicly owned treatment works

South Carolina Department of Transportation roadways are considered an MS4, and are covered by their own individual permit.

National Pollutant Discharge Elimination System (NPDES) Permit: permit for stormwater discharges issued by South Carolina Department of Health and Environmental Control pursuant to the Clean Water Act and the Federal stormwater discharge regulations (40 CFR 122.26) that allows for restricting pollutant loads as necessary to meet water quality standards.

Navigable Waters: According to the Environmental Protection Agency, a waterbody qualifies as a "navigable water of the United States" if it meets any of the tests set forth in 33 CFR 329 (e.g., the waterbody is (a) subject to the ebb and flow of the tide or (b) presently used, or has been used in the past, or may be susceptible for use (with or without reasonable improvements) to transport interstate or foreign commerce.

Non-erodible: a material (e.g., natural rock, riprap, concrete, plastic) that will not experience surface wear due to natural forces of wind, water, ice, gravity, or a combination of those forces.

Nonpoint Source Pollution: pollution contained in stormwater runoff from ill-defined, diffuse sources.

Non-stormwater Discharge: any discharge to the stormwater system or Waters of the State that is not composed entirely of stormwater.

Operator: the person who is operating the property on behalf of the owner, the operator's agent, or any other person who acts in the operator's behalf.

Outlet Facility: stormwater management facility designed to regulate the elevation, rate, and volume of stormwater discharge from detention facilities.

Owner: the legal property owner, the owner's agent, or any other person who acts in the owner's behalf.

Oxygen Demand: the amount of oxygen needed by aerobic organisms to break down organic material present in water.

Person and/or Parties: any and all persons, and/Parties that includes any individual, association, firm, corporation, limited liability company, business trust, estate, trust, partnership, two or more persons having a joint or common interest, or an agent or employee thereof, or any other legal entity.

Person Responsible for Land Disturbing Activity:

- Person who has or represents having financial or operational control over the land disturbing activity
- Landowner or person in possession or control of the land who directly or indirectly allowed the land disturbing activity or has benefited from it or who has failed to comply with any provision of this ordinance.

pH: a quantitative measure of the acidity or basicity of aqueous or other liquid solutions. The scale ranges from 0 to 14 where low pH indicates the solution is acidic, high pH indicates the solution is basic/alkaline, and a pH of 7 indicates the solution is neutral.

Pollutant: anything that may cause or contribute to exceedances of water quality standards, including but not limited to sediment, bacteria, nutrients, dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, soil, and industrial, municipal, and agricultural waste discharged into receiving waters.

Pollutant Load: a numeric value representing an estimate of the mass of a pollutant entering a stormwater system or receiving water.

Post-Development: the conditions that exist following the completion of the land disturbing activity in terms of topography, vegetation, land use and rate, volume, quality, and direction of stormwater runoff.

Pre-Development: the conditions that existed prior to the initiation of the land disturbing or redevelopment activity, or at the time of application, whichever is earlier, in terms of topography, vegetation, land use and rate, volume, quality, and direction of stormwater runoff.

Project: improvements and structures proposed by the applicant to be built on a defined site as part of a common plan of construction, development, or redevelopment.

Public Infrastructure: infrastructure that is owned by the public, represented by the government, for public use. Includes public water, sewer and stormwater facilities, electric lines, gas lines, telephone or cable television lines, curbs, and sidewalks located within the public right-of-way, and other public improvements.

Qualified Individual: a licensed professional (as defined by the South Carolina Construction General Permit) who is authorized to prepare, amend, certify, and stamp a construction Stormwater Pollution Prevention Plan. The Qualified Individual is knowledgeable in the principles and practices of erosion prevention and sediment controls and possesses the skills to assess conditions at the construction site that could impact stormwater quality and to assess the effectiveness of an erosion prevention and sediment control measures selected to control the quality of stormwater discharges from the construction activity.

Rate: volume of water passing a point per unit of time, generally expressed in cubic feet per second (cfs).

Receiving Water(s) or **Waters of the State**: refers to any lakes, bays, sounds, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Atlantic Ocean within the territorial limits of the State of South Carolina, and all other bodies of surface or underground water, natural or artificial, public or private, inland or coastal, fresh or salt.

Redevelopment: development on a previously developed site where the impervious surface on the previously developed site is equal to or greater than 20 percent of the total site and where any repair, reconstruction, or improvement to that site or to any structures located on that site such that the cumulative costs of repairs, reconstruction, or improvements, over a five-year period equals or exceeds 50 percent of the fair market value of the property and the structures located on that property. The cost of repairs, reconstruction, or improvements includes remodeling of existing building interiors, resurfacing of paved areas, and exterior building changes. The cost of repairs excludes ordinary maintenance activities that do not materially increase or concentrate stormwater runoff, or cause additional nonpoint source pollution.

Regulation: any regulation, rule, or requirement prepared by or adopted by the City of Charleston, the State, and Federal regulatory agency(ies).

Retention: the collection and storage of stormwater runoff without subsequent discharge to surface waters. The collected water must be infiltrated into the soil, reused for beneficial purpose, and/or evaporated or evapotranspirated.

Retention Structure: a permanent structure whose primary purpose is to permanently store a given volume of stormwater runoff. Release of the given volume is by infiltration, reuse, or evaporation/evapotranspiration.

Retrofit: the process of altering an existing drainage system to function properly or more efficiently than currently exists.

Sea Level Rise: an increase in sea level that is primarily related to climate change: added water from melting ice sheets and glaciers and the expansion of seawater as it warms. Global sea level has been increasing over the past century, and the rate has increased in recent decades. In 2014, global sea level was 2.6 inches above the 1993 average—the highest annual average in the

satellite record (1993-present). Sea level continues to rise at a rate of about one-eighth of an inch per year

Sediment: solid particulate matter, both mineral and organic, that has been or is being transported by water, air, ice, or gravity from its site of origin.

Sediment Control: the control of solid material, both mineral and organic, during a land disturbing activity to prevent its transport out of the disturbed area by means of air, water, gravity, or ice.

Sedimentation: the process that operates at or near the surface of the ground, which deposits soils, debris, and other materials either on other ground surfaces or in the waterbody.

Sedimentation Facility: any structure or area that is designed to retain suspended sediments from collected stormwater runoff, including sediment basins, and allows the sediment to settle out of the stormwater.

Sensitive Waters: any waters with approved or established total maximum daily loads; any waters included in the most recent South Carolina Department of Health and Environmental Control Bureau of Water Clean Water Act Section 303(d) list; or any waters pursuant to South Carolina's Water Classifications & Standards (Regulation 61-68) and Classified Waters (Regulation 61-69) regulations that are classified as either outstanding national resource waters, outstanding resource waters, trout waters, or shellfish harvesting waters; or in source water protection areas.

Single-Family Residence (SFR)-Separately Built: a noncommercial dwelling that is occupied exclusively by one family and not part of a residential and subdivision development.

Site: the land or water area where any development is physically located or conducted, including adjacent land used in connection with the development, and borrow and spoil locations associated with the development.

Small Municipal Separate Storm Sewer (SMS4): defined in South Carolina Regulation 61-9, Water Pollution Control Permits, Section 122.26(b)(16). Refers to all small separate storm sewer systems that are owned or operated by the United States, a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under State law such as a sewer district, flood control district, or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under Section 208 of the Clean Water Act that discharges to waters of the United States, but is not defined as "large" or "medium" municipal separate storm sewer system. This term includes systems similar to separate storm sewer systems in municipalities, such as systems at military bases, large hospital or prison complexes, and highways and other thoroughfares. The term does not include separate storm sewers in very discrete areas, such as individual buildings.

Special Protection Area (SPA) or **Stormwater Management Area**: areas within the City of Charleston that require additional stormwater management controls due to existing concerns.

Stabilization: the installation of vegetative or structural measures to establish a soil cover to reduce soil erosion by stormwater runoff, wind, ice, and gravity.

Storm Frequency: the probability of recurrence of a storm event.

- ***Fifty Percent Exceedance Storm Event***: a storm of specific intensity and duration that delivers rainfall with a 50% chance of being equaled or exceeded in any given year. This was formerly incorrectly referred to as a "2-yr storm" because the probability in any year of a storm of this rainfall duration and intensity was the same as the probability of 1 in 2.
- ***Twenty Percent Exceedance Storm Event***: a storm of specific intensity and duration that delivers rainfall with a 20% chance of being equaled or exceeded in any given year. This was formerly incorrectly referred to as a "5-yr storm" because the probability in any year of a storm of this rainfall duration and intensity was the same as the probability of 1 in 5.
- ***Ten Percent Exceedance Storm Event***: a storm of specific intensity and duration that delivers rainfall with a 10% chance of being equaled or exceeded in any given year. This was formerly incorrectly referred to as a "10-yr storm" because the probability in any year of a storm of this rainfall duration and intensity was the same as the probability of 1 in 10.
- ***Four Percent Exceedance Storm Event***: a storm of specific intensity and duration that delivers rainfall with a 4% chance of being equaled or exceeded in any given year. This was formerly incorrectly referred to as a "25-yr storm" because the probability in any year of a storm of this rainfall duration and intensity was the same as the probability of 1 in 25.
- ***Two Percent Exceedance Storm Event***: a storm of specific intensity and duration that delivers rainfall with a 2% chance of being equaled or exceeded in any given year. This was formerly incorrectly referred to as a "50-yr storm" because the probability in any year of a storm of this rainfall duration and intensity was the same as the probability of 1 in 50.
- ***One Percent Exceedance Storm Event:*** a storm of specific intensity and duration that delivers rainfall with a 1% chance of being equaled or exceeded in any given year. This was formerly incorrectly referred to as a "100-yr storm" because the probability in any year of a storm of that rainfall duration and intensity was the same as the probability of 1 in 100.
- ***Two Tenths Percent Exceedance Storm Event:*** a storm of specific intensity and duration that delivers rainfall with a 0.2% chance of being equaled or exceeded in any given year. This was formerly incorrectly referred to as a "500-yr storm" because the probability in any year of a storm of that rainfall duration and intensity was the same as the probability of 1 in 500.

Storm Surge: temporarily elevated shoreline stage and velocity as a result of atmospheric pressure changes and wind associated with a storm. Storm surge can be caused by storms a great distance away as well as closer to the location(s) where the storm surge is observed.

Stormwater: runoff or excess water caused by precipitation.

Stormwater Management:

- Quantitative control, a system of vegetative or structural measures, or both, that ensure no increase in volume and rate of stormwater runoff caused by man-made changes to the land
- Qualitative control, a system of vegetative, structural, or other measures that reduce or eliminate pollutants that might otherwise be carried by stormwater runoff

Stormwater Management and Sediment Control Plan: a set of drawings, other documents, and supporting calculations submitted as a prerequisite to obtaining a permit to undertake a land disturbing activity that contains all the information and specifications required by the City of Charleston. This plan is part of the Stormwater Pollution Prevention Plan.

Stormwater Management Program: The City of Charleston's Stormwater Management Program, which describes the components to be used by the City of Charleston to control stormwater discharges, address flooding, and meet water quality standards.

Stormwater Management System(s) and Drainage Facility(ies): natural and man-made channels, swales, ditches, swamps, rivers, streams, creeks, branches, reservoirs, ponds, drainageways, inlets, catch basins, pipes, head walls, storm sewers, pumping and discharge facilities, lakes and other physical works, properties, and improvements that transfer, control, convey, or otherwise influence the movement of stormwater runoff, be it for quantity or quality control.

Stormwater Pollution Prevention Plan (SWPPP): a site-specific document that

- Identifies potential sources of stormwater pollution
- Describes stormwater control measures to reduce or eliminate pollutants in stormwater discharges
- Identifies procedures the operator shall implement to comply with the terms and conditions of a permit

The Stormwater Pollution Prevention Plan includes site map(s), drawings and plans, other documents, and supporting calculations; identification of activities that could cause pollutants in the stormwater; and description of measures or practices to control these pollutants. A Stormwater Pollution Prevention Plan may be prepared for construction sites, municipal facilities, or industrial facilities.

Stormwater Runoff or **Runoff:** the direct response of a watershed to precipitation and includes the surface and subsurface runoff that enters a ditch, stream, storm sewer, or other concentrated flow during and following the precipitation. The part of rainfall that is not absorbed into the site but flows over the site as surface waters.

Structure: anything constructed or erected, the use of which requires a location on the ground or attached to something having a location on the ground, for example, playgrounds, swimming pools, fences, and buildings.

Subdivision: the division of a tract of land or of a parcel of land into two or more lots, building sites, or other divisions, for the purpose, whether immediate or future, of sale, legacy, or building developments, which includes any of the following:

- Creation of a new city road or the alteration of an existing road
- Need for drainage, sedimentation, or flood control measures
- Installation of a water delivery system
- Installation of a sanitary sewerage system

Subdivision shall not include the division of a tract of land wherein each lot created meets the standards of the City of Charleston Department of Public Service regarding the use of individual wells and septic tanks and does not involve any of the activities referenced above. When appropriate to the context, the term subdivision relates to the process of subdividing or to the land area subdivided.

Submerged System: a system in which the permanent pool of water is above the flowline invert elevation of the outlet.

Subsurface: relating to or situated in an area beneath a ground surface or body of water.

Swale: a vegetated open channel for the purposes of conveying stormwater with side slopes no steeper than 3H:1V. The cross-sectional shape may be triangular or trapezoidal.

Tailwater: the water depth downstream of a hydraulic structure or conveyance facility that restricts the flow of water from the structure or conveyance facility.

Total Maximum Daily Load (TMDL): a calculation of the maximum amount of a specific pollutant that a waterbody can receive and still meet water quality standards. It is the sum of the allowable loads or allocations of a given pollutant from all contributing point and nonpoint sources. It also incorporates a margin of safety and consideration of seasonal variation. For impaired waters, the total maximum daily load document specifies the level of pollutant reductions needed for waterbody use attainment.

Undeveloped Land: property not altered from its natural state by construction or installation of improvements such as roads, drainage improvements, buildings, structures, or other impervious surfaces, or which has less than 20 percent of its property covered by impervious surfaces.

Vegetation: all plant growth, especially trees, shrubs, mosses, and grasses.

Violator: a person who violates any provision of Chapter 27 of the City of Charleston Ordinance, the Stormwater Management Program, the Stormwater Design Standards Manual, or any permit or authorization issued by the City of Charleston pursuant to the ordinance, Stormwater Management Program, or Stormwater Design Standards Manual.

Waiver: the relinquishment from certain erosion protection, sediment control, and stormwater management requirements by the Appropriate Plan Approval Authority for a specific land disturbing activity on a case-by-case review basis.

Water Quality: characteristics of stormwater runoff or receiving waters that relate to the physical, chemical, biological, or radiological composition of water.

Water Quantity: characteristics of stormwater runoff that relate to the rate, duration, and volume of the stormwater runoff.

Watercourse: any natural or man-made conveyance used to transport runoff from one location to the next.

Waters of South Carolina, or Waters of the State: defined as lakes, bays, sounds, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Atlantic Ocean within the territorial limits of the State, and all other bodies of surface or underground water, natural or artificial, public or private, inland or coastal, fresh or salt, which are wholly or partially within or bordering the State or within its jurisdiction and all waters of the United States within the political boundaries of the State of South Carolina. Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of Clean Water Act, are not waters of South Carolina. This exclusion applies only to man-made bodies of water that neither were originally created in waters of South Carolina (such as disposal areas in wetlands) nor resulted from the impoundment of waters of South Carolina.

Waters of the United States:

- All waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide
- All interstate waters, including interstate “wetlands”
- All other waters such as interstate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, wet meadows, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
    - That are or could be used by interstate or foreign travelers for recreational or other purposes
    - From which fish or shellfish are or could be taken and sold in interstate or foreign commerce
    - That are used or could be used for industrial purposes by industries in interstate commerce
- All impoundments of waters otherwise defined as waters of South Carolina under this definition
- Tributaries of waters identified in the preceding paragraphs of this definition
- The territorial sea
- Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in the preceding paragraphs of this definition

Watershed: the drainage area contributing stormwater runoff to a single point. In this document, the term *Watershed* is considered synonymous with *Drainage Area*.

Wetlands: areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetland areas typically fall under the jurisdiction of one or both of the following agencies: South Carolina Department of Health and Environmental Control Office of Ocean and Coastal Resource Management or the United States Army Corps of Engineers.

Executive Summary

The objective of the City of Charleston Stormwater Design Standards Manual is to provide guidance on the design process during all phases of construction and the latest permanent construction stormwater management practices available to minimize the negative impacts of increasing stormwater runoff and its associated pollutants. Building on the previous version, this updated manual will help the City of Charleston take a comprehensive approach to stormwater management that integrates drainage design, stormwater quantity, and water quality considerations. The goal is to provide an effective tool for the City of Charleston and the development community to reduce both stormwater quality and quantity impacts and ensure protection of both upstream and downstream areas as well as receiving waters.

Stormwater management has entered a new era, the City of Charleston recognizes the need for more innovative policies and practices. The requirements for National Pollution Discharge Elimination System municipal and industrial permits, total maximum daily loads, and watershed assessments and the desire to protect human life, property, aquatic habitats, and the quality of life in the City of Charleston have brought home the pressing need to manage both stormwater quality and quantity from developed and developing areas.

To enhance its utility and ease of use, this manual has been divided into eight chapters. Each chapter provides information that supports the implementation of an integrated, green infrastructure-based approach to natural resource protection, stormwater management, and site design that can be used to protect the City of Charleston's and coastal South Carolina's valuable natural resources from the negative impacts of land development and nonpoint source pollution. The eight chapters presented in the document include:

- **Chapter 1 – Introduction and Legal Authority:** Chapter 1 provides an introduction of the Stormwater Design Standards Manual and summarizes the legal authority the City of Charleston has been authorized to review and approve stormwater construction permits through Federal, State, and local laws, regulations, and ordinances.
- **0 – Conceptual Overview:** 0 provides a conceptual overview of stormwater concepts, water quality and quantity, management and planning, low impact development design, various types of development, best management practices, and sea level rise.
- **Chapter 3 – Design Requirements:** Chapter 3 provides information necessary to develop adequate systems that will control the rate, volume, and pollutants released from construction, development, and redevelopment projects. Chapter 3 also includes requirements for special protection areas, sea level rise, landscape design, and additional design considerations.
- **Chapter 4 – Construction Activity Permitting**: Chapter 4 provides information on the permitting process prior to any land disturbing activity. The chapter includes roles and responsibilities, types of projects and permits required, approvals of applications, and changes made after project approval, fees, exemptions, and exceptions.
- **Chapter 5 – Construction Phase:** Chapter 5 provides requirements during the land disturbing phase of the construction process. The chapter includes implementation of temporary best

management practices; requirements for changes to approved designs and approved stormwater pollution prevention plans, inspections by the construction applicant, owner, and/or operator during construction; and erosion prevention and sediment controls.

- **Chapter 6 – Post-Construction:** Chapter 6 provides requirements for closeout operations during the post-construction phase. The chapter includes information on final stabilization of the site, inspections, and in situ testing by the construction applicant, owner, and/or operator, stormwater record drawings, city roadways inventory, final plats, stormwater GIS, maintenance plans and covenants, and stormwater facility warranties.
- **Chapter 7 – City Inspection and Enforcement:** Chapter 7 provides requirements for inspections and enforcement actions conducted by the City of Charleston. The inspection section of Chapter 7 includes duties and responsibilities for the City of Charleston, inspector qualifications, associated fees, and inspection reports. The enforcement section of Chapter 7 includes information about common violations, correction orders, notices of violations, stop work orders, penalties, and uniform ordinance summons.
- **Chapter 8 – References:** Chapter 8 lists all references in this manual. It includes references to laws, regulations, standards, ordinances, manuals, permits, studies, and websites.

This manual is intended to provide guidance for the City of Charleston's government officials and staff on implementing stormwater management programs. Developers planning land disturbing activities in the City of Charleston shall use this manual to find the minimum requirements needed throughout the design process from the beginning of the project to closeout.

Other interested parties and the public may also find this manual helpful because it describes how managing stormwater improves water quality and quantity, helps protect the City of Charleston's valuable natural resources, and contributes to other social and economic benefits. Adoption of new comprehensive management strategies using low impact development concepts, such as green infrastructure, will reduce the negative impacts of stormwater runoff. These low impact development concepts help reduce runoff from new and redevelopment sites by using best management practices that encourage infiltration, evaporation, capture, and reuse of stormwater runoff onsite.

Chapter 1 Introduction and Legal Authority

1.1 Purpose

Stormwater management is extremely important, particularly in coastal cities, such as the City of Charleston (City). With sea level rise, king tides, and the increase in population density, the City has and will continue to implement high standards with regard to public infrastructure, development, and redevelopment projects. The purpose of the Stormwater Design Standards Manual (SWDSM) is to provide guidance on the design of the City's stormwater system. The SWDSM addresses issues related to pre-construction and permitting, construction, and post-construction for public infrastructure, development, and redevelopment projects within the City.

The SWDSM describes the policies and procedures that will be used by the City's Department of Stormwater Management to implement the City's ordinances related to stormwater. The SWDSM provides:

- Application submittal requirements and approval process
- Technical design standards, to include standards that address flow rates, runoff volume, and pollutant load/concentration, as well as standards applicable during construction, and post-construction performance
- General information on measures to improve water quality, prevent illicit discharges, and minimize stormwater runoff impacts due to construction activity, development, and redevelopment
- Other protection provisions related to stormwater discharges such as wetlands and watercourse conservation

1.2 Scope

The SWDSM is intended to be a resource for City officials, staff, designers, and developers on the stormwater design requirements approved by the City's Department of Stormwater Management. Additionally, the SWDSM provides information to the interested citizen regarding the City's approach to stormwater management.

1.3 Legal Authority

Federal regulatory agencies delegate authority to the States, providing that State requirements meet or exceed Federal requirements. The United States Environmental Protection Agency (EPA) delegates authority for the Clean Water Act (CWA) and other environmental laws to the State of South Carolina. In turn, the South Carolina Department of Health and Environmental Control (SCDHEC) is the regulating and permitting agency for the State. SCDHEC has the ability to delegate authority to local stormwater management programs, if local programs meet or exceed Federal and State requirements. The City has combined Federal, State, and local laws, regulations, and ordinances for stormwater into the SWDSM.

The SWDSM incorporates design standards that are required by the regulatory agencies. The City requires any construction activity to incorporate the standards stated in the SWDSM, or enforcement and corrective actions will be taken. The City strictly adheres to the SWDSM, and will require the same from any parties designing and engaging in construction activities, in order to improve flood control, water quality, and infrastructure integrity.

1.4 Authorization

The SWDSM has been prepared under the direction of the Department of Stormwater Management, which has been granted the authority by the City Council to develop engineering design standards and enact programs and policies to ensure compliance with State and Federal

laws for the purposes previously described. A detailed description of the laws, regulations, and assigned authorizations to the City is provided in the following section.

1.5 Stormwater-Related Laws, Regulations, and Permits

Any construction activity is required by law to regulate water quality and quantity to protect the waters of the State and waters of the United States. Federal laws and regulations provide the overarching guidelines for the United States. South Carolina laws include Federal laws and require other regulations specific to the State. This section contains the Federal and State laws, regulations, and permits that are included and required by the City of Charleston Ordinance and are encompassed in the SWDSM (**Figure 1-1**).

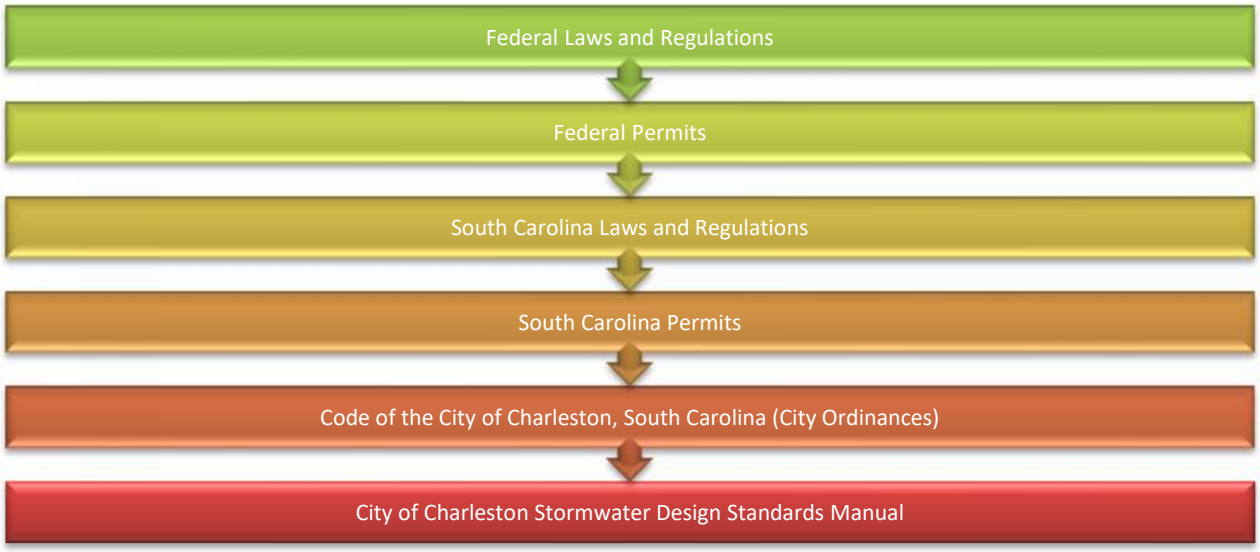


Figure 1-1. Hierarchy of laws and regulations from Federal to local governments

1.5.1 Federal Clean Water Laws

1.5.1.1 Clean Water Act

The Federal Water Pollution Control Act, as amended by the CWA, requires the reduction of water pollution and gives EPA the congressional authority to develop programs to improve the health of navigable waters. EPA developed regulations that created a program of discharge permits as part of the National Pollutant Discharge Elimination System (NPDES) to regulate point sources from a variety of discharges. The 1987 amendments to the CWA extended NPDES permits to industrial discharges, including stormwater runoff associated with land disturbing activity. The 1987 CWA Amendments also require NPDES permitting for stormwater runoff from urbanized areas. A Municipal Separate Storm Sewer System (MS4) NPDES permit is required based on population. Authority to administer the NPDES permit program was delegated to State agencies, such as SCDHEC, by EPA.

1.5.1.2 Federal Coastal Zone Management Act of 1972

The United States Congress recognized the fragile balance between economic growth and preservation of the environment and passed the Coastal Zone Management Act (CZMA) in 1972. The goal of CZMA is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone." CZMA is administered by the National Oceanic and Atmospheric Administration (NOAA) and provides for the management of the nation's coastal resources. Coordination between Federal and State jurisdictions is a requirement and allows flexibility for local programs to address their specific needs.

1.5.2 Required Federal Permits

1.5.2.1 United States Army Corps of Engineers Section 404 Permit

Under the CWA Section 404(b)(1) Guidelines, EPA established regulations and guidelines for discharges of dredged or fill materials into the waters of the United States, including wetlands. The United States Army Corps of Engineers (USACE) is charged with evaluating applications of the Section 404 Permit under a public interest review, CWA, and additional regulations promulgated by EPA. The basis of the Section 404 Permit is to show that steps have been taken to avoid discharges of dredged or fill material into waters of the United States, potential impacts have been minimized, and compensation will be provided for all remaining unavoidable impacts. Activities requiring a Section 404 Permit include, but are not limited to, fill for development, water resources projects (e.g., dams and levees), infrastructure development (e.g., highways and airports), and mining activities.

1.5.3 South Carolina Water Laws

1.5.3.1 South Carolina Pollution Control Act

The South Carolina Pollution Control Act was originally enacted in 1950 and was last amended in 1970 during the initial stages of the environmental movement. It was broadly written and is applicable to essentially any activity that could negatively impact the environment by requiring attainment of a permit and implementation of measures to mitigate potential negative impacts.

1.5.3.2 South Carolina Stormwater Management and Sediment Reduction Act

The South Carolina Stormwater Management and Sediment Reduction Act of 1991 (SMSRA) (Section 48-14-10 et seq.) was enacted to address the increase in stormwater runoff rate and quantity, the decrease of rainwater infiltration, and the increase in erosion associated with the extensive urban development occurring throughout the State. SMSRA gave legislative authority to SCDHEC to enact programs to meet its purpose.

1.5.3.3 South Carolina Coastal Zone Management Act

CZMA provides grants to States that develop and implement Federally approved coastal zone management plans. The Office of Ocean and Coastal Resource Management (OCRM), a division of SCDHEC, implements this management plan for the State's eight coastal counties as established by the Coastal Zone Management Act of 1976. Within the coastal zone, the program provides authority to review any project requiring a State permit (certification), a Federal permit or license (including NPDES), Federal funding, and direct Federal activities to determine whether the project is consistent with the policies and procedures of the South Carolina Coastal Zone Management Program.

1.5.3.4 South Carolina Stormwater-Related Regulations

South Carolina became the permitting authority over the NPDES Stormwater Program through SMSRA in 1991. SCDHEC has the responsibility of enforcing the stormwater regulations. These regulations provide information about stormwater standards and the regulatory process. Below is a list of regulations from SCDHEC:

- South Carolina Regulation 61-9, Water Pollution Control Permits
- South Carolina Regulation 61-68, Water Classifications & Standards
- South Carolina Regulation 61-69, Classified Waters
- South Carolina Regulation 61-110, Total Maximum Daily Loads (TMDLs) for Pollutants in Water
- South Carolina Regulation 72-101 through 72-108, Erosion and Sediment Reduction and Stormwater Management
- South Carolina Regulation 72-300 through 72-316, Standards for Stormwater Management and Sediment Reduction
- South Carolina Regulation 70-405 through 72-445, Standards for Stormwater Management and Sediment Reduction

1.5.4 Required South Carolina Permits

1.5.4.1 Ocean and Coastal Resource Management Coastal Zone Consistency

Under the guidelines of CZMA and the South Carolina Coastal Tidelands and Wetlands Act of 1977, the South Carolina Coastal Management Program was established to manage coastal resources. Under the program, a Coastal Zone Consistency (CZC) Certification is required for any land disturbing activities in the coastal counties, including Charleston County and Berkeley County, prior to receiving coverage under the NPDES Permit Program. All CZC Certifications are granted through the OCRM in SCDHEC. CZC Certification guarantees a balance of environmental protection and economic and social improvements of the coastal zone. A CZC Certification must be obtained prior to applying for any Federal or State permit.

1.5.4.2 NPDES General Permit for Stormwater Discharges from Regulated Small Municipal Separate Storm Sewer Systems (Permit No. SCR030000)

The City is required to have a NPDES permit to discharge stormwater from MS4, officially titled the "State of South Carolina NPDES General Permit for Storm Water Discharges from Regulated Small Municipal Separate Storm Sewer Systems (SMS4)." Since land disturbing activities contribute to the discharge of pollutants, the NPDES permit requires that the City encourage, promote, and implement practices, programs, and procedures for reducing or limiting discharge of pollutants into receiving waters of the State. The permit requires that the City develop and implement a Stormwater Management Program (SWMP) to control the discharge of pollutants from its MS4 to the maximum extent practicable. The location of the NPDES General Permit can be found in **Appendix A**.

1.5.4.3 NPDES General Permit for Stormwater Discharges Associated with Industrial Activities (Permit No. SCR000000)

Stormwater runoff from "industrial activities" is considered an illegal discharge without a NPDES discharge permit. The permit is titled "NPDES General Permit for Storm Water Discharges Associated with Industrial Activities (Except Construction)," and is informally known as the Industrial General Permit (IGP). These permits require certain industries to develop and implement a Stormwater Pollution Prevention Plan (SWPPP), which must include appropriate best management practices (BMPs) to minimize pollution to receiving waters. The two general types of industrial activity permits are construction related and other. Coverage under the NPDES General Permit for Stormwater Discharges from Construction Activities is required for construction sites that disturb 0.5 acre or more. Coverage is required for construction activities within 0.5 mile of a receiving water. The requirements for obtaining and complying with this type of permit are the focus of the SWDSM. The location of the NPDES IGP can be found in **Appendix A**.

1.5.4.4 NPDES General Permit for Stormwater Discharges from Construction Activities (Permit No. SCR100000)

Stormwater runoff from construction activities is considered an illegal discharge without a NPDES discharge permit. The NPDES General Permit for Stormwater Discharges from Construction Activities, also known as a Construction General Permit (CGP), addresses discharges during and post-construction activities. Requirements for discharges during construction activities set forth in the permit are based on the CWA, 33 U.S.C. 1251 et seq. and the South Carolina Pollution Control Act, Section 48-1-10 et seq. Additional requirements are established in South Carolina Regulation 61-9, Water Pollution Control Permits, South Carolina Regulation 72-300, SMSRA, and coastal zone citation. EPA has delegated the authority to implement the CGP to SCDHEC within the State of South Carolina. Any land disturbing activities (e.g., clearing, grading, or excavating) are required to obtain coverage for stormwater discharges under the NPDES CGP. The location of the NPDES CGP can be found in **Appendix A**.

1.6 Section 303(d) Listed Waters and Total Maximum Daily Loads

Through the provision of Section 303(d) of the CWA, EPA requires States to submit a list of all waterbodies (Section 303(d) Listed Waters) that do not meet minimum water quality standards every two years. The Section 303(d) list allows water quality impairments to be identified and corrective actions to be implemented. Once on the Section 303(d) List, a TMDL for the waterbody must be developed within 2 to 13 years of the initial listing by the State. SCDHEC develops the TMDL and forwards the information to the EPA Region 4 office for final approval.

1.7 City of Charleston Ordinances, Regulations, and Standards

1.7.1 Qualifying Local Program

EPA gives authority of NPDES permitting agencies SCDHEC to recognize when a local sediment and erosion control program meets or exceeds the requirements of the stormwater regulation 40 CFR 122.44(s). SCDHEC has the authority to incorporate the local program by reference in its permit for construction activities. The local program is then known as a Qualifying Local Program (QLP). The advantages of a QLP include streamlining the permit process and providing one set of requirements for construction activities. QLPs allow municipalities to modify stormwater programs to meet local needs as long as the requirements are met on a State and Federal level. QLPs undertake the responsibility of reviewing and approving erosion and sediment control plans, inspecting sites to ensure compliance, and taking corrective actions when needed to protect water quality.

The City has promulgated and adopted ordinances and standards based on State and Federal regulations to address concerns associated with uncontrolled stormwater runoff. City ordinances and standards that may affect construction activities, and the development and redevelopment of land, include the following:

- Building
- Design, Development, and Preservation
- Floodplain
- Stormwater Management Ordinances
- Utilities
- Zoning
- Other ordinances and standards may also be applicable and should be consulted as necessary.

1.7.2 1984 Master Drainage Plan

The *Master Drainage and Floodplain Management Plan for City of Charleston, South Carolina* (1984 Master Drainage Plan) was the first phase of a four-phase plan to improve the existing stormwater facilities in the City (Davis and Floyd, Inc. 1984). The plan was submitted in

compliance with the agreement between the City and the Engineers and constituted the completion of the first phase of identifying the existing drainage problems and recommendations for improvement. The Master Drainage Plan included all areas within the 1984 City boundaries.

1.7.3 Level of Service for Maintenance

Level of Service (LOS) is a set of standards and services the community can expect from the stormwater management program. The citizens of the City are ensured consistent and reasonable standards of service through paying the monthly stormwater fee. The City maintains the MS4 and certifies the system is serviceable and has minimal negative impact on the receiving waters in order to comply with the requirements set forth by SCDHEC. The LOS and fee can only be applied within the City boundaries and MS4 jurisdiction.

1.8 Easements

An easement is a “right of use for access granted on, above, under, or across a tract of land by the landowner to another person or entity” (Section 54-1051(k) Ordinance No. 2018-031 § 11, 4-10-18). Specifically, a drainage easement is the “right of access of stormwater runoff from adjacent drainage basins into the drainageway within the defined easement” (Section 54-1051(i) Ordinance No. 2018-031 § 11, 4-10-18). Easements are permanent and exist even after transfer of ownership of property. The City uses easements for maintenance and repairs of stormwater infrastructure and other utilities within the easement. The location of the easement agreement, known as a Covenants for Permanent Maintenance of Stormwater Facilities (CPMSF), is in **Appendix B.**

1.9 Standards Superseded

When the SCDHEC or the City updates design standards associated with stormwater discharges, the City provides notification of the new design standards and the cancellation of current design standards via the City’s website. The City also provides a timeline when the new design standards will be implemented.

1.10 Other Standards Sought

The City requires the most restrictive standard as the driver of design standards:

> *Whenever the provisions of this article impose more restrictive standards than are required in or under any other law, regulation, or article, the requirements contained in this article shall prevail. Whenever the provisions of any other law, regulation, or ordinance require more restrictive standards than are required in this article, the requirements of such law, regulation, or ordinance shall prevail. (Ord*inance *No. 2007-158 § 2, 8-21-07)*

1.11 Duty to Comply

Unless otherwise allowed by the City of Charleston Ordinance or the SWDSM, the surface of land in the City shall not be disturbed or altered for any purpose whatsoever, nor any major drainage channel or component of the stormwater system impeded or encroached upon without approval from the Department of Stormwater Management. Construction, development, and redevelopment activities shall not begin prior to approval from the Department of Stormwater Management and other City Departments as necessary.

1.12 Engineering Design Accountability

The SWDSM will assist engineers, plan reviewers, inspectors, and contractors in the design and layout of most land disturbance projects. The user of the SWDSM is hereby cautioned that many aspects of engineering design must be considered, including but not limited to:

- Public health, safety, and welfare
- Site-specific conditions or unusual features of a project site that warrant special designs
- Current versions of design texts, manuals, technical documents, and research

The design engineer must have sufficient education and experience to perform a complete and thorough design of each element shown on the construction plans and must also have complete control to change or alter the plans during the design phase. The design engineer shall thoroughly investigate field conditions and coordinate design efforts with the City. **Construction plans, site plans, details, calculations, construction specifications, and other technical documents must be designed, stamped, and sealed by a Professional Engineer or Tier B Land Surveyor actively licensed in the State of South Carolina**, unless otherwise stated in the SWDSM.

The SWDSM is not intended to restrain or inhibit engineering creativity, freedom of design, or the need for engineering judgment. When shown to be applicable, design engineers are encouraged to submit new procedures, techniques, and innovative stormwater BMPs with supporting documentation. However, the use of such approaches shall be substantiated with submitted documentation by design engineers showing that the proposed design is equal to or exceeds the traditional procedures in terms of performance and economic feasibility.

1.13 Severability

It is the declared intent of the City that, if any portion of the SWDSM is ruled to be invalid or unconstitutional by any court with adequate jurisdiction over the City, then such portion shall be considered to have been selectively removed from the SWDSM without affecting the overall applicability, validity, or enforceability of any remaining provisions, and it is the intent of the City that such remaining provisions shall continue in full force and effect.

1.14 Language and Interpretation of Text

The following language rules are applicable to the SWDSM:

- The imperative words "**shall**" and "**must**" indicate mandatory actions. These actions must be performed unless sufficient engineering justification is submitted to the City's Department of Stormwater Management and written approval has been specifically granted.
- The word "**should**" indicates an action that is highly recommended under most conditions.
- The word "**may**" indicates an allowable action or choice that is usually beneficial in meeting the minimum City requirements.
- Use of the singular or plural case of a noun shall not affect the applicability of the SWDSM, or any other law, regulation, or ordinance, unless the context of the sentence specifically indicates that the singular/plural case affects the intended use or function on a scientific or engineering basis. The use of a singular or plural noun does not necessarily indicate whether to design or construct a single unit or multiple units.
- Any reference to the Department of Stormwater Management shall mean the duly authorized representatives, sections, or employees under the Director's supervision who have delegated responsibilities. Areas of delegated responsibility may include, but are not limited to, review and approval of plans, review and approval of survey plats, interpretation of standards or requirements, approval of special conditions, review and issuance of approvals, inspections and field investigations, enforcement actions, issuing notices of violation, conducting public meetings, etc.
- The use of "**and**" shall imply conjunction of items in lists of required elements, in which all items must be complied with.
- The use of "**or**" shall imply the disconnection of items in lists of required elements, in which either or one or the other items in the list must be complied with.
- The rules of verbal construction found in the City of Charleston Ordinance also apply to the SWDSM.

1.15 Disclaimer

The SWDSM is not intended as a textbook or as a comprehensive engineering design reference. It was developed under the assumption that the user possesses a thorough understanding of stormwater control design, construction, and land development. Guidance documents from Federal, State, and local agencies as well as other relevant references are referenced throughout the SWDSM and are only for the purposes of providing additional information. See **Chapter 8** for a complete list of references.

Chapter 2 Conceptual Overview

2.1 Introduction

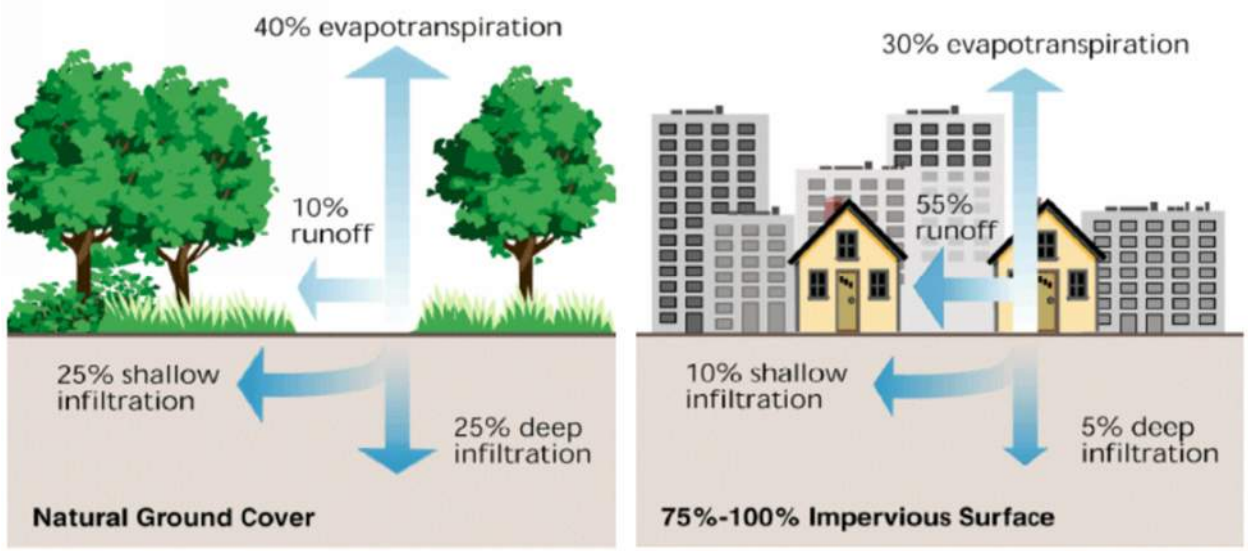
This chapter provides a conceptual overview of stormwater, the site conditions that dictate stormwater runoff quantity and quality, and the impacts that urban development have on stormwater. The topics introduced throughout this chapter are intended to establish a baseline understanding of stormwater concepts for developers, engineers, and any other members of the public who have an interest in the many factors that impact stormwater management in the Charleston area. Later chapters go more in depth into the stormwater considerations that factor into design, permitting, and construction.

2.2 Stormwater and Watersheds

The City has many water resources that we all enjoy. This chapter describes how proper stormwater management can protect and preserve these water resources for generations to come.

2.2.1 Introduction to Stormwater

During a storm, rainfall can either be intercepted by plants and trees or fall on the land. In a natural condition, the land absorbs the majority of rainfall by a process called infiltration. As the land is developed and becomes urbanized, more of the landscape is covered by impervious surfaces, such as rooftops, pavement, and compacted soil. As shown on **Figure 2-1**, an increasing percentage of impervious surface results in less rainfall being infiltrated into the soil, and more of the rainfall running off. These hard surfaces generate a larger volume of stormwater runoff, and without the natural obstacles that would otherwise slow the water down, the runoff travels at a faster rate. Fast-moving, large volumes of water cause erosion and flooding, and can damage land and property downstream. Additionally, as the runoff travels over the land, it picks up pollutants. Pollutants are any substance or material not naturally present in rainwater or surface water, or a natural substance that is present in excessive quantities (such as sediment). Impaired waters cannot be used as intended, for recreation, water supply, fishing or shellfishing, etc., due to pollution, or may lose their ability to support aquatic life.



Source: City of Charleston 2009

Figure 2-1. Diagram depicting changes in runoff and infiltration with increasing amounts of impervious surface

The basis for stormwater design in the City is the storm annual exceedance probability (AEP) percentage, or the percent chance that a 24-hour rain event will occur in any year, for the area. For example, a 1 percent AEP storm event in Charleston will result in 10.3 inches of precipitation over a 24-hour period. The AEP is determined using historical rainfall data within a region. AEP is used as opposed to recurrence intervals to avoid the public incorrectly interpreting that an X-year storm event only happens once in every X-years. **Table 2-1** shows the equivalents for the most commonly used storm recurrence intervals and AEPs.

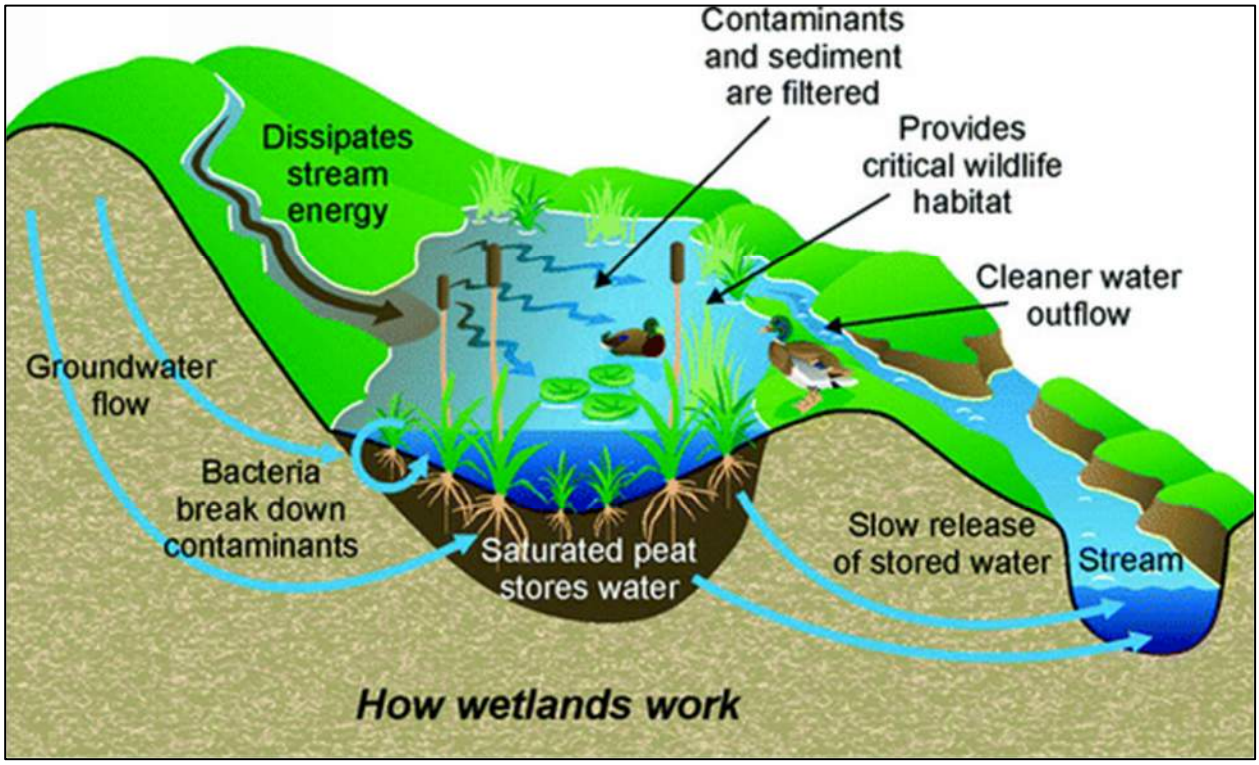
Table 2-1. Recurrence interval compared to annual exceedance probability

Recurrence Interval (years)	Annual Exceedance Probability (percent)
2	50
5	20
10	10
25	4
50	2
100	1
500	0.2
1000	0.1

2.2.2 What is a Watershed?

A watershed is an area of land that drains to a single point, bounded by higher elevations at the edges. Within a watershed, water travels over land until it reaches a body of water, and as the

water passes farther downstream, draining a larger area, pollutants can accumulate. Ultimately, the rivers and streams reach the ocean, and any accumulated pollutants are discharged into the ocean. In coastal areas, wetlands border the land, and many of the local streams and creeks enter wetlands before discharging to the ocean. Wetlands perform a crucial function in the watershed, intercepting pollutants carried downstream and removing them from the water in a natural treatment process. Additionally, wetlands slow the water down, allowing some of the runoff to infiltrate or be stored in the wetlands and slowly released long after the storm has passed. **Figure 2-2** depicts how wetlands work.



Source: City of Charleston 2016

Figure 2-2. Diagram depicting role of wetlands in a watershed

2.2.3 Changes from Natural Conditions to Development

Land development is the process of converting natural landscapes, such as forests, swamps, and grasslands, to developed, urban, or residential areas. This process typically begins with site clearing, which is the removal of trees, shrubs, and other vegetation. The landscape is then graded using a combination of cut and fill of the existing soil surface to provide clear, level building sites. In place of the previously vegetated land, developed impervious areas such as buildings, roads, and parking lots are constructed. By altering the landscape from a natural to a developed condition, the hydrology of the site is also changed. The natural drainage pathways that dominate the undisturbed stormwater system are replaced with a system of gutters, pipes, and channels designed to efficiently move water offsite.

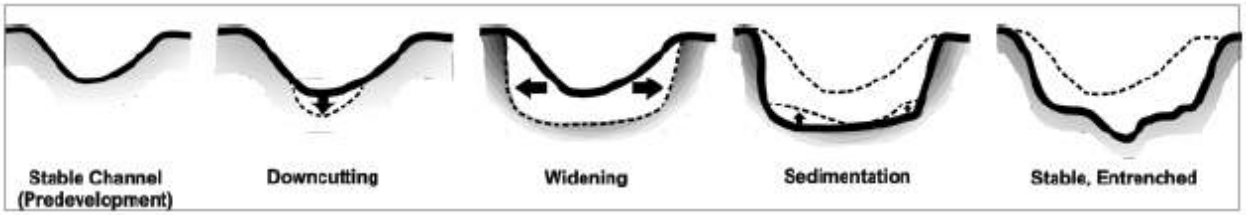
Due to the continued increase in the stringency of stormwater management regulations, as outlined in **Chapter 1**, the inclusion of vegetated land and natural drainage pathways in site development designs has become more common. By including natural systems into their designs, developers can help offset the impact of urbanization on the stormwater system.

2.2.4 Effects of Development

Development and redevelopment of urban and residential areas are an essential and dynamic part of any vibrant community, and are particularly important to consider in Charleston as economic and population growth remain anticipated. Given that development will continue for the foreseeable future, the key is to consider the impacts that development will have on the landscape and receiving waterbodies. **Chapter 3** through **Chapter 6** of this document outline the design, permitting, and construction standards that should be implemented to ensure that stormwater management is a major consideration in development going forward.

Changing a landscape from a natural condition to a developed condition also alters the hydrology of the site. By compacting the soil, installing roads, and constructing buildings, the overall impervious area of a site is dramatically increased. The reduction in evapotranspiration and infiltration, increase in impervious area, and traditional stormwater management principle of moving stormwater runoff offsite as fast as possible often lead to increased stream flow downstream of a development. This increased stream flow offsite can be seen in the increased runoff volume, peak runoff discharges, and runoff velocities. The high runoff rates and decreased infiltration rates caused by development also lead to decreases in groundwater recharge rate, which reduces the base flow in streams.

Urbanization also leads to significant changes in the geometry of streams in a watershed. Traditionally, farmers and developers would straighten stream channels to reduce the area covered by a meandering stream channel and to increase the speed at which stormwater flows offsite. Additionally, the increase in runoff volume and velocity offsite increases the amount of channel forming bankfull and near bankfull events. Bankfull events are the flow condition where the highest stresses are applied to streambanks, causing streambank erosion and channel enlargement. **Figure 2-3** shows a typical stream progression as a watershed is developed.



Source: ARC 2016.

Figure 2-3. Changes to a stream's geometry due to watershed development

Direct and indirect changes to the landscape following development have an impact on the aquatic habitats of these ecosystems. The increase in channel-forming bankfull events causes increased streambank erosion rates that undercut and uproot riparian vegetation. The streambed

is scoured away as a result of more intense storm events that mobilize the native bed material downstream. In addition to the loss of valuable habitat along the streambank and bed, increased erosion causes higher sediment loads to downstream aquatic ecosystems. The additional sediment load often accumulates in downstream stream reaches and wetlands, degrading their aquatic habitat value. In wetlands, the higher runoff rates and volumes resulting from development cause greater fluctuations in water levels. Water levels fluctuating from extreme high levels to extreme low levels can stress wetland ecosystems, causing a decline in aquatic plants and wildlife. Stormwater runoff from developed areas also has a higher temperature than runoff from natural landscapes. Aquatic organisms are typically sensitive to water temperatures, so the addition of warmer water from runoff can have a harmful effect on habitat diversity.

Stormwater runoff due to development also increases the pollutant loads associated with runoff, degrading the water quality in aquatic resources. As stormwater runoff flows over developed areas, hydrocarbons from oil and gasoline, heavy metals, pesticides, and other pollutants are picked up and transported to receiving waters. Sediment contaminated by oil spills, pesticides, or construction operations also may discharge into receiving waters as a result of surface erosion from runoff. Green spaces (e.g., parks, recreational fields, gardens) in urbanized areas can be over fertilized or fertilized immediately prior to a rain event. The excess fertilizer is transported in stormwater runoff to bodies of water, increasing nutrient loads. The added nutrient load causes a rapid increase in the algal growth, which in turn increases nutrient competition for other organisms. In extreme cases, the increased algal growth can lead to algal blooms that can harm other plants, animals, and humans and lead to no oxygen being present in the water when the sun goes down.

The increased stormwater runoff rates caused by development may also result in property damage and public safety concerns. Surface erosion around building foundations, scour around roadways, and streambank loss due to erosion are potential sources of property damage and safety concerns due to the increased stormwater runoff in developed areas. Additionally, algal blooms caused by increased nutrient loads in waterways can cause human health hazards.

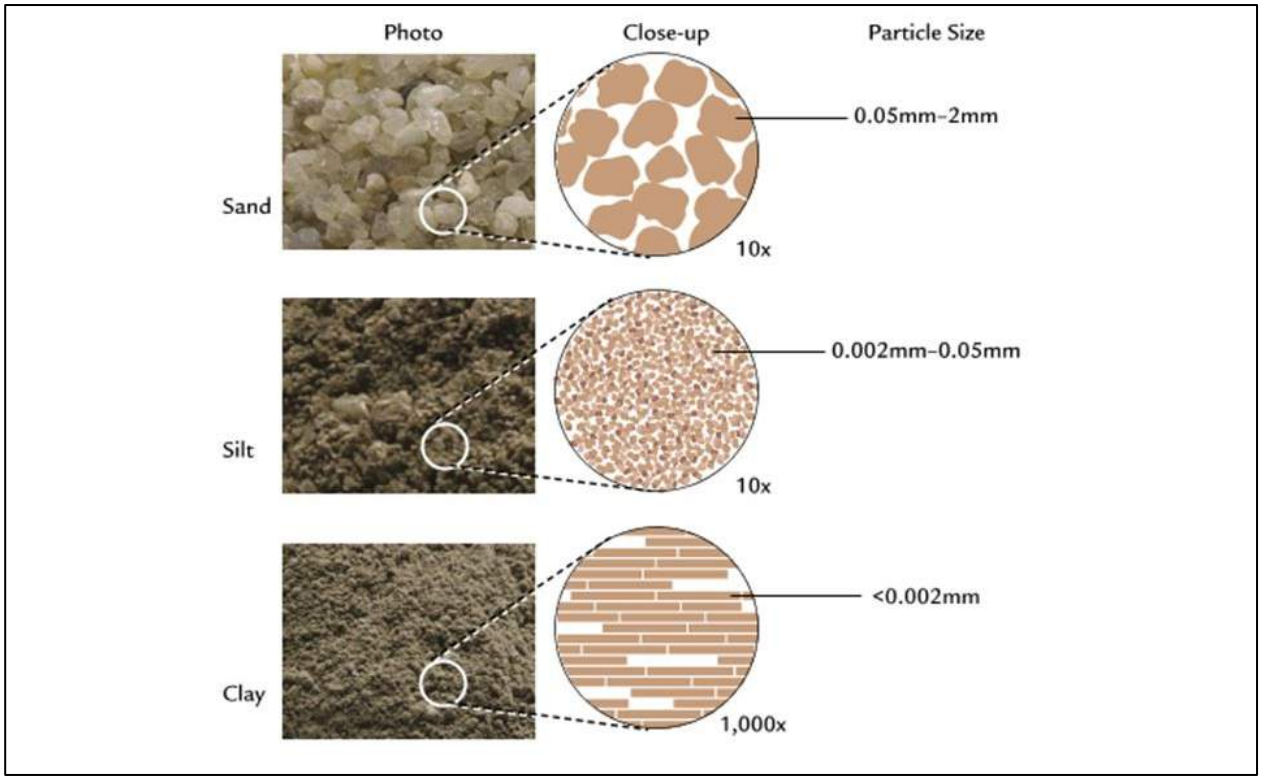
Surface runoff over roadways and parking lots often picks up and deposits loose trash and debris into rivers, ponds, and lakes. The discharge of trash into waterways and degradation of natural ecosystems contribute to a loss in the aesthetic value of the areas surrounding developments. The decline in wildlife abundance and diversity resulting from the loss and degradation of terrestrial and aquatic ecosystems also reduces the recreational value of these areas.

2.3 Introduction to Soils

Soils provide nutrients for plant growth, filtration of pollutants, and storage or release of stormwater. The soil characteristics at a site should be considered when designing a development or redevelopment. Soil characteristics often dictate which practices are necessary for the management of stormwater during and after construction. Site factors that impact stormwater drainage include soil texture, soil permeability, vegetation, topography, groundwater levels, and climate. Based on these soil characteristics, one of four hydrologic soil groups (HSGs) are used to classify the infiltration rates of different soil units: Group A, Group B, Group C, and Group D.

Additionally, characteristics such as the pH and organic content of soil influence the type of vegetation that can thrive at a site. The growth of vegetation on a site can help to stabilize the soil, improve infiltration, and promote pollutant removal from stormwater.

Soils are generally made up of four main components: mineral elements, pore space, organic matter, and living organisms. Soil texture is determined by the concentration of the three sizes of mineral elements found in soil. From smallest to largest, these particles are clay, silt, and sand. Soils with a higher concentration of sand are considered coarse textured and tend to be well draining, have low nutrient content, and are highly erodible. A higher concentration of clay will result in fine-textured soils that have reduced air and water movement, tend to shrink and swell, and become slippery when saturated (**Figure 2-4**).



Source: RainMachine 2019.

Figure 2-4. Soil mineral sizes

Soil permeability is the measure of the ability of fluids to pass through soil. Permeability is determined based on a combination of soil texture, structure, and density. Soils with very low permeability have dense, clayey mineral elements restricting the movement of air and water between pores. Highly permeable soils have loose, sandy minerals allowing fluids to easily infiltrate into pore spaces. In terms of stormwater management, this characteristic is one of the main factors in determining how quickly an area will drain following a storm event. The ability, or in some cases inability, of water to infiltrate through soil may determine the design requirements for a development's stormwater management.

While soil texture and permeability are important to site stormwater infiltration, many other site conditions and soil characteristics influence the overall drainage of a particular soil unit. To simplify the determination of soil infiltration rates, the Natural Resources Conservation Service (NRCS) classifies soils as one of four HSGs (**Table 2-2**). Group A is characterized by low runoff potential, high infiltration rates even when wetted, and large amounts of sand and gravel. Group B soils have moderate infiltration rates when wetted and are composed of fine to moderately coarse sand. Soils in Group C have low infiltration rates when wetted, have a layer that impedes the infiltration of water, and are composed of fine-textured soils. Group D soils have a high runoff potential, have low infiltration rates, and consist of clay soils with a permanent high water table or shallow soils over nearly impervious material. The infiltration rates for all the HSGs are reduced when the soil is saturated due to large storm events.

Table 2-2. Characteristics of NRCS Hydrologic Soil Group Classifications

Soil Group	Description	Runoff Potential	Infiltration Rate
A	Deep sandy soils	Very low	High
B	Shallow sandy soils over low permeability layer	Low	Low
C	Sandy soil with high clay or mineral content	Medium to high	Low
D	Clayey soils	Very high	Low to none

The characteristics influencing the HSGs are often site-specific; however, the addition of vegetation to a site design can stabilize the soil, improve infiltration, and promote pollutant removal from stormwater. Soil characteristics such as pH and organic content influence the ability of vegetation to grow in soil. Topsoil and compost can be added to the upper layer of the existing soil onsite to provide the nutrients and chemical composition for vegetation to establish.

2.4 Water Quality

The potential impacts to water quality should be considered when designing developments and redevelopments. Stormwater pollutants most often come from nonpoint sources and are an indirect impact of land development. As stormwater runoff washes over streets and parking lots, garbage, vehicle-related chemicals, pesticides, and other debris are picked up and discharged into ditches and receiving waterbodies. Common pollutants associated with land development are provided in **Table 2-3** and include suspended solids, oxygen demanding matter and bacteria, and nutrients. High levels of these pollutants in stormwater runoff can lead to multiple issues for receiving waterbodies, including reduced dissolved oxygen (DO) levels; increased algal growth, which may lead to eutrophication; and habitat degradation.

Table 2-3. Typical stormwater pollutants and sources

Pollutant Source	Pollutants of Concern
Erosion	Sediments and attached soil nutrients, organic matter, and other adsorbed pollutants.
Atmospheric Deposition	Hydrocarbons emitted from automobiles, dust, metals, nutrients, and other chemicals released from industrial and commercial activities.
Roadways/Transportation Related Areas	Hydrocarbons emitted from automobiles, dust, and metals.
Construction Sites	Sediment, metals, paint, and wood preservatives.
Manufactured Products (Industrial Land Uses)	Heavy metals, phenols, and oils from automobiles, and zinc and cadmium from tire wear.
Lawn and Landscape Maintenance	Fertilizer and pesticides.
Plants and Animals	Plant debris, grass clippings, and animal excrement.
Septic Tanks	Coliform bacteria, nitrogen, and nitrate.
Non-Stormwater Connections	Sanitary sewage, industrial wastewater, commercial discharge, swimming pool discharge, and water line flushing.
rAccidental Spills	Pollutants of concern depend on the nature of the spill.
Animal Waste Management	Coliform bacteria, nitrates, and phosphorus.
Pesticide Applications	Pollutants of concern depend on the pesticide being used and the type of crop or pest being treated.
Agricultural Land Disturbance	Sediment and attached soil nutrients, organic matter, and other adsorbed pollutants.
Fertilizer Applications	Nitrogen and phosphorus.

2.4.1 Suspended Solids

The most prevalent form of stormwater pollution is the presence of suspended matter that is either eroded by stormwater or washed off paved surfaces by stormwater. Sediment is derived from a variety of sources, including erosion from disturbed areas and washoff of sediment deposited on impervious areas. Several models are available to predict total suspended solids (TSS) contributions from “clean” sediment, but few of the models have parameters specific to urbanized areas. Models that have capabilities that have been used for predicting urban clean sediment include Stormwater Management Model (SWMM), Sediment Erosion Discharge Program (SEDPRO), Soil and Water Assessment Tool (SWAT), and Sediment Erosion Discharge by Computer Aided Design (SEDCAD) models. For the models to be effective in sizing BMPs, predictions should be made of time varying quantities as well as the size distribution. Those distributions should be of the aggregated particles, not just the primary particles.

2.4.2 Oxygen Demanding Matter and Bacteria

Sufficient levels of DO in the water column are necessary to maintain aquatic life, growth, and reproductive activity, as well as to maintain aerobic conditions. The introduction of stormwater containing oxygen-demanding organic matter can impair the receiving water quality by reducing the DO levels, such that it is unable to sustain certain forms of aquatic life and can further cause the water to become foul.

Bacteria enters the stormwater drainage system typically from the washoff of animal feces and organic matter from the catchment's surface, through leaking sewer systems (lateral connections, manholes, and industrial or commercial drains, etc.), and malfunctioning septic systems. Leaking sewer systems and malfunctioning septic systems are considered illicit discharges and illegal by the City of Charleston Ordinance, and are discussed more in **Section** Illicit Discharge Detection and Elimination**2.4.4**. Pathogenic bacteria and viruses in stormwater discharges pose human health threats. The removal of pathogenic bacteria is achieved primarily through the process of biological decay and physical-chemical disinfection where practiced. The reduction of bacteria in waters of the State has been the focus of TMDL efforts by SCHDEC to date.

2.4.3 Nutrients

Nitrogen and phosphorus are nutrients that promote the growth of plants and Protista, such as algae, and are the second leading stressor of impaired rivers and streams and the leading stressor of impaired lakes (USEPA 1997). Such nutrients contribute to the eutrophication of waterbodies, resulting in associated liabilities such as decreased oxygen supply, alteration of aquatic life, and decreased recreational value (Novotny et al. 1985).

Nutrients are typically derived from agricultural runoff and runoff from chemicals applied to lawns in urbanized areas, runoff from industrial sites, municipal wastewaters (of more concern for combined sewer overflows), or dry fall onto impervious surfaces that are later washed into stormwater. Nutrients can be removed from stormwater prior to discharge through biological uptake, such as by plantings in BMPs.

Models of nutrient loading in urban runoff are typically based on washoff type calculations or user-defined loadings and concentrations, all of which require user-defined constants. BMPs treat nutrient-rich runoff through settling (particulates), adsorption (to clay particles), uptake (by plants), and denitrification (nitrogen only).

2.4.4 Illicit Discharge Detection and Elimination

An illicit discharge is any discharge to the City's stormwater system that is not composed entirely of stormwater. There are a variety of illicit discharge sources, including those depicted in **Table 2-4**. It is important for property owners to know and understand these sources so that they may help to reduce or mitigate their impact on the pollutant load of the stormwater system.

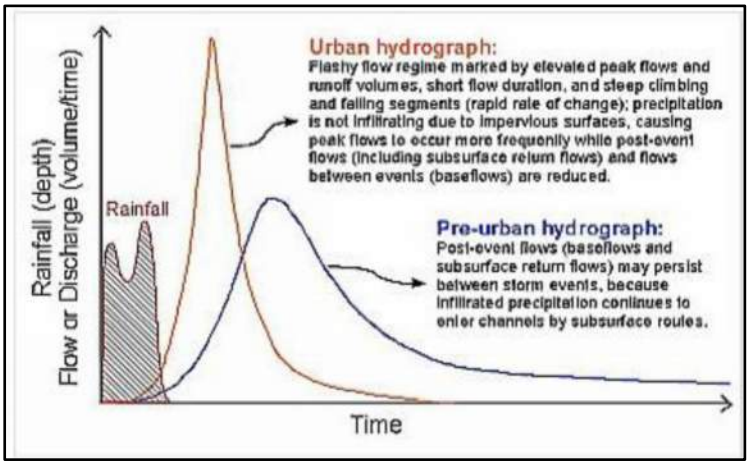
Table 2-4. Typical illicit discharge sources

Land Use	Source	Activity
Residential	• Apartments • Single family homes	• Car washing • Driveway cleaning • Chemical dumping/spills • Septic system maintenance • Landscaping • Swimming pool discharges
Commercial	• Car dealers • Car washes • Laundry facilities • Auto repair shops • Gas stations • Restaurants • Swimming pools	• Building maintenance (power washing) • Chemical dumping/spills • Landscaping • Outdoor material storage • Vehicle fueling • Vehicle washing • Washout of grease traps
Industrial	• Recycling centers • Distribution centers • Food processing • Construction vehicle washouts • Garbage truck washouts • Marinas • Chemical storage facilities	• Industrial process water or rinse water • Loading and unloading area washout • Outdoor material storage • Vehicle washing • Vehicle fueling • Building maintenance • Landscaping
Municipal	• Airports • Landfills • Maintenance facilities • Fleet storage • Public works facilities • City buildings	• Building maintenance • Chemical dumping/spills • Landscaping • Outdoor material storage • Road and parking lot maintenance • Vehicle fueling • Vehicle maintenance/repair • Vehicle washing

The City's Small MS4 General Permit requires the implementation of a program to detect and eliminate illicit discharges. The City is responsible for field screening to identify potential illicit discharges and their source, and the subsequent enforcement and elimination of the illicit discharge source. This procedure is essential to the reduction in point source pollution in the City's waterways (USEPA 2005 and USEPA 2010).

2.5 Water Quantity

Often, the first consideration when designing a new development or redevelopment is water quantity. The addition of impervious surfaces and removal of vegetation when developing a previously natural landscape disrupts the hydrologic cycle and leads to increases in stormwater runoff peak flows and total runoff volume. Changes in water quantity can be readily visible to property owners when flood frequency, severity, and duration increase. In coastal areas, factors such as changing tides, low depths to the groundwater table, and a generally flat terrain can exacerbate the impact that development has on flooding (**Figure 2-5)**.



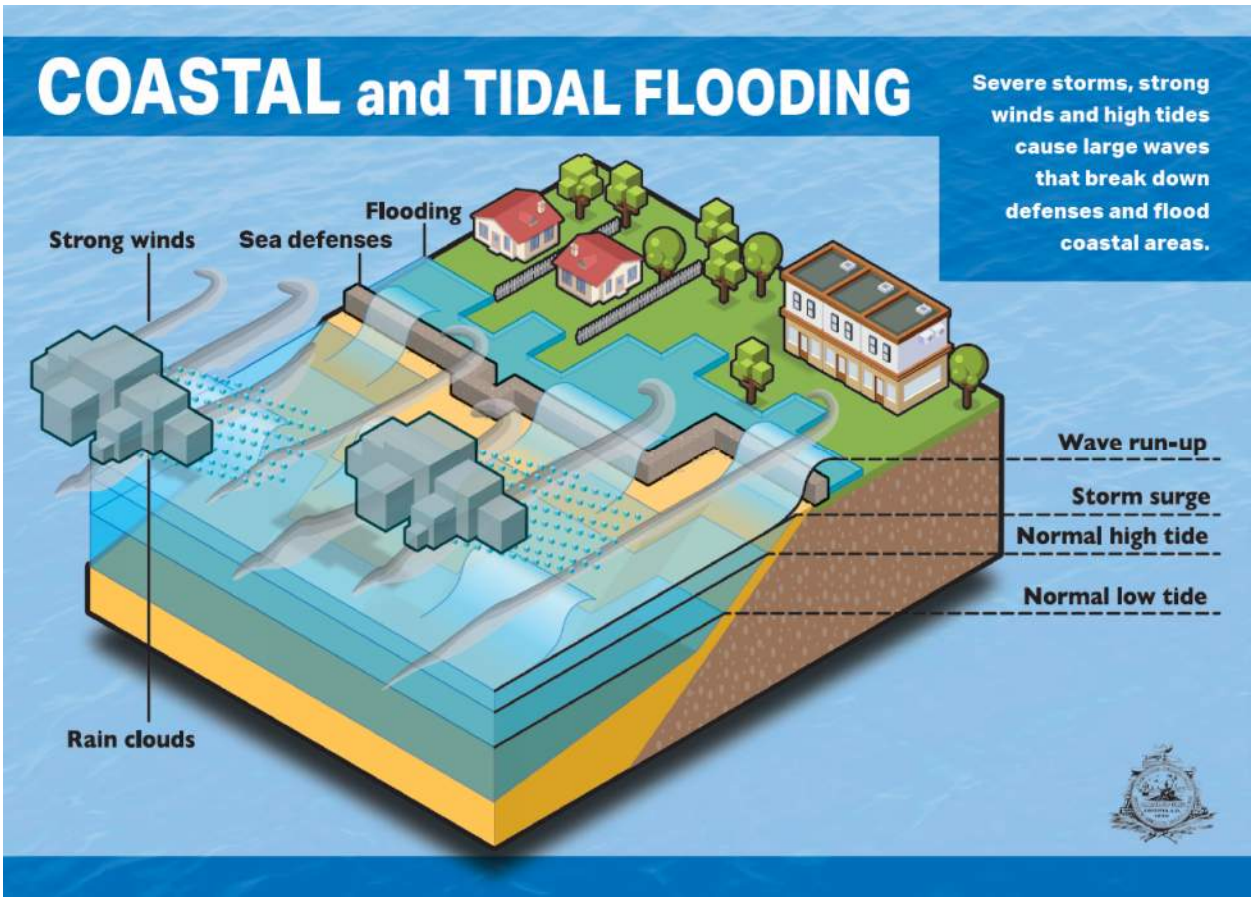
Source: U.S. EPA CADDIS Vol. 2

Figure 2-5. Stormwater flow changes associated with urbanization

Five types of flooding occur in the Charleston area, as discussed in the following sections.

2.5.1 Coastal and Tidal Flooding

In areas along the coastline, factors including high tide, storm surge, and tailwater contribute to the risk of coastal flooding. High tide flooding, also referred to as sunny day flooding or nuisance flooding, occurs during higher than average high tide conditions in low-lying areas along the coast (NOAA 2018 and NOAA 2019). These higher than average high tide conditions are also called spring tides or king tides. High tide flooding may lead to more frequent road closures, overwhelmed storm drains, or deterioration of stormwater infrastructure. In some areas, land subsidence, or the sinking of land over time, has led to an increased frequency of high tide flooding. Another condition impacting coastal flooding is storm surge. Storm surge is the rising of coastal water levels as a result of strong winds and changing atmospheric pressure during hurricanes and tropical storms. Higher high tides and land subsidence can also lead to tailwater issues for stormwater drainage systems. Tailwater occurs when the water surface elevation of a receiving waterbody is higher than the discharge point of a stormwater system. When at this condition, there is not enough energy for the stormwater to be discharged out of the system, causing the stormwater system to become overloaded. **Figure 2-6** depicts this type of flooding.

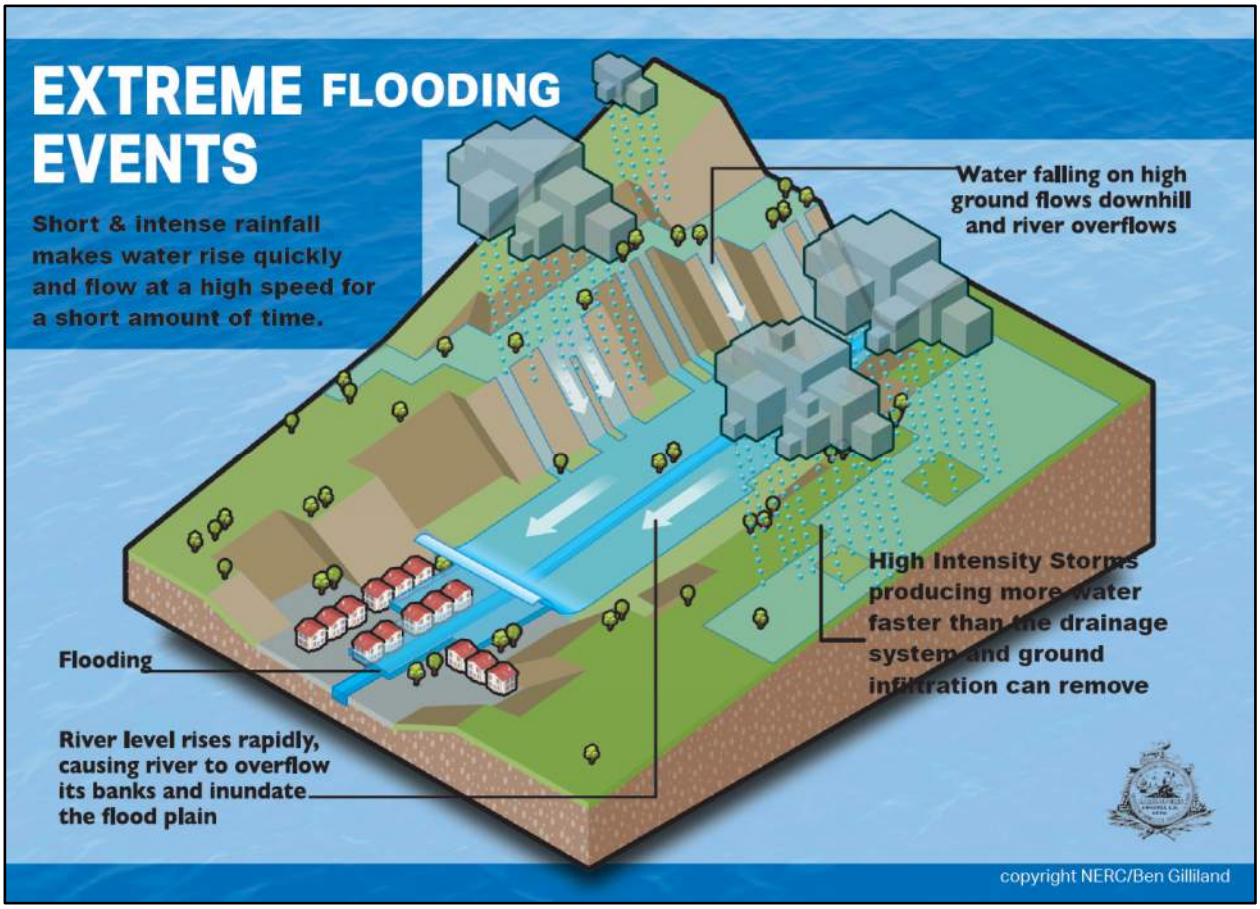


Source: Ben Gilliland and Natural Environment Research Council (NERC)

Figure 2-6. Coastal flooding causes and impacts

2.5.2 Extreme Event (Flash) Flooding

Floods that develop within six hours of their immediate cause are considered to be extreme event floods. Extreme event floods are typically associated with mountainous regions where stormwater flows rush down mountainsides and overwhelm downstream communities. However, extreme event floods can occur in coastal areas under certain conditions, including intense rainfall during king tides; high-intensity rainfalls inland of a coastal community that drain toward the coast, leading to inundation of coastal river systems; and high-intensity rainfalls that occur in areas that are already partially inundated by previous storm events. **Figure 2-7** depicts this type of flooding.



Source: Ben Gilliland and NERC

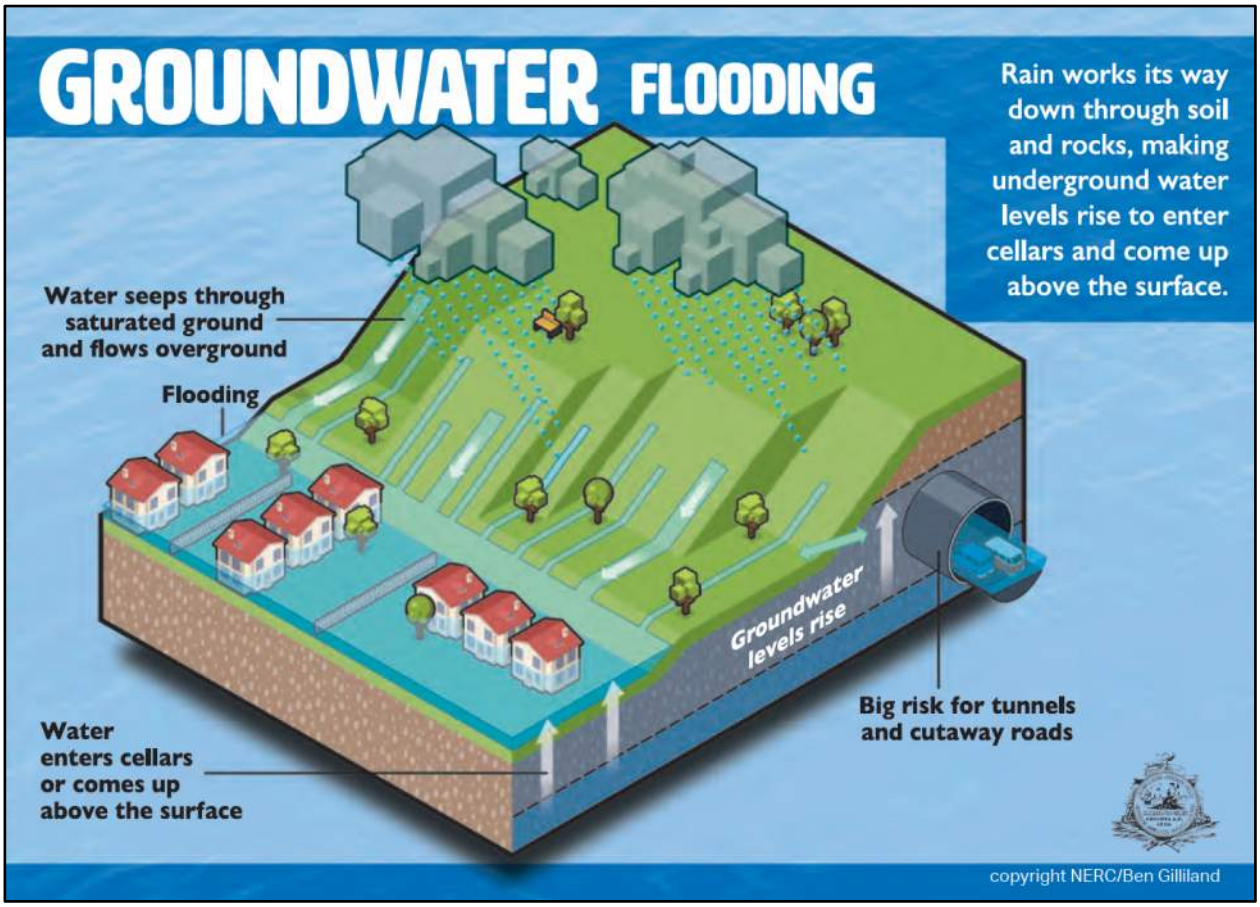
Figure 2-7. Extreme event flood causes and impacts

2.5.3 Fluvial (Riverine) Flooding

Another flooding risk experienced in coastal regions is fluvial flooding. This type of flooding occurs when water levels in stream channels rise and overtop the streambanks, causing water to flow into the floodplain. In natural landscapes, this process is an integral part of a stream ecosystem that reduces stress on the channel during high flows and helps add nutrients to the stream that boost the aquatic habitat. In developed landscapes, riverine flooding can cause damage to buildings, roadways, and other infrastructure that have been built too close to the stream. The frequency of fluvial flooding is often increased in developed, coastal areas due to multiple factors, including impervious area that increases stormwater runoff volume and intensity; persistent, intense rain events; and debris or log jams causing blockages in the stream channel. The National Weather Service classifies fluvial floods as minor, moderate, or major based on the projected water surface elevation and impacts along the river. Minor floods occur in low-lying areas adjacent to streams found in rural areas and secondary roads. Moderate flooding is characterized by water levels high enough to impact homes, businesses, and larger roads. This level of flood event may require evacuations for residents in the impacted areas. Major floods cause extensive flooding that may flood major traffic routes and isolate some neighborhoods. These events require evacuations of numerous homes to protect citizens from injury.

2.5.4 Groundwater Flooding

In pervious landscapes, the higher intensity and duration of storm events along the coast can cause groundwater recharge to occur faster than groundwater discharge. This leads to the water table rising and saturating subsurface soil layers, resulting in groundwater flooding. During this condition, previously permeable soil layers are no longer able to allow stormwater to infiltrate, causing ponding along the soil surface. **Figure 2-8** depicts this type of flooding.

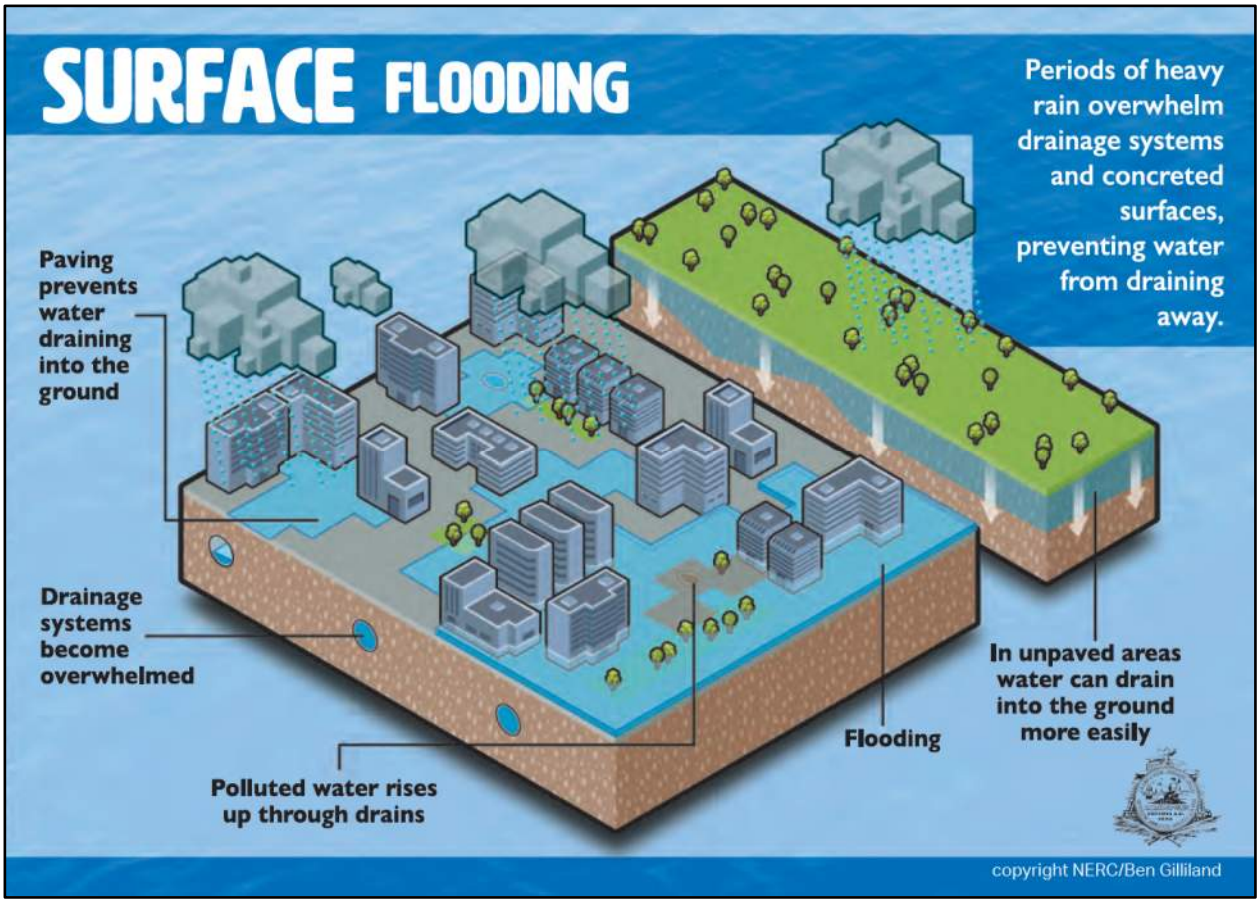


Source: Ben Gilliland and NERC

Figure 2-8. Groundwater flooding causes and impacts

2.5.5 Surface Flooding

A common misconception is that flooding can only occur near bodies of water. Surface flooding occurs when the excessive stormwater flows from intense or extended rain events cause the ground to become saturated. This type of flooding is observed as standing water in grassed and impervious areas resulting from stormwater flows that saturate the soil and overwhelm the stormwater drainage system. Surface flooding does not typically have a significant flood depth but can cause property damage when combined with other sources of flooding. **Figure 2-9** depicts this type of flooding.



Source: Ben Gilliland and NERC

Figure 2-9. Surface flooding causes and impacts

2.6 Principles of Floodplain Management

Floodplain management is a community program of preventive and corrective measures implemented to reduce the risk of current and future flooding. The main goals of floodplain management are to promote the natural functions of the floodplain, where practical, and mitigate damages to structures in Federal Emergency Management Agency (FEMA) designated Special Flood Hazard Areas (SFHAs) from natural flooding events. Promoting the functions of the floodplain improves natural flood storage and erosion control, water quality maintenance, groundwater recharge, and biological productivity. In the City, these goals are achieved by promoting and managing multiple programs, including:

- FEMA requirements and recommendations
- National Flood Insurance Program requirements and recommendations
- Expanded participation in the Community Rating System
- Flood Insurance Rate Map information
- Filing of elevation certificates for structures in the SFHA

2.7 Master Planning for Stormwater

Implementing stormwater considerations into a city master plan is integral to improving the effectiveness and longevity of a stormwater system. Stormwater master plans typically outline the characteristics of the watershed, define the existing stormwater system, and make recommendations on how to improve the stormwater infrastructure within the city. Key concepts to ensure a stormwater master plan's success include:

- Adopting a long-term approach to planning. Communities can provide a plan for implementation that allows for the integration of selected projects within other community development plans, such as capital improvement.
- Managing stormwater close to where precipitation falls. Encourage features such as wetlands and riparian buffers to control stormwater runoff volumes and rates.
- Implementing innovative technologies, or green infrastructure, to site designs. This can generate benefits ranging from improved water quality to cost savings for community amenities.
- Use of requirements set forth by the CWA and the City's Phase II MS4 Permit. Considering these requirements at the front end of the planning process helps to ensure that stormwater regulations are easily attainable long-term.

The City has developed multiple stormwater master plans including the 1984 Master Drainage Plan, the *Dupont-Wappoo Watershed Master Plan* (City of Charleston 2019a), and the *City of Charleston Church Creek Watershed Storm Water Master Plan* (Woolpert, LLP 2001). The 1984 Master Drainage Plan is intended to improve stormwater drainage throughout the City municipal area. The Dupont-Wappoo and Church Creek Master Plans are specifically aimed at mitigating the stormwater drainage issues within the Dupont-Wappoo and Church Creek watersheds in West Ashley. Each master plan is divided into phases to ensure their effective implementation. These sequential phases include:

- Assess the current conditions of the stormwater drainage system.
- Make recommendations for drainage improvements.
- Secure funds for the construction of recommended improvements.
- Design and construct recommended improvements.

These Master Plans can be accessed online through the City's Department of Stormwater Management website (https://www.charleston-sc.gov/2144/Stormwater-Management).

2.8 Principles of Stormwater Management

At its core, the goal of stormwater management is to prevent flows associated with rain events from negatively impacting human health and safety. Traditional stormwater management was solely focused on controlling water quantity. Stormwater systems were composed mainly of pipes designed to convey runoff directly to downstream aquatic resources. Over time, the water quality impacts of stormwater have become a much greater consideration, which is reflected in the

regulations, municipal codes, and permits that drive the stormwater management of new developments and redevelopments. However, managing stormwater quality and quantity is the goal of stormwater management.

2.8.1 Introduction to Stormwater Management

Construction, development, and redevelopment have the potential to alter the natural drainage patterns, flow rates, and volumes of water in the environment. Construction, development, and redevelopment can directly or indirectly change the physical, chemical, and biological conditions of natural waterways. When land is developed or redeveloped, the natural hydrology of the watershed is disrupted and traditionally stormwater systems that have facilitated the efficient removal of not just runoff but associated pollutants into receiving waters is impacted. Clearing land removes vegetation that intercepts and slows rainfall runoff. Grading removes the benefits of topsoil, compacts the subsoil, and fills in depressions that provide natural storage. As a result of land development and redevelopment, infiltration is decreased and rainfall that once seeped into the ground runs off the surface at an accelerated rate.

2.8.2 Innovative Design

In recent times, the innovative design of new developments has helped to address the impacts of stormwater quantity and quality. The goal of innovative design is to reduce runoff, reduce the amount of pollutants carried offsite by runoff, and capture and treat runoff onsite. The amount of pervious area onsite can be maximized by preserving the amount of open spaces and functional landscapes, which reduces the impact new development and redevelopment has on stormwater runoff. BMPs are used to enhance open spaces and capture and treat stormwater runoff onsite. Source control provides added pollutant reduction by preventing pollutants from ever being exposed to stormwater.

2.8.3 Site Planning

The first step in addressing stormwater management begins in the site planning and design stage of the construction, development, and redevelopment project. By implementing BMPs during the site planning process, the amount of runoff and pollutants generated from a site can be reduced by minimizing the amount of impervious area and using natural onsite treatments. Design engineers should consider using BMPs and site planning to minimize adverse stormwater runoff.

The reduction of runoff volumes and stormwater pollutants decreases the number and size of stormwater management controls that must be implemented under the guidelines set forth in this SWDSM. BMPs reduce the amount of post-construction, post-development, and post-redevelopment impervious areas and maintain natural characteristics of the pre-construction and pre-development site conditions. Therefore, the post-construction, post-development, and post-redevelopment curve number and time of concentrations are maintained more closely to the pre-construction and pre-development conditions. This reduces the overall hydrologic and hydraulic impact of the construction, development, and redevelopment.

2.8.3.1 Maintaining Site Resources and Natural Undisturbed Areas

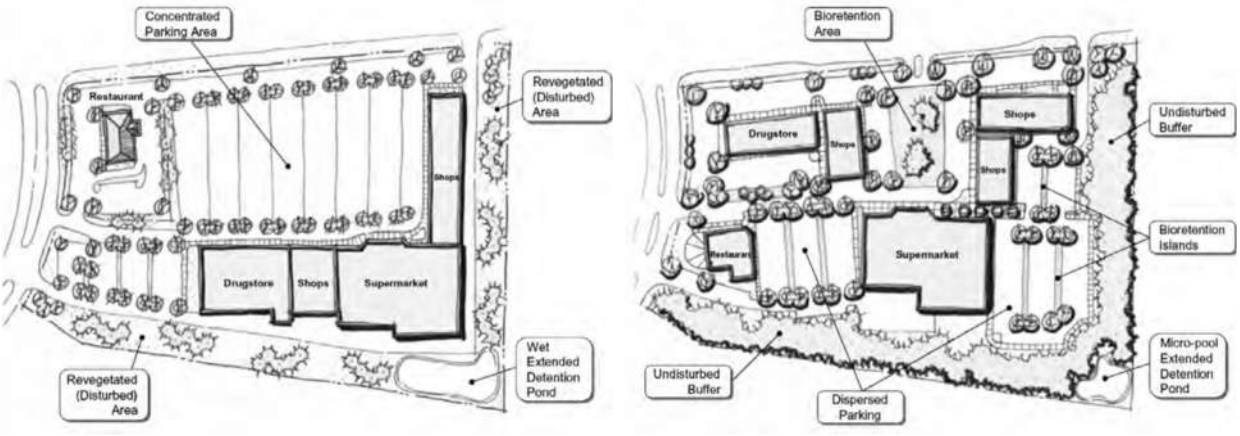
Conservation of site resources and natural, undisturbed areas helps to reduce the post-construction, post-development, and redevelopment runoff volume and provides areas for natural stormwater management. Natural site resources that should be maintained include, but are not limited to:

- Natural drainageways
- Vegetated buffer areas along natural waterways
- Floodplains
- Areas of undisturbed vegetation
- Low areas within the site terrain
- Natural forested infiltration areas
- Wetlands

2.8.3.2 Lower Impact Site Layout Techniques

Lower impact site layout techniques involve identifying and analyzing the location and configuration of structures on the site to be constructed, developed, or redeveloped (**Figure 2-10**). Where applicable, the following options that create lower impact layouts should be used:

- Fit the design layout to follow the natural contours of the site to minimize clearing and grading and preserve natural drainageways and patterns.
- Limit the amount of clearing and grading by identifying the smallest possible area on the site that would require land disturbance.
- Place construction activities, development, and redevelopment areas on the least sensitive areas of the site and avoid steep-sloped areas when possible.
- Use nontraditional designs to reduce the overall imperviousness of the site by providing more undisturbed open space and minimizing clear-cutting.
- Consider using cisterns and rain barrels to collect stormwater for reuse.
- Consider the use of energy dissipation devices, such as level spreaders, at discharge points. Such devices should also be considered for discharge points into ponds and other basin-type BMPs.



Source: *Ellis et al. 2014.*

Figure 2-10. Conventional parking lot layout vs. parking lot layout using low impact development techniques

2.8.3.3 Minimization of Impervious Cover

The minimization of total impervious area directly relates to a reduction in stormwater runoff volume and associated pollutants from a construction, development, and redevelopment site. The amount of impervious cover on a site can be reduced by the following techniques where applicable:

- Reduce building footprints by constructing some buildings as multi-story.
- Reduce parking lot areas and use porous/pervious pavement surfaces for overflow parking.
- Increase the amount of vegetated parking lot "islands" that can also be used for stormwater management practices such as bioretention areas.
- Disconnect impervious surfaces by directing runoff to adjacent pervious areas so that runoff can be filtered and infiltrated.

2.8.3.4 Use of Natural Features for Stormwater Management

Structural stormwater drainage controls are traditionally designed to remove stormwater runoff quickly from the site without utilizing any of the natural storage areas. These natural drainage areas should be considered as potential stormwater drainage systems. The natural areas can be used in the following ways where applicable:

- Vegetated buffers and undisturbed areas on the site are useful to control sheet flow (not concentrated flows) by providing infiltration, runoff velocity reduction, and pollutant removal.
- Natural drainageways (e.g., streams, lakes, rivers, wetlands, and swamps) should be maintained to provide a natural stormwater drainage system to carry runoff to an existing outlet. The use of natural drainageways can allow for storage of stormwater runoff, lower peak flow rates, reduction in erosive runoff velocities, and capture and treatment of pollutants.

- The use of vegetated swales instead of curb and gutter applications allows for more storage of stormwater runoff, lower peak flow rates, reduction in erosive runoff velocities, and capture and treatment of pollutants.
- Rooftop runoff should be directed to pervious natural areas for water quality treatment and infiltration instead of connecting rooftop drains to roadways and other structural stormwater conveyance systems.

2.8.3.5 Engineered/Proprietary Devices

The City is aware of the potential benefit in using a number of stormwater engineered devices currently available on the market, such as baffle boxes, cartridge filters, and sock and tube erosion control devices. The City will evaluate all such devices specified for a project and require drawings, specifications, and discussions as to the applicability of the product, expected performance, and required maintenance to be submitted. The City reserves the right to require that certain devices be installed or certain devices be prevented from use.

2.8.3.6 Green Infrastructure

Engineered stormwater infrastructure can be designed to mimic natural systems, and on many sites can supplement or replace conventional engineered systems, such as storm sewers and detention ponds. This type of “living infrastructure” or “green stormwater infrastructure” can range from small scale rain gardens and bioretention basins to large scale constructed stormwater wetlands (See **Section 3.12**). Generally, these design elements rely on fine grading, plant materials, and engineered outflow structures to mimic wetland hydrology and thereby to control and improve both the quantity and quality of stormwater runoff.

2.9 Types of Development

Urban development is categorized as new development, redevelopment, or brownfield development. The design requirements for stormwater management in each category are different to ensure that negative impacts are minimized. In general, new development requirements are aimed at minimizing the amount of impervious area in the design, whereas redevelopment requirements are aimed at reducing the amount of impervious area on the existing site. Brownfields may have unique requirements regarding the co-mingling of surface and groundwater based on the individual site’s contamination history.

2.9.1 New Development

New development includes land-disturbing activities, structural development, and the creation of impervious surfaces on land that was previously predominantly pervious with minimal building and roadway footprints. The transition from native landscapes to a developed condition reduces the infiltration, evapotranspiration, and surface roughness onsite, regardless of the amount of green space and BMPs implemented into the site design. This results in a significant increase in the site stormwater runoff volume and rate, which often impacts areas downstream of the development. The stormwater management portion of a new development’s design is typically

based on location-specific storm event probabilities of exceedance (50 percent, 10 percent, 1 percent, etc.), soil characteristics, and water quantity and quality requirements.

2.9.2 Redevelopment

Redevelopment includes land-disturbing activities, structural development, installation of impervious surfaces, and replacement of impervious surfaces on a previously developed site. Activities such as exterior remodeling or routine maintenance are not typically considered to be redevelopment. The change in impervious area, and the associated stormwater impacts, for redevelopment activities are typically less significant than for new development. The standards for redevelopment design are typically based on the reduction of stormwater runoff rate, runoff volume, amount of impervious area, and pollutant load. In some cases, there may be exceptions to the need for reduction of these factors if the initial developed condition was within the required standards.

2.9.3 Brownfields

Redevelopment of brownfields provides a unique opportunity to mitigate pollutants. EPA defines brownfields as a property in which expansion, redevelopment, or reuse may be complicated by the presence or potential presence of hazardous substances, pollutants, or other contamination. In preparing these landscapes for redevelopment, the contaminated soils are often capped to prevent their exposure to stormwater runoff generated onsite, which creates additional impervious area (USEPA 2008). Challenges associated with the management of stormwater on brownfield sites include:

- Capping contaminated soils while mitigating the negative impact the impervious surfaces have on downstream waterways
- Implementing practices designed to increase infiltration, which may inadvertently mobilize pollutant loads in the soil and discharge them into groundwater and nearby surface water
- Installing green infrastructure practices that can retain, treat, and release stormwater without coming in contact with contaminated soils
- Considering how the location of the site within the watershed may impact areas downstream and groundwater

2.10 Introduction to Permanent Best Management Practices

BMPs are practices that are implemented in the design of developments to prevent or reduce the pollutant load carried offsite by stormwater runoff. Typically, multiple BMPs are implemented at a site to meet pollutant and runoff discharge requirements. Permanent BMPs can be placed into two main categories, structural and non-structural. Structural BMPs are features that must be constructed to mitigate the runoff rate, runoff volume, and pollutant load offsite. These structures are designed to capture and treat stormwater runoff onsite, and include practices such as rain gardens, filter strips, pervious pavement, extended detention ponds, and wetlands. Non-structural BMPs focus on source reduction to reduce the amount of stormwater runoff and pollution

generated onsite. Implementing features into site design such as minimizing the total disturbed area, protecting existing wetlands and natural flow pathways, and directing rooftop runoff to vegetated areas can help to reduce the stormwater runoff generated by a development. Non-structural BMPs can also be behavioral practices that reduce pollutant loads at the source, such as routinely sweeping streets and sidewalks to keep impervious surfaces clean, encouraging homeowners to clean up pet waste, and handling and storage of chemicals.

2.11 Sea Level Rise

Over the past 100 years, the sea level in the City has risen slightly more than 1 foot. Climate experts have projected that sea levels will continue to rise at an increasing rate over the next 100 years. Being a coastal city with elevations near sea level, the City already experiences tidal flooding of streets during spring tides ("minor coastal flooding") and due to storm surge. The marked increase in observed and predicted "minor coastal flooding" is shown in **Figure 2-11**.

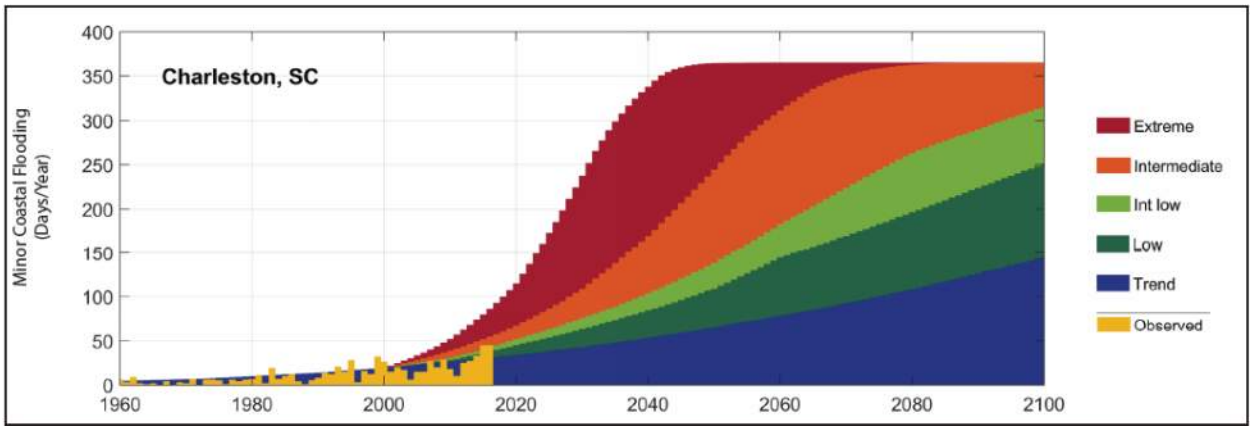


Figure 2-11. Observed and Predicted "Minor Coastal Flooding" In Charleston

To begin planning for continued sea level rise, the City released an update to the S*ea Level Rise Strategy* in February 2019, which provides a framework to improve the City's resilience to sea level rise. The five critical components of the *Sea Level Rise Strategy* are:

1. **Resources** – sufficient funding and proper staffing to meet the City's immediate and long-term goals under the Sea Level Rise Strategy
2. **Governance** – establish policies and regulations aimed at protecting public and private investments
3. **Infrastructure** – identifying innovative solutions and prioritizing projects to protect the most critical and vulnerable areas affected by the rising sea levels and more extreme wet-weather events.
4. **Land Use** – effective land use planning can maximize value and minimize risk from potential influences to strengthen community resilience by directing growth to where it makes the most sense over the long term in lower risk areas, and seek to adapt and retreat in higher risk areas.
5. **Outreach** – educating the public about the threat of flooding and sea level rise, its causes, and what can be done to protect the City.

Information about the *Sea Level Rise Strategy* can be found on the City's website at:

https://www.charleston-sc.gov/1981/Flooding-Sea-Level-Rise-Strategy

Chapter 3 Design Requirements

3.1 Introduction

This chapter provides engineers, designers, developers, and others with the information needed to develop adequate stormwater management approaches and systems that will manage the stormwater rate, volume, and pollutants released from new development, and redevelopment projects. These design requirements have been developed based on common engineering practices and references to State and Federal requirements, engineering publications, and other municipal and academic guidance.

A goal of this chapter is to provide a minimum set of design standards that will result in effective stormwater management to mitigate the impact of land development on existing/natural hydrologic and hydraulic processes, as well as attempt to prevent further degradation of the water resources in the City through proper planning, design, installation, and maintenance. All land shall be developed in a manner consistent with City Ordinances and the SWDSM. Specific methods and applications not covered in the SWDSM can and should be discussed with the Department of Stormwater Management for applicability. The following sections detail the criteria that shall be followed in the absence of specific watershed master plan criteria.

3.2 Determination of Construction Activity

A party wanting to construct, develop, or redevelop in the City limits is subject to the Stormwater Design Standards requirements as determined by the application type. The application types determine the construction activity and design parameters. Specifics can be found in **Section 4.5**.

3.3 Design Approach

Proper planning is necessary to ensure that stormwater management is considered and fully integrated at the various stages of construction, development, and redevelopment. This involves a comprehensive approach to site planning and a thorough understanding of the physical characteristics and resources associated with the project site. This planning includes addressing each of the following categories:

- Stormwater quantity controls
- Erosion prevention and sediment controls
- Stormwater quality controls
- Stormwater conveyance controls
- Maintenance schedules for temporary and permanent stormwater BMPs

The design of successful stormwater management plans involves adhering to the following principles, where applicable:

- Pre-submittal site meeting/site visit
- Review of site development requirements
- Detailed site analysis and supporting calculations
- Creation of a Stormwater Concept Plan
- Design aspects of the stormwater management plans
- Completion and approval of the construction activity application

When designing for land disturbing activities, the design should address the following three categories of control: (1) water quantity (flood control), (2) erosion prevention and sediment control (EPSC), and (3) pollution control (permanent water quality standards). If an innovative stormwater design approach is to be used, the design engineer shall take the following considerations in mind, in addition to meeting the above listed three categories of control:

- Stormwater quantity and quality are best controlled at the source of the problem by reducing the potential maximum volume of runoff and pollutants. Source control will typically be more economical in order to treat the first flush of a storm event.
- Implement stormwater management by using simple structural and non-structural methods which are reasonably maintained.
- Equaling or exceeding traditional stormwater management designs in terms of performance (rate/volume attenuation, pollutant removal) and economic feasibility (long-term) are essential to a proposed concept's eventual approval.

Innovative approaches to site design often focus on source control for stormwater runoff that limit the amount of runoff generated and incorporate permanent BMPs throughout the site. These types of design concepts are described in detail in several sources, including *Georgia Stormwater Management Manual, Volume 1: Policy Guidebook* (ARC 2016); *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014); and *Green Infrastructure Design Manual – Green Management Practices and Design Strategies to Manage Stormwater in Our Community* Chapter 18 (Louisville and Jefferson County MSD 2011).

General requirements for all stormwater systems and facilities shall include, but may not be limited to, the following:

- Site designs shall minimize the stormwater runoff from the site and maximize pervious areas by:
    - Selecting portions of the site where the drainage pattern, topography, and soils are favorable for the intended use.
    - Exposing the smallest practical area of land for the least possible time during construction, development, and redevelopment. This includes maintaining or creating buffers and preserving natural areas.

  - Limiting the drainage area to all BMPs and installing BMPs as soon as practical in the development process.
  - Retaining and protecting natural vegetation and saving topsoil for replacement on graded areas.
  - Using temporary plant cover, mulching, hydroseeding, or BMPs to control runoff and protect areas subject to erosion during and after construction.
  - Maintaining pre-development infiltration rates through soil amendments/treatments for post-development pervious areas.

- One of the goals of the City's stormwater program is to comply with the water quality requirements in the Phase II MS4 permit, which requires 80 percent TSS removal in the stormwater runoff by using permanent structural BMPs. The following four tiers (described in **Section 3.9.2**) are considered by the City to be equivalent and comply with the MS4 permit, though the water quality volumes for each differ. The permittee must choose which tier, or combination of tiers in the case of multiple subwatersheds, they will implement on their project. The four tiers are as follows:
  - Green Infrastructure
  - Green Infrastructure with an Underdrain
  - Detention Practices
  - Pass-through Devices that provide the requisite water quality treatment through physical/mechanical, chemical, or biological processes

3.4 Stormwater Hydrology and Routing

This section discusses the hydrologic criteria that a designer should use when designing stormwater infrastructure on their projects. In addition, this section presents stormwater collection and conveyance design criteria and design criteria for roadway drainage.

3.4.1 Introduction to Hydrologic Requirements

Hydrologic computations shall be completed using volume/peak/duration-based hydrograph methods acceptable to the Department of Stormwater Management. The design storm duration for these computations shall be the 24-hour storm event based on a NRCS Type III distribution with a 0.1-hour duration time increment and a 484 peaking factor. The applicant may propose a lower peaking factor by providing justification in the Engineering Report narrative, which may include, but is not limited to, an associated Zoning classification and/or impervious area determination. Typical hydrologic inputs include, but are not limited to, the following:

- Rainfall depth or intensity
- NRCS soil classification and hydrologic soil group
- Land use
- Time of concentration
- Initial abstraction (surface storage and/or vegetative capture).

All modeling results must be presented to the hundredth place.

The remainder of this section provides basic information for the hydrologic calculations. The intent of the SWDSM is not to provide detail on every aspect of hydrologic computations, their limitations, assumptions, or appropriateness of use, but rather to present general guidance on commonly accepted standards.

3.4.2 Rainfall and Design Storms

The 24-hour duration precipitation depths corresponding to various probabilities for exceedance in any given year are shown in **Table 3-1** and are to be used for projects within the City. These values contain a 10 percent safety factor to account for uncertainties in the design process and the increasing intensities of storms.

Table 3-1. 24-hour design storm precipitation data for Charleston, South Carolina

Probability Exceedance	100%	50%	20%	10%	4%	2%	1%
Return Frequency (Year)	1	2	5	10	25	50	100
Precipitation (inches)	3.8	4.6	6.1	7.2	8.7	9.9	11.3

Rainfall intensities must be pulled from the most recent NOAA Atlas Point Precipitation Frequency Estimates Map for the specific site area and a 10 percent safety factor must be applied to each value.

3.4.3 Reservoir Routing

Controls shall be designed by a traditional reservoir routing procedure.

3.4.4 Recommended Methods and Design Procedures

3.4.4.1 Stormwater Computation Methodologies

The City recommended methods and corresponding design circumstances are listed in **Table 3-2** and **Table 3-3**. If other methods are used, approval shall first be obtained from the Department of Stormwater Management. Complete source documentation shall be submitted for review.

Table 3-2. Recommended methodologies based on land disturbance area

Method	Size Limitations[a]	Comments
(Modified) Rational Method	0 – 2 acres	Acceptable for sizing individual culverts or storm drains that are not part of a pipe network or system. Not to be used for storage design.

Method	Size Limitations[a]	Comments
NRCS Method (TR-55)	0 – 2,000 acres	Used for estimating peak flows from urban areas.

[a]Size limitations refer to the subwatershed size to the point where a stormwater system component (i.e., culvert, inlet, BMP) is located.

Table 3-3. Recommended hydrologic methods for designing various stormwater management systems and controls

Method	Rational Method	NRCS Method
Large Watersheds		+
Storage/Sedimentation Facilities		+
Outlet Structures		+
Gutter Flow and Inlets	+	+
Storm Drain Pipes	+	+
Culverts	+	+
Small Ditches	+	+
Open Channels		+
Energy Dissipation		+

Details of the Rational Method and Modified Rational Method can be found in Chow, Maidment, and Mays (1988), American Society of Civil Engineers (ASCE) (1996), US Department of Agriculture (USDA) (1986, 2004), and Mays (2001). Documentation on the commonly used NRCS Method can be found on the USDA website:

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf.

The United States Geological Survey (USGS) regression equations for South Carolina can be obtained from the USGS website:

https://water.usgs.gov/software/NFF/manual/sc/.

Haan, Barfield, and Hayes (1995) and USDOT (1996, 2001b) can also be referenced for more detail on hydrology calculations and assumptions.

3.4.4.2 Computer Modeling Methodologies

Designers may select an appropriate modeling program to calculate the pre-development and post-development site conditions. In circumstances where backwater, tailwater, and tidal conditions are not present, and for storm drainage systems with less than five connections, programs using Manning's equation will be considered satisfactory. However, if these conditions are present, programs that incorporate Saint-Venant equations shall be selected to better

represent the hydrodynamic environment. The selected program and its associated computational methodologies and inputs shall be listed in the Engineering Report narrative.

3.4.5 Time of Concentration

Time of concentration (T_c) is the time for runoff to travel from the most hydraulically remote point of the watershed to a point of interest. Methods for calculating the time of concentration and abstraction are numerous. The most common method to calculate time of concentration for surface flow is using the USDA TR-55 methodology (USDA 1986), which divides time of concentration into Three components: (1) sheet flow, (2) shallow concentrated flow, and (3) open/closed channel flow. For the purposes of calculating time of concentration in the City, the maximum sheet flow length shall be 100 feet, and maximum shallow concentrated flow length shall be 1,200 feet. From there, it is considered open/closed channel flow until the ultimate outlet. Each component has a travel time (T_t) associated with it, and will be added together to become the time of concentration. A minimum time of concentration of 6 minutes shall be used for all hydrologic calculations.

Hydrographs shall be used to evaluate entire systems by routing storm events through pipe or storage systems. The use of a hydrograph will provide better insight into system performance than simply using the peak discharge. The City will accept commonly used computer models. Other models may be accepted with appropriate documentation.

3.4.6 Collection and Conveyance Requirements

This section provides the design requirements for various stormwater drainage and collection system components, including design storms, velocities, and pipe and inlet sizes. Storm drainage systems shall include all storm drainage structures and pipes that convey runoff under roadways. The standards in the following sections are required for all publicly maintained drainage systems and are recommended for privately maintained systems.

When a project is solely for drainage infrastructure improvements, and not associated with a development, these standards should be achieved to the Maximum Extent Practicable (MEP) within the constraints of the project. For projects that propose to complete drainage improvements to support an associated development, then these standards shall be met.

Note that the design storm for all public infrastructure is the 4 percent 24-hour storm event probability unless stated otherwise.

3.4.6.1 Storm Drain Pipes

1. The minimum size storm drainage pipe allowable in the right-of-way shall be 15 inches in nominal inner diameter. The minimum size pipe allowable outside the right-of-way shall be 12 inches in diameter.
2. The minimum slope for storm drainage pipe shall be three tenths of 1 percent [0.003 ft/ft] where possible. The minimum pipe flow velocity shall be 2 fps; A technical procedure document on computer modeling for velocity computations has been provided in this manual, but if a five tenths

of 1 percent [0.005 ft/ft] pipe slope or greater can be provided then no additional velocity computations are required. Pipes that have the purpose of equalization between two or more ponds do not have to meet this requirement. Maximum allowable flow velocity shall be 10 fps under any flow condition.

3. Drainage system installation shall be such that stormwater discharge is not concentrated on adjacent property and that the velocity is less than erosive limits for the site soils. At pipe outfalls, this normally requires the use of a riprap apron placed on filter fabric, turf reinforcement mats, or articulating concrete mat for a minimum distance equal to or greater than six pipe diameters. To use an alternative measure, the design engineer shall submit supporting documentation that the proposed measure shall perform at least equivalent to the currently approved erosion prevention measures approved and contained in this SWDSM.

4. **Equalization Pipes and Submerged Systems** (**Section 3.11**) shall require a design exception (**Section 4.10**) due to the significant nature of maintenance on such conveyances. Equalization pipes between ponds may be submerged if isolator boxes are installed at both ends of the conduit to facilitate draining for maintenance purposes. The maximum distance between isolator boxes shall be 600 feet. The minimum pipe size for equalization pipes is 24 inches in diameter.

   For submerged conveyances, the design exception request shall address pretreatment for sediment, demonstrate construction methodology to replace system (including dewatering and excavation without the need for shoring), and provide for a methodology for cleaning of the submerged pipes such as isolator boxes.

5. **Type and class** of storm drainage pipe and the installation of pipes shall be in accordance with Sections 714 (Permanent Pipe Culverts) and 715 (Temporary Pipe and Pipe Arch) of the latest South Carolina Department of Transportation (SCDOT) specifications. The use of any storm drain pipe other than reinforced concrete pipe (RCP) shall require approval in writing by the Department of Stormwater Management.

6. All pipes and boxes (catch basins, drop inlets, manholes, junction boxes, etc.) shall have **stone bedding** made of 4 inches and 6 inches, respectively, of #57 stone. **Backfill** shall consist of suitable material and compaction requirements per the latest SCDOT specifications. Alternative pipe bedding shall be considered when supported by the site-specific geotechnical report.

7. A minimum of 1 foot of **cover** shall be provided for storm drainage pipes unless otherwise granted by the Department of Stormwater Management. RCP Class IV or V pipe may be requested by the Department of Stormwater Management in special conditions (deep installation, excessive surface loads, etc.).

8. Storm drainage pipe shall be placed to minimize the length running under pavement. Where it is necessary for pipe to cross the roadway, it preferably shall be placed at a 90-degree angle and in no case at less than 45 degrees. All cross lines in the roadway shall have backfill compacted in 6-inch lifts to 95 percent Modified Proctor Compaction Test maximum density and to 98 percent Modified Proctor Compaction Test on the last 6 inches.

9. Any "open" storm drainage cross line pipe shall extend beyond the toe of the roadway embankment. In no case shall the end of the pipe be within the 5-foot **roadway shoulder**.

10. Storm drainage pipe discharging into a **drainage channel** shall intersect the channel in a manner such that the interior angle measured from their centerlines of flow is less than or at most equal to 90 degrees. Riprap , articulating concrete matting, or other suitable protection is required from the top of the pipe at the outlet point to the bottom of the channel and on the opposite channel bank to

prevent scour and erosion. Pipe must be cut at outfall to be flush with the bank of the intersecting channel.

11. Storm drainage pipe discharging into wet ponds shall have the **discharge invert above the permanent pool elevation.**

12. Any connections to existing **brick arch** drainage systems shall be coordinated with the Department of Stormwater Management during initial planning stages. Failure to communicate early in the design process will delay processing.

13. A **maintenance access point** shall be available at a minimum within every 200 feet for closed conduit conveyance structures (e.g., pipes). Junction boxes with manholes shall be placed at all pipe intersections, grade changes, alignment changes, and pipe size or geometry changes.

14. **Hydraulic grade line** and head loss calculations for determining water surface elevations shall be performed for all system connections.

15. Calculations shall be performed for the appropriate **design storm event**, as prescribed in **Section 3.9.3**.

16. **Storm drain profile plots** shall be included in the set of construction plans and shall show the **hydraulic grade line** for the required design storm.

17. Storm drainage systems shall be designed to convey stormwater runoff by **gravity flow** (during the required design storm hydraulic grade line must remain below pipe crown) unless otherwise approved.

18. It shall be unlawful for any person to uncover any component of the public stormwater system or connection branches thereof, for any purpose or to make connection therewith, unless and except with the **approval and inspection** of the Department of Stormwater Management.

19. A **5 foot horizontal** separation shall be maintained between the outside edges of the public stormwater system and any new pipes or conduits laid in a street.

20. In **opening trenches** in any street or public way, the paving or ballast shall be removed in a manner directed by the Department of Stormwater Management. The sides of the trench shall be sheeted or braced in accordance with current Occupational Safety and Health Administration standards. The earth removed from the trench shall be placed so as not to obstruct the gutters and so as to cause the least obstruction to public travel. Gas and water pipes shall be protected from injury, the trench shall be enclosed and lighted at night, and every precaution shall be taken to prevent injury to person or property during the progress of the work.

21. Notice shall be left at the Engineering Division of the Department of Public Service **two working days** prior to the beginning of any work laying a storm drain. No material shall be used or work covered until inspected and approved by the Engineering Division.

22. The area upstream of and outside a project area (i.e., offsite areas) that drains to a particular design point (on or downstream from the project area) shall be included in determining the appropriate conveyance size. Hydrological computations shall be based on the contributing watershed, not just the project area or disturbed area.

3.4.6.2 Culverts

1. Culvert design shall include all cross drains that transport stormwater runoff under roadways. Culvert selection techniques can range from using empirical formulas, nomographs and charts; or

comprehensive mathematical analysis for specific hydraulic conditions. The models used for these calculations are listed below in item 8. Other widely accepted models may be used, but shall be approved by the Department of Stormwater Management. Designs shall be based on SCDOT requirements as defined in the *SCDOT Requirements for Hydraulic Design Studies* manual.

2. Proper consideration of inlet and outlet control shall be given in the design of culverts and outlets.
3. The pipe, appurtenant entrance, and outlet structure shall properly account for water, bed-load, sedimentation, and floating debris at all stages of flow.
4. The **outlet** shall be designed to prevent undermining and washout.
5. A 25 percent factor of safety in flow area shall be used for culvert design to account for debris and clogging. If culvert grating within the cross section is proposed, then a 50 percent factor of safety shall be used for grate area calculations. This can be done with a reduction in the overall culvert size or utilizing a bottom clip to obtain the necessary factor of safety.
6. The 20 percent, 10 percent, 4 percent, and 1 percent AEP, 24-hour storm event hydraulic grade lines shall be included in the Permit Package as part of the Engineering Report narrative. All four of the hydraulic grade lines are not required to be shown on the construction drawings. The design storm event is based on the *SCDOT Requirements for Hydraulic Design Studies* manual.
7. Additional hydraulic capacity shall be required as necessary to prevent backwater effects that may adversely impact upstream property or structures.
8. Acceptable models for designing culverts are discussed in **Section 3.4.4.2**. Culvert nomographs are allowed in instances where backwater and tailwater conditions do not apply.
9. A complete study of culverts and design considerations is provided in USDOT (2001a).

3.4.6.3 Headwalls and Outlets

1. All exposed ends of pipes shall be protected by one of the following methods:
    a. Riprap headwalls are acceptable for pipes 24 inches or less. Note that this technique requires the use of filter fabric.
    b. Flared end sections are acceptable for pipes 36 inches or less in diameter.
    c. Concrete headwalls are required on culverts with a diameter of 24 inches or greater where a flared end section is not used.
2. Storm drainage or pond outfalls shall be carried to an existing conveyance system.
3. For any outfall routed into and through existing wetlands area:
    a. Demonstrate that the wetlands located on the site can act to manage the runoff generated with reasonable assumptions regarding the wetlands condition. A baseline functionality shall be provided for the existing wetlands relative to water surface elevations and conveyance capacity to be used in the event the wetland system is not functioning hydraulically as designed. If maintenance within the wetland would need to be accomplished by the City, the City would then have to coordinate with the USACE on work within the wetland to return the system to that baseline functionality.
    b. Provide a method ensuring the on-site wetlands that would be a component of stormwater management on your site are not impacted by future projects (operating BMP might be an approach that would work).

c. Demonstrate that your site stormwater does not have off-site impacts in the 1% AEP. This would include the adjacent properties that share the wetland system.

4. No new point discharge onto adjacent property where there was not an existing point discharge shall be allowed without the adjacent property owner's written consent, or where an existing stormwater drainage easement exists within a public drainage easement.

5. Discharge points created by construction, development, and redevelopment shall connect to an existing drainage system, whether natural or man-made. The new outlet shall not cause flooding or in any way degrade the existing stormwater drainage system and proof of such shall be provided. In some cases, conveyances shall be constructed from the project to a point of discharge into the existing stormwater drainage system and this shall be done at the owner's expense. In these cases, the owner shall be responsible for obtaining necessary easements and agreements to construct such. If no easement is downstream of the site, the pre-development and post-development peak flow rates must match and runoff volumes must not increase.

6. The inverts of all discharge pipes and channels shall not be less than 5.5 feet North American Vertical Datum (NAVD) 88 or 2 feet above MHHW (referenced to NAVD88), whichever is greater. Any variance request from this standard shall incorporate measures to prevent sedimentation and the need for frequent maintenance.

7. Outlets shall not discharge on fill slopes.

3.4.6.4 Energy Dissipation Structures

1. All outlets shall be sufficiently stabilized. Calculations shall be provided justifying the design and material used (e.g., riprap aprons, geometry, and diameter). SCDOT methodologies are acceptable.

2. If riprap aprons are used, filter fabric shall be installed beneath the apron.

3. If Level spreaders, plunge pools, etc. are used, then they shall be properly designed and installed at the proposed outlet(s).

3.4.6.5 Catch Basins, Inlets, Manholes, and Junction Boxes

1. Materials and construction shall be as specified in Section 719 (Catch Basins, Drop Inlets, Manholes, Junction Boxes, and Spring Boxes) of the latest SCDOT specifications.

2. Side inlet catch basins or junction boxes with concrete covers shall have a metal ring and manhole lid cast within the top for easy access. Manhole lids and catch basins shall contain a label identifying the system as stormwater and marked with an appropriate stormwater awareness message such as 'No Dumping – Drains to Waterways.' Contact the Department of Stormwater Management for more information.

3. When the depth of a catch basin or junction box exceeds 4 feet, rungs or steps shall be provided for ascent and descent. Steps shall be American Society for Testing and Materials (ASTM) C478 or equivalent.

4. The box top shall be a minimum of 3 feet by 3 feet. Sides shall be plastered with non-shrink grout. Circular junction boxes with tapered top section are also permitted.

5. Pipes entering or leaving a catch basin or junction box shall not protrude more than 6 inches into the box.

6. Roadway catch basins, concrete flumes, and curb cuts shall comply with the latest SCDOT standard specifications and details.

7. Maximum roadway catch basin inlet capacity for an inlet shall be determined based on the following:

    a. For inlets at sags, capacity shall be based on either weir flow (unsubmerged) or orifice flow (submerged). The depth of flow shall be limited to the curb depth, but may be further limited by the allowed spread. In sag conditions, a 15 percent factor of safety shall be used to account for debris and clogging if an open throat inlet is proposed. A 50 percent factor shall be used if a grate is proposed.

    b. For inlets on grades, theoretical capacity shall consider in the design the longitudinal and cross slopes, and gutter depression. The length of the gutter opening shall be such that the gutter efficiency is 80 percent of the theoretical capacity. Maximum flow depth shall be limited to the depth of curb.

8. SCDOT Type 9 inlets shall be designed to accommodate a given flow based on road type and so as not to cause flooding on adjacent property.

9. It is desirable to locate catch basins outside curve radii. If this is not reasonably possible, the catch basin shall be set back an extra 1 foot and the face of the catch basin shall be parallel to a chord joining the two points on the curve radius located by projecting lines from the sides of the catch basin box.

10. Where possible, junction boxes and catch basins shall contain a minimum drop of 0.1 feet from invert in to invert out.

11. Waffle and knockout boxes are prohibited. Boxes with pre-cast openings shall be used.

12. Inlet catch basins shall have a 1-foot sump at the bottom to contain sediment and debris.

13. Within a catch basin, inlet, manhole, or junction box, the elevation at the crown of any inlet pipe shall be equal to or greater than the crown of the outlet pipe. Where crowns do not match, the engineer must demonstrate that the unmatched crowns do not adversely affect the capacity or functionality of the system.

14. Rubber gaskets and resilient flexible type connections conforming to ASTM C923 shall be used for all pipe-to-box connections, including road subgrade connections. Pipes shall enter perpendicularly to the face of the box. Pipe may extend into the box such that it breaks the plane of the inside wall, but by no more than 6 inches. If pipes must enter structure at an angle, circular junctions shall be used. Use of an approved alternative detail will be allowed for non-perpendicular pipe connections where circular junctions cannot be used.

15. Subgrade drains connected to catch basins, manholes, or junction boxes shall be required for the length of all roads unless a geotechnical report shows less is necessary.

16. All stormwater structures under this heading shall be backfilled in 6 inch lifts compacted to 95 percent Modified Proctor Compaction Test maximum density.

17. Inlet protection shall be provided at all inlets into the stormwater system during the construction of the project until the closure procedures have been completed or notification from the Department of Stormwater Management has been given stating that an acceptable level of stabilization has been achieved. Guidance on design, installation, and maintenance of inlet protection can be found in the latest SCDOT specification.

18. Inlet spacing shall be based on the maximum spread of water into the travel lane. Allowable gutter spread is limited to one-half of the travel lane for the appropriate design storm listed in SCDOT *Requirements for Hydraulic Design Studies* (2009). Inlet spacing for alleys shall be based on a 50 percent AEP storm event, limited to one-half of the travel lane.
19. Inlets upgrade of a road intersection, sag inlets, or the last inlet for a given system shall be designed with sufficient capacity to handle the entire flow, such that there is no flow through or bypass. Spread calculations shall be provided for review by the Engineering Division of the Department of Public Service.
20. Maximum depth in which the water may pond above or around an inlet shall not threaten surrounding permanent structures or facilities including vehicular or pedestrian traffic.
21. Design procedures for inlet and stormwater facility design may be referenced in AASHTO (1999), USDOT (2001c), Mays (2001), and Yen (2001). Culvert design guidance is found in USDOT (2001a).

3.4.6.6 Underdrain Piping

Underdrain piping may be polyvinyl chloride (PVC) or polyethylene (PE) pipes in accordance with Section 802 (Pipe Underdrains) of the latest SCDOT specifications.

3.4.6.7 Emergency Spillways

All ponds shall have an emergency spillway designed to convey the peak flow associated with the 1 percent AEP, 24-hour storm event if the storage capacity is exceeded. All emergency spillways shall be armored to resist erosive flows. For a system of ponds, the downstream-most pond shall have an emergency spillway able to pass the 1 percent AEP storm event, and the design shall demonstrate how the overtopping flow paths from the remainder of the ponds avoids impacts to buildings.

3.4.6.8 Open Channels

Open channels shall include all permanent storm drainage channels including swales, ditches, and diversions. These stormwater drainage systems shall be designed based upon the following criteria:

1. Open channels shall fully contain all stormwater from the appropriate design storm event with no overtopping of the bank along the channel's entire length.
2. The design of open channels shall be based on Manning's Formula. Where backwater effects from obstructions and/or tailwater is are present, the design of open channels shall be based on the Saint-Venant Equations.
3. The minimum channel grade shall be 0.003 ft/ft and shall be designed to accommodate flows resulting from the appropriate design frequency storm.
4. Design conditions can be assumed to be steady, uniform flow.

5. Channels may be designed with multiple stage levels with a low flow section to carry the 50 percent AEP, 24-hour storm event and a high flow section to carry storms of larger frequencies up to the 1 percent AEP, 24-hour storm event.
6. The City encourages vegetated channels. Guidance on the design of these types of channels can be found in the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).
7. Additional hydraulic capacity shall be required as necessary to prevent backwater effects that may adversely impact upstream properties or structures.
8. The side slopes of grassed lined channels without erosion control blankets or turf reinforcement matting shall be no steeper than 3H:1V.
9. Open channels shall be uniform and shall be stabilized to prevent erosion in a manner approved by the Engineering Division of the Department of Public Service. Acceptable techniques are shown in SCDHEC (2005).
10. Permissible velocities for channels shall be established and not exceeded during the design storm(s) used to size the conveyance. In the case of an existing conveyance, permissible velocities shall not be exceeded during the design storm(s) used to size the outlet. See **Table 3-4** for vegetated channels. For bare soils, permissible velocities will depend on the nature of the soil (cohesiveness and void ratio) and runoff (sediment concentration). Mays (2001) provides graphs to select the permissible velocity. For typical soils in the City, the maximum permissible velocity is less than 3.5 fps. For well vegetated channels, velocity shall be 5 fps or less.

Table 3-4. Maximum permissible velocities for channels

Cover	Permissible Velocity (fps)[a]					
	Erosion Resistant Soils			Easily Eroded Soils		
	% Slope			% Slope		
	0-5	5-10	> 10	0-5	5-10	> 10
Bermuda Grass	8	7	6	6	5	4
Buffalo Grass	7	6	5	5	4	3
Blue Gamma	7	6	5	5	4	3
Centipede Grass	7	6	5	5	4	3
Kentucky Bluegrass	7	6	5	5	4	3
Grass-legume Mixture	5	4	NR	4	3	NR
Lespedeza Sericea	3.5	NR	NR	2.5	NR	NR
Temporary Vegetation	3.5	NR	NR	2.5	NR	NR

Sources: Schwab and Frevert (1985), Haan. Barfield, and Hayes (1995); and NRCS (2007), General guidance on open channel design can be found in USDOT (1996, 2001b).
NR = Not Recommended
[a] Allow velocities over 5 fps only where good cover and maintenance will be provided. If poor vegetation exists due to shade, climate, soils or other factors, the permissible velocity shall be reduced by 50 percent.

11. Acceptable models for designing open channels are discussed in **Section 3.4.4.2**.

3.4.7 Roadway Drainage Design

This section provides additional design requirements for stormwater drainage on roadways.

1. Roadside channels shall meet the definition of a swale.
2. For the purposes of road passage and hydraulic design, the capacity of a system to transport stormwater runoff shall be based on the criteria provided in **Section 3.4.6**.
3. The minimum street center line elevation at finish grade shall be 7.5 feet NAVD88. If a model demonstrates site-specific considerations, a minimum street center line elevation of no less than 5.5 feet NAVD88 will be allowable.

3.5 Redevelopment Requirements

According to the definition in the City of Charleston Ordinance, redevelopment pertains to development on a previously developed site where the impervious surface exceeds 20 percent of the total site and improvements to subject property exceed 50 percent of the total site value. For purposes of this requirement, redevelopment does include remodeling of existing building interiors, resurfacing of paved areas, and exterior building changes. Redevelopment excludes ordinary maintenance activities which do not increase or concentrate stormwater runoff or cause additional nonpoint source pollution. All requirements of this section need to be met for the entire parcel in question but does not apply to parcel areas that are less than 1 acre or sites with a greater than 80 percent existing building footprint that is not being removed.

3.5.1 Redevelopment Standards

In an effort to improve stormwater management on existing developed sites, the City requires one of the following performance standards to be implemented on redeveloped sites (City of Charleston Ordinance (Section 27-29)):

- Reduce the impervious cover on the site by at least 20 percent, based on a comparison of existing impervious cover at the time of submittal of a Construction Activity Application (CAA). Note that permeable pavers that are only being used to meet this requirement and meet the material and construction requirements of the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014) do not require infiltration or Seasonal High Water Table testing.
- Achieve a 10 percent reduction in the 24-hour volume of runoff generated from the site by a 50 percent AEP storm event. Runoff calculations shall be based on a comparison of existing site conditions at the time of submittal of a CAA to the post-development site conditions. Confirm the post-development peak discharge rate does not exceed the pre-development peak discharge rate for the 50 percent AEP storm event.
- Reduce the post-development peak discharge rates by 10 percent of the existing peak discharge rates at the time of submittal of a CAA for the 10 percent and 4 percent AEP storm events based on a comparison of existing ground cover at the time of submittal of a CAA to post-development site conditions. Confirm the 24-hour post-development volume does not exceed the pre-development volume for the 10 percent and 4 percent AEP storm event.

For non-special protection areas, one of these requirements shall be applied unless adequate downstream storm drainage conveyance capacity all the way to receiving waters can be demonstrated. For special protection areas, one of these requirements must be applied in addition to the requirements set in **Section 3.9.3** and **Section 3.6**.

3.5.2 Redevelopment Exemptions

Exemptions must be documented for City approval as stated in **Section 4.10**. Exemptions for redevelopment include:

- Construction or improvement of a SFR, except for SFR located in a special protection area adding 500 square feet or more impervious area.
- Minor land disturbing activities that do not disturb more than 0.5 acres, are not part of a LCP, are not located in a special protection area and do not increase post-development impervious area by greater than 10 percent of the impervious area at the time of submittal of a CAA.

3.6 Special Protection Areas

In an effort to address some of the most critical water resource problems that exist in the City, special protection areas have been established. Any development or redevelopment within or discharging to these special protection areas must comply with a more stringent set of design criteria in addition to the minimum standards and LOS determined by the City. For any conflicting design criteria, the more stringent set will supersede the minimum standards for special protection areas. Please note that these standards are based on the entire parcel area, but applicable to only the disturbed areas of the property associated with the project.

The City can designate any area as a special protection area. The permittee has the responsibility to contact the City through the Technical Review Committee (TRC) to determine whether the proposed project site is within or discharging to a special protection area. The Director of Stormwater Management shall make the determination on whether a site is within a special protection area.

3.6.1 Areas Associated With Known Flooding

Flooding occurs in many locations around the City where development has increased stormwater runoff to the point that stormwater conveyance systems have become overwhelmed. The following design criteria shall be used for projects discharging to receiving waters within these special protection areas outside of linear projects located on existing public infrastructure (i.e. addition of sidewalks or turn lanes):

- For parcel areas of 1 acre or more where a Construction Activity Application is required, the City requires one of the following performance standards to be implemented.:
    - Achieve a 20 percent reduction for the 50 percent, 10 percent, and 4 percent AEP storm event peak flow rate and 24-hour discharge volume. However, no site shall be required to reduce below the values for an undeveloped site with the assumption of

cover as good condition woods. If only Low Impact Development (LID) practices as defined by Table 4.1-1 in the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014) are utilized or the project is utilizing City funding then the 20 percent reduction may be revised to a 15 percent reduction.

- If it can be shown that the proposed work will generate no additional runoff volume or changes in discharge rate in the post-development condition for the 50 percent, 10 percent, and 4 percent AEP storm events, then the requirements can be met by providing storage equal to 50 percent of the existing condition 24-hour runoff volume for the 4 percent AEP storm event. If the project utilizes City funding then only 40 percent of the existing condition runoff volume for the 4 percent AEP storm event must be provided. If Low Impact Development (LID) practices as defined by Table 4.1-1 in the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014) are being utilized, then every 1 unit of storage for these practices can count as 1.1 units to meet the required storage volume.

  A technical procedure document has been provided within the manual to provide additional information on how this requirement is satisfied.

- For SFR or non-SFR parcel areas with an increase of 500 square feet of impervious area or more and no Construction Activity Application, offset the increase in runoff through implementation of runoff control practices (e.g., disconnected downspouts, rain garden, infiltration trench, rain barrel in **Table 3-5**). Per *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014), rain barrels should be used where there is a direct corollary reuse demand. In absence of such, an orifice outlet should be used to slowly drain to impervious surfaces.

Table 3-5. Runoff Control Practices

Reduction Practice	Requirement
Disconnect Downspouts from Impervious Areas or Piped Systems	500 sf of impervious area allowed per 500 sf of roof area disconnected
Install Rain Barrel	500 sf of impervious area per 50 gallon rain barrel installed
Install Rain Garden	500 sf of impervious area allowed per 50 sf of rain garden installed
Install Infiltration Trench	1’ deep x 2’ wide trench filled with clean sand along each side of surface features such as driveways or patios with no more than 15 feet of linear unit area flowing to the feature

Additional stormwater design criteria may be determined and required by the Department of Stormwater Management during the permitting process.

3.6.2 Areas Discharging to Total Maximum Daily Load and Impaired Waters

Projects that discharge either directly or indirectly into an impaired waterbody as determined by the existence of an adopted TMDL by SCDHEC or through SCDHEC’s listing of the waterbody on the latest Section 303(d) list shall reduce pollutant loads to meet applicable water quality

standards. This will require the installation and implementation of measures, structural or non-structural BMPs shall adequately reduce pollutant loads to levels required by the TMDL (currently expressed as percent reductions) or prevent further impairment. An evaluation of the BMPs chosen to control the release of pollutants shall be provided. Such evaluations may reference published values on BMP effectiveness. The following design criteria shall be used for projects occurring within or discharging to these special protection areas:

- BMP and water quality analysis following design procedures in **Section 3.12**.

  Buffers along perennial and intermittent streams adjacent to the project within a watershed where there is an established TMDL involving waste load allocations associated with non-point source pollution. Buffers shall be required on waters as dictated by the City to minimize any further degradation of impaired waterbodies, pending TMDL waterbodies, or anticipated impairment of a waterbody.

  Within buffer areas, significant sources of aquatic contamination and degradation shall be excluded including construction resulting in land disturbance, impervious surfaces, logging roads, mining, septic tank drain fields, agricultural fields, waste disposal sites, stormwater BMPs (except those designed as wetlands), access of livestock, clear cutting, and application of pesticides and fertilizers. The width of buffers shall be as follows:

  - Base width shall be 50 feet plus 2 feet per 1 percent of slope of the stream valley, centered on the stream.
  - Existing impervious surfaces in the riparian zone as well as wetlands do not count toward buffer width (i.e., the width is extended by the width of the impervious surface, just as for wetlands).
  - Slopes over 4H:1V do not count toward the width.

3.6.3 Basin Specific Requirements

Certain basins within the City have been studied in additional detail to develop basin specific requirements that target the specific stormwater management needs of an area. Projects in these areas are required to meet additional basin specific requirements. Basins may be added or modified by City Council. Information regarding existing or anticipated basin specific requirements and justifications are maintained on the City's website:

https://www.charleston-sc.gov/2144/Stormwater-Management

3.6.3.1 Church Creek Drainage Basin Requirements

The Church Creek Drainage Basin drains nearly 5,000 acres located along the western side of the Ashley River. The drainage basin consists of a natural drainage channel and marsh area located between the outlet under U.S. Highway 61 and the Seaboard Systems Railroad.

Studies have been completed in the Church Creek Drainage Basin to analyze the flooding that occurs during minor storm events. Properties in the drainage basin experience severe flooding because of the topography and the insufficient stormwater infrastructure. Specific stormwater standards have been established to lessen the impact of proposed development and

redevelopment within the drainage basin. Projects in the Church Creek Watershed shall meet the following requirements:

1. **From City of Charleston Ordinance (27-102)**
    a. Detain the excess runoff volume difference between the pre-development and post-development conditions for 24-hours for the 50 percent, 10 percent, 4 percent, 2 percent, and 1 percent AEP, 24-hour storm events.
    b. Detention facilities shall be designed and constructed to contain the excess runoff volume difference between the pre-development and post-development conditions for the 24 hour period and the volume required to release the post-development peak flow rates at or below the pre-development peak flow rates.
    c. These requirements are specified in the City of Charleston Church Creek Watershed Storm Water Master Plan Summary Report (Woolpert, LLP 2001) and more fully explained online at: https://www.charleston-sc.gov/1515/Church-Creek-Drainage-Basin
2. **Runoff Volume and Release Rates**
    a. Release rates will be controlled to prevent downstream impacts.
    b. For areas in the Church Creek Basin north of Bees Ferry Road, storm event volumes above predevelopment volumes shall be released over a minimum period of 72 hours.
    c. For areas located south of Bees Ferry Road, release rates shall be reviewed on a case-by-case basis to determine the optimum storage period based on conditions anticipated during a 100-year event.
3. **Main Conveyance Components**
    a. A main conveyance is defined as a drainage asset that serves 100 lots or more or provides drainage for more than one subdivision or community or commercial project greater than 30 acres.
    b. Main conveyance components shall use open drainage channels and ponds to move large volumes of stormwater over long distances.
    c. Culverts may be used where required where main conveyances cross topographical features.
    d. Box culverts or pre-engineered spans or bridges shall be used in lieu of pipes for locations where main conveyance assets or channels cross roadways or trails.
    e. Channels shall be sized to operate at full capacity with reasonable vegetation growth. A channel opening dimension factor of safety of 125 percent shall be used for conveyance structures to account for normal accumulation of debris and sediment between maintenance cycles. The 125 percent factor of safety shall be based upon hydraulic capacity during the 2 percent AEP and 1 percent AEP storm events.
4. **Conveyance culverts**
    a. Conveyance culverts shall be sized to ensure operation at full required capacity under severe conditions common in the area of installation.
    b. Minimum sizes shall be determined to reduce the potential for fouling or clogging due to trapped debris. Culverts shall be sized with a 125 percent safety factor based on hydraulic capacity during a 2 percent AEP storm event to allow for normally occurring conditions.

c. Culvert headwalls shall include robust components not easily damaged by a backhoe or excavator bucket.

5. **Easement Requirements**

a. The minimum required easement width for any open conveyance shall be 24 feet. This easement shall include maintenance shelf accessible to a public right-of-way of 20 feet. Easements will be required on both sides of the channel if there is more than 20 feet between the top of banks.

b. For open conveyances greater than 4 foot wide and/or 4 foot deep, the easement width shall be increased by 2 feet for each foot of channel width or depth in addition to 4 feet.

c. Channel easement width shall be adequate for the channel as well as for access and maintenance.

d. Access shall be sufficient to allow for loading and unloading of equipment and enable mowers and excavators to traverse the length of the conveyance asset. Access for loading/unloading equipment shall be within, adjacent to, and nearby to enable efficient maintenance activity.

e. Main conveyance easements shall allow for a maintenance shelf on one side of the channel. Side slopes shall include a maximum slope of 2.5H:1V.

f. Projects where alternate channel side slopes are proposed, such as a wall, bulkhead, or hardscape will be considered on a case-by-case basis.

g. The minimum width for a main conveyance channel easement shall be 50 feet. Access and shelf areas shall accommodate maintenance equipment such as excavators and other equipment required for effective operation to transverse, function, and free move without risks associated with encroaching upon private property.

h. Maintenance access easements shall be provided on each side of culvert crossings parallel to the flow way to enable maintenance equipment to stage and operate without risk of inflicting permanent damage to improvements in the easement.

6. **Surge Protection**

a. Discharges to tidally affected receiving waters shall be equipped with surge protection devices.

b. Surge protection devices will not be required in areas located upstream of existing devices where protection is provided.

c. Devices shall be located to facilitate maintenance and shall be constructed of stainless steel, aluminum, or other materials that are corrosion resistant and designed for installation in a marine, saltwater environment.

d. In cases where maintaining tidal flow under normal conditions may be necessary, a self-regulating tide gate shall be used to prevent storm surge in upstream areas. Tide gates and self-regulating tide gates shall be manufactured from non-corrosive material.

7. **Floodplain Storage**

a. Floodplain storage impacts that reduce storage shall be prevented.

b. In cases where floodplain impacts are proposed, impacts shall be mitigated on a minimum 1.25:1 basis based on storage volume to prevent deterioration of basin storage capacity during storm events over time.

c. Mitigation shall be within the same basin having an effect on the same water surface elevations and hydraulics as the proposed impact.

8. **Basin Improvement Plan Participation:**

a. Projects located in a portion of the basin where capital improvements have been recommended to improve drainage or reduce flooding potential, designers may incorporate improvements into site design plans, provided the drainage improvements shown on plans are consistent with the function, intent, and effect of the capital improvement project recommended in the Church Creek Basin Study or any prior or subsequent study or evaluation commissioned by the City or their agent.

b. Projects will be reviewed on a case-by-case basis and the City reserves the right to engage in collaborative and creative design efforts that result in improvements to drainage in the basin serving the best interest of the public.

c. As part of the TRC review process, basin improvement plans that may work in conjunction with site development or redevelopment will be reviewed and summarized to determine consistency.

9. **Infiltration**

a. The soil characteristics of fill material placed on non-structural areas to ensure that granular soils are used which promote infiltration and reduce runoff.

b. Soil infiltration BMPs shall be incorporated into the site design where practical.

c. Soils in non-structural areas shall have an infiltration rate of 0.3 inch per hour or greater.

d. Infiltration BMPs must be consistent with the most current version of the *Low Impact Development in Coastal South Carolina: Planning and Design Guide* (Ellis et al. 2014).

10. **Low Impact Development**

a. Home builders shall be encouraged to retain stormwater on site for re-use as irrigation water.

b. Low Impact Development aspects shall be considered during the design process to help mitigate stormwater runoff volume while improving quality.

3.7 Sea Level Rise and Tailwater Conditions

The City has adopted a sea level rise strategy to accommodate future sea level rise and storm surge. The *Flood and Sea Level Rise Strategy* (City of Charleston 2019b) can be found at:

https://www.charleston-sc.gov/slr

To accommodate sea level rise and storm surge, all designs shall use 5.5 feet NAVD88 datum tailwater elevation as a boundary condition with roadway elevation no less than 7.5 feet NAVD88. If the developer/designer desires to design a lower road elevation, they shall develop a hydrologic and hydraulic model, using computational methods or software approved by the City's Department of Stormwater Management, that demonstrates the performance of the roads during a 1 percent AEP, 24-hour storm event that coincides with a storm surge elevation of 5.5 feet NAVD88.

The tidal range used in any stormwater model must match the range shown at the most adjacent tidal station (NOAA stations are acceptable). The bottom of the range must be vertically adjusted so that the top matches the required high water elevation of 5.5' NAVD88. This condition can be included in the boundary set and applied to the furthest downstream node or entered at the furthest downstream node in a time / stage table. The tidal data must be extended a minimum of 24 hours or long enough to show that all SWDSM requirements are being met. The model can show the tide changing from the low water elevation to high water elevation every six hours, but the peak of boundary condition must be adjusted to match the peak of the model's hydrograph.

Please note that all offsite runoff that will impact the tailwater condition of this site will also need to be included in the model being used to show compliance with the requirements of this manual. This modeling effort is required regardless of if a 1% analysis is needed for a project and the modeling may need to be extended downstream if there is a constriction that will impact the tailwater condition for this project.

An alternative to utilizing dynamic tailwater conditions and offsite modeling is to take a conservative approach by modeling a peak static and 'free' tailwater condition and taking the worst-case values of each storm event analysis to show compliance with the City's requirements listed elsewhere in this document.

3.8 Soils and Geotechnical Information

Information on the native soils in the City can be obtained from the NRCS Web Soil Survey at the following website.

https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

The challenge with most of the soils in the City is that they are no longer native because they have been modified by development. The modifications may include compaction or import of non-native fill. The best way to understand the types of soils that are on a site is to hire professional engineers, geologists, or scientists. They can provide critical information such as soil types, depth to relatively impenetrable soil type, and depth to groundwater and infiltration ability. These are critical considerations when performing calculations for stormwater runoff and determining the ability to implement green infrastructure.

3.9 Permanent Stormwater Design

This section discusses the design criteria for stormwater management measures that will remain after the construction project is complete. Permanent stormwater management measures are separate but can be related to measures required during construction. Important considerations in all permanent stormwater management measure designs are access and ease of maintenance.

3.9.1 Introduction to Permanent Stormwater Design Requirements

3.9.1.1 Stormwater Quantity Control

Water quantity control is an integral component of overall stormwater management. Its purpose is to negate the effects of development during storm events. Quantity control is effectively flood control, reducing potential damage and health risks, but because uncontrolled runoff can cause erosion, it can also be a form of water quality control. The design criteria, as described in **Section 3.12**, shall be considered when determining the types of quantity controls to be implemented in a project. For further information and documentation on the design, installation, and maintenance of stormwater quantity facilities, see the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

3.9.1.2 Stormwater Quality Control:

Water quality control is an integral and required component of an overall stormwater management system. Construction, development, and redevelopment projects shall include controls that treat or otherwise limit the discharge of pollutants. These requirements have been added due to State and Federal requirements, but also due to the need to improve and preserve the water resources in the City.

- **Use of BMPs**: Stormwater runoff generated from construction, development, and redevelopment shall be treated through the use of structural and/or non-structural practices. It is presumed that sufficient treatment is provided by the proposed BMPs if they are:
    - Designed according to the specific performance criteria outlined in the SWDSM
    - Constructed properly
    - Maintained regularly
- **Special Protection Areas**: Stormwater discharges to special protection areas with sensitive resources or that have existing flooding or water quality problems (e.g., recreational waters, water supply reservoirs, TMDLs, and Section 303(d) listed waterbodies) are subject to additional performance criteria. Additional performance criteria are listed in **Section 3.6**.
- **Maintenance Agreement**: All BMPs shall have an enforceable operation and maintenance agreement to ensure the system functions as designed.
- **Sediment Basins**: Sediment basins and other BMPs shall be used during construction to remove heavy sediment loads from runoff waters leaving the disturbed area.
- **Disturbed Area Limit**: Clearing for installation of utilities and roads or for development shall be allowed, but limits have been established. The total disturbed area shall not exceed 25 acres. The Department of Stormwater Management may reduce the total area that may be disturbed at any time. Project areas exceeding 25 acres in disturbed area shall be phased to comply with this requirement. All clear-cutting areas shall be clearly identified on construction documents. The decision to consider an activity as clear cutting (logging) versus land disturbance for development shall belong to the Director of Development Services or their designee.

- **Wetlands**:
    - If wetlands are suspected to exist on the property, they shall be investigated and delineated by a qualified consultant. The USACE and OCRM policies regarding wetlands shall be followed.
    - Where existing wetlands are intended as a component of an overall stormwater management system, the approved plan for stormwater management shall not be implemented until all necessary Federal and State permits have been obtained.
- **Vector Control**: Stormwater management and sediment control practices shall be designed, constructed, and maintained with consideration of the proper control of mosquitoes and other vectors.
- **South Carolina Building Code**: On all new construction or renovations required by the South Carolina Building Code to conform to requirements for new buildings, it shall be unlawful for any person to collect stormwater for deposit on any public street, sidewalk, or right-of-way, or otherwise suffer or permit, or by mechanical means propel stormwater on such public street, sidewalk, or right-of-way.

3.9.2 Permanent Stormwater Design Volumes

The City has adopted a tiered approach to managing post-construction stormwater runoff. One of the goals of this approach is to reduce stormwater runoff and thus reduce stormwater pollutant loads. If stormwater runoff volumes are removed through infiltration, evapotranspiration, or beneficial reuse, then the pollutants associated with those volumes will also be removed.

The City requires that all post-construction stormwater runoff from development or redevelopment sites that require a Construction Activity Application be managed for water quality control; Four technology tiers are available for use to meet this runoff management requirement. Each tier prescribes a maximum amount of rainfall (rainfall depth) be applied to the area draining to the four technology tiers. These rainfall depths correspond to a runoff volume to be treated.

Post-construction stormwater runoff from the developed site must be managed through one, or a combination of the technology tiers. Rainfall depths exceeding the values prescribed in **Table 3-6** are allowed to bypass or pass through the permanent stormwater management practices. The rainfall depths for the four tiers are based on a 24-hour duration, Type III distribution storm and are summarized in **Table 3-6** and described in detail in the following bullets:

Table 3-6. Tiered approach rainfall depths based on a 24-hour duration storm

Tier	Rainfall Depth (inches)
I – Green Infrastructure	1.0
I – Green Infrastructure (within 1,000 feet of shellfish beds)	1.5
II – Green Infrastructure with an Underdrain	2.0
III – Detention Practices	2.8
IV – Pass Through Devices	Peak flow from 2.8

- **Tier I**: Green infrastructure includes any permanent stormwater management measure that infiltrates, evapotranspires, or beneficially reuses stormwater runoff. These measures can be at a development or at a lot level. These measures provide water quality treatment through reduction of stormwater runoff volume.
- **Tier II**: Green infrastructure with an underdrain provides some stormwater volume reduction as the stormwater infiltrates into surrounding soils and is absorbed by vegetation, but mostly provides water quality treatment through the filtering process.
- **Tier III**: Detention practices are permanent stormwater management measures that capture stormwater runoff and then release it slowly over time. These measures provide peak flow reduction and water quality treatment, but little to no stormwater runoff volume reduction. This tier is not allowed for projects discharging within 1,000 feet of shellfish beds.
- **Tier IV**: Pass through devices are permanent stormwater management measures that only provide water quality treatment. They do not provide peak flow reduction or stormwater runoff volume reduction. This tier is not allowed for projects discharging within 1,000 feet of shellfish beds.
- **For Tier I – III** (not within 1,000 feet of shellfish beds): Two approaches can be used to show water quality compliance as detailed below:
    - Place the computed water quality volume into the stormwater practice at time zero and provide computations showing that the stormwater practice is still draining after 24 hours.
    - Show that the proposed stormwater practice is able to contain a storm event that generates an equivalent water quality volume and show that the stormwater practice is still draining after 24 hours.

Water Quality Volume:

- The water quality volume for a construction project, or any portion thereof, is the stormwater runoff volume from the rainfall depth selected from the tier chosen, applied over the area of the disturbed area.
- Designers may use different tiers for different portions of the construction project.
- Designers may manage more water quality volume required in portions of the construction project to compensate for portions of the project only where it can clearly be shown that they cannot provide the required water quality volume, provided the required water quality volume is managed for the disturbed area to the maximum extent practicable.
- Detention practices shall return to their normal pool elevation over a minimum period of 24 hours and maximum period of 72 hours unless otherwise indicated by watershed models.
- All projects within 0.5 mile of a receiving waterbody in the coastal zone must meet Section III.C.3.XIII.A of the Coastal Zone Management Program Refinements. Recommended Methods and Design Procedures.

3.9.3 Project Discharge

Stormwater runoff generated and discharged from construction, development and redevelopment activities shall not exceed pre-development discharge rates for the 4 percent, 10 percent, and 50 percent AEP, 24-hour duration storm events. Of particular importance to the City is whether detention anywhere in the watershed will cause downstream coincident peak flows greater than pre-development peak flow rates. The same hydrologic procedures shall be used in determining both the pre-development and post-development peak flow rates.

All designs must also account for the discharge rates and volumes into the downstream and adjacent properties if proper easements and permissions are not in place. Unless the discharge rates and total volumes for the site's discharge locations onto downstream and adjacent properties match the pre-development conditions, a legal right from that property owner or a proper drainage easement for any increase in runoff rates and volumes would be required.

In certain instances where re-development occurs within a Special Protection Area (see **Sections 3.5 and 3.6**), the Department of Stormwater Management may require runoff rates be reduced below pre-development peak flow rates.

3.9.4 1 Percent Probability of Exceedance Storm Event Analysis

Construction, development, and redevelopment activities that disturb 1 acre or more or a project that needs to meet the rate and volume reduction requirements of section 3.6.1shall include a hydrologic/hydraulic analysis to determine the impacts of the proposed development during the 1 percent AEP, 24-hour storm event.

For the 1 percent AEP Storm Event Analysis, the project shall not:

- Increase the likelihood of dwelling flooding and property damage above current conditions.
- Increase water surface elevations or reduce system capacity in the stormwater system and facilities upstream or downstream of the project. An increase or reduction shall be based on a comparison with pre-development conditions (with more stringent requirements potentially applied in special protection areas).
- Increase erosion potential and pollutant loads that would adversely impact the quality of receiving waters.

If the project is in an area that has a stormwater master plan and model, the analysis shall use the boundary conditions from the master plan model provided by the City. The model shall extend up to the top of the watershed and down to the project. If the modeling results indicate there is an impact as listed above, then stormwater volume and flowrate leaving the site must be reduced until such point that there are no impacts.

If the project is not in an area that has a stormwater master plan and model, then an analysis shall be performed from the top of the watershed to a point down system of the site where the site makes up 10% of the basin. The evaluation should also continue downstream for the project

to identify any likely choke points. If the modeling results indicate there is an impact as listed above, then stormwater volume and flowrate leaving the site must be reduced until such point that there are no impacts.

The analysis criteria shall include, but are not limited to:

- Use current zoning for all upstream and downstream land parcels.
- Utilization of existing land use curve numbers for all developed areas outside the project.
- The weighted curve number for the proposed development site shall be used.
- Flows shall be routed using a hydrologic and hydraulic method accepted by the City Department of Stormwater Management.

Other calculations may be required by the Department of Stormwater Management based on the severity of potential impact and the location of the project.

3.9.5 Recommended Methods and Design Procedures

3.9.5.1 General Requirements for BMPs

The following design criteria are established for permanent stormwater management BMPs and shall be incorporated in one or more BMPs for a given subbasin unless a specific quality design exception is granted by the Department of Stormwater Management. Incorporation of these requirements shall constitute adequate control of the discharge of pollutants.

- **Quality Control Threshold**: All sites that disturb 0.5 acres or more shall have at least one permanent water quality structural BMP installed and shall require the execution of a CPMSF.
- **Pretreatment**: Pretreatment devices or forebays shall be provided as described in **Section 3.10**.
- **Maintenance Plan**: All BMPs shall have a maintenance plan. Suggested schedules and routine activities are provided in the South Carolina BMP Handbook (SCDHEC 2005) and the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).
- **Effluent Limits**: The Department of Stormwater Management reserves the right to require specific effluent limits for any pollutant from a site if necessary to ensure the water quality standards and other State and Federal water quality regulations are met.

3.9.5.2 Typical Design Procedures

1. Determine design criteria for site including additional criteria for redevelopment projects, projects in special protection areas, and projects with basin specific requirements.
2. Determine appropriate accepted BMPs needed for the site, considering the land use, pollutants of concern, soils, maintenance requirements, location in relation to receiving waters, and any impairments that may exist.

3. For detention practices capturing runoff from 5 acres or more, provide a forebay or vault at each inlet, unless the inlet provides less than 10 percent of the total design storm inflow to the pond.
4. Calculate the water quality volume using **Equation 3-1.**

Equation 3-1. Water Quality Volume

$$WQV = \frac{P \times DA}{12}$$

Where:

WQV = Water quality volume (acre-feet)

P = Precipitation depth (inches) based on the tier selected

DA = Drainage area to permanent stormwater management BMP (acres)

5. Compute the inflow hydrograph for the permanent stormwater management BMP for the 50 percent, 10 percent, 4 percent, and 1 percent AEP, 24-hour storm events for both the existing and proposed conditions. From this, determine peak flow rates for each storm.
6. Compute a stage-storage relationship for the proposed BMP. A stage-storage curve defines the relationship between the depth of water and storage volume within the detention practice.
7. Compute the stage-discharge relationship for the outlet control structure. A stage-discharge curve defines the flow capacity of a structure at a given stage or elevation.
8. Perform routing calculations for the 50 percent, 10 percent, 4 percent, and 1 AEP, 24-hour storm events. Calculations may be done by hand or by using a storage routing computer model.
9. Evaluate the control structure outlet flow velocity and volume. Drawings and details shall be provided for outlet structures and basin.
10. Repeat steps 2-9 for post-development condition until peak, volume, and velocity criteria are met.
11. Submit calculations in the application package in a cohesive, easy-to-follow format.

Stage-storage and stage-discharge calculations shall be included in the engineering calculations. Common methodologies for stage-storage curves include the double end area method and the pyramid frustum method. Other methods will be accepted upon adequate justification at the discretion of the Department of Stormwater Management.

Hand calculations are available for routing hydrographs through detention structures; however, they are time consuming and inefficient when multiple designs are required to be evaluated. For the SWDSM, the design engineer shall use one of the many computer software packages available to perform storage routing calculations. All models and methodologies used shall be approved by the City (**Section 3.4.4.2**).

3.10 Detention and Infiltration Requirements

This section contains the requirements for the design and maintenance of permanent structural stormwater detention and infiltration practices. These practices help to improve water quantity and quality and may be implemented as part of the overall site design for any project. The following requirements should be applied to all detention and infiltration facilities:

- **Forebays and Pretreatment Devices**: Permanent structural BMPs shall have a forebay or pretreatment BMP to facilitate more efficient removal of debris and coarse sediments unless the inlet provides less than 10 percent of the total design storm inflow to the pond. These can be created through grading or a manufactured or engineered device.
    - Forebays shall be placed upstream of the inlets into the main BMP storage area.
    - Unless a separate vault (engineered device) is to be used for the forebay, the forebay shall be separated from the larger BMP storage area by barriers or baffles that may be constructed of earth, stones, riprap, gabions, or geotextiles.
    - Maintenance of forebays shall be performed once a year unless otherwise specified by a manufacturer. Designs shall consider the maintenance needs by ensuring equipment has adequate access to forebay and adequate clearance to perform dredging and cleaning operations. A visual marker shall be placed in the forebay to assist in monitoring sedimentation depth.
    - The forebay shall be sized to contain 0.1 inch of runoff per impervious acre of contributing area. The forebay shall be a minimum of 2 feet deep with the top of the associated berm being no more than 0.5' below the normal water level. The volume in the forebay counts towards the total water quality volume requirements of the BMP if it is above the normal water level. As an alternative, the forebay may be designed to meet a sediment trapping efficiency of 60 percent.
- **Construction Specifications:** Construction specifications shall conform to the latest version of SCDOT's *Standard Specifications for Highway Construction* (2007).

3.10.1 Detention and Retention Requirements

Detention practices are essential for providing increased storage within a stormwater management system. The storage of stormwater flows by these structures helps provide water quality protection and reduces peak flows. Designs of storage facilities used for stormwater flow rate control and required downstream analyses shall be submitted as part of the engineering calculations. Requirements that shall be applied to detention practices include the following:

- **Discharge Velocities:** Post-development discharge velocities shall be reduced to provide non-erosive flow velocities from structures, channels, or other control measures, or equal the pre-development 10 percent AEP, 24-hour storm event flow velocities, whichever is less. Refer to **Table 3-4** for maximum non-erosive flow velocities.
- **Impoundment / Freeboard Requirements:**
    - Ponds with vegetated embankments shall be less than 15 feet in height and shall have side slopes (inside and outside) no steeper than 3H:1V. Embankments protected with turf reinforcement mats (TRM) may be used but shall be no steeper than 2H:1V. Geotechnical slope stability analysis is required for slopes greater than 10 feet in height and embankments that have steeper slopes than those indicated above. Access inside a pond shall be provided with at least one side slope at 3H:1V or flatter for maintenance.
    - A minimum freeboard of 0.5 feet above the 1 percent AEP, 24-hour design storm high water elevation shall be provided for all impoundments.

3.10.2 Detention-Specific Requirements

Stormwater detention facilities are used to reduce the peak discharge and capture runoff for a short period of time. Detention facilities should be designed to completely drain or return to a normal pool elevation after a design storm has passed. Requirements specific to detention facilities include:

- **Limits of Detention Pool**: Any detention storage capacity shall clearly identify the limits and depths of the expected detention pool on the construction plan set.
- **Recovery Time**: The detention volume from detention facilities shall be drained within 0.10 feet of the normal water surface elevation from the structure within 72 hours or a second storm event analysis can be performed to show the detention facilities still have 0.5 feet of available freeboard. The storm being analyzed for this requirement is the 4 percent AEP storm event for all projects not located in the Church Creek Basin which requires the 1 percent AEP storm event for analysis (see section 3.6.3 for specific Church Creek Basin requirements).
- **Pond Requirements**: The bottom of detention facilities shall be graded towards the outlet structure(s) to prevent standing water conditions in dry facilities and to facilitate draining of wet facilities to perform maintenance. The bottom slope shall be a minimum of 0.5 percent.

3.10.3 Wet Detention-Specific Requirements

Wet stormwater detention facilities contain a permanent pool of water and are primarily implemented to promote water quality treatment. The maximum depth of wet detention facilities with a permanent pool shall be determined by site conditions, design constraints, and environmental needs. The facility shall provide a permanent pool of water with a depth sufficient to discourage weed and mosquito growth without creating undue potential for anaerobic bottom conditions. A depth of 3 to 8 feet is reasonable unless County Mosquito Control requirements dictate otherwise. Aeration or other means shall be used as necessary to prevent anaerobic conditions.

- **Aquatic Bench**: A minimum 10-foot-wide aquatic bench around the perimeter of the wet stormwater detention facility (with exception of the forebay area) with the inside edge of the shelf 6” below the permanent pool level and the outside edge 6” above the permanent pool level with a resulting slope of 10H:1V must be provided when site area is greater than 2 acres. With half the shelf below the water and half the shelf above the water, the vegetated shelf will provide a location for an appealing diverse population of native, emergent wetland vegetation that enhances biological pollutant removal, provides a habitat for wildlife, protects the shoreline from erosion, promotes ecological mosquito control (i.e., attracts a variety of predator insects for natural mosquito control) and improves sediment trapping efficiency.

  The wet stormwater detention facility must incorporate several (minimum of three (3)) diverse native species of shallow water emergent and shall land herbaceous vegetation on the vegetated shelf. A minimum of 50 plants per 200 sf of shelf area shall be planted. Diversity in species increases the robustness of the vegetated shelf by increasing the chances that some species will service minor changes in the permanent pool water level. This vegetation enhances pollutant removal, protects the shoreline from erosion, and increases safety by discouraging people from entering the basin. Planting density is dependent on the targeted time to full coverage, and on the individual selected species’ mature size. Spacing must be approximately 24” to 36” centers; yielding coverage in approximately 1-2 years respectively. On the tops of

berms and on the exterior slopes of containment berms, maintain turf grass in access areas; Vegetation selection information can be found in **Section 3.15.2.**

3.10.4 Infiltration Requirements

Infiltration BMPs are encouraged at all sites and may be required on those sites that do not currently discharge stormwater runoff, have no existing outlet, or are in special protection areas (e.g., Church Creek Basin). The following other criteria, based primarily on South Carolina Regulation 72-307.C requirements, shall be followed in the design of infiltration systems:

- Areas draining to these facilities shall be stabilized and vegetative filters established prior to runoff entering the system. Infiltration devices shall not be used if a suspended solids filter system does not accompany the practice. If vegetation is the intended filter, there shall be at least a 20-foot length of vegetative filter prior to sheet flow stormwater runoff entering the infiltration practice. Forebays or other engineered devices for sediment removal are also required.
- Each system shall be designed to prevent clogging by fine material and for ease of maintenance.

- The bottom of the infiltration practice shall be at least 0.5 feet above the seasonal high water table, whether perched or regional, determined by direct piezometer measurements, which can be demonstrated to be representative of the maximum height of the water table on an annual basis during years of normal precipitation, or by the depth in the soil at which mottling first occurs as determined by an appropriately licensed individual.
- The infiltration device shall be designed to completely drain of water within 72 hours.
- Soils shall have adequate permeability to allow water to infiltrate. Infiltration practices are limited to soils having an infiltration rate of at least 0.5 inch per hour. Initial consideration shall be based on a review of the appropriate soil survey and proposed depths of excavation or field testing. The survey or testing may serve as a basis for rejection. Onsite soil borings and textural classifications shall be accomplished to verify the actual site and seasonal high water table conditions when infiltration is used.
- Infiltration practices greater than 3 feet deep shall be located at least 25 feet from basement walls.
- Infiltration practices designed to handle runoff from any parking areas or commercial properties shall be a minimum of 150 feet from any public or private water supply well.
- The design of an infiltration practice shall have a properly sized overflow or bypass for larger storm events. Measures to provide a non-erosive velocity of flow along its length and at the outfall shall also be included as necessary. Additional control devices will typically be necessary prior to a release to a watercourse to meet water quality requirements.
- The slope of the bottom of the infiltration practice shall not exceed 5 percent.
- An infiltration practice shall not be installed on or atop a slope whose natural or existing angle of incline exceeds 20 percent.
- If an underdrain system is required, clean-outs shall be provided at a minimum every 100 feet along the infiltration practice to allow for access and maintenance.
- If sod is proposed in areas counted towards stormwater infiltration, calculations or product certifications shall be provided to ensure the sod bedding does not hinder site specific infiltration requirements.

3.11 Equalization Pipes and Submerged Systems

The City acknowledges that in some cases equalization pipes and submerged systems may be an appropriate solution. Due to maintenance concerns these will be limited and require a design exception. Design requirements are in **Section 3.4.6.1** and design exception instructions are in **Section 4.10**.

3.12 Accepted Permanent Structural and Non-Structural Best Management Practices

Permanent structural BMPs are those practices that remain after the project has been closed out. Permanent structural BMPs typically fall into two categories: water quantity (runoff retention for a

design rainfall depth) and water quality. Permanent structural quantity BMPs accepted by the City are listed in **Table 3-7**.

Table 3-7. Structural BMPs for Water Quantity and/or Quality

BMP	Description	Water Quantity	Water Quality
Bioretention Areas – Rain Gardens, Stormwater Planters, Tree Boxes	Bioretention areas are shallow stormwater basins or landscaped areas that use engineered soils and vegetation to capture and treat stormwater runoff. Runoff may be returned to the conveyance system through an underdrain or exfiltrated into the soil.	+	+
Permeable Pavement Systems	Permeable pavement systems are pavement surfaces that promote infiltration of stormwater through gaps in the pavement to an underlying course of gravel and then to an underdrain or underlying soils resulting in a reduced volume of runoff.	+	
Stormwater Infiltration - Infiltration Trenches and Basins	Infiltration practices are shallow excavations that are filled with stone or engineered soil that allow stormwater runoff to enter and exfiltrate through the adjoining soils or through an underdrain.	+	
Green Roofs	Green roofs are roofs where engineered soil media and vegetation is installed on all or a portion of the surface area. Green roofs reduce the impervious area and the volume of stormwater runoff.	+	
Rainwater Harvesting	Rainwater harvesting is the practice of collecting and beneficially reusing rainwater. Typically, this is limited to rainwater runoff from roofs.	+	
Impervious Surface Disconnection	Runoff from a rooftop, driveway, or other small impervious surface is directed to a pervious surface or practice to provide infiltration, filtering, or reuse. Disconnection practices are intended to reduce the volume of runoff created by impervious surfaces.	+	
Open Channel Systems – Grass Channel and Dry Swale	Vegetated open channels with amended soils or suitable soils for infiltration that are explicitly designed and constructed to capture, route, and infiltrate stormwater runoff.		+
Site Reforestation	Site reforestation is planting trees on a site. The trees capture rainfall in their leaves and uptake infiltrated water through their roots to reduce stormwater runoff volumes.	+	+
Open Channel Systems – Wet Swale and Two Stage Ditches	Stormwater conveyance systems that provide water quality benefits through filtration and pollutant uptake.		+
Stormwater Filtering Systems: Perimeter Sand Filter	Perimeter sand filters are multi-chamber structures designed to treat stormwater runoff through filtration using a sand bed as its primary filter media. Filtered runoff may be returned to the conveyance system.		+

BMP	Description	Water Quantity	Water Quality
Dry Detention Ponds	Dry detention ponds are constructed stormwater basins that are dry between rain events. Runoff from each rain event is detained and treated in the basin, and released at a designed rate.	+	
Wet Detention Ponds	Wet detention ponds are constructed stormwater basins that have a permanent pool, shallow marsh, or micropool of water. Runoff from each rain event is detained and treated in the pool, and released at a designated rate.	+	+
Stormwater Wetlands	Stormwater wetlands are natural or constructed systems used for stormwater management. Stormwater wetlands consist of a combination of shallow marsh areas, open water and semi-wet areas above the permanent water surface.		+
Vegetated Filter Strip	A vegetated buffer, or filter strip, is a uniformly graded and densely vegetated area that treats sheet flow stormwater runoff. The vegetation in the buffer works to slow down the stormwater runoff, settling and filtering some pollutants and uptaking others.		+
Underground Detention	Underground detention is used as an alternative to surface dry-detention basins. They are used in areas that are space-limited where there is not adequate land to provide the required detention volume. The underground storage uses tanks, vaults, and buried pipes to supply the required storage volume.	+	
Manufactured Treatment Devices: Vortex Separator Baffles Cartridges Skimmers Gravity Oil-Grit Separator Filter Material Inlet Inserts	Pre-fabricated controls use the movement of stormwater runoff through a specially designed practice to remove target pollutants. They are typically used on smaller commercial sites and urban hotspots. There are numerous commercial vendors of these practices, but there is limited data on their performance. Until further research is done and substantial removal efficiencies are published, these structures may require monitoring.	+	+

Regardless of the structural control used, maintenance schedules shall be included for each proposed BMP. Maintenance schedule is included on the grading and drainage details sheet of the construction plan set.

Listed below are some permanent non-structural BMPs that shall be considered for use in larger construction, development, and redevelopment projects.

- **Buffers**: an area along a shoreline, wetland, or other waterway where development is restricted or prohibited. The primary function of the buffer is to physically protect and separate a stream, lake, or wetland from future disturbance or encroachment.

- **Disconnected Roof Drains**: directing stormwater runoff from rooftops towards pervious areas where it is allowed to filter through vegetation and other landscaped material and infiltrate into the soil.
- **Cluster Development**: concentrate development away from environmentally sensitive areas such as streams, wetlands, mature wooded areas, and steep slopes.
- **Education Materials:** literature for owners and homeowner's associations to educate themselves on the impact they can have on water quality and the activities necessary to maintain structural controls. These efforts are particularly critical in low impact development (LID) designs.

3.12.1 Bioretention Basins

Bioretention basins are shallow depressional areas (18 to 36 inches deep) that are filled with an engineered soil media and are planted with trees, shrubs, and other herbaceous vegetation. They are an effective practice to reduce post-construction stormwater runoff rates, volumes, and pollutant loads. They also provide several other benefits, including improved aesthetics, wildlife habitat, urban heat island mitigation, and improved air quality. These BMPs are either a Tier I or Tier II practice depending upon whether the practice has an underdrain.

Bioretention basins are designed to capture, infiltrate, and evapotranspire stormwater runoff. However, if the soils do not percolate as much as desired, an underdrain can be installed, so at least the stormwater runoff is temporarily stored before being conveyed back into the storm drain system through an underdrain. However, the underdrain must have an upturned elbow that induces subsurface infiltration in the submerged (French) drain but allows excess flow to progress to receiving drainage system. The engineered soil media is comprised of sand, soil, and organic matter.

The City requires the design, installation, and maintenance requirements for bioretention basins to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014). Bioretention basins designed and installed in the City shall also meet the following criteria:

- An observation well shall be provided to allow easy monitoring of the water level within the practice. The observation well shall be a 6-inch perforated PVC pipe with a removable and lockable cap.

3.12.2 Permeable Pavement Systems

Permeable pavement allows the stormwater to infiltrate through the pavement into a rock storage layer under the pavement. Examples of permeable pavement include porous asphalt, pervious concrete, and permeable pavers. Pervious concrete is designed without any "fine" material, resulting in a gap-graded mixture with high void space. Porous asphalt is similar to pervious concrete and consists of an open-graded surface course. Permeable pavers consist of individual concrete or stone shapes that are placed adjacent to one another, but with gaps all around, over a specially designed sub-base. These BMPs are either a Tier I or Tier II practice depending upon whether the practice has an underdrain.

The critical aspect of permeable pavement systems is application. They can be very effective, but not when they are placed in areas where they will regularly receive runoff concentrated with mulch, leaf litter, grass clipping, etc. This organic matter will plug the void spaces in the pavement and restrict the infiltration that can occur.

The City requires the design, installation, and maintenance requirements for permeable pavement system to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014). Permeable pavement systems designed and installed in the City shall also meet the following criteria:

- Permeable pavement systems shall be designed to completely drain within 72 hours.
- The proportion of drainage area to permeable pavement footprint should be less than 10:1.
- An observation well shall be provided to allow easy monitoring of the water level within the practice. The observation well shall be a 6-inch perforated PVC pipe with a removable and lockable cap.

3.12.3 Infiltration Trenches/Basins

Infiltration trenches/basins are shallow excavated areas that receive stormwater. Infiltration trenches/basins are suitable for sites with limited space, reduce the volume of stormwater runoff and peak flows, are appropriate for small sites (less than 5 acres), provide infiltration and pollutant filtration, and work well with other BMPs in series. These BMPs are either a Tier I or Tier II practice depending upon whether the practice has an underdrain.

Infiltration trenches/basins are applicable for a variety of uses such as the perimeter of parking areas or medians between drive lanes. They can also be applicable for sites with limited space available for water quality features. There are a variety of ways these structures can be designed but must include pretreatment. Infiltration trenches/basins can receive overland flow from a forebay through gravel or grass. They can also receive point flow from a proprietary water quality unit that drains to the aggregate filter media.

The City requires the design, installation, and maintenance requirements for infiltration trenches/basins to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

3.12.4 Green Roofs

Green roofs are roofs of buildings that have a waterproof membrane overlaid with planting media and vegetation including plants, shrubs, or trees. Green roofs capture and absorb rainwater, resulting in decreased stormwater runoff. Green roofs provide more than a stormwater benefit, such as reducing rooftop temperatures, creating urban habitats, and enhancing outdoor gathering spaces. These BMPs are a Tier I practice and qualify for a curve number reduction (see worksheet in **Appendix C**).

All buildings must have the structural capacity to hold a green roof. Extensive green roofs use less than 6 inches of planting media, whereas intensive green roofs use greater than six inches of planting media. Rooftop applications will vary based on structural capacity of the building. It is important to consider the maintenance requirements, leak detection systems or tray systems, planting plans (using plants with minimal irrigation requirements), and replacement of green roof layers.

The City requires the design, installation, and maintenance requirements for green roofs to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

3.12.5 Rainwater Harvesting

Rainwater harvesting is the practice of capturing and temporarily storing rainwater, typically from rooftops, in a cistern or rain barrel for beneficial use. The beneficial use often includes landscape watering but may include water for flushing toilets (contact City for regulations regarding reuse of rainwater), make-up water for HVAC units and boilers, and water for vehicle washing. These BMPs are typically a Tier I practice.

Rainwater harvesting can be used in most land use practices, including high-density residential, commercial, institutional, and industrial areas. Considerations for rainwater harvesting include the distance of the harvested rainwater from its intended use, water treatment requirements that may limit use of harvested rainwater, storage of harvested rainwater below ground versus above ground, seasonal use, and decrease in potable water usage.

The City requires the design, installation, and maintenance requirements for rainwater harvesting to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

3.12.6 Impervious Surface/Roof Disconnection

The goal of downspout disconnection is to allow stormwater from impervious surfaces to run across pervious surfaces to be treated and infiltrated. For new SFR construction or redevelopment, it is prohibited to connect downspouts to the stormwater system. When disconnecting impervious surfaces/roofs from the stormwater system or allowing impervious surfaces to be directed to pervious surfaces, the designer needs to consider the proximity of adjacent buildings, the direction of downspout conveyance after disconnection, and the routing of disconnected downspouts to other BMPs or pervious surfaces.

The City requires the design, installation, and maintenance requirements for impervious surface/roof disconnection to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

3.12.7 Open Channel Systems – Grass Channel and Dry Swale

Grass channels and dry swales are long, shallow stormwater basins (typically 4 to 18 inches deep) that mimic the ecological functions of a natural landscape. Dry swales are similar to linear bioretention areas. These open channel systems can be flexible in design to accommodate landscape requirements and can be used to retrofit the natural or design landscape, reduce the volume of stormwater runoff, provide infiltration, provide filtration, provide groundwater recharge, and are suitable for runoff from highly impervious areas. These BMPs are either a Tier I or Tier II practice depending upon whether the practice has an underdrain.

The City requires the design, installation, and maintenance requirements for grass channels and dry swales to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

3.12.8 Site Reforestation

Site reforestation is a practice in which an impervious area is retrofit with or replaced (entirely or in part) with a combination of vegetation and trees. This reduces the impervious area and consequently reduces the peak stormwater runoff flows and overall stormwater volume that discharges from a site. These BMPs are typically a Tier I practice and qualify for a curve number reduction (see worksheet in **Appendix C**).

Site reforestation promotes infiltration; reduces the heat island effect, soil erosion, and stream temperatures; and can provide bank stabilization. When evaluating the feasibility of site reforestation, consideration should be given to land development code standards, a combination of site reforestation with other BMPs, the use of site reforestation as a visual buffer or a part of a filter strip, soil conditions, and the type of trees/vegetation proposed.

The method for incorporating trees into runoff reduction calculations shall be in accordance with the Green Infrastructure Center Case Study “Trees to Offset Stormwater – Case Study 04: Charleston, South Carolina” (2018) and the associated calculator tool.

3.12.9 Stormwater Filtering Systems - Perimeter Sand Filter

Sand filters are shallow, excavated areas that receive stormwater through overland flow or a perforated inlet pipe. The stormwater runoff flows through the sand bed and into the underdrain filtering and treating stormwater pollutants. These BMPs are typically a Tier IV practice, but may be a Tier II.

A pretreatment device or forebay is required to filter large sediment and debris before entering the filter to prevent clogging. Sand filters are applicable for a wide variety of uses such as the perimeter of parking areas or medians between drive lanes. They can also be applicable for sites with limited space available for water quality features.

The City requires the design, installation, and maintenance requirements for stormwater filtering systems to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

3.12.10 Dry Detention Practices – Dry Ponds

Dry detention basins or dry ponds are surface storage facilities intended to provide temporary storage of stormwater runoff and to release it at a designed flow rate to reduce downstream water quantity impacts. These practices contain a forebay for capturing the heavier sediment and floatables and are designed to completely drain to a dry condition within 72 hours. These BMPs are a Tier III practice. If the practice can infiltrate significant amounts of stormwater runoff, then the practice should be treated as a bioretention basin.

Dry ponds require a significant footprint and are best suited for drainage areas greater than 10 acres. Dry ponds also do not reduce the overall stormwater runoff volume and provide less pollutant removal than other practices.

The City requires the design, installation, and maintenance requirements for dry ponds to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014). Dry ponds designed and installed in the City shall also meet the following criteria:

- Dry ponds must retain the water quality volume required for Tier III and release it over 24 to 72 hours, unless the pond is in an identified flood-prone area.

3.12.11 Wet Pond

Water quality wet ponds are similar to standard extended wet detention ponds, except they contain an aquatic bench along the perimeter of the pond just below the normal pool level and possibly other plantings above the normal pool elevation (safety bench) in the extended detention portion of the pond that provide water quality benefits and detain the stormwater runoff for a slow release over at least 24-hours and no more than 72 hours. The vegetation helps provide water quality benefits. These BMPs are a Tier III practice.

Wet ponds improve water quality by biological uptake and filtering of native plants, sediment settling, including attached pollutant, and detention of stormwater. Wet ponds have a relatively high removal rate for many pollutants, increase biodiversity by providing habitats for wildlife and aquatic life, reduce channel/streambank erosion by reducing the number of bankfull events, and provide an opportunity for multiple use areas, including active and passive recreation. Wet ponds may require complying with South Carolina dam regulations, have a large space requirement, present possible safety concerns with a pool of water (fence may be required), and are not to be used in high groundwater areas.

The City requires the design, installation, and maintenance requirements for wet ponds to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide*

(Ellis et al. 2014). Wet ponds designed and installed in the City shall also meet the following criteria:

- Extended detention above the normal pool elevation shall be based on the 2.8 inch, 24-hour storm per Tier III requirements.
- The aquatic bench should contain plantings to aid in the treatment of the stormwater runoff. Plant selection can be found in **Section 3.15.2**.

3.12.12 Stormwater Wetlands

Constructed wetlands incorporate marsh and pool areas to temporarily store stormwater runoff, treat pollutants, and create habitat. Constructed wetlands are generally shallow, except for the pool areas, and contain dense native aquatic vegetation, typically covering 50 percent of the surface area, that help treat the stormwater. Wetland systems can store runoff, provide extended detention, or incorporate the benefits of a pond in a pond/wetland system. Stormwater wetlands should detain the stormwater runoff for a slow release over at least 24-hours and no more than 72 hours. These BMPs are a Tier III practice.

Constructed wetlands improve water quality through biological uptake through native plants and biodegradation by microorganisms, sediment settling, adsorption, and other chemical/physical processes. Wetlands also increase biodiversity by providing habitat for aquatic and wildlife species and provide an opportunity for multiple uses including passive recreation. Wetlands typically require larger tracts of land, need a regular flow of water (so stormwater runoff may need to be supplemented during dry conditions), and need to be properly designed and managed to reduce the potential to breed mosquitoes. Water quality of the discharge can also change with seasonal growth of plantings.

The City requires the design, installation, and maintenance requirements for stormwater wetlands to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design* Guide (Ellis et al. 2014). Stormwater wetlands designed and installed in the City shall also meet the following criteria:

- Extended detention above the normal pool elevation shall be based on the 2.8 inch, 24-hour storm per Tier III requirements.

3.12.13 Vegetated Filter Strip

A vegetated filter strip is a uniformly graded and densely vegetated area that treats and infiltrates stormwater runoff. The vegetation in the filter strip works to slow down the stormwater runoff, settling and filtering some pollutants and uptaking others. The stormwater runoff volume can also be reduced by infiltration into the pervious soil, if available, and by absorption and evapotranspiration of the vegetation. For a vegetated filter strip to be effective, the stormwater has to enter and flow through the buffer in sheet flow. A vegetated buffer can be managed or unmanaged depending on the desired aesthetics.

Often a vegetated filter strip is used as preliminary treatment of the stormwater prior to entering another permanent stormwater BMP; however, if the soils are suitable, it can be a Tier I practice.

3.12.13.1 Vegetated Filter Strip Feasibility Criteria

The following feasibility criteria shall be considered when designing a vegetated filter strip:

- **Sheet Flow:** A vegetated filter strip should receive stormwater runoff from an upstream impervious area and through sheet flow it is able to treat the runoff and, if the soils allow, infiltrate some of the stormwater runoff volume. For the filter strip to be effective, the runoff needs to enter and flow through the entire strip length in sheet flow. Uniform grading within the strip is required to maintain the sheet flow throughout the strip.
- **Depth to Water Table:** The designer must ensure a standard separation distance of at least 0.5 feet between the seasonally high groundwater table or any soil layer without minimum infiltration rates (e.g., clay lenses) and the bottom invert of the filter strip.
- **Drainage Area:** The vegetated filter is intended to treat runoff from a small contributing drainage area, typically not to exceed 3 acres.
- **Flow Length of Drainage Area:** The flow length of the drainage area shall be less than 300 feet.

3.12.13.2 Vegetated Filter Strip Design Criteria

- **Slope:** The filter strip slope shall be a maximum of 6 percent to allow the flow to move slow enough for the vegetation to filter and settle out the pollutants and for the runoff to infiltrate, if possible. If the slope is less than 1 percent, then ponding water may be produced, which can lead to mosquito concerns.
- **Length:** The length of the filter strip (parallel to flow) shall be a minimum of 25 feet and shall be determined using **Equation 3-2**.

Equation 3-2. Calculation of Length of a Vegetative Filter Strip

$$L = \frac{T^{1.25} P^{0.625} S^{0.5}}{0.334n}$$

Where:

L = Length of the filter strip parallel to the flow path (feet)

T = Travel time through the filter strip (minutes), see **Equation 3-3**

P = Required WQV rain amount (inches)

S = Slope of the filter strip along the flow path (%)

n = Manning's roughness coefficient, typical values per USDA *Urban Hydrology for Small Watersheds* (1986):

Grass, dense grasses, n=0.24

Range (natural), n=0.13

Woods, light underbrush, n=0.40

Woods, dense underbrush, n=0.80

- **Travel Time:** The amount of time (minutes) water flows through the filter strip shall be calculated as follows:

Equation 3-3. Calculation of Travel Time of Water in a Vegetative Filter Strip

$$T = \frac{0.42(nL)^{0.8}}{P^{0.5}S^{0.4}}$$

Where

T = Travel time through the filter strip (minutes)

n = Manning's roughness coefficient

L = Length of the filter strip parallel to the flow path (feet)

P = Required WQV rain amount (inches)

S = Slope of the filter strip along the flow path (%)

- **Width:** The width of a vegetated filter strip is perpendicular to the flow. The width shall be greater than or equal to the width of the contributing drainage area.
- **Velocity:** The velocity of the stormwater runoff across the filter strip shall be less than 2.0 fps using **Equation 3-4**.

Equation 3-4. Calculation

$$V = \frac{Q}{dW}$$

Where

V = Velocity (fps)

Q = Peak discharge to the filter strip from the required WQV rain event (cfs)

d = Depth of flow (feet)

W = Minimum width of the filter strip (perpendicular to the flow) (feet)

- **Soils:** A vegetated filter shall be used on soils that have minimal clays and an infiltration rate greater than 0.5 inch/hour. The objective is to use soils that are able to sustain a dense vegetative growth.

3.12.13.3 Vegetated Filter Strip Landscaping Criteria

A naturalized planting plan is required for vegetated filters. Native species or native, non-invasive cultivars shall be used in vegetated filters. Plants shall consist of native or native cultivars of deep-rooted herbaceous plants (grasses, forbs, wildflowers), shrubs, and trees. Native plants indigenous to Charleston that are low-maintenance and require minimal watering, weeding, pest control, fertilization, and pruning are ideal for naturalized vegetated filters. For this reason, exotic, non-native species are not suitable for vegetated filters due to watering and other maintenance

requirements. Invasive plant species shall be removed if they are present in the vegetated filter and replaced with approved native plants. For more information on plant selection, see **Section 3.15.2**. An inventory of plants present in the vegetated buffer shall be provided in the planting plan.

The plan shall include the following:

- Delineation of filter strip
- Selection or inventory of corresponding plant species
- Sources of native plant material
- Bedding preparation
- Identification of the various planting zones and recommended plants for each planting zone

3.12.13.4 Vegetated Filter Strip Construction Sequence

The following is a typical sequence for constructing or preserving a vegetated filter strip.

1. If the vegetated filter strip is existing, protect it from damage during construction with demarcation and sediment control.
2. Stabilize the portion of the construction site draining to the filter strip. The vegetated filter strip should not be constructed, or if existing, allowed to received stormwater runoff, until the area draining to the BMP is permanently stabilized.
3. If the filter strip is existing, remove any invasive or undesired species, and complete planting per the planting plan.
4. If the filter strip is to be planted, remove existing vegetation; prepare the soil, including tilling, scarifying, fertilizer, lime, and amendments; and install plantings per the planting plan.

3.12.13.5 Vegetated Filter Strip Maintenance Criteria

Maintenance of the filter strip is important to allow it to function as intended. In general, the inspection and maintenance of vegetated filter strips includes:

- Removal of debris from filter strip and areas immediately upstream
- Local erosion prevention and sediment control
- Irrigation and weeding during the first few months of planting to ensure species establishment
- Maintenance of the health and abundance of native species and plantings
- Removal of any invasive species

A typical maintenance plan is provided in **Table 3-8.**

Table 3-8. Example of a maintenance plan for a vegetative filter strip

Maintenance Items	Frequency
Water as recommended by the nursery during establishment and then as needed during dry conditions	As needed
Mow or trim vegetation in accordance with nursery recommendations	
Inspect grading of vegetative buffer to ensure sheet flow across the entire buffer length and width	Semiannually in spring and fall during the first year and annually thereafter
Inspect vegetation for health and signs of stress; if tree/shrub/grass begins showing signs of stress, including drought, flooding, disease, nutrient deficiency, or insect attack, treat the problem or replace the vegetation	
Inspect buffer for erosion and bare spots and repair	
Inspect and repair eroded or damaged areas to maintain sheet flow to and across the vegetative buffer	Following significant rain events (>10 percent AEP)

3.12.14 Underground Detention

Underground detention is the practice of collecting and detaining stormwater runoff underground in pipes, vaults, chambers, or modular structures. The collected stormwater runoff is intended to be released back to the surface drainage system or storm sewer system at a reduced rate and completely drained prior to the next rain event, similar to a dry detention pond. Underground storage systems may also infiltrate the stormwater into the underlying soils, provided the surrounding soils have the necessary permeability. An underground storage system may be constructed of concrete, steel, or plastic with many proprietary products in the market. This permanent structural BMP is typically a Tier III practice.

Underground detention reduces the peak stormwater runoff flows, requires less installation than other BMPs, adapts to unusual shaped properties, and has increased public safety when compared with other BMPs. These systems provide very little water quality benefit, so additional BMPs or pretreatment devices are required where water quality improvements are needed. These systems also cannot be used in areas with a high groundwater table.

3.12.14.1 Underground Detention Feasibility Criteria

The following feasibility criteria should be considered when designing an underground detention system:

- **Location:** Underground detention should be located such that the stormwater runoff gravity feeds into and out of the detention system.
- **Accessibility:** Underground detention should be located in areas that can be excavated in the future, should the need arise.

- **Access:** Several manholes/access ports should be provided to allow for maintenance and inspection of the system. Spacing of access ports should consider the ability of equipment intended to be used for maintenance.
- **Space availability:** Sufficient space is needed to locate the required storage volume in accordance with the SWDSM.

3.12.14.2 Underground Detention Pretreatment Criteria

Pretreatment, focused on the removal of floatables and sediment, should be provided at the inlets to reduce maintenance efforts and prevent groundwater contamination, if infiltration is provided. Pretreatment may include catch basin inserts or proprietary water quality units.

3.12.14.3 Underground Detention Design Criteria

The design of underground detention includes several elements to properly reduce stormwater runoff volumes and reduce peak flow rates into the storm sewer system.

- **Inlet and Pretreatment:** Inlets should be provided in the quantity and size needed for the desired stormwater runoff to enter the underground detention system.
- **Outlet:** The outlet orifices shall be be sized and designed no smaller than 3 inches..
- **Overflow and Bypass:** The underground detention system should have an emergency overflow to allow for safe passage of the larger storm events. In addition, a bypass system should be provided to allow the underground system to be taken out of service if it becomes inoperable.
- **Infiltration:** If the underground detention system intends to infiltrate the stormwater runoff into the surrounding soils, the soils should have a permeability rate of at least 0.5 inches/hour. Pretreatment of the stormwater runoff should be provided to prevent groundwater contamination.
- **Overburden Support:** When selecting the underground detention system material, loading from above should be considered. The loading includes backfill, pavement, and possibly vehicular traffic.
- **Access Ports:** The underground detention system shall be designed with multiple access ports that are of such size and spacing to allow maintenance to be readily performed with the intended type of maintenance equipment. Access shall include provisions for necessary equipment to perform the necessary maintenance in site layout.
- **Drain Time:** The stormwater runoff WQV collected in the underground detention should drain out to a surface drainage or storm sewer system or infiltrate into the surrounding soils in no less than 24-hours and no more than 72 hours.
- **Installation:** Installation should occur per manufacturer's recommendations. A manufacturer's representative should be present on-site during the installation of the manufactured treatment device to ensure proper installation. Based on the manufactured treatment device chosen, screens may also be installed to prevent mosquitos and rodents from entering the device.
- **Pollutant Removal:** Pollutant removal varies based on the individual design of the manufactured treatment device and can be customized per manufacturers' recommendations.

At a minimum, units must achieve a TSS removal efficiency of 80 percent based on OK-110 (D_{50}=110 µm) particle size distribution for the peak flow rate and must be approved by the City. If the manufactured treatment device is to be used as pretreatment for another BMP, a minimum of 50 percent TSS removal is required. Manufacturers' claims for device performance must be verified by data that are obtained through independent, third party testing and submitted for City review and approval. Devices currently New Jersey Corporation for Advanced Technology verified and the New Jersey Department of Environmental Protection certified are acceptable.

- **High Flow Bypass:** Manufactured treatment devices shall be designed to safely bypass flows higher than the requirement for Tier IV to protect the device from the higher flows.

3.13 Site Grading Requirements

The grading plan shall include the following general measures at a minimum:

- The finished cut and fill slopes to be vegetated shall not be steeper than 3H:1V.
- Cuts or fills shall not be so close to property lines as to endanger adjoining property without adequately protecting such properties against erosion, sedimentation, slippage, settlement, subsidence, or other damage.
- Fill slopes shall meet the following buffer requirements (This buffer may overlay other vegetated buffers and may contain stormwater features designed to manage stormwater generated by the fill slope. For grades between listed slopes, the necessary buffer shall be interpolated):
    - 3H:1V slopes 1 foot in height or more above adjoining property shall maintain a 5 foot wide vegetated buffer area for every additional 1 foot of height. (e.g., a 4 foot embankment would equate to a 15 foot buffer).
    - 4H:1V slopes 1 foot in height or more above the adjoining property shall maintain a 3 foot wide vegetated buffer area for every additional 1 foot of height.
    - 5H:1V slopes 1 foot in height or more above the adjoining property shall maintain a 1 foot wide vegetated buffer area for every additional 1 foot of height.
- Construction drawings shall include a note that compaction of non-structural fill shall be minimized during construction.
- Construction drawings shall include required soil classification of fill material to meet drainage system design, and require submittal of soil classification verification to the City Department of Stormwater Management prior to placement of fill and its recording as part of as-built drawing package.
- Subsurface drainage shall be provided in areas having a high-water table to intercept seepage that would affect slope stability or bearing strength or create undesirable wetness.
- No fill shall be placed where it can slide or wash onto another property.
- Fill shall not be placed adjacent to channel banks where it can create bank failure, reduce the capacity of the stream, or result in downstream sediment deposition.
- Borrow and disposal areas shall be included as part of the grading plan.

- Adequate channels and floodways shall be provided to safely convey increased runoff from the developed area to an adequate outlet without causing significant channel degradation or increased offsite flooding.
- The site shall be graded to direct flows to appropriate controls.
- Disturbed soils intended to be vegetated in final site stabilization shall be protected and promote infiltration and on-site water retention. Refer to **Section 3.15.1** for soil scarification and treatment methods required prior to final establishment of vegetation.

3.14 Erosion Prevention and Sediment Control

This section discusses the considerations for EPSC.

3.14.1 Introduction to Erosion Prevention and Sediment Control Requirements

The City requires that an EPSC plan be submitted and approved prior to initiating construction, development, or redevelopment activities. This plan shall describe the practices and controls that will be used during and after construction to meet the following goals:

- Minimize the extent and duration of disturbed soil exposure
- Protect offsite and downstream locations, drainage systems, and natural waterways from the impacts of erosion and sedimentation
- Limit the exit velocities of the flow leaving the site to non-erosive or pre-development conditions
- Design and implement an ongoing inspection and maintenance plan

The design procedures vary depending on the EPSC BMP. Many of the BMPs listed in **Table 3-9**, **Table 3-10**, and **Table 3-11** do not need to be "designed" using calculations, such as surface roughening or dust control. Others require the use of equations or design aids to be properly designed. SCDHEC has two handbooks, the BMP Handbook (SCDHEC 2005) and the Stormwater Management and Sediment Control Handbook for Land Disturbing Activities (SCDHEC 2003), that provide the procedures and equations needed to design the EPSC BMPs and include example problems for most types of EPSC BMPs. Proper design shall be complemented with proper installation and routine maintenance in order for BMPs to be effective and adhere to the provisions of **Section 3.14**.

3.14.2 Rainfall, Design Storms, and Design Volumes

3.14.2.1 NRCS Procedures

NRCS procedures shall be used to determine runoff amounts. When a BMP is designed for the 10 percent AEP, 24-hour storm event, the BMP shall have a greater trapping efficiency for more frequent events such as the 50 percent AEP, 24-hour storm event.

3.14.2.2 Sediment Basin Threshold

A sediment detention basin is required when 10 or more acres of disturbed land area drain to a single outlet point. Such basins shall be designed to have a design effluent concentration of 0.5 mg/L peak suspended solid concentration or 80 percent trapping efficiency, whichever is less, and control the 10 percent AEP, 24-hour storm event to pre-development conditions and successfully pass the 1 percent AEP, 24-hour storm event. A single sediment basin shall be limited to controlling runoff for up to 20 acres. Sediment traps shall not have more than 5 acres draining to it.

Activities that disturb between 1 and 5 acres that do not drain to a single outlet point may incorporate practices other than a sediment basin to achieve an equivalent removal efficiency.

3.14.3 Accepted Erosion Prevention and Sediment Control Best Management Practices

The types of EPSC BMPs that are acceptable for use in the City are presented in the following sections. These generally fall into three categories: erosion prevention measures, temporary sediment controls, and runoff controls and conveyance measures. Runoff from sites shall contain controls that fall into each one of these categories.

3.14.3.1 Erosion Prevention Measures

Erosion prevention measures shall be used during and after construction site preparation to avert the discharge of runoff highly concentrated with sediment and other associated pollutants. One or more measures are typically needed on a site. Measures that fall into this category along with their preferred application are provided in **Table 3-9**.

Table 3-9. Erosion prevention BMP suggested uses

BMP	Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
Surface Roughening	X		X				
Bench Terracing	X		X				
Temporary Seeding	X		X		X	X	X
Mulching	X				X	X	
Erosion Control Blankets (ECB) and Turf Reinforcement Mats (TRM)	X	X	X			X	
Final Stabilization	X		X		X		X
Topsoiling			X		X		
Permanent Seeding and Planting of Grasses	X		X		X		X
Permanent Ground Cover Plants	X		X				X
Sodding	X		X		X		X
Riprap or Aggregate	X	X	X				
Outlet Protection		X		X			X
Dust Control					X	X	X
Polyacrylamide	X		X	X	X	X	X

3.14.3.2 Temporary Sediment Control Measures

The City emphasizes preventive measures as the main control to protect against erosion, both during and following construction. However, there are instances where erosion prevention measures alone do not provide sufficient control. For these instances, temporary sediment controls shall be implemented to control the migration of eroded sediment offsite. These temporary sediment control measures are typically only applicable as practices for use during construction. One or more of the measures shall be used as appropriate during the project's construction phase. **Table 3-10** lists some of the suggested controls of this type along with their

intended use. Details on these and other measures can be found in Appendix B in SCDHEC (2003).

Table 3-10. Temporary sediment control BMP suggested uses

BMP	Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
Storage Volumes and Maintenance Schedules		X		X			X
Temporary Sediment Basin		X	X	X			X
Multipurpose Basin		X	X	X			X
Temporary Sediment Trap		X	X				X
Silt Fence	X	X					X
Rock Ditch Check			X				X
Stabilized Construction Entrance					X		X
Storm Drain Inlet Protection		X		X			X
Vegetated Filter Strips		X					X
Rock Sediment Dike		X	X				X

3.14.3.3 Runoff Controls and Conveyance Measures

This category of EPSC BMPs shall be used as necessary during and following construction. Suggested varieties and their corresponding uses are provided in **Table 3-11**.

Table 3-11. Runoff control and conveyance BMP suggested uses

BMP	Slope Protection	Waterway Protection	Surface Protection	Enclosed Drainage	Large Flat Areas	Borrow Areas	Adjacent Properties
Pipe Slope Drains	X		X				
Temporary Stream Crossing		X	X				X
Runoff Conveyance Measures	X					X	X
Construction De-watering		X		X	X	X	
Level Spreader			X		X		X
Subsurface Drains			X		X		

3.14.3.4 Temporary and Permanent Vegetation

Information regarding temporary and permanent vegetation for construction and post-construction activities can be found in the SCDHEC BMP Handbook (2005).

3.14.4 Erosion Prevention and Sediment Control Best Management Practice Design Requirements

Information regarding EPSC BMP design requirements can be found in the SCDHEC BMP Handbook (2005) and in Appendix E of the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014). Additional requirements and standards include:

1. **Removal Efficiency**: EPSC plans shall be developed to achieve an 80 percent design removal efficiency goal. Simply applied, when a site is completely denuded of vegetation, the structural and non-structural EPSC measures are designed to trap 80 percent of TSS or 0.5 mg/L peak settable solids concentration, whichever is greater, that are generated by the site. The design storm event associated with this level of control is the 10 percent AEP, 24-hour NRCS Type III storm event. Calculations using models, such as SEDPRO or SEDCAD, or SCDHEC design aids shall be provided to show adherence to these criteria.
2. **Non-Structural Site Management Practices**: The following non-structural site management practices shall be used on the plans where applicable:
    a. Minimize site disturbance to preserve and maintain existing vegetative cover.
    b. Limit the number of temporary access points to the site for land disturbing activities.
    c. Protect offsite and downstream locations, drainage systems, and natural waterways from the impacts of erosion and sedimentation.

d. Phase and sequence construction activities to minimize the extent and duration of disturbed soil exposure.

e. Implement an ongoing inspection and maintenance plan. Maintenance schedules are provided in SCDHEC (2005).

3. **Sediment Storage Volumes**: Sediment storage volumes shall be calculated for all sediment controls to determine the required clean-out frequencies and maintenance schedules. The Universal Soil Loss Equation or other acceptable methods that determine sediment yield may be used to predict the required sediment storage volumes for specific sediment control structures.

4. **Alternative EPSC Controls**: To encourage the development and testing of innovative alternative EPSC BMPs, alternative management practices that are not included in the SWDSM may be allowed upon review and approval by the Department of Stormwater Management. To use an alternative BMP, the design engineer shall submit substantial supporting documentation that the proposed measure will perform at least equivalent to currently approved BMPs contained in the SWDSM. Documentation shall include, but is not limited to, the following:

   a. Supporting hydraulic and trapping efficiency calculations

   b. Peer-review by a panel of licensed professional engineers

   c. Research results as reported in professional journals

   d. Manufacturer literature

5. **EPSC Plans**:

   a. Detailed EPSC plans shall comply to the maximum extent practicable with the following specific standards and review criteria:

      i. Sediment tracking control shall be implemented using stabilized construction entrances that are located and used at all points of ingress and egress on a construction site. The transfer of soil, mud, and dust onto roads shall be prevented.

      ii. Crossings of waterways during construction shall be minimized and shall be approved by the Department of Stormwater Management and possibly the USACE. Encroachment into stream buffers, riparian areas, and wetlands shall be avoided.

      iii. Topsoil shall be stockpiled and preserved from erosion or dispersal during and after site grading operations.

      iv. Where construction, development, or redevelopment will or have temporarily ceased on any portion of a site, temporary site stabilization measures shall be implemented as soon as practicable, but no later than 14 calendar days after the activity has ceased. Hydroseeding shall be done as often as necessary to avoid bare areas of soil. Stabilization of disturbed areas is one of the best approaches for EPSC.

      v. Slopes shall be stabilized through grassing, hydroseeding, synthetic or vegetative matting, diversion berms, temporary slope drains, etc., and shall be performed within 2 working days after the necessary grading (temporary or permanent) has been achieved.

      vi. Final stabilization of the site shall occur within 14 calendar days of construction completion.

      vii. Temporary structural controls installed during construction shall be designed to accomplish maximum stabilization and control of erosion and sedimentation and shall be installed, maintained, and removed according to the specifications set forth in the SWDSM and

project specifics developed as part of the permit application and engineering calculations. Temporary structural controls shall be designed to control the peak runoff resulting from the 10 percent AEP, 24-hour storm event.

viii. Permanent structural controls, including drainage facilities such as channels, stormwater inlets, and detention basins, shall be cleaned out as part of the project closeout and Notice of Termination (NOT) processes.

ix. Linear projects (utility lines, road construction) over, under, or along a waterbody shall include measures and controls that adequately protect the waterbody from undue impact. Such work shall not be performed without approval from USACE. In addition, such work shall be coordinated with the installation of EPSC measures so that disruption is minimized. Every effort shall be made to install utilities during the initial construction phases. Trench sharing is encouraged to the extent practicable.

b. EPSC plan shall contain the following information in a cohesive and easy-to-follow manner:

i. Location of all EPSC BMPs on construction documents

ii. Delineation of sensitive features (wetlands, streams, ponds, existing stormwater structures, etc.) and potential sediment sources

iii. Installation sequencing and maintenance schedules for EPSC BMPs during and after construction

iv. Provisions to preserve topsoil and limit the amount of total disturbed area

v. Details of site grading

vi. Design details and computations for EPSC BMPs

vii. Protection of storm drain inlets and outlets

viii. For sites that disturb greater than 5 acres, a list or calculation of the trapping efficiency for all EPSC BMPs

ix. For sites that disturb greater than 5 acres, calculations of required sediment storage volumes for all EPSC BMPs

x. Explanation of any computer models or software used with highlights of or notes on the output data

xi. Location of temporary and permanent soil disposal areas, haul roads, and construction staging areas to minimize erosion, sediment transport, and disturbance to existing vegetation

3.15 Landscape Design

Landscape design with the intention of reducing stormwater runoff improves the function and appearance of stormwater BMPs. Designing landscapes with stormwater routing as an objective can provide benefits, such as lower construction costs, reduced maintenance, aesthetic enhancement, increased property value, and improved long-term functionality. Once established, a well-designed landscape can prevent soil erosion post-construction. Other benefits of a well-designed landscape include mitigation of urban heat island effects, improved air and water quality, improved local habitat and ecosystems, and reduced atmospheric carbon levels.

Site improvements shall include the installation of landscaping and the maintenance of existing landscaping as required by the Zoning Administrator. A landscaping plan must be provided with the overall construction plans and must include species selection.

3.15.1 Best Management Practice Soils and Compaction

Soils in the landscaping areas should be protected, amended as needed, and treated similar to soils of green infrastructure. Refer to the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014) for guidance on green infrastructure soils. Disturbed soils in areas of fill or heavy equipment operation that will be vegetated in the final site stabilization shall be scarified or treated as directed by the designer to improve infiltration and water retention prior to final establishment of vegetation.

3.15.2 Plant Selection

Plants play a vital role in natural drainage patterns, and landscape-based stormwater treatment (vegetated BMPs) is encouraged as an effective, aesthetic, and relatively simple way to achieve LID goals. Plants can be used to aid in infiltration, evapotranspiration, sedimentation, pollutant trapping, phytoremediation, and soil stabilization. Given these varying and important functions, each planting plan shall be carefully designed and shall be site and BMP specific with the long-term goal of naturalization.

Plant selection must take several factors into consideration to ensure plant success, including but not limited to, geographic region, soil characteristics (type, moisture, and pH), sunlight and water availability, wildlife (attracting or deterring), salt tolerance, planting season, and proximity to existing and proposed infrastructure. In addition, plants shall be selected that can tolerate heat, coastal conditions, flooding, and high winds.

It is also important to determine whether temporary or permanent vegetation is required. Temporary seeding is recommended to serve as EPSC until permanent vegetation is established. This method uses quickly growing plants to provide rapid ground cover. Permanent vegetation should be established once construction is complete, and future maintenance must be taken into consideration. Vegetation should be selected that minimizes the need for fertilizers, pesticides, irrigation, and mulching.

When selecting plants, it is important to select native (recommended) and non-invasive species that will thrive together. Several sources from the State of South Carolina list native plant and tree species, such as the South Carolina Wildlife Foundation and South Carolina Forestry Commission. For guidance on determining which plant species will best suit a project, the Carolina Yards Plant Database is a tool that has over 300 plants that are suited to grow in South Carolina and has plant recommendations that benefit specific stormwater BMPs. The database was created through the collaborative effort of the Clemson Cooperative Extension, Carolina Clear, and South Carolina Master Gardener. These programs are helpful resources that aim to provide stormwater education, outreach, and opportunities for public involvement. **Table 3-12** includes websites for plant selection resources.

Table 3-12. Resources for plant selection

Resource	Website
City of Charleston Street Tree Manual	https://www.charleston-sc.gov/DocumentCenter/View/791
South Carolina Wildlife Foundation	http://www.scwf.org/native-plant-list/
South Carolina Forestry Commission	http://www.state.sc.us/forest/refsel.htm#what
Carolina Yards Plant Database	https://www.clemson.edu/extension/carolinayards/plant-database/index.html
Clemson Cooperative Extension	https://www.clemson.edu/extension/
Carolina Clear	https://www.clemson.edu/extension/carolinaclear/
South Carolina Master Gardener Program	https://www.clemson.edu/extension/mg/
Low Impact Development in Coastal Caroling: A Planning and Design Guide	http://www.northinlet.sc.edu/wp-content/uploads/2019/12/LID-in-Coastal-SC.pdf

Plants that are known to be or could potentially be invasive are illegal in the State of South Carolina via the South Carolina Noxious Weed Act shall not be used. Invasive species are defined as “an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.” **Table 3-13** lists State and Federal resources that can be consulted to help determine whether a specific species of plants is invasive.

Table 3-13. Resources for invasive plant species

Resource	Website
USDA NRCS	https://plants.usda.gov/java/noxious?rptType=State&statefips=45
South Carolina Exotic Pest Plant Council	https://www.se-eppc.org/southcarolina/index.cfm
South Carolina Native Plant Society	https://scnps.org

3.15.3 Fertilizer, Pesticides, Irrigation, and Mulch

Final stabilization of a site includes establishing the flora landscape quickly. While plant selection includes limiting maintenance (needing the use of fertilizer, pesticide, irrigation, and mulch), these may be needed to quickly establish vegetation after completion of construction activity (**Table 3-14**). Frequent inspections are necessary to check that conditions for growth are good.

Table 3-14. Landscaping activity to establish final stabilization vegetation

Landscaping Activity	Requirement
Fertilizer	• A minimum of 1,000 pounds per acre of a complete 10-10-10 fertilizer (23 pounds per 1,000 square feet) or equivalent should be applied during permanent seeding of grasses unless a soil test indicates a different requirement. • Fertilizer and lime (if used) should be incorporated into the top 4 to 6 inches of the soil by disking or other means where conditions allow. Do not mix the lime and the fertilizer prior to the field application.
Pesticide	• Use of pesticides during final stabilization is prohibited.
Irrigation	• Permanent seeded areas should be kept adequately moist, especially late in the specific growing season. • Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. • Water seeded areas at controlled rates that are less than the infiltration rate to prevent runoff and erosion.
Mulching	• Permanent seeded areas should be covered with mulch immediately upon completion of the seeding application to retain soil moisture and reduce erosion during establishment of vegetation. • The mulch should be applied evenly in such a manner that it provides a minimum of 75 coverage. • Typical mulch applications include straw, wood chips, bark, wood fiber, and hydro-mulches. • Mulch applications shall be dry and free from mold damage and noxious vegetation. • Light weight mulch applications shall be anchored with netting or asphalt emulsions to prevent it from being blown or washed away.

3.16 Maintenance Access and Easements

The following section provides the required easement widths for various components of the stormwater system. In all cases, there will be an allowance for offset easements, in which the pipe, channel, or other stormwater system components do not necessarily have to be in the middle of the easement width but may be offset to allow for certain construction needs. Proposed offset easements will be identified and additional width may be required as prescribed by the Department of Stormwater Management.

All publicly-maintained stormwater facilities shall have adequate access from the public right-of-way. The width of the access shall be equal to or greater than the minimum width required for the easement or maintenance shelf, whichever is greater. Maintenance access areas and easements shall provide adequate area for equipment to safely maneuver including, but not limited to, turning, turning around, backing up, and parking. The maximum cross slope for maintenance access areas shall be 10H:1V.

3.16.1 Stormwater Pipe

Drainage easements shall provide adequate room for maintenance equipment to operate and maintenance activities to occur. **Table 3-15** provides minimum drainage easement widths for typical situations:

Table 3-15. Storm drain pipe easements

Pipe size (inches)	Maximum depth to invert (feet)	Width of drainage easement (feet)
15 - 18	3.5	16
21 - 24	5.0	20
27 - 42	7.0	26
48 - 54	7.0	30
60 - 72	9.0	36

Notes:
(1) For depths greater than shown, add 2 feet to the easement width for each additional foot to the invert. Additional easement width shall not reduce with pipe run.
(2) For pipe sizes not specifically listed above, the easement width and depth to invert shall be that of the next larger size.
(3) For larger pipe sizes and/or multiple lines of pipe, easement width shall be as determined by the Director of Stormwater Management or their designee.

3.16.2 Open Conveyances

A minimum easement width for any open conveyance is 20 feet. For open conveyances with trapezoidal geometry or a depth greater than 2 feet, a minimum width of 15 feet shall be provided for a maintenance shelf with a maximum slope of 10H:1V in addition to the easement for the channel. For channels where the depth exceeds 4 feet, a shelf may be required on both sides of the channel as determined by the Director of Stormwater Management.

3.16.3 Detention Ponds

An access easement with a width of 20 feet, minimum, shall be provided from the right-of-way to the pond. In addition, the entire pond and sufficient access room on the perimeter shall be included as part of the drainage easement that will include a minimum width of 20 feet outward from the top of the bank for the bench. The perimeter easement around the top of the bank of a pond shall have a maximum cross slope of 10H:1V.

3.16.4 Other Stormwater Facilities and Best Management Practices

All other structures used for the control of stormwater runoff (quantity or quality) not otherwise covered above shall have an easement for access and maintenance that is a minimum of 10 feet beyond the boundary of any such structure. The Department of Stormwater Management may require or allow other easement widths on a case-by-case basis given site constraints or special conditions.

3.16.5 Offsite Easements

Any required offsite easements shall be obtained prior to construction activity that would impact that area. Any work done without proper and adequate easements shall be at the owner's own risk. Non-subdivision projects shall provide validation of necessary easements before a construction activity application approval will be given.

3.17 Additional Design Considerations

Apart from designing a site to meet established water quantity and quality requirements, the interaction of the public with the stormwater management system should also be considered. Public safety should be a top priority when designing a stormwater management system, as this is essentially the purpose of water quantity and quality requirements. Promoting public education of the stormwater system's intended function helps to ensure the effectiveness and longevity of the constructed design.

3.17.1 Safety

In general, safety considerations in stormwater design are limited to directing stormwater away from public property and restricting access to stormwater facilities. Stormwater flows should be discharged from ponds in a manner that prevents erosion at the outfall.

The principle outfall shall not permit access. Pipe outfalls greater than 24 inches in diameter should be fenced or include a trash rack in the design to prevent access.

A safety bench shall be provided for embankments greater than 10 feet in height and having a side slope steeper than 3H:1V. The safety bench shall extend no less than 15 feet outward from the normal water edge, and the slope shall not exceed 10H:1V. Warning signs should be posted near ponds to prohibit swimming and fishing.

3.17.2 Signage and Stenciling

Signage should be provided near stormwater facilities to help educate the public and restrict access as necessary. Educational signage varies from interpretive signs that explain the function of BMPs, to signs intended to prevent the public from damaging BMPs or polluting stormwater. For BMPs requiring a buffer strip of native vegetation, signage designating the area as a "no mow" zone should be provided. In designated green spaces, signs should be posted to restrict the public from dumping yard waste or littering. Manhole lids and catch basins shall contain a label identifying the system as stormwater and marked with an appropriate stormwater awareness message such as "No Dumping – Drains to Waterways".

Stormwater facilities intended to have restricted access shall have signs posted indicating the facility-specific access restriction. Signs at stormwater ponds should indicate that no swimming is allowed.

The City encourages signage posting warnings about wildlife (e.g., alligators and snakes) that tend to reside in stormwater facilities.

Chapter 4 Construction Activity Permitting

4.1 Overview of Application/Approval Process

This chapter provides applicants (including, but not limited to, developers, owners, engineers, and contractors) with the information needed to obtain approval of a stormwater management plan from the City as required for certain construction, development, and redevelopment activities within the city. This chapter describes conditions when City approval is needed, the types of applications that apply based on the construction activity, application package and submittal requirements, and criteria for design exceptions (formerly variances).

4.2 Roles and Responsibilities

This section of **Chapter 4** details the responsibilities of all parties affected by the application/approval process. These parties include the City, the Applicant, the Owner/Operator (Permittee), and the Engineer-of-Record.

4.2.1 City of Charleston Stormwater Management

The City will process and approve, or reject, permit documentation related to construction activities in accordance with the requirements set forth in this SWDSM. The City will have Certified Stormwater Plan Reviewers assess each application.

4.2.2 Applicant, Owner/Operator (Permittee)

In accordance with applicable local, State, and Federal stormwater requirements including, but not limited to, the NPDES CGP, owner/operators are responsible for conducting construction, development, and redevelopment projects.

The **Primary Permittee** has operational control over the SWPPP and the construction plans and specifications, including the ability to request modifications to those plans (typically the owner or developer).

The **Secondary Permittee** is an individual lot owner or residential builder that conducts land-disturbing activity at a construction site that is limited to an individual lot or a group of lots that are part of an LCP.

In addition to the responsibilities outlined in the City of Charleston Ordinance and in other sections of this SWDSM, during construction, development, or redevelopment activity, the owner/operator shall carry out the proposed work in accordance with the approved plan, specifications, and schedule and in compliance with the requirements of the City of Charleston Ordinance and this SWDSM. SCDHEC may request additional information from the applicant for NPDES permit compliance, which may result in changes to the technical report or construction plans. Such changes shall be provided to the City as well. During construction, the owner shall conduct inspections of temporary erosion and sediment controls on the site in accordance with the

submitted and approved maintenance schedule, and if applicable, the NPDES permit from SCDHEC OCRM.

4.2.3 Engineer-of-Record

The Engineer-of-Record is the individual who provides their signed seal, or stamp, on the construction documents including, but not limited to, stormwater management reports and construction plans.

Signed construction plans with Certificates of Authorization shall be included as part of the approval application in the number required by the City's TRC.

A **Qualified Individual** is a person who is knowledgeable in the principles and practices of stormwater management and infrastructure and who possesses the skills to assess the quality of the infrastructure installation.

4.3 Permanent Structural Stormwater Facility Ownership

This section of **Chapter 4** specifies who is responsible for owning and maintaining the stormwater facilities, inclusive of conveyances, for both residential and non-residential developments. The necessity for easements is also addressed in this section.

4.3.1 Residential

Ownership of residential permanent structural stormwater facilities (green infrastructure, ponds, etc.) shall belong to the owner of the parcel or to the Home Owners' Association (HOA). The City will maintain the stormwater conveyances (pipes, junction boxes, inlets, etc.). Easements shall be granted to the City for maintenance where stormwater conveyances are located on private property.

4.3.2 Non-Residential

Ownership of the entire non-residential stormwater system (permanent structural facilities, conveyances, BMPs, ponds, etc.) shall belong to the owner.

For any project, the owner of a portion or the entire non-residential stormwater system shall be clearly designated before a construction activity approval will be given by the City. Ownership shall also be recorded on the final plat. Ownership shall imply responsibility for maintaining the entire non-residential stormwater system. Ownership does not imply that the owner(s) may in any way alter the size or function of any component of the stormwater system without consent from the City. Owners found altering such components shall be required to remove any alterations and restore the stormwater system to its approved condition.

4.3.3 Easements

City maintained stormwater conveyances located on private property and outside of the City right-of-way shall be located in an easement. See **Section 3.16** for easement width discussion.

4.4 Construction Activity Applications

A party wanting to construct, develop, or redevelop in the City limits is subject to the requirements determined by the application type: CAA shall be made via the City's Citizen Access Portal (CAP). (**Applicants MUST register for a CAP account at https://cap.charleston-sc.gov/energov_prod/citizenaccess/site/public/main in order to submit an application.**) Construction activity applications for review and approval under this chapter may be obtained by contacting the City and initiated by petition of (1) all the owners of the property that is the subject of the application or (2) the owners' authorized operators. The application package shall be uploaded to the CAP and then distributed to the necessary City departments for their review and approval. Once an application is approved by the City, documentation of such approval and a signed set of construction plans will be issued through the City's TRC. The City may require applicants that need certain permit coverage from any State or Federal agency to have such permits in hand prior to approving a CAA.

Applications required in this SWDSM will be considered complete only if they are submitted in the required format, include mandatory information, and are accompanied by the fees established in this SWDSM (see **Section 4.9.1**). An application that is determined to be incomplete will be returned to the applicant along with an explanation of the application's deficiencies via the CAP. Fees established in this SWDSM will not be refunded. No further processing of the application will occur until the deficiencies are corrected. Once the deficiencies are corrected, the application may be resubmitted via the CAP without the payment of additional fees established in this SWDSM, provided that it is resubmitted within six months of the date that the application was returned to the applicant. Applications resubmitted more than six months after the date that the application was returned as incomplete will require repayment of applicable fees established in this SWDSM.

Whenever the procedures of the City expressly state that applications are to be submitted after a pre-submittal meeting (see **Section 4.5.4**), applicants shall schedule and attend such meetings. When pre-submittal meetings are required, an application will not be accepted until the pre-submittal meeting has been conducted.

Once a complete application has been forwarded to the Department of Stormwater Management, the Department will review the application and either approve, deny, make comments, or request additional information from the applicant as part of the TRC or Subdivision Review Committee process.

If review comments or requests for additional information are required or a denial is issued, a letter detailing the comments, requests, or reasons for the denial will be issued to the applicant. Prior to replying to this letter, a meeting between the City and the engineer/developer may be

required to be scheduled and attended by the applicant. If a meeting is required, the applicant may submit a reply after the meeting has been held.

If the reply from the applicant does not contain the requested information, another letter will be issued by the City to the applicant. The applicant must then reply with the requested information. This process will continue until all information needed by the City has been received.

ALL CORRESPONDENCE BETWEEN THE CITY AND APPLICANT WILL BE FACILITATED VIA THE CITY'S CAP.

4.5 Types of Applications

This section of **Chapter 4** details the various types of applications and the requirements for each. The City currently has five applications that are specific to the type of construction activity. Those activities are SFR, Small Construction (Type I), Medium Construction (Type II), Large Construction (Type III), and Linear/Utility.

4.5.1 Single Family Residence Applications

SFR construction shall require the submittal of a complete building permit application. This application requires the completion of an EPSC certification form by the owner or contractor to ensure that measures will be installed and maintained during construction to prevent the discharge of sediment-laden runoff and to prevent the construction from causing noncompliance for adjacent construction activities that may be under another city, State, or Federal permit.

4.5.2 Small Construction Activity Applications (Type I)

A construction, development, or redevelopment activity that falls within the following parameters shall use a Type I application:

- Construction, development, or redevelopment activities disturbing 0.5 acre to 1 acre.

The following submittal shall be provided as part of a complete small construction activity application:

1. **Application Form**: The applicant shall complete the Small Construction Activity Application form (**Appendix B**). Information requested in the form shall be provided and the certifications shall be signed.
2. **EPSC Certification Form**: This certification requires that measures be installed and maintained to prevent the discharge of sediment-laden runoff and to prevent construction from causing noncompliance issues for adjacent construction activities that may be under another city, State, or Federal permit.
3. A checklist of guidelines for submittal is located in **Appendix D**.

4.5.3 Medium Construction Activity Applications (Type II)

A construction, development, or redevelopment activity that falls within the following parameters shall use a Type II application:

- Construction, development, or redevelopment activities disturbing at least 1 acre, but less than 5 acres.

Some medium projects may be required to comply with conditions for large construction activities such as those developments that have a high potential for waterbody impacts as determined by the City. The following submittal shall be provided as part of a complete medium construction activity application:

1. **Application Form**: This form, as shown in **Appendix B**, serves as the City's form and Notice of Intent (NOI) to SCDHEC OCRM. Information requested shall be completely filled in. Certifications shall be signed.
2. **Site Narrative**: A narrative shall be submitted with the application describing the site in general, purposes of the construction activity, topographic and soil information, adjacent properties and owners, waterbodies receiving stormwater runoff (existing and proposed), anticipated starting and completion dates of the various stages of the construction activities and the expected date of final stabilization, existing water quality and flooding issues, and anticipated impacts and benefits. If applicable, the narrative shall also contain justification for design exceptions or other special conditions for the site. Also, if applicable, wetland and waterbody disturbance issues shall be discussed along with details on the status of necessary permit applications to the USACE. If a TMDL is in place for the receiving waterbody, the narrative shall describe how the project will comply with the TMDL. The narrative shall also discuss the roles and responsibilities of co-responsible parties and others involved in the construction, development, or redevelopment activity.
3. **Sketch**: A sketch of the project area shall accompany the narrative and contain the following:
    a. Site location drawing of the proposed project showing the project location in relation to roadways, jurisdictional boundaries, streams, rivers, lakes, and the boundary lines of the site to be developed
    b. Identification of areas within the site that will be included in the construction activities and a calculation of the total disturbed area
    c. Location of temporary and permanent structural stormwater management controls
4. **Stormwater Technical Report**: The technical report shall be prepared by a licensed professional engineer and submitted as part of the application package. This report shall consist of maps, supporting design calculations for the proposed stormwater system, and erosion measures used during construction, and shall include, but not be limited to, the following:
    a. Pre-development hydrologic analysis that determines the existing stormwater peak flow rates, flow velocities, runoff volumes, and pollutant loads for delineated sub-basins/discharge points. The natural or historic condition will be the standard by which the stormwater plan for a construction, development, and redevelopment activity is evaluated.
    b. Post-development hydrologic analysis that determines the existing stormwater peak flow rates, flow velocities, runoff volumes, and pollutant loads for delineated sub-basins/discharge points.

The stormwater plan shall demonstrate control of runoff quantity and quality in accordance with the design criteria provided in **Chapter 3**.

c. Stormwater management system design to include:

   i. Description of the stormwater management system, methodologies used in the design, existing and proposed runoff patterns, outfalls, offsite run-on, and critical downstream areas.

   ii. Map(s) showing the location of existing and proposed stormwater management control facilities and outfalls.

   iii. Supporting calculations that demonstrate that the system meets the City's requirements for runoff rates, volumes, and pollutant loads. The following computations shall be included: hydrographs, routing of hydrographs through system components, estimates of trapping efficiencies of each BMP used, pipe and open channel capacity, velocity calculations, and water surface elevations. System components shall have standard details and specifications.

   iv. Calculations for energy dissipation, fill slopes and embankments, and channel stabilization.

   v. Explanation and discussion of models used in the design.

d. If the project is located in a stormwater management area, a comprehensive evaluation of engineering calculations and analysis shall be included that demonstrates the project will not negatively impact current drainage conditions and will comply with State and Federal conditions on stormwater discharges.

e. EPSC plan to include:

   i. Description of the EPSC facilities selected.

   ii. Map showing the location of EPSC facilities.

   iii. Design calculations of each measure, including trapping efficiencies. Each measure shall also have a standard detail and specification.

   iv. Explanation and discussion of models used in the design.

f. Downstream analysis calculations showing the effect of post-development design flows on downstream stormwater conveyance systems and channels.

g. Watershed delineation maps with consistent sequential notations.

h. Location map showing topography and waters of the State in relation to proposed project.

i. Discussion and calculation of any wetland issues.

j. Map showing type and classification of soils expected to be encountered or used at the development site including imported soils.

k. Presentation of existing and proposed contours at the development site.

l. General description of the adjacent properties and description of existing structures, buildings, and other fixed improvements located on surrounding properties.

m. Discussion of site access issues and easements to be obtained and provided to the City.

5. **Construction Plans**: The information required on the construction plans shall include, but is not limited to, the following list. Other items may be required by the City. Some items may be included

in other components of the application package, but this shall be adequately noted on the construction plans. D-Size or larger plan sheets/drawings are required. Drawing scale shall be large enough to show required detail at the discretion of the City.

a. North arrow and scale.

b. Property lines, adjacent landowners' names, and land use conditions.

c. Legend.

d. Licensed engineer's seal.

e. Certificate of Authorization seal.

f. Existing and proposed contours and land uses.

g. Limits of disturbed area.

h. Delineation of wetlands and waters of the State.

i. Easements.

j. Stormwater system profiles with existing and proposed ground elevations.

k. Construction sequence. The purpose of a construction sequence is to list and describe the order of events and activities for a construction site. This sequence must include the following:

    i. The order in which planned major construction activities that relate to soil disturbance will occur and the anticipated timing.

    ii. It must start with the installation of the construction entrance(s) and perimeter control BMPs and it must end with the removal of temporary BMPs and the construction of permanent stormwater control measures once final stabilization has been reached.

l. Locations of temporary and permanent structural control measures.

m. Details for temporary and permanent structural control measures.

n. Grassing and stabilization specifications and schedule.

o. Maintenance requirements (for temporary and permanent structural controls).

p. Construction entrance and exit.

q. Tree protection, preservation, and overall landscaping plan with appropriate species selection and screening for ponds and other components required by the City's Zoning Ordinances.

r. Details and specifications of necessary construction components.

s. Location map.

t. A cover sheet that contains, at a minimum, the following items:

    i. Project name

    ii. Engineer's contact information to include name, mailing address, telephone, and fax

    iii. Owner or operator contact information to include name, mailing, address, telephone, and fax

    iv. Vicinity map

    v. Table of contents

vi. Tax map number

u. Drawing elevations shall be based on the NAVD88 datum clearly stated on all sheets of plan sets where elevations are noted and referenced to the state plane coordinate system North American Datum (NAD) 83 Federal Information Processing Standard (FIPS) 3900 feet.

v. The following standard notes shall be shown on the plans. This list is not meant to be exhaustive and other notes shall be included as necessary:

i. Slopes that exceed 8 vertical feet shall be stabilized with synthetic or vegetative mats in addition to hydroseeding. It may be necessary to install temporary slope drains during construction. Temporary berms may be needed until the slope is brought to grade.

ii. Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after work has ceased, except as stated below:

1. Where stabilization by the 14th day is precluded by snow cover or frozen ground conditions, stabilization measures shall be initiated as soon as practicable.

2. Where construction activity on a portion of the site is temporarily ceased and earth-disturbing activities on that portion of the site will be resumed within 14 days, temporary stabilization measures do not have to be initiated on that portion of the site.

iii. Final stabilization shall provide a uniform (i.e., evenly distributed, without large bare areas) perennial vegetative cover with a density of 70 percent of the native background vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures.

iv. EPSC measures shall be routinely inspected every seven days and after each rainfall occurrence that exceeds 0.5 inch. The inspection schedule shall be clearly stated on the plans and in the EPSC Plan. Damaged or ineffective devices shall be repaired or replaced. Inspection frequencies for portions of the construction site that have reached temporary or final stabilization may be reduced to at least once every month, as long as the stabilization is maintained and there is no additional disturbance in these areas.

v. Silt fence and/or other sediment control devices shall be provided to control sedimentation during utility construction. Disturbed areas shall be cleaned, graded, and stabilized with grassing immediately after the utility installation.

vi. EPSC measures shall be properly maintained during all phases of construction until the completion of construction activities and disturbed areas have been finally stabilized. Additional EPSC measures may be required during construction to prevent erosion and offsite sedimentation. Temporary control devices shall be removed once construction is complete and the site is finally stabilized.

vii. Sediment track-out shall be minimized by using approved construction entrances at all points that exit onto paved roads and restrict vehicle use to properly designated exit points. Sediment shall be removed from pavement as required.

viii. Residential subdivisions require EPSC features for infrastructure as well as for individual lot construction. Individual property owners shall follow these plans during construction.

ix. Temporary diversion berms and/or ditches shall be provided as needed during construction to protect work areas from upslope runoff and/or to divert sediment-laden water to appropriate traps or stable outlets.

x. If water is encountered while trenching, the water shall be filtered to remove any sediment before being pumped back into the stable outlet(s).

xi. Sediment controls shall be installed along perimeter areas of the site that will receive pollutant discharges and remove sediment before it has accumulated to one-third of the aboveground height of perimeter control.

xii. Stockpiles shall be located outside of natural buffers and away from stormwater conveyances, drain inlets, and areas where stormwater flow is concentrated. A sediment barrier shall be installed along downgradient perimeter areas. For piles that will be unused for 14 or more days, cover or appropriate temporary stabilization shall be provided.

xiii. Dust generation shall be minimized in areas of exposed soil or gravel through the appropriate application of water or other dust suppression techniques.

xiv. Storm drain inlets shall be protected by installing inlet protection measures that remove sediment from discharges prior to entry into a storm drain inlet. Clean, or remove and replace, the protection measures as sediment accumulates, the filter becomes clogged, or performance is compromised.

xv. Erosion controls and velocity dissipation devices shall be used within and along the length of any stormwater conveyance channel and at any outlet to slow down runoff to minimize erosion.

xvi. Litter, construction debris, oils, fuels, building products with significant potential for impact (such as stockpiles of freshly treated lumber), and construction chemicals that could be exposed to stormwater shall be prevented from becoming a pollutant source in stormwater discharges.

xvii. Catch basins shall be field staked to ensure proper catch basin inlet alignment with the street gutter line.

xviii. Storm drainage lines shall be staked at each box or at intervals that would be sufficient to check alignment and grade of the construction with the approved plans. The use of lasers to augment control is encouraged.

6. **Plans and Specifications**: Activities shall have a complete set of plans and specifications to include, but not be limited to, the following items, as appropriate:

   a. Lot layout/site plan and staking

   b. Acreage

   c. Road plan/profiles

   d. Storm drainage plan/profile

   e. Drainage areas (both onsite and offsite) with characteristics

   f. EPSC measures

   g. Utilities (water and sanitary sewer)

   h. Permanent structural stormwater management facilities

   i. Traffic patterns with temporary (construction) traffic signage

7. Plans shall provide existing and proposed contours with intervals of not more than 1 foot. Where possible, and as needed, contour lines shall be extended beyond the site boundary lines. While

some of these items lend themselves to combining information on a single sheet/drawing, care shall be taken to ensure that plans are not overcrowded or cluttered. The lot layout sheet shall show a tie distance from the primary entrance of the proposed project to the nearest existing intersection.

8. **Benchmarks and Elevations**: Available or used benchmarks and elevations shall be shown on this or other applicable sheets. At least one benchmark shall be available or established on or near (within survey instrument sight distance) the site. The benchmark shall be referenced to NAVD88.
9. **Construction Schedule**: The applicant shall provide a tentative construction time schedule for the development. EPSC measures shall be some of the first work at a site and such implementation shall be demonstrated on the plans. The schedule shall also provide for coordination with the responsibilities of all parties and other contractors, including those installing utilities.
10. **Specifications**: Specifications for components of construction activities related to grading, utilities, EPSC, temporary and permanent vegetation, and water quality BMPs.
11. **Maintenance Schedules and Maintenance Covenants**.
12. **Datum**: Datum used for plans must be clearly stated on documentation including, but not limited to, all sheets of construction plans sets where elevations are noted and all supporting documentation.

A checklist of guidelines for submittal is located in **Appendix E**.

4.5.4 Large Construction Activity Applications (Type III)

A Type III application shall be completed for construction, development, and redevelopment activities that disturb an area that is 5 acres or greater. The following submittal shall be provided as part of a complete large construction activity application:

1. Pre-submittal Meeting: This meeting is intended to coordinate stormwater management needs such as impaired water and existing flooding problems. The meeting shall be scheduled by the applicant and attended by the applicant prior to submitting a Type III application. The meeting may be held in conjunction with other concept and early-stage meetings; however, the City may require separate and additional meetings.
2. Items 1-12 identified in **Section 4.5.3** for medium construction activities.
3. Stormwater Master Plan
    a. For large construction activities that are located in stormwater management areas, a stormwater Master Plan shall be submitted prior to the submittal of the complete package. The Master Plan shall be created to give the design engineer the opportunity to propose a site layout and to propose stormwater controls to the City. The Master Plan shall be submitted via the City's CAP and can be incorporated for discussion at the pre-submittal meeting.
    b. The master plan can be a preliminary sketch of the site and shall contain the following items:
        i. Site layout showing buildings, roads, parking areas, utilities, and grassed or landscaped areas
        ii. Vicinity map
        iii. Pre- and post-development primary runoff patterns and discharge points

iv. Location/distances to waters of the State and other existing natural features such as wetlands, ponds, lakes, floodplains, and stream buffers

c. The applicant should be prepared to discuss the following items:

i. Modeling methodologies to be used

ii. Methods to show compliance with adopted TMDLs or other waterbody impairments that may limit the allowable pollutant load that can be discharged

iii. Preliminary design exception requests

4. Phased EPSC Plan. For non-linear construction sites disturbing more than 5 acres, the construction plans must include a phased EPSC plan. This phased plan identifies BMPs and grading work implemented during a specific portion of a site's construction sequence (e.g., initial grading and perimeter controls, interim land disturbances through final grading, final stabilization, and permanent stormwater practices). Each phase must be addressed and identified on at least one separate plan sheet. One sheet showing BMPs and grading work for the entire course of the construction project will not be considered a complete phased plan.

a. For site disturbances less than 10 acres and more than 5 acres, at least two separate plan phases shall be developed. Each plan phase shall be identified and must be addressed separately on at least one single plan sheet, with each sheet reflecting the conditions and the BMPs necessary to manage stormwater runoff, EPSC during the phases, at a minimum, listed below:

i. **Initial Land Disturbance Phase**. This includes, but is not limited to, the perimeter BMPs, EPSC BMPs to be installed prior to initial/mass grading, and additional BMPs to keep the construction site in compliance with this permit.

ii. **Stabilization Phase**. This includes, but is not limited to, BMPs required to be installed, maintained, and retrofitted during the time required to begin the majority of construction and grading activities, and the time required to bring the construction site into compliance with permanent water quality requirements and into final stabilization.

b. For site disturbances greater than or equal to 10 acres, at least three separate plan phases shall be developed. Each plan phase shall be identified and must be addressed separately on at least one single plan sheet, with each sheet reflecting the conditions and the BMPs necessary to manage stormwater runoff and EPSC during the phases, at a minimum, as listed below:

i. **Initial Land Disturbance Phase**. This includes but is not limited to the perimeter BMPs, the EPSC BMPs to be installed prior to initial/mass grading, and additional BMPs to keep the construction site in compliance with this permit.

ii. **Construction Phase**. This includes but is not limited to EPSC BMPs to be installed, maintained, and designed to prevent sediment-laden stormwater from discharging offsite during construction. Examples of such BMP control measures to include in this phase are temporary BMPs used to convey, manage, and treat stormwater runoff including additional sediment traps and sediments basins, rock check dams, silt fence, sediment tubes, inlet protection, temporary conveyance channels, and other sediment control measure.

iii. **Stabilization Phase**. This includes but is not limited to BMP control measures required to be installed, maintained, and retrofitted during the time required to bring a construction site into compliance with permanent water quality requirements and into final stabilization.

A checklist of guidelines for submittal is located in **Appendix E**.

4.5.5 Linear/Utility Applications

If SCDHEC does not issue a general permit to cover utility construction activities, the City requires that companies performing utility installations shall obtain City approval prior to beginning work. This shall be done whether the utility installation is done as part of another construction project (e.g., telephone line extension) or an independent project (e.g., gas force main). A complete linear/utility application shall include the following items:

1. Site narrative that describe the installation to be performed and the measures that will be used for EPSC. Inclusion of typical design details is preferred, but simple sketches may be used. Details shall include, at a minimum, temporary and final stabilization measures and silt fencing. Supporting calculations should be provided as necessary but are required if disturbing greater than 1 acre.
2. A sketch of the location and type of EPSC practices if a waterbody crossing is necessary. If a USACE permit is needed, a copy of the permit application shall also be included. City approval will not be issued until USACE approval is obtained.
3. A signed EPSC certification form agreeing to the conditions of the City approval and NPDES permit if applicable. The certification form is provided in **Appendix B.**
4. A Type I, Type II, or Type III CAA may be required by the City.

A checklist of guidelines for submittal is located in **Appendix F**

4.6 Additional Permits and Approvals

In addition to the CAA, the applicant or owner/operator is responsible for obtaining required permits and/or approvals. These include, but are not limited to, SCDOT encroachment permit, USACE permits, and SCDHEC CZC approval. CAAs **WILL NOT** be approved without the necessary permits/approvals.

4.6.1 South Carolina Department of Transportation Encroachment Permits

An encroachment permit, which controls the impacts of traffic, storm drainage, and sediment entering upon public property and the public rights-of-way, shall be obtained from the SCDOT and/or the City's Department of Public Service Engineering Division before construction begins. Applicants shall be aware of the City's requirements, which may differ from SCDOT's.

A copy of an Encroachment Permit application to SCDOT shall be included in the CAA package. The applicant shall comply with SCDOT Encroachment Permit application requirements. Approved encroachment permits are required prior to final approval of the application from the Department of Public Service Engineering Division.

4.6.2 US Army Corps of Engineers Permits

A Section 404 permit shall be obtained from the USACE before construction begins for projects that occur in or discharge into waters of the United States. The permitting process typically starts with a jurisdictional determination at the project site to determine whether wetlands or other waters are present and whether they are regulated by the USACE. If such waters are present and regulated by the USACE, then the process proceeds with the following steps:

1. An optional pre-application meeting. It may be requested for any type of project and can be beneficial for complex or potentially controversial projects.
2. Submittal of the completed application and required attachments. The types of permit applications include nationwide, regional, individual, and joint Federal and State.

For more information, visit https://www.sac.usace.army.mil/Missions/Regulatory/Permitting-Process/.

4.6.3 South Carolina Department of Health and Environmental Control Office of Ocean and Coastal Resource Management Coastal Zone Consistency Certification

A CZC Certification is required for land-disturbing activities that require permit coverage within the eight coastal counties (Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper) prior to receiving coverage under the NPDES Permit Program.

A request for CZC Certification must include the following:

- State CZC request form
- Project outline (digital boundary) and Digital Boundary Details form
- Appropriate Coastal Zone Management Plan policy checklists and Statement of Consistency

For more information, visit https://www.scdhec.gov/coastal-zone-consistency.

4.7 Approval of Applications

Once the City approves the application and required documentation, including additional permits or approvals required, the City will issue a CAA Approval and MS4 Approval Letter. The MS4 Approval Letter shall be forwarded to the SCDHEC for coverage under South Carolina NPDES General Permit for Stormwater Discharges from Construction Activities.

4.8 Changes After Project Approval

This section of **Chapter 4** details how an applicant or owner addresses changes to the project/permit after the application has been approved by the City, MS4 Approval Letter has been issued, and NDPES coverage has been granted to the project. These changes may include

revisions to the approved application, transferring ownership, and approval expiration. Each have specific requirements and should be taken into consideration.

4.8.1 Changes to Approved Applications

Revisions to the approved plans and construction documents shall be submitted in writing to the City along with any subsequent fees established in this SWDSM. Changes shall not be implemented until review and approval is given by the City. Revisions for stormwater management issues may include, but are not limited to, pipe size and grade alterations that affect hydraulic capacity, changes to easement boundaries due to changes in the stormwater system components, or changes to the general grading plan of the site that affect the flow direction, rate, volume, or quality of stormwater runoff.

4.8.2 Transfer of Responsibility (Change of Owner)

In certain cases, and as requested by an applicant, approval to conduct construction activities may be transferred from one applicant or responsible party to another. The most obvious example of this is when a developer readies a piece of property for a new neighborhood by performing grading activities, utility installation, and building of roads, then turns the property over to a homebuilder. In such cases, the applicant shall make the City and SCDHEC aware of plans to transfer responsibility of the approval and associated stormwater management issues through completion of the transfer form in **Appendix B**. A transfer of responsibility is also allowed for phases within a project. At the time of transference, the City/SCDHEC will issue the NOT for the responsible party and issue a new permit to the new responsible party. If a transfer is not requested using the appropriate form, the current responsible party will continue to responsible for stormwater management concerns at the site. No work shall be performed during the process of transferring responsibility and an application for transference shall only be made and granted after a construction phase has been completed.

4.8.3 Expiration of City Approval

A CAA Approval will remain valid for up to five years from the date of issuance, provided that the project is in compliance with the City of Charleston Ordinance and this SWDSM and is not inactive for a period of 24 consecutive months. Construction, development, and redevelopment activities shall be initiated within 24 months of issuance of the City approval. Failure to initiate these activities will render the approval invalid at the end of the twenty-fourth month.

4.9 Fees

This section of **Chapter 4** explains the fees associated with construction activity, both the permit application and the pre-construction inspection. The fees associated with the pre-construction inspection are assessed after obtaining application approval and issuance of a land disturbance permit. Both the construction activity plan review and construction activity inspection fees are based on disturbed area. The plan review fee is a one-time fee submitted with the initial

application and the inspection fee is paid to the City in order to inspect pre-construction activity EPSC measures.

4.9.1 Construction Activity Fee

For land-disturbing activities, the following fees shall be paid to the City by the permittee:

Construction Activity Plan Review Fee:

Single Family Residential Properties with less than 0.5 acres of disturbance have a total review fee of $100. All other submittals have a base fee of $500 plus $200 per disturbed acre rounded up to the next whole acre (up to $5,000 maximum)

Construction Activity Inspection Fee to Authorize Commencement of Construction:

For each inspection:

$75 for less than 1-acre site

$150 for 1 to 5-acre site

$250 for 5.01 to 10-acre site

$500 for 10.01 or more-acre site

Inspection fees are only for the initial inspection prior to the authorization to begin construction. Two re-inspections are included with the initial fee at no additional cost to the owner/permittee.

If after two re-inspections the BMPs are not installed and operating per the approved set of construction plans during the initial inspection effort, commencement of construction shall not be authorized, re-inspection shall be necessary, and additional inspection fees shall apply as per the schedule above.

Transfer Fees:

$100.00 for each property ownership transaction

Fees are subject to change per approval from the City Council. These fees are separate from other fees charged by the City or other agencies with jurisdiction over construction, development, or redevelopment projects. Fees shall be paid separately.

4.9.2 Major Modification

Changes to the disturbed area after the CAA has been submitted, but before approval or after an application has been approved, will be considered a major modification. The permittee is responsible for notifying the City and paying fees incurred as a result of the modification.

4.10 Exemptions and Design Exceptions

Per the City of Charleston Ordinance, the provisions of this section shall not apply to:

- Land-disturbing activities undertaken on forestland for the production and harvesting of timber and timber products and conducted in accordance with BMPs and minimum erosion protection measures established by the South Carolina Forestry Commission pursuant to the South Carolina Code of Laws Title 48, Chapter 18, Erosion and Sediment Reduction Act of 1983, Section 70, as amended.
- Activities undertaken by persons who are otherwise regulated by the provisions of the South Carolina Code of Laws, Title 48, Chapter 20 - South Carolina Mining Act.
- Land-disturbing activities on agricultural land for production of plants and animals, including but not limited to, forages and sod crops, grains and feed crops, tobacco, cotton, and peanuts; dairy animals and dairy products; poultry and poultry products; livestock, including beef cattle, sheep, swine, horses, ponies, mules, or goats, including the breeding and grazing of these animals; bees, fur animals, and aquaculture. The construction of an agricultural structure that requires the disturbance of 1 or more acres, such as, but not limited to, broiler houses, machine sheds, repair shops, coops, barns, and other major buildings shall require the submittal and approval of an application prior to the start of the land-disturbing activity.

The City may grant a design exception from the requirements of this SWDSM if exceptional circumstances applicable to a site exist such that strict adherence to the provisions of this SWDSM will not fulfill the intent of the SWDSM.

A written design exception request shall be required and shall state the specific exception sought and the reasons, with supporting data, why the exception should be granted. Requests can be for either water quantity or water quality requirements. The request shall include information necessary to evaluate the proposed exception. A separate written exception request shall be required if there are subsequent additions, extensions, or modifications that would alter a previously approved exception. A project may be eligible for an exception of stormwater management for water quantity and quality control if the applicant can demonstrate that the imposition of peak or volume control requirements of stormwater runoff would aggravate downstream flooding.

Final approval of a design exception request will be given at the discretion of the City. The City is cognizant that the need for an exception may not be known during planning stages and only evident after considerable design work has been completed. The City intends to work with the owner and engineers during the design process to find a resolution as long as the above items are adequately demonstrated.

Approved design exceptions shall be fully documented on a table similar Table **4-1**. This table is to be included on the title sheet of the approved stamped construction drawings, and in the title sheet of the project record drawings.

Table 4-1. Example of a Design Exceptions Table

STORMWATER DESIGN STANDARDS MANUAL (SWDSM) DESIGN EXCEPTIONS			
APPLICABLE SECTION	**DESCRIPTION OF THE DESIGN EXCEPTION**	**SUBMITTAL DATE**	**APPROVAL DATE**

Chapter 5 Construction Phase

5.1 Roles and Responsibilities

This section of **Chapter 5** details the responsibilities of parties involved during the construction, inclusive of pre-construction, process. Those parties include the City, the Applicant, the Owner/Operator (Permittee), and the inspector.

5.1.1 City of Charleston Stormwater Management

The City has the authority to enter and inspect facilities, conduct sampling, examine and copy records that must be kept under the conditions of an NPDES permit and to comply with their MS4 permit, and perform any other duties deemed necessary by State and Federal law.

5.1.2 Applicant, Owner/Operator (Permittee)

In accordance with applicable local, State, and Federal stormwater requirements including, but not limited to, the NPDES CGP, owner/operators are responsible for conducting construction, development, and redevelopment and post-construction, post-development, and post-redevelopment site inspections. Records of such inspections shall be kept for a minimum of five years and shall be made available to the City upon reasonable request.

The Primary Permittee meets one or both of the following criteria:

- Has operational control over the SWPPP, construction plans, and specifications, including the ability to request modifications to those plans (typically the owner or developer)
- Has day-to-day operational control of those activities necessary to ensure compliance with the SWPPP

A Secondary Permittee is an owner/operator with control of an individual lot or a group of lots within a larger construction site, independent of the Primary Permittee. The Secondary Permittee is also subject to the approved Comprehensive Stormwater Pollution Prevention Plan (C-SWPPP) submitted by the Primary Permittee for the overall construction site.

5.1.3 Inspector

The Inspector must be a Certified Erosion Prevention and Sediment Control Inspector (CEPSCI) or SCDHEC-approved equivalent. The Inspector is responsible for inspecting the construction sites, issuing the Stormwater Field Inspection Report, determining compliance of construction sites, and recommending stabilized sites for site closeout.

5.2 Pre-Construction Requirements

After MS4 approval has been granted and NPDES coverage has been issued by SCDHEC, a series of events must occur before CAA approval. This section of **Chapter 5** details the events,

which involve both the City and the applicant. The construction process cannot occur without CAA approval.

5.2.1 Pre-Construction Activities

Prior to any construction activities, the following must occur:

- All necessary permits must be in hand.
- On-site pre-construction meeting must be completed.
- Inspections and approvals of tree protection and temporary EPSC BMPs must be completed by the City.

5.2.2 Inspection Fees

The primary permittee shall be responsible for inspection fees. See fee schedule in **Section 4.9**.

5.2.3 Other Planning Considerations

Before starting construction, due diligence for site investigation shall be performed by the applicant or permittee.

- Call to notify South Carolina 811 (SC811) of planned excavation to avoid damages to existing underground infrastructure.
- Be prepared to implement traffic control measures if working in a roadway or right-of-way.
- Provide ancillary permit requirements as needed.
- Prepare On-Site Stormwater Pollution Prevention Plan (OS-SWPPP).

The OS-SWPPP must contain the following documents, which may not be required to be part of the C-SWPPP submitted prior to approval of the City:

- **SCDHEC CGP**: one copy of this permit, excluding the appendices. Provisions may be made for the general permit to be accessed electronically as long as a hard copy can be made available by the end of the working day when required.
- A copy of the **NOI**.
- **NPDES Coverage Approval Letter**: the letter generated once the C-SWPPP is determined to be in compliance with the CGP.
- **Local Approvals**: any additional letters, approvals, or certifications necessary to implement the OS-SWPPP, when necessary.
- **USACE Permits**: permits necessary to allow impacts to waters of the State or jurisdictional wetlands, when necessary.
- **Critical Area Permit** (Coastal Zone Only): authorizations necessary to allow impacts to a critical area, when necessary.

- **Contractor Certifications**: certifications necessary to allow contractors to conduct construction activities within the construction site. This includes contractor certifications required under **Chapter 4**of this SWDSM.
- **Recordkeeping**: logs necessary to track the progress, compliance, and modifications associated with the construction site. These logs may include, but are not limited to:
    - Pre-construction conference log
    - Inspection log
    - Stabilization log
    - Rain log
    - Contractor log
    - Additional recordkeeping as deemed necessary by the permittee, contractor, SCDHEC, MS4, or an entity delegated under South Carolina Regulation 72-300
- **CZC Certification**: For projects located in the coastal zone, the acquired CZC certification must be kept in the OS- SWPPP.

The OS-SWPPP contains all items required for review and approval of the C-SWPPP, except for the Engineering Reports.

5.2.4 Pre-Construction Meeting

Before any construction activities occur, a pre-construction meeting must be held for each construction site or project for which there is an approved C-SWPPP. The attendees include, but are not limited to, the design professional, contractors, subcontractors, and inspectors. During this meeting the following activities must occur:

- The SWPPP preparer, the person with operational control of the plans and specifications, or the authorized representative shall review and explain the OS-SWPPP so that everyone is aware of the design intent and requirements, as well as any areas that will require special attention.
- All parties shall be made aware of the construction sequence and timeframe, as well as possible time constraints and anticipated issues.
- Attendance shall be recorded and maintained in the OS-SWPPP.
- All parties shall be informed of modification procedures.

The location of the pre-construction meeting shall be as follows:

- For non-linear projects that disturb 10 acres or more, the meeting shall be held onsite.
- For non-linear projects that disturb less than 10 acres, the meeting may be held offsite.
- For linear projects that are not part of an LCP, the meeting may be held offsite.
- For linear projects that are part of an LCP and are less than 10 acres, the meeting may be held offsite.

- For linear projects that are part of an LCP and are 10 acres or more, the meeting shall be held onsite.

The person conducting the pre-construction meeting shall have the choice of conducting an offsite meeting, onsite, if so desired.

5.3 Construction Requirements

After the pre-construction requirements have been met, the City will issue CAA approval and the applicant can begin construction activities. The applicant shall adhere to the guidance of the OS-SWPPP throughout the entirety of the construction process. This section of **Chapter 5** details the applicant's responsibilities in addition to those outlined in the OS-SWPPP.

5.3.1 Implement and Maintain Erosion Prevention and Sediment Control Best Management Practices

EPSC BMPs shall be implemented and maintained in accordance with the requirements stated in the OS-SWPPP throughout the entirety of the construction process.

5.3.2 Conduct Inspections

The purpose of the SWPPP inspections is to regulate non-stormwater discharges to the storm drainage system as required by Federal and State law. After construction activities begin, inspections must be conducted a minimum of at least once every calendar week, with no time period between inspections exceeding 9 days, and must be conducted until final stabilization is reached on all areas of the construction site. An inspection is recommended within 24-hours of the end of a storm event of 0.5 inch or greater and during the first rain event after the initiation of construction activities, after the installation of EPSC BMPs.

Inspection frequencies for portions of the construction site that have reached temporary or final stabilization may be reduced to at least once every month, as long as the stabilization is maintained and there is no additional disturbance in these areas.

If the entire site has reached final stabilization and the permit holder does not submit a NOT, the permit holder must continue to perform monthly inspections.

If site inspections identify EPSC BMPs that are damaged or are not operating effectively, the OS-SWPPP must be modified as necessary to include additional or modified EPSC BMPs that are designed to correct the identified problems. Revisions to the OS-SWPPP must be completed within seven calendar days following the inspection.

If site inspections identify EPSC BMPs that require maintenance, maintenance shall be performed as soon as practical or as reasonably possible and before the next storm event, whenever practicable.

5.3.2.1 Inspection Reports

At a minimum, the inspection report must include:

- Inspection
- Names, titles, and qualifications of personnel conducting the inspection if not previously given in an inspection report, unless those qualifications change
- Discharge points and a description of discharges occurring at the time of the inspection
- Current weather information
- Total rainfall since last inspection
- Location(s) of discharges of sediment or other pollutants from the site
- Location(s) of EPSC BMPs that need maintenance
- Location(s) of EPSC BMPs that failed to operate as designed or proved inadequate for a particular location
- Location(s) where additional EPSC BMPs are needed that did not exist at the time of inspection
- Corrective action required including any necessary changes to the OS-SWPPP and implementation dates
- Site name, operator name, and permit number
- Verification that EPSC BMPs and stormwater controls identified in the OS-SWPPP have been installed and are operating as designed
- Whether the construction sequence is being followed
- Status of corrective actions undertaken following previous inspection to include date(s) each item was addressed
- List of items that have carried over from previous inspection reports that were not addressed

5.3.2.2 Monthly Reports

The City may require, on a case-by-case basis, that the permittee submit a monthly report summarizing the inspections at the site and associated maintenance activity.

5.3.2.3 Inspection Records

A record of each inspection and of any actions taken in accordance with this section must be retained as part of the OS-SWPPP for at least three years from the date that permit coverage expires or is terminated. The qualified inspector, as identified in **Section 5.1.3**, must sign the inspection report.

5.3.2.4 Primary Permittees

Inspectors employed by the Primary Permittee retain the authority to inspect, report, and document areas of the construction site that are under direct control of the Secondary Permittee,

but only when a lack of compliance by the Secondary Permittee inhibits the Primary Permittee's ability to maintain compliance with the overall OS-SWPPP or the CGP.

5.3.2.5 Maintain Stormwater Documents Onsite

The owner is required to maintain at least one copy of the City approved construction plans and OS-SWPPP on the project site and make them available upon request by the City. The City will conduct inspections during the construction phase. Frequency and specific times and dates of these inspections will be done at the discretion of the City.

5.3.2.6 Spills and Illicit Discharge Detection and Elimination

40 CFR 122.26(b)(2) defines illicit discharge as:

> *any discharge to an MS4 that is not composed entirely of storm water except discharges pursuant to a NPDES permit and discharges resulting from firefighting activities.*

The permittee is responsible for the prevention of spills and illicit discharge detection and elimination. Spills shall be prevented by taking appropriate precautions and preparing a response procedure for expeditiously stopping, containing, and cleaning up spills, leaks, and other releases. Appropriate facility personnel, emergency response agencies, and regulatory agencies shall be notified where a leak, spill, or other release containing a hazardous substance or oil has occurred. The permittee must provide contact information in locations that are readily accessible and available to all employees. The permittee may also reference the existing Spill Prevention, Control, and Countermeasure plans developed for the construction activity under Part 311 of the CWA.

5.4 Changes During Construction

The construction process may be subject to changing climatic conditions and unforeseen site conditions. If any of the involved parties (City, Applicant, or Inspector) notice the need for EPSC changes, this section of **Chapter 5** gives the protocol for how to implement those changes. Changes range from revisions to the design/SWPPP, transferring ownership, and the potential for the approval expiring.

5.4.1 Changes to Approved Design

Refer to **Section 4.8**.

5.4.2 Changes to Approved Stormwater Pollution Prevention Plan

Major modifications to the SWPPP include the following:

- Modification that will affect the hydrology or trapping efficiency calculations, including:

  - Resizing sediment or detention basin that either reduces the stormwater volume capacity and/or is resized to handle increase/decrease incoming peak flows or runoff volumes due to revised site development plans
  - Deleting sediment or detention basin or sediment trap
  - Relocating sediment or detention basin resulting in increases/decreases in receiving drainage area and/or resulting in a new/relocated basin outlet location, which is directed towards an outfall that was not approved within the C-SWPPP
  - Addition/Removal of sediment or detention basin
  - Modification of sediment or detention basin outlet structure
  - Changes in grading that alter drainage patterns that may result in increased or decreased flow to a sediment or detention basin
  - Amending construction sequence in a fashion that the detention basin is not installed before grubbing operations begin
- Point discharge or outfall location change
- Any modification to regulated water quality structural control measures
- Addition of new point discharge
- Addition of impervious area due to revised site development plans
- Addition of disturbed area
- Changes to navigable water crossing
- Addition of sediment trap(s) when required to obtain 80% trapping efficiencies for disturbed areas not previously permitted or redirected away from an approved water quality BMP
- Site layout changes that require redesigning the stormwater management system
- Any additional modifications as determined by DHEC, a regulated MS4, a tribal or any entity delegated under Regulation 72-300

If such changes are necessary, then construction plans and the SWPPP must be updated and submitted to the City for approval. Major modifications to the construction plans and SWPPP shall comply with **Chapter 3** of this SWDSM. Additional fees may be incurred as a result of increasing the disturbed area.

Minor modifications include the following changes to the approved SWPPP:

- Addition of silt fence, slope drains, inlet protection, outlet protection that does not involve additional wetland impact, or check dams
- Relocation of construction entrance, pond inlet pipes (still within the pond), and any other proposed BMP
- Removal of disturbed areas as long as the removal of the disturbed area does not also remove any BMPs (ponds, traps, etc.) that are required to meet South Carolina's Water Quality or Quantity Standards. Removal of disturbed area only qualifies for disturbed area that was

included in the initial coverage approval and that was never disturbed (i.e., cleared, grubbed, or graded)

- Modifying individual lot drainage unless the changes the inflow to a detention structure or analysis point to which the lot drains.

If such changes are necessary, then construction plans must be updated, the modification must be recorded in the OS-SWPPP and be made available upon request. No changes to approved applications are necessary.

5.4.3 Qualifications

Major modifications to the EPSC Plan and the SWPPP shall be properly prepared and signed by a registered engineer, landscape architect, or Tier B land surveyor.

5.4.4 Transfer of Responsibility (Change of Owner)

Where the operator changes (new owner), after the initial NOI and C-SWPPP have been approved, SCDHEC and the City must be notified in writing within 14 calendar days. Accompanying this notification, the new operator must submit one of the following:

- A new NOI (to SCDHEC and the City) and C-SWPPP (to the City), when the new operator does not agree to comply with the approved C-SWPPP and/or elects to modify the approved C-SWPPP
- A new NOI and Compliance Statement (to both the SCDHEC and the City), when the new operator agrees to comply with the approved C-SWPPP.

The new operator may not commence work at the construction site until approved by the SCDHEC. The new NOI must reference the project's name and tracking number assigned to the initial operator's NOI. Acknowledgement from the of the change in operator should be included with the new NOI.

If the construction site under the control of the new owner is ***inactive and all areas disturbed have reached stabilization***, the NOI may not need to be submitted immediately. Written notification to SCDHEC should:

- Identify both the previous owner and new owner that will obtain operational control at a construction site.
- Identify the construction site as inactive.
- Identify each project area and the stabilization status (either as temporary stabilization or final stabilization).
- Provide a detailed explanation for delayed commencement of construction at the construction site under the direction of the new owner and proposed plans, schedule, dates, etc., for recommencement under the new owner.

- An NOI will need to be submitted before any additional construction activities are implemented at the construction site. A copy of the NOI will shall be provided to the City.

If the site under the control of the new owner is inactive and all areas disturbed have not reached stabilization, the new Owner must obtain permit coverage and provide stabilization as defined in the permit. Stabilization measures may be implemented prior to issuance of new permit coverage.

- If the new owner or operator has elected to modify the layout of the construction site, thereby altering the approved C-SWPPP, then the new owner or operator must apply for new coverage under the CGP.
- If the sale or transfer of the construction site's ownership does not change the signatory requirements for the NOI, but the site's owner or developer's company name has changed, an updated NOI should be submitted to the SCDHEC along with written notification defining the proposed sale or transfer of ownership. If the new operator agrees to comply with an existing C-SWPPP already implemented at the site, an SWPPP acceptance and compliance statement should be included in the notification to SCDHEC. If the new operator does not agree to comply with an existing C-SWPPP, a new C-SWPPP must be submitted with the NOI to apply for new coverage under the permit. A copy of all documentation shall be provided to the City.
- Each new owner/operator will be subject to the standard NPDES permit coverage fee for construction sites. There will be no additional review fees associated with the sale or transfer of ownership for existing permitted construction sites when no major modifications to a C-SWPPP occur.
- If a lending institution, government entity, etc., takes operational control of a construction site due to foreclosure, permittee filing for bankruptcy, abandonment, etc., then that entity is responsible for the construction site's stormwater discharges. Coverage is required prior to the entity initiating construction activity at the site. The entity shall contact SCDHEC and the City within 14 business days of taking title to the property. If stabilization of the inherited construction site is required, SCDHEC may issue a compliance agreement. A copy of the compliance agreement shall be provided to the City.

5.4.5 Expiration of City Approval

Refer to **Section 4.8.3**.

5.4.6 Notifications

Notification to designated personnel shall be provided, at a minimum, for the following occurrences:

Table 5-1. Required notifications

Occurrence	Contact	Timeframe
Modifications to the construction sequence or timeframe	Onsite personnel	Immediately
Major modifications to the approved design or SWPPP	City and SCDHEC	Prior to Implementing modification

Occurrence	Contact	Timeframe
Transfer of responsibility	City and SCDHEC	14 calendar days
Dangerous spills or leaks	Minor: Onsite personnel Major: Contact 911 or local emergency response team	Immediately
Illicit discharge(s)	City	24 hours
Inspection reports	Personnel responsible for EPSC maintenance	Notify immediately, seven days to perform maintenance
Changes to permit status	Citizen Access Portal	Immediately
City enforcement as described in Section 7.2	Onsite personnel	Immediately

Chapter 6 Post-Construction

6.1 Overview of Project Closeout Requirements

Chapter 6 details the Department of Stormwater Management's requirements for project closeout. Requirements are based on the submitted and approved CAA. Prior to the City's acceptance of the stormwater management system and related structural elements, the owner shall adhere to the process and requirements outlined in this chapter.

6.2 Final Stabilization and Project Closeout

At the conclusion of construction activities, the owner shall ensure the site is stabilized with permanent vegetation, paved areas, and stormwater conveyances are clean of debris and sediment, and that permanent stormwater controls are working properly. The City will conduct an inspection to confirm the aforementioned and upon confirmation, the City will notify the owner to complete and submit a CAA Close-out Application Form (COA) as found in **Appendix B** along with supporting documentation based on construction activity designation. The submittal package requirements are as follows:

6.2.1 Single-Family Residential

- CAA Close-out Application
- Hydrostatic testing and dye testing results (if applicable according to detail provided in **Section 6.8**)
- In situ testing results for infiltration based permanent stormwater measures (if applicable according to detail provided in **Section 6.9**)
- Site Plan (Commercial, Multi-Family) Projects
- CAA COA
- SCDHEC NOT (SCDHEC Form D-2610)
- Stormwater record drawings (as-builts)
- CPMSF agreement with fee ($10 for the first four pages and $1/per additional page)
- Hydrostatic testing and dye testing results (if applicable according to detail provided in **Section 6.8**)
- In situ testing results for infiltration based permanent stormwater measures (if applicable according to detail provided in **Section 6.9**)
- Stormwater inspection video

If the project has a permanent structural stormwater measures, as-builts and CPMSF are required.

If there are no permanent structural stormwater measures, as-builts and CPMSF are not required.

6.2.2 Subdivision/Road Construction Plan Projects

- CAA COA
- SCDHEC NOT (SCDHEC Form D-2610)
- Stormwater record drawings (as-builts)
- CPMSF agreement with fee ($10 for the first four pages and $1/per additional page
- Final plat
- Hydrostatic testing and dye testing results (if applicable according to detail provided in **Section 6.8**)
- In situ testing results for infiltration based permanent stormwater measures (if applicable according to detail provided in **Section 6.9**)
- Stormwater inspection video

Final plat, as-builts, and CMPSF will be addressed at the time of right-of-way dedication/final platting.

6.2.3 Utility Projects

- CAA COA
- SCDHEC NOT (SCDHEC Form D-2610)

6.3 Stormwater Record Drawings (As-Builts)

As part of the project closeout process, a full-size hard copy and one electronic PDF format copy of the record drawings, properly identified, executed, and certified shall be delivered to the Engineering Division. Additionally, the record drawings for stormwater facilities shall contain the following information:

6.3.1 Piped Drainage Systems

For piped drainage systems, the following information shall be provided on the drawings.

1. Actual values beside planned values on the approved construction plans.
2. Elevations to the nearest 0.01 foot. Actual elevations within 0.10 foot of the planned values are sufficient except where higher accuracy is needed to indicate positive flow.
3. Diameter, material, and class of all pipes.
4. Type of joint of all pipes (O-Ring, T&G, etc.).
5. Invert of pipe at outfall and all structures.

6. Slope and lengths of all pipe.
7. Structure type and elevations (top of grate, throat elevation, etc.).
8. Location of pipe and structures in relation to drainage easements on plan view.
9. Centerline roadway elevations at all low points and other stormwater crossings.
10. Length, depth, and width of outfall protection as specified.

6.3.2 Open Channel Drainage Systems

For open channel drainage systems, the following information shall be provided on the drawings.

1. Actual values beside planned values on the approved construction plans.
2. Elevations to the nearest 0.1 foot except where higher accuracy is needed to indicate positive flow.
3. Actual elevations within 0.1 foot of the planned values are sufficient except where higher accuracy is needed to indicate positive flow.
4. Slope of all open channels.
5. For swales 1 foot or less in depth, actual side slopes and spot invert elevations at a frequency of at least every 100 feet.
6. For swales or ditches greater than 1 foot in depth, top of bank and toe of slope designations and elevations at a frequency of at least every 100 feet.
7. For ditches 3 feet or greater in depth, actual 1 foot contours.
8. Location of ditch or swale in relation to drainage easements on plan view.
9. Length, depth, and width of outfall protection or other erosion control as specified.

6.3.3 Stormwater Management Pond or Basin

For stormwater management ponds or basins, the following information shall be provided on the drawings.

1. Actual values beside planned values on the approved construction plans.
2. Elevations to the nearest 0.01 foot. Actual elevations within 0.10 foot of the planned values are sufficient except where higher accuracy is needed to indicate positive flow.
3. Sufficient elevations along top of dam/pond to verify design elevation.
4. Sufficient elevations along toe of slope and bottom of pond to verify design elevation.
5. Actual 1 foot contours and a stage-volume table to confirm design volume.
6. Pond slopes and vegetative cover (include infiltration rate of sod placed in proposed infiltration basins, if applicable).
7. Location, elevations, slopes, and dimensions of orifices, weirs, spillways, trash racks, or any other aspects of outfall control.
8. Location, dimensions, and elevations of emergency spillway.

9. Outfall protection location and dimensions.
10. Water elevation in pond at time of survey, if applicable.
11. Location, dimensions, make or brand, model, serial number and maintenance manual for any engineered water quality treatment devices.

6.3.4 Project Datum

As-builts shall clearly state the project datum (NAVD88) on all pages where elevations are noted.

6.3.5 Certifications Statement

The record drawing must include the following statement:

I hereby sign and affix my seal to certify to the best of my knowledge that this record drawing accurately represents existing field conditions and that the comprehensive stormwater management system, as constructed, is in substantial conformance with the standards, dimensions and specifications of the approved construction plans.

_____

SC Registered Professional Engineer

6.4 Maintenance Plan and Covenants

Each component of the stormwater management system shall have a maintenance plan as part of the application to conduct construction, development, and redevelopment activities. The plan shall also cover temporary EPSC measures used during construction in addition to the long-term maintenance of the system.

In addition, the owner, HOA, and/or operator will enter into a permanent maintenance agreement with the City. The CPMSF is recorded in the permanent land records with the Charleston County Register Mesne Conveyance Office, in addition to being fully described on the final plat. The CPMSF document is prepared with assistance from the Department of Stormwater Management and shall be signed and executed prior to the issuance of City approval of the final plat. The CPMSF shall address maintenance to be performed by a third party such as an operator or other contractor. However, the owner shall also be listed and is ultimately responsible for adherence to the maintenance requirements. The CPMSF agreement draft is now incorporated into the CAA review process. An example of the Covenant template is provided in **Appendix B.**

6.5 Final Plat

Ownership shall also be recorded on the final plat. Ownership shall imply responsibility for maintaining the permanent stormwater system, including all ponds and permanent structural stormwater measures. Ownership does not imply that the owner(s) may in any way alter the size

or function of any component of the stormwater system without consent from the City. This will be considered a major modification and subject to the procedures outlined in **Section 5.4.1.** Owners found altering such components without City approval must remove any alterations before the City will accept the stormwater management system and related structural elements.

6.6 Stormwater Video Inspection

All closed conveyances (pipes, boxes, etc.) to be owned and maintained by the City shall be inspected with a video system showing the condition of the installed sections prior to recording the final plat and acceptance of the system by the City. All video inspections shall be completed in fully dewatered conditions at the expense of the owner. The video files shall be submitted to the City as part of the closeout procedure. All video inspections shall be reviewed by a Professional Engineer or another qualified individual under the direct supervision of a Professional Engineer. A report documenting the inspections shall be prepared by the Engineer and submitted to the City at the expense of the owner. All videos shall comply with the following requirements:

- Color video submitted on a CD or DVD in a high-resolution digital format compatible with City-approved and available software and equipment.
- All visual observations recorded on a log inspection form incorporating at a minimum the following items:
    - Date and time televised;
    - Operator name;
    - Starting and ending manhole (Sta. number, street name, etc.);
    - Pipe diameter (inches), geometry, and material;
    - Location of any connections (feet);
    - Location of broken pipe, offsets, obstructions, or notable items (feet);
    - Location of sags and standing water (feet);
    - Location of inflow and infiltration (feet); and,
    - Location of dry weather flow (feet).
    - The notation of footage (starting at 0.0 feet at the beginning manhole and moving upstream through the pipe) superimposed on the video and be recorded in increments of tenths of feet.

Any problems detected shall be corrected by the owner. Upon confirming such corrections are complete and the site is ready, the City will release any remaining bonds and notify the TRC. The City may require additional items to close out a project.

6.7 Stormwater Facility Warranty

After the stormwater facilities have been inspected and approved by the City, a two-year warranty of the installed stormwater system shall be signed by the owner and submitted to the City. Any

deficiencies, defects, or failures that occur during the warranty period shall be addressed by the owner/permittee. The City shall be notified, and a subsequent inspection will be required.

Prior to the end of the warranty period, the City will re-inspect the stormwater facilities. Any deficiencies noted shall be addressed by the owner/permittee and a subsequent inspection will be required. Pipes shall be video inspected at the end of the two-year warranty period and will be subject to the same requirements as the initial video inspection outlined in **Section 6.6**.

The stormwater facility warranty MUST be signed and submitted along with the City's acceptance of the stormwater management system with its structural elements before issuance of any of the various types of Certificates of Occupancy.

During the stormwater facility warranty period, the following maintenance activities shall be completed:

- Trash and debris removal from permanent structural measures
- Sediment removal from permanent structural measures
- Weed/brush removal from permanent structural measures
- Cartridge/media and/or filter replacement
- Street sweeping and/or vacuuming of permanent structural measures
- System flushing or other maintenance required for proper function of permanent structural measures

All impermeable surfaces shall be clean and free of dirt and debris. All catch basins, vaults, manholes, pipes, culverts, etc., shall be free of sediment or debris. Erosion damage shall be repaired during warranty period.

Manufactured BMPs with a separate one-year warranty; cartridge, media, or filter replacement and other provided maintenance shall be as directed by the manufacturer and at a minimum, mandatory at the end of the warranty period.

6.8 Hydrostatic Testing and Dye Testing

The City may require hydrostatic testing on leak resistant joints if there is a threat of cross-contamination from sanitary sewer lines. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443. Certified copies of test results shall be delivered to the City before gaskets or jointing materials are installed.

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures that might adversely affect the performance of such materials. Performance requirements for joints in reinforced concrete pipe shall conform to ASTM C990 or ASTM C443.

Dye testing may also be required to detect and eliminate illicit discharges. The owner shall follow the manufacturer's recommendation on the amount of dye used.

A representative from the Stormwater Management Department shall be present for all testing and must be notified 72 hours prior to any testing. The owner/permittee shall be responsible for coordination.

6.9 In Situ Testing of Permanent Structural Best Management Practices that Rely on Infiltration

Post-construction permeability tests of infiltration based permanent structural measures shall be conducted in accordance with the following approach to ensure that the installed BMP functions as designed. Such testing should be carefully undertaken when all BMP construction that may affect soil permeability has been completed. This includes the use of all construction equipment and the placement of all construction material that may affect soil permeability. All in situ testing of permanent structural BMP's shall comply with the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014).

6.10 City Roadways Inventory/Stormwater Geographic Information System

File format, data standards, and other information shall conform to the current data submittal requirements as issued by the City's GIS Division for merging into the City's stormwater geodatabase.

Chapter 7 City Inspection and Enforcement

7.1 Stormwater Management Inspections

The City will inspect, at its discretion, applicable construction, development, and redevelopment project sites for the purposes of verifying compliance with and enforcement of the City's SWMP, City of Charleston Ordinance, and SWDSM. Additionally, maintenance inspections, at the City's discretion, will be performed on permanent stormwater management systems and facilities throughout their useful life to confirm adherence to their submitted maintenance plans. Additional information can be located in the City's Construction Activities Standard Operating Procedure (City of Charleston 2018a).

7.1.1 City Inspection Duties and Responsibilities

Inspections for the purposes of ensuring compliance and enforcement of the City's SWMP and Ordinance include the following:

- Ensuring that the approved City CAA, SWMP, SWPPP, and construction, development, and redevelopment plans are on the project site and are being followed and implemented.
- Ensuring that the permittee is conducting required inspections, documenting those inspections, and leaving copies of the reports on the project site within seven days after the site inspection.
- Conducting post-construction, post-development, and post-redevelopment inspections to ensure that maintenance is being performed in accordance with the maintenance schedules for the permanent stormwater management facilities.
- Taking enforcement actions, as necessary, when any portion of the construction, development, and redevelopment and post-construction, post-development, and post-redevelopment activity does not comply with the approved City CAA or SWMP, or work is occurring without appropriate approvals.
- Performing a final inspection upon the completion of the stormwater system to determine whether the system is constructed in accordance with the approved City CAA and SWMP. The permittee shall furnish stormwater record drawings in accordance with this SWDSM to the City's Engineering Division for use prior to final inspection.
- Taking immediate action, if necessary, if the permittee fails to comply with the approved City CAA or the approved stormwater management plan and an imminent hazard exists along with notifying any applicable local, State, and Federal agencies.
- Maintaining accurate and comprehensive project inspection files ensuring relevant information is entered in the files, which are to be maintained by the City.

7.1.2 Inspector Qualifications

The Inspector must be a CEPSCI or SCDHEC approved equivalent.

7.1.3 Inspection Reports

Upon completion of a construction, development, or redevelopment site inspection, the City will include the following in their inspection report and correspondence to be provided to the permittee:

- Date and identification of the site inspected
- Status of the site in relation to the approved City CAA or SWMP, SWPPP, and construction plans
- Identification of maintenance deficiencies noted (photos to identify deficiencies)
- Any corrective actions needed
- Time period for correcting the deficiencies

Upon completion of a permanent BMP maintenance inspection, the City will include the following in the inspection report to be provided to the permittee as necessary:

- Date and location of the site inspection
- Status of the activities identified in the approved maintenance schedule
- Identification of maintenance deficiencies noted (photos to identify deficiencies)
- Any corrective actions needed
- Time period for correcting the deficiencies

7.2 Enforcement

If the City determines that a project is in noncompliance with the City of Charleston Ordinance, the City may direct conformity by proceeding with the appropriate enforcement action. The types of enforcement tools available to the City include an Administrative Order (AO), Notice of Violation (NOV), Uniform Ordinance Summons (UOS), and other civil and criminal penalties. The enforcement mechanism to be used will be at the City's discretion.

7.2.1 Administrative Order

The Director of the Department of Development Services or their designee may issue a written AO for offenses of noncompliance with the City of Charleston Ordinance, the approved City CAA, or the approved SWMP. AOs will be made in writing, but a verbal notice may be given if the deficiency needs immediate correction to prevent offsite or downstream impacts. All AOs, verbal or written, shall be noted in the project file.

The four common types of AOs are (1) Cease and Desist Orders, (2) Show Cause Orders, (3) Consent Orders, and (4) Compliance Orders. The circumstances of the violation will determine the type of AO the violator will receive. Since no single type of AO can account for all circumstances, the City may issue multiple AOs for the violation.

Each of the types of AOs will include the following:

- Nature of the violation(s)
- Proposed penalty
- Required corrective actions
- Time period for correcting the violation(s)

7.2.1.1 Cease and Desist Order and Stop Work Order

A Cease and Desist Order directs a violator to cease illegal or unauthorized discharges or activity immediately. A Cease and Desist Order will be used in situations where the discharge could cause environmental damage or cause an emergency. The Order may be issued immediately upon discovery of the problem or following a hearing. In an emergency, the Order to cease and desist may be given by telephone. However, a subsequent written order will be served on the violator, either in person or by certified mail. **If necessary, the City may order immediate cessation of any illegal discharge to its stormwater system**. In non-emergency situations, the Cease and Desist Order may be used to suspend or revoke stormwater discharge permits or land-disturbance permits. A Stop Work Order is a specific type of Cease and Desist Order authorized under Chapter 27, Division 5 of the City of Charleston Ordinance.

A Stop Work Order may be issued for, but is not limited to, the following:

- Construction, development, and redevelopment activities occurring without an approved City CAA or a City approved stormwater plan
- Past enforcement actions taken by the City to remedy a situation(s) that have not been properly addressed with appropriate and prompt action to the satisfaction of the Director of the Department of Development Services or their designee
- A health or safety issue resulting from failure to comply with the City of Charleston Ordinance, an approved City CAA or an approved stormwater plan
- Offsite sedimentation resulting from noncompliance with the approved stormwater plan that has eliminated or degraded a use in a downstream waterbody or that such degradation is imminent
- Offsite sedimentation resulting from noncompliance with the approved stormwater plan that has caused damage to adjacent land

A Stop Work Order may allow or require correction of violations, but no other construction activities may occur. The Stop Work Order will state that failure to comply may result in the suspension or revocation of any City approvals for development activities and possible criminal penalties, civil penalties, or both.

7.2.1.2 Show Cause Order

An Order to Show Cause directs the violator to appear before the City's Hearing Officer, explain the noncompliance, and show cause why more severe enforcement actions against the violator should not go forward, including but not limited to, civil penalties. The Order to Show Cause is

typically issued after informal contacts or NOVs have failed to resolve the noncompliance or if civil penalties are being sought. The Show Cause Hearing can also be used to investigate violations of previous orders. During the hearing, the City can explore the circumstances surrounding the noncompliance and evaluate the sufficiency of evidence for subsequent civil or criminal actions. The Hearing Officer must then determine whether further action is warranted and, if so, its nature and extent.

7.2.1.3 Consent Order

The Consent Order combines the force of an AO with the flexibility of a negotiated settlement. The Consent Order is an agreement between the City and the violator that may contain three elements:

- Compliance schedule(s)
- Stipulated fines or remedial actions
- Signatures of the City and violator(s)

A Consent Order is appropriate when the violator assumes responsibility for the noncompliance and is willing (in good faith) to correct its cause(s). The violator need not admit the noncompliance in the text of the Order. Thus, signing the Order is neither an admission of liability for purposes of civil litigation nor a plea of guilty for purposes of criminal prosecution. However, the City must make sure that the Consent Order prohibits future violations and provides for corrective action on the part of the violator.

7.2.1.4 Compliance Order

A Compliance Order directs the violator to achieve or restore compliance by a date specified in the Order. It is issued unilaterally, and its terms need not be discussed with the violator in advance. The Compliance Order is usually issued when noncompliance cannot be resolved without construction or repair. Compliance Orders are also frequently used to require violators to develop BMPs, spill prevention programs, and related City stormwater program requirements. The Compliance Order should document the noncompliance and state required actions to be accomplished by specific dates, including interim and final reporting requirements. In drafting the compliance schedule, the City should be firm but reasonable taking into consideration all factors relevant to an appropriate schedule duration. Once these milestones are set, the City must track the violator's performance against them and escalate its enforcement response as needed (City of Charleston 2018b). For example, the City orders the violator to show cause for failing to meet a major milestone, imposes an additional fine, or initiates judicial proceedings.

7.2.2 Notice of Violation

The NOV is an official communication from the City to the violator that informs the violator that a stormwater program violation has occurred. The NOV is an appropriate initial response to minor violations, with no significant adverse environmental impact, or when the violator is cooperative in resolving its problems. In the case of a major violation resulting in significant adverse impact to

the environment or when the violator does not promptly undertake corrective action, an NOV may also be issued prior to issuing an AO or pursuing civil or judicial remedies. The NOV's purpose is to notify the violator of the violation(s); it may be the only response necessary in cases of infrequent and generally minor violations. If the violator does not return to compliance following receipt of the NOV, the City will proceed to more stringent enforcement measures. For maximum effectiveness, the NOV will be written and delivered to the violator immediately upon detection of the violation. As a general rule, the NOV will be mailed to the violator no later than five business days after discovery of the noncompliance. The NOV will either be hand delivered by City personnel or be sent to the violator via Certified Mail, Return Receipt Requested.

In addition to stormwater program violations, if the City determines that an owner or operator of any property is causing or partially causing flooding, erosion, or noncompliance with water quality standards, upon providing valid proof of such impacts, the City can issue an NOV to the owner to require removal of the proven impact in a concerted, prudent manner and to restore the impacted property.

The Director of the Department of Development Services or their designee may issue an NOV for offenses of noncompliance with the City of Charleston Ordinance, the approved City CAA, or the approved SWMP. If an AO has been previously issued and there are either subsequent noncompliance issues or failure to complete the items on the AO within a specified time period, an NOV may be issued.

A NOV will include the following:

- Nature of the violation(s)
- Proposed penalty
- Notification that a Stop Work Order may be issued or that approvals for the site may be suspended or revoked if there is continued noncompliance
- Required corrective actions;
- Time period for correcting the violation(s)

7.2.3 Uniform Ordinance Summons

A code enforcement officer authorized by State law or any other city employees designated by the City Council as a code enforcement officer may issue a UOS for offenses of noncompliance with the City of Charleston Ordinance or SWDSM. This UOS may result in the offending individual having to appear before the Magistrate in the Livability Court of the City of Charleston. These violations can result in a fine, incarceration, or both.

7.2.4 Civil and Criminal Penalties

Through the use of UOSs, the City may summon the violator to civil or criminal proceedings, depending on the severity of the violation. A violator may be summoned for both civil litigation and criminal prosecution. Criminal prosecution may be brought prior to, concurrently with, or

subsequent to civil litigation. If the City litigates or prosecutes in court, the courts will determine the appropriate penalties for the violations. The penalties for violations may include but are not limited to fines, incarceration, or both.

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List of Appendices

Appendix A. NPDES Permits

As of the date of this SWDSM, the following NPDES Permits for Stormwater Discharges can be found on the SCDHEC website at https://www.scdhec.gov/environment/water-quality/stormwater/stormwater-construction-activities/design-aids-and-technical or by contacting SCDHEC directly.

- NPDES General Permit for Stormwater Discharges from Regulated Small Municipal Separate Storm Sewer Systems (SMS4) (SCR030000)
- NPDES General Permit for Stormwater Discharges Associated with Industrial Activities (SCR000000)
- NPDES General Permit for Stormwater Discharges from Construction Activities (SCR100000)

Appendix B. City of Charleston Forms

The following forms for the City of Charleston can be found on the City of Charleston's Department of Stormwater Management website at https://www.charleston-sc.gov/351/Stormwater-Design-Standards-Manual.

- Covenants for Permanent Maintenance of Stormwater Facilities
- Type I (Small Construction Activities and Utility/Linear Projects) Application
- Type II and III (Medium and Large Construction Activities) Application
- Erosion Protection Sediment Control Certification
- Transfer of Construction Activity Application
- Close-Out Application

Appendix C. Green Infrastructure Center Curve Number Reduction Worksheet

This is a Placeholder

Appendix D. Small Construction Activity Guidelines and Checklist

City of Charleston Guide for Design of Development and Redevelopment Activities

This checklist will be used by the City of Charleston in reviewing proposed construction, development, or redevelopment activity applications. This guide shows the components for the Small Construction Activity (Type I) and Single Family Residences (SFR). In the event there is a conflict between this guide and the Stormwater Management Ordinance or the Stormwater Design Standards Manual, the Stormwater Management Ordinance and Stormwater Design Standards Manual shall prevail.

The submitted information shall include three parts: the application, the technical engineering calculations and discussions, and the construction documents (plans, details, specifications, Stormwater Pollution Prevention Plan [SWPPP]).

I. Application Form

Initial	Requirement	Comment
	All applications shall be completed in full.	
	Signatory authority (original signatures) shall be provided.	

II. Technical Report/Engineering Calculations

Detailed Map(s)

Initial	Requirement	Comment
	All shall include:	
	1. North arrow and scale	
	2. Site location drawing of the proposed project	
	3. Boundary lines of the site to be developed	
	4. Labeled road names	
	5. Jurisdictional boundaries	
	6. Nearest labeled waterbodies, discharge points, and Receiving Waters	
	7. Location of any nearby protected areas (waters, wetlands, etc.)	

	8. Topographic information showing runoff patterns/overland flow paths for pre- and post-development	
	9. Soil Types	
	10. 100-year floodplain contours	
	11. Onsite Wetlands	
	12. Identification of all areas within the site that will be included in the construction activity	
	13. Calculation of disturbed Area	
	14. Location of temporary and permanent stormwater management controls	
	15. Outfalls	

Note: Simple Sketches will suffice for Type I and SFR applications at the discretion of the Director of Public Service

Project Narrative

Initial	Requirement	Comment
	A description of:	
	1. Site in general	
	2. Purpose of the Construction Activity	
	3. Topographic and Soil Information	
	4. Adjacent properties and owners	
	5. Waterbodies receiving stormwater runoff (existing and proposed)	
	6. Anticipated starting and completion dates of the various stages of the construction activities and the expected final stabilization	
	7. Existing water quality and flooding considerations	
	8. Anticipated impacts (quality, downstream structures, etc.) and benefits (open space, treatment, etc.)	
	9. Wetland and waterbody disturbance issues with details on the status of necessary permit USACE applications, if applicable	

Initial	Requirement	Comment
	10. Description of how the project will comply with TMDL(s), if applicable	
	11. Discuss roles and responsibilities of all co-responsible parties and others involved in the construction activity	
	A discussion of issues relating to other State and Federal permits needed or regulations to be followed.	
	A summary of the maintenance of the stormwater system and arrangements for post-construction maintenance responsibility. Maintenance agreements and/or operating permits must be provided in the application or otherwise addressed.	

Note: Simple narratives will suffice for Type I and SFR activity applications at the discretion of the Director of Public Service

Receiving Waters, Including Wetlands:

Initial	Requirement	Comment
	Delineation of all Receiving Waters located on the site, including wetlands, shall be shown and labeled on plans.	
	If impacts to Receiving Waters, areas of impact shall be outlined and labeled such that no work can begin in this area until all necessary USACE permits and SCDHEC 401 certifications have been obtained.	
	Double row of silt fence shall be provided in all areas where a 50’ undisturbed buffer cannot be maintained between the disturbed area and the Receiving Waters.	
	Minimum 10’ maintenance buffer shall be provided between last row of silt fence and Receiving Waters; or, if buffer not provided, then a statement from Tier A professional engineer on plans indication how silt fence will be installed and maintained without impacts to Receiving Waters shall be included on the plans	

Note: If there are proposed impacts to Receiving Waters, then applicant shall contact the USACE (866-329-8187) and/or SCDHEC Water Quality Certification, Standards & Wetlands Programs Section (803-898-4300) to determine additional requirements before submitting the application to the City.

Note: If Receiving Waters are to be impacted, work shall not be performed in these designated areas until all necessary permits have been acquired.

Note: If USACE permit is required for construction of a permanent stormwater management structure, the City’s final approval shall not be granted until all applicable State and Federal permits have been obtained. A preliminary approval is issued instead.

Post-Construction Maintenance Plan

Initial	Requirement	Comment
	Submit a signed agreement accepting ownership and maintenance of the stormwater management structures (Covenant Agreement).	
	Provide a description of maintenance plan to be used.	
	Provide a schedule of maintenance procedures, including time to replacement.	
	Provide a detailed, manufacturer-specific maintenance plan for proprietary control devices (oil-water separators, etc.), underground detention structures, and non-traditional stormwater controls (constructed wetlands, bioretention, etc.).	
	Typical maintenance items to be address include:	
	1. Grass to be mowed	
	2. Trees to be maintained	
	3. Trash to be removed from within and around the pond outlet structure and outlet pipes to be cleaned, inspected, and repaired, sediment accumulation to be removed from pond(s)	
	4. Energy dissipater to be cleaned and repaired	
	5. Pond bottom to be regraded to provide proper drainage towards the outlet discharge point and/or energy dissipater to be cleaned and repaired	
	6. Emergency spillway, if applicable, to be inspected and erosion repaired on side slopes, if present	
	7. A Transfer of Ownership application shall be approved by the Director of Stormwater Management before ownership and maintenance responsibilities of the stormwater BMP are transferred.	
	8. Specific maintenance items particular to more complex structures.	

Access

Initial	Requirement	Comment
	Demonstrate that project layout has considered access for maintenance and inspection during and after construction.	

Appendix E. Medium and Large Construction Activity Guidelines and Checklist

City of Charleston Guide for Design of Development and Redevelopment Activities

This checklist will be used by the City of Charleston in reviewing proposed construction, development, or re-development activity applications. This guide shows the components for the Medium Construction Activity and Large Construction Activity (Types II and III). In the event there is a conflict between this guide and the Stormwater Management Ordinance or the Stormwater Design Standards Manual, the Stormwater Management Ordinance and Stormwater Design Standards Manual shall prevail.

The submitted information shall include three parts: the application, the technical engineering calculations and discussions, and the construction documents (plans, details, specifications, Stormwater Pollution Prevention Plan [SWPPP]).

I. Application Form

Initial	Requirement	Comment
	All applications shall be completed in full.	
	Signatory authority (original signatures) shall be provided.	

II. Technical Report/Engineering Calculations
Report Composition

Initial	Requirement	Comment
	Table of Contents	
	Map(s)	
	Description of the stormwater management system, outfalls, offsite run-on, and critical downstream areas	
	A summary table shall include the following at a minimum:	
	1. All hydrologic results (design storms and distribution type, pre- and post-development peak discharges, flow velocities, runoff volume, Curve Numbers, T_c's, and Peak Rate Factor (PRF))	
	2. Results of hydraulic calculations (road overtopping, velocities, 100-yr event analysis)	
	3. Methodology/models used in the design	
	4. Tidal Considerations	
	5. Sea Level Rise Considerations	

Initial	Requirement	Comment
	6. Documentation showing that post-development peak stages are below minimum finished floor elevation, that the ponds accommodate the 100 year storm event without exceeding 1 foot of freeboard, and that the system will not cause increased frequency of dwelling flooding, property damage, or public access and/or utility interruption	
	7. Results of water quality calculations	
	Report shall be put together in a manner that facilitates review.	
	Report shall be prepared by a Tier A licensed professional engineer.	

Detailed Map(s)

Initial	Requirement	Comment
	All shall include:	
	1. North arrow and scale	
	2. Site location drawing of the proposed project	
	3. Boundary lines of the site to be developed	
	4. Labeled road names	
	5. Jurisdictional boundaries	
	6. Nearest labeled waterbodies, discharge points, and Receiving Waters	
	7. Location of any nearby protected areas (waters, wetlands, etc.)	
	8. Topographic information showing runoff patterns/overland flow paths for pre- and post-development	
	9. Soil Types	
	10. 100-year floodplain contours	
	11. Onsite Wetlands	
	12. Identification of all areas within the site that will be included in the construction activity	

Initial	Requirement	Comment
	13. Calculation of disturbed Area	
	14. Location of temporary and permanent stormwater management controls	
	15. Outfalls	

Project Narrative

Initial	Requirement	Comment
	A description of:	
	1. Site in general	
	2. Purpose of the Construction Activity	
	3. Topographic and Soil Information	
	4. Adjacent properties and owners	
	5. Waterbodies receiving stormwater runoff (existing and proposed)	
	6. Anticipated starting and completion dates of the various stages of the construction activities and the expected final stabilization	
	7. Existing water quality and flooding considerations	
	8. Anticipated impacts (quality, downstream structures, etc.) and benefits (open space, treatment, etc.)	
	9. Wetland and waterbody disturbance issues with details on the status of necessary permit USACE applications, if applicable	
	10. Description of how the project will comply with TMDL(s), if applicable	
	11. Discuss roles and responsibilities of all co-responsible parties and others involved in the construction activity	
	A discussion of issues relating to other State and Federal permits needed or regulations to be followed.	

Initial	Requirement	Comment
	A summary of the maintenance of the stormwater system and arrangements for post-construction maintenance responsibility. Maintenance agreements and/or operating permits must be provided in the application or otherwise addressed.	

Note: Increased level of detail in narratives is required for Type II and Type II activity applications

Hydrologic Analysis

Initial	Requirement	Comment
	Proper delineation of the site shown on maps or construction plans on 24” x 36” sheets (D-Size drawings).	
	Pre- and post-development hydrologic analysis calculations for the 2-, 10-, 25-, 50-, and 100- year storm events, as necessary, at each outfall point. Analysis should be performed at the same points and with the same drainage area for both pre- and post-development conditions and correspond to the delineation. Hydrograph calculations should be provided as needed.	
	Analysis performed using NRCS methodology. Rational method is not acceptable.	
	Use rainfall data in accordance with Chapter 3.	

Detention Analysis and Design

Initial	Requirement	Comment
	Analysis	
	Pond routing using a volume based hydrograph for the 2-, 10-, 25-, 50-, and 100-year NRCS Type III 24-hour rainfall event (Drain:Edge, ICPR, HEC-1, SedCAD, HYDRAFLOW, etc. perform full pond routings. TR55 does not perform a full pond routing. Rational method cannot be used.	
	Hydrologic and hydraulic calculations necessary to determine the impact of hydrograph timing modifications of the proposed land disturbing activity, with and without the pond. Results of anlaysis will determine the need to modify the pond design or eliminate the pond requirement (See note in item 10).	
	Inputs and outputs from analysis program.	
	Summary table of the peak inflows, peak outflows, and maximum water surface elevations (WSE) for the 2-, 5-, 10-, 25-, and 100-year storm events for each pond.	

Initial	Requirement	Comment
	Stage-storage-discharge relationship for the outlet structure must be generated externally from the analysis program (Drain:Edge, HEC-1, HydroCAD), include data and equations used to rate the outlet structure.	
	Design	
	Detail of the outlet structure and cross-section of the dam, including elevations and dimensions that correspond to the calculations.	
	Orifice construct6ability considerations (do not specify orifice diameters with increments of less than ¼").	
	Maximum WSE for the 100-year storm event below the embankment with a minimum of 1-ft of freeboard.	
	The volume within any structure used for water quantity control shall be drained from the structure within 72 hours.	
	Bottom of all detention and retention ponds graded shall have a slope of not less than 0.5% towards the outlet structure(s) and side slopes no steeper than 3:1 unless adequately protected.	
	If the pond is to be used for sediment control during construction, outlet structure shall be sufficiently protected. Adequate access and maintenance shelf for routine dredging shall be present.	
	Permanent maintenance access to all permanent detention structures (easements may be needed for structures surrounded by lots).	
	Infiltration and underground detention systems designed in accordance with Chapter 3.	
	Emergency spillways shall not be built on fill slopes.	
	If pond is to be used to meet water quality requirements, a forebay, designed in accordance with the manual, is required.	
	Installation of a trash rack or other debris-screening device is recommended on all pond risers.	

Hydraulic Design

Initial	Requirement	Comment
	Design calculations for all conveyances, inlets, and outlets shall be based on the contributing area, allowable velocities, and upstream and downstream conditions.	

	Upstream and downstream analysis shall demonstrate that the activity will not impact new and existing structures or reduce downstream system capacity.	
	Engineer shall ensure the proper design storms were used at the appropriate design points.	

Water Quality Requirements

Initial	Requirement	Comment
	Permanent water quality shall be addressed (all activities or Larger Common Plans that disturb 5 or more acres).	
	Wet ponds designed to catch the first ½" of runoff from the entire area draining to the pond and then release the captured volume in a minimum of 24 hours.	
	Dry ponds designed to catch the first 1" of runoff from the entire area draining to the pond and then release the capture volume in a minimum of 24 hours.	
	For areas not draining to a pond, demonstrate how permanent water quality requirements shall be addressed.	
	Receiving waters shall not be used for permanent water quality control. Alternative means of treatment shall be used if an existing pond is to be used for water quantity control.	

Note: Other non-traditional stormwater controls such as Bioretention areas, constructed wetlands, etc. may be used.

Note: Pre-fabricated or proprietary treatment devices are approved on a case-by-case basis if adequate removal efficiency can be demonstrated. Provide pollutant removal efficiency data from a third-party testing company. Type of system to be used shall be based on the ability to remove the pollutants of concern in that area/situation (i.e. bacteria, hydrocarbons, etc.).

Inlet Protection

Initial	Requirement	Comment
	Shall be provided at all inlets (no hay bales).	
	Steel posts and buried wire-reinforced fabric shall be used for filter fabric inlet protection.	
	Inlet protection details shall be provided for pre-paving and post-paving of roadways.	

Discharge Points

Initial	Requirement	Comment
	The post-development discharge rates shall be less than pre-development discharge rates for each discharge point for the 2-, 10-, and 25-year storm events.	
	Storm drainage or pond outfalls shall be connected to an existing drainage outfall such as a pipe, ditch, easement, etc.	
	New point discharges shall not discharge onto adjacent property where there was not a point discharge previously without providing the adjacent property owner's written consent.	
	A 20-foot minimum buffer between the property line and the end of all pipes shall be provided or energy dissipation measures shall be installed.	
	Outlets shall not discharge on fill slopes.	
	Headwall with wings shall be required for discharge pipes greater than 24-inches.	
	Headwalls shall be required in major drainage channels.	
	All outlets shall be stabilized.	
	Riprap aprons shall be sized appropriately.	
	Riprap details shall show apron dimensions and stone sizes.	
	Filter fabric shall be installed beneath all riprap.	

Slope and/or Channel Stabilization

Initial	Requirement	Comment
	All slopes shall be designed and stabilized properly.	
	All channels and diversion ditches shall be able to accommodate the 10-year storm event with non-erosive velocities during construction and post-construction.	
	Rock check dams shall be provided in temporary diversion.	
	Include installation detail for erosion control blanket (ECB) or turf reinforcement matting (TRM) if ECBs or TRMs to be used.	

	For all slopes steeper than 1.5:1, stabilization practices shall be identified (e.g., ECB, TRM).	

Note: Measures, in addition to grassing or hydroseeding, include synthetic or vegetative matting, diversion berms, temporary slope drains, etc.
Note: If retaining walls or fill slopes are to be constructed at the downstream property line, a 10' buffer is required for construction and maintenance.

Utility/Linear Lines

Initial	Requirement	Comment
	Ensure limits of disturbance only include areas disturbed for water, sewer, gas, and electric line installation.	
	Ensure the utility company is covered by the SCDHEC General Stormwater Permit.	

Sedimentology

Initial	Requirement	Comment
	BMPs shall be properly placed (silt fence, inlet protection, construction entrance, riprap at outfalls, check dams, etc.)	
	Trapping efficiency calculations demonstrating that all sediment basins/traps or other BMPs are capable of achieving a sediment trapping efficiency of 80% for suspended solids or 0.5 ML/L peak settable solids concentration, which ever is less, shall be required. The efficiency shall be calculated for disturbed conditions for the 10-year, 24-hour design event.	
	Sediment basins shall provide storage for the 10-year, 24-hour storm event for disturbed conditions if 10 acres or more drain to a common point (stream, lake, property line, etc.).	
	Sediment traps shall be used only for drainage areas of less than 5 acres.	
	Trapping efficiency calculations shall be complete, specifying methods, assumptions, and results.	
	Sediment basins and traps shall be designed for total area draining to them.	
	Drainage area map shall outline the area draining to each basin/trap.	
	Copies of any figures used to determine V_{15} and trapping efficiencies shall be included. The Design Aids in SCDHEC (2003) may be used for these calculations.	
	Silt fence shall be used only in areas with drainage areas of less than 1/74 acre per 100 LF of fence and shall not be used in areas with concentrated flows.	
	Clean-out stake, marked at ½ the designed sediment storage depth, shall be provided in all sediment basins/traps.	

Initial	Requirement	Comment
	Clear cutting (including tree stump removal) shall be limited to 10 acres.	
	Construction schedule with timeline for each activity shall be included.	

Note: SCDHEC (2003) and SCDHEC (2005) provide information on the design of these and other devices.

Note: The Design Aids in SCDHEC (2003) shall not be used to determine trapping efficiencies for structures in series. If the flow for the 10-year, 24-hour storm for construction conditions overtops the structure or the structure's spillway, then the Design Aids cannot be used. If multiple soil types are in the area draining to the structure, then the soil type with the smallest D_{15} for the appropriate depth should be used to determine the settling velocity, V_{15}; an average D_{15} should not be used.

Receiving Waters, Including Wetlands:

Initial	Requirement	Comment
	Delineation of all Receiving Waters located on the site, including wetlands, shall be shown and labeled on plans.	
	If impacts to Receiving Waters, areas of impact shall be outlined and labeled such that no work can begin in this area until all necessary USACE permits and SCDHEC 401 certifications have been obtained.	
	Double row of silt fence shall be provided in all areas where a 50' undisturbed buffer cannot be maintained between the disturbed area and the Receiving Waters.	
	Minimum 10' maintenance buffer shall be provided between last row of silt fence and Receiving Waters; or, if buffer not provided, then a statement from Tier A professional engineer on plans indication how silt fence will be installed and maintained without impacts to Receiving Waters shall be included on the plans	

Note: If there are proposed impacts to Receiving Waters, then applicant shall contact the USACE (866-329-8187) and/or SCDHEC Water Quality Certification, Standards & Wetlands Programs Section (803-898-4300) to determine additional requirements before submitting the application to the City.

Note: If Receiving Waters are to be impacted, work shall not be performed in these designated areas until all necessary permits have been acquired.

Note: If USACE permit is required for construction of a permanent stormwater management structure, the City's final approval shall not be granted until all applicable State and Federal permits have been obtained. A preliminary approval is issued instead.

Special Protection Areas

Initial	Requirement	Comment
	List the nearest SCDHEC Water Quality Monitoring Station (WQMS) that the site's stormwater discharges drain to and the waterbody on which it is located.	

	If nearest WQMS is listed on the latest 303(d) List of Impaired Waters and if site's stormwater construction discharges contain the pollutant of impairment and if the site disturbs 25 or more acres, then qualitative and quantitative assessment is required (described in Section 3.4C of SCR100000).	
	Evaluate selected BMPs if nearest WQMS is listed on the latest 303(d) List of Impaired Waters and if site's stormwater construction discharges contain the pollutant of impairment and if the site disturbs less than 25 acres.	
	If an Approved TMDL has been developed for the nearest WQMS and if the site's stormwater construction discharges contain the pollutant of impairment, show that measures and controls on the SWPPP meet assumptions and requirements of TMDL (may need to contact SCDHEC Watershed Manager for assistance).	

Post-Construction Maintenance Plan

Initial	Requirement	Comment
	Submit a signed agreement accepting ownership and maintenance of the stormwater management structures (Covenant Agreement).	
	Provide a description of maintenance plan to be used.	
	Provide a schedule of maintenance procedures, including time to replacement.	
	Provide a detailed, manufacturer-specific maintenance plan for proprietary control devices (oil-water separators, etc.), underground detention structures, and non-traditional stormwater controls (constructed wetlands, bioretention, etc.).	
	Typical maintenance items to be address include:	
	1. Grass to be mowed	
	2. Trees to be maintained	
	3. Trash to be removed from within and around the pond outlet structure and outlet pipes to be cleaned, inspected, and repaired, sediment accumulation to be removed from pond(s)	
	4. Energy dissipater to be cleaned and repaired	
	5. Pond bottom to be regraded to provide proper drainage towards the outlet discharge point and/or energy dissipater to be cleaned and repaired	
	6. Emergency spillway, if applicable, to be inspected and erosion repaired on side slopes, if present	

Initial	Requirement	Comment
	7. A Transfer of Ownership application shall be approved by the Director of Stormwater Management before ownership and maintenance responsibilities of the stormwater BMP are transferred.	
	8. Specific maintenance items particular to more complex structures.	

Access

Initial	Requirement	Comment
	Demonstrate that project layout has considered access for maintenance and inspection during and after construction.	

Detention Exemptions and Exceptions

Initial	Requirement	Comment
	If the 2- and 10-year post-development flow rates exceed the pre-development rates, design exception for detention may be granted in accordance with Chapter 3.	
	Justification shall be provided in a separate written request and demonstrate that:	
	1. The proposed activity will have no significant adverse impact on the receiving natural waterway or downstream properties	
	2. The imposition of peak control requirement for rates of stormwater runoff would aggravate downstream flooding	
	Design Exception application shall be signed by the project's Professional Engineer.	
	Design Exception from water quality criteria is not allowed, however, another equivalent method or criteria may be considered for water quantity.	

III. Construction Plans

1. General Items

Initial	Requirement	Comment
	All sheets 24” x 36” (Standard D Size) or larger	
	A coversheet that includes at a minimum: project name, engineer’s contact information (name, mailing address, telephone, and fax number), owner or operator’s contact information (name, mailing address, telephone, and fax number), vicinity map, table of contents, and tax map number	
	Engineer stamp and signature on every sheet	
	Engineering firm’s Certificate of Authorization seal on grading plan	
	Correct scale	
	North arrow	
	Project datum clearly stated on all sheets: NAVD88 datum with State Plane Coordinate System NAD 83 FIPS 3900 feet referenced	
	All available or used bench marks and all elevations shown and referenced to NAVD88	
	Existing and proposed contours are to be tied to NAVD88 datum, no **assumed** elevations (1’ interval minimum)	
	Lot layout/site plan and staking	
	Property lines, adjacent landowners’ names, and land use conditions (locate houses, driveways, etc. onsite/offisite, critical or protected area)	
	Legend	
	Existing and proposed contours tied to NAVD 88 for entire disturbed area and offsite areas	
	Limits of disturbed area	
	Delineation of Receiving Waters, including wetlands with letter from US Army Corps of Engineers, if applicable	
	Easements and any offsite easements that will be used	
	Road profiles with existing and proposed ground elevations tied to NAVD88 datum	
	Lot layout sheet showing a tie distance from the primary entrance of the proposed project to nearest intersection	

Initial	Requirement	Comment
	Construction sequence (include implementation of all stormwater and sediment controls in the first phase of construction. Sequence shall also provide for coordination with the responsibilities of all parties and other contractors, including those installing utilities	
	Locations of all temporary and permanent control measures	
	Details for all temporary and permanent control measures	
	Grassing and stabilization specifications	
	Location Map	
	Individual lot erosion control plan (applicable to subdivisions)	
	Revision block with appropriate information	
	Maintenance requirements for temporary and permanent controls	
	Maintenance schedules and maintenance covenants	
	Construction entrance and exit	
	Tree protection, preservation, and overall landscaping plan with appropriate species selection and screening for ponds and other components required by the City's Zoning Ordinances	
	Details and specifications of all necessary construction components	
	Standard Notes	
	Complete set of plans that includes: Acreage, Road plan/profiles, storm drainage plan/profile, drainage areas (both on and offsite) with characteristics, sediment and erosion control, utilities (water and sanitary sewer), post-construction stormwater management facilities, and traffic patterns with temporary (construction) traffic signage	

2. Stormwater/Drainage Sheets

Initial	Requirement	Comment
	All sheets 24" x 36".	
	Provide drainage area map for existing and proposed conditions, including pathways, outline delineated sub-basins, sub-basin characteristics (watershed identifier, Curve Number, T_c, area length, slope), and the areas draining to all structural BMPs on site. Offsite drainage areas should be included.	

Initial	Requirement	Comment
	Labeling shall be consistent with technical report.	
	Indicate high and low points for the site.	
	Catch basin locations shall be outside intersection curve radii and uphill of intersection.	
	Easements for storm drainage.	
	10-foot wide flat riding surface around entire pond for maintenance, install gravel if needed (e.g. clay soils).	
	20-feet wide access from road to pond, dedicated with pond.	
	Discharge pipes greater than 24-inches require headwall with wing walls.	
	Label all storm drainage structures.	
	Water surface elevation in pond/BMPs for all necessary storm events.	
	Cut/fill volumes for the site.	
	Utility crossings (water, sewer, storm drainage) to have minimum 1 foot of cover.	
	15-inch minimum pipe size (no decreases in pipe size in the downstream direction).	
	Only reinforced concrete pipe (RCP) within right-of-way (ROW).	
	0.5% minimum pipe slope.	
	20% maximum pipe slope.	
	Minimum fall across boxes shall be equal to or greater than 0.1 feet.	
	Crown elevation of inlet pipes equal to or greater than crown elevation of outlet pipe in manholes and junction boxes.	
	Waffle and knock-out boxes shall not be used.	
	Steps required for boxes greater than 4 feet deep.	
	Minimum inside boxes box measurements are 3’x3’.	
	Label calculated design flows on each pipe.	

Initial	Requirement	Comment
	Stormwater system profiles with existing and proposed grade	
	Include hydraulic grade lines on stormwater system profiles	.
	Catch basins shall be field-staked to ensure proper alignment with the street and gutter.	

3. Details

Initial	Requirement	Comment
	Curb (rolled, barrier, expulsion).	
	Typical road cross section(s).	
	Silt fence.	
	Inlet protection.	
	Lot to lot sediment and erosion control.	
	Headwalls.	
	Riprap apron.	
	Construction entrance.	
	Swale/ditch.	
	Typical detail for all BMPs (sediment traps, ponds, water quality devices, etc.).	
	Catch basins, manholes, junctions, etc.	

4. Standard Notes

Initial	Requirement	Comment
	Include all notes as required by State and Federal agencies and any additional notes for compliance with the City of Charleston requirements other than those listed below.	

	Slopes which exceed eight (8) vertical feet shall be stabilized with synthetic or vegetative mats, or hydroseeded. It may be necessary to install temporary slopes during construction. Temporary berms may be needed until the slope is brought to grade.	
	Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than fourteen (14) days after work as ceased, except as stated below: • Where stabilization by the 14th day is precluded by snow cover or frozen ground conditions, stabilization measures shall be initiated as soon as practicable. • Where construction activity on a portion of the site is temporarily ceased and earth-disturbing activities will be resumed within 14 days, temporary stabilization measures do not have to be initiated on that portion of the size.	
	All sediment and erosion control devices shall be routinely inspected every seven days or every fourteen days and after each rainfall occurrence that exceeds one-half inch. The inspection schedule shall be clearly stated on the plans and in the Erosion and Sediment Control Plan. Damaged or ineffective devices shall be repaired or replaced.	
	Provide silt fence and/or other control devices to control soil erosion during utility construction. All disturbed areas shall be cleaned, graded, and stabilized with grassing.	
	All erosion control devices shall be properly maintained during all phases of construction until the completion of all construction activities and all disturbed areas have been stabilized. Additional control devices may be required during construction in order to control erosion and/or offsite sedimentation. All temporary control devices shall be removed once construction is complete and the site is stabilized.	
	The contractor shall take necessary action to minimize the tracking of mud onto the paved roadway from construction areas. The contractor shall daily remove mud and soil from pavement, as may be required.	
	Residential subdivisions require erosion control features for infrastructure as well as for individual lot construction. Individual property owners shall follow these plans during construction.	
	Temporary diversion berms and/or ditches will be provided as needed during construction to protect work areas from upslope runoff and/or to divert sediment laden water to appropriate traps or stable outlets.	

Appendix F. Linear/Utility Guidelines and Checklist

City of Charleston Guide for Design of Development and Redevelopment Activities

This checklist will be used by the City of Charleston in reviewing proposed construction, development, or re-development activity applications. This guide shows the components for the Linear/Utility Projects. In the event there is a conflict between this guide and the Stormwater Management Ordinance or the Stormwater Design Standards Manual, the Stormwater Management Ordinance and Stormwater Design Standards Manual shall prevail.

The submitted information shall include three parts: the application, the technical engineering calculations and discussions, and the construction documents (plans, details, specifications, Stormwater Pollution Prevention Plan [SWPPP]).

I. Application Form

Initial	Requirement	Comment
	All applications shall be completed in full.	
	Signatory authority (original signatures) shall be provided.	

II. Technical Report/Engineering Calculations Detailed Map(s)

Initial	Requirement	Comment
	All shall include:	
	1. North arrow and scale	
	2. Site location drawing of the proposed project	
	3. Boundary lines of the site to be developed	
	4. Labeled road names	
	5. Jurisdictional boundaries	
	6. Nearest labeled waterbodies, discharge points, and Receiving Waters	
	7. Location of any nearby protected areas (waters, wetlands, etc.)	
	8. Topographic information showing runoff patterns/overland flow paths for pre- and post-development	

Initial	Requirement	Comment
	9. Soil Types	
	10. 100-year floodplain contours	
	11. Onsite Wetlands	
	12. Identification of all areas within the site that will be included in the construction activity	
	13. Calculation of disturbed Area	
	14. Location of temporary and permanent stormwater management controls	
	15. Outfalls	

Note: Simple sketches will suffice for Linear/Utility applications at the discretion of the Director of Public Service

Project Narrative

Initial	Requirement	Comment
	A description of:	
	1. Site in general	
	2. Purpose of the Construction Activity	
	3. Topographic and Soil Information	
	4. Adjacent properties and owners	
	5. Waterbodies receiving stormwater runoff (existing and proposed)	
	6. Anticipated starting and completion dates of the various stages of the construction activities and the expected final stabilization	
	7. Existing water quality and flooding considerations	
	8. Anticipated impacts (quality, downstream structures, etc.) and benefits (open space, treatment, etc.)	
	9. Wetland and waterbody disturbance issues with details on the status of necessary permit USACE applications, if applicable	
	10. Description of how the project will comply with TMDL(s), if applicable	

Initial	Requirement	Comment
	11. Discuss roles and responsibilities of all co-responsible parties and others involved in the construction activity	
	A discussion of issues relating to other State and Federal permits needed or regulations to be followed.	
	A summary of the maintenance of the stormwater system and arrangements for post-construction maintenance responsibility. Maintenance agreements and/or operating permits must be provided in the application or otherwise addressed.	

Note: Simple narratives will suffice for Linear/Utility Project applications at the discretion of the Director of Public Service

Utility/Linear Lines

Initial	Requirement	Comment
	Ensure limits of disturbance only include areas disturbed for water, sewer, gas, and electric line installation.	
	Ensure the utility company is covered by the SCDHEC General Stormwater Permit.	

Receiving Waters, Including Wetlands:

Initial	Requirement	Comment
	Delineation of all Receiving Waters located on the site, including wetlands, shall be shown and labeled on plans.	
	If impacts to Receiving Waters, areas of impact shall be outlined and labeled such that no work can begin in this area until all necessary USACE permits and SCDHEC 401 certifications have been obtained.	
	Double row of silt fence shall be provided in all areas where a 50’ undisturbed buffer cannot be maintained between the disturbed area and the Receiving Waters.	
	Minimum 10’ maintenance buffer shall be provided between last row of silt fence and Receiving Waters; or, if buffer not provided, then a statement from Tier A professional engineer on plans indication how silt fence will be installed and maintained without impacts to Receiving Waters shall be included on the plans	

Note: If there are proposed impacts to Receiving Waters, then applicant shall contact the USACE (866-329-8187) and/or SCDHEC Water Quality Certification, Standards & Wetlands Programs Section (803-898-4300) to determine additional requirements before submitting the application to the City.

Note: If Receiving Waters are to be impacted, work shall not be performed in these designated areas until all necessary permits have been acquired.

Note: If USACE permit is required for construction of a permanent stormwater management structure, the City's final approval shall not be granted until all applicable State and Federal permits have been obtained. A preliminary approval is issued instead.

Post-Construction Maintenance Plan

Initial	Requirement	Comment
	Submit a signed agreement accepting ownership and maintenance of the stormwater management structures (Covenant Agreement).	
	Provide a description of maintenance plan to be used.	
	Provide a schedule of maintenance procedures, including time to replacement.	
	Provide a detailed, manufacturer-specific maintenance plan for proprietary control devices (oil-water separators, etc.), underground detention structures, and non-traditional stormwater controls (constructed wetlands, bioretention, etc.).	
	Typical maintenance items to be address include:	
	1. Grass to be mowed	
	2. Trees to be maintained	
	3. Trash to be removed from within and around the pond outlet structure and outlet pipes to be cleaned, inspected, and repaired, sediment accumulation to be removed from pond(s)	
	4. Energy dissipater to be cleaned and repaired	
	5. Pond bottom to be regraded to provide proper drainage towards the outlet discharge point and/or energy dissipater to be cleaned and repaired	
	6. Emergency spillway, if applicable, to be inspected and erosion repaired on side slopes, if present	
	7. A Transfer of Ownership application shall be approved by the Director of Stormwater Management before ownership and maintenance responsibilities of the stormwater BMP are transferred.	
	8. Specific maintenance items particular to more complex structures.	

Access

Initial	Requirement	Comment
	Demonstrate that project layout has considered access for maintenance and inspection during and after construction.	

Appendix G. Technical Procedure Documents

Technical Procedure Document

Subject: City Permitting, Construction, and Close-Out Process

Introduction

In September 2007, the City of Charleston (City) passed a stormwater ordinance incorporating the federally mandated requirements of the National Pollution Discharge Elimination System (NPDES) Phase II stormwater program. Part of this ordinance included the authorization to develop and implement a Stormwater Design Standards Manual (SWDSM) to be used by the City when reviewing approving and permitting construction, development, and re-development projects. The SWDSM describes the policies and procedures that will be used by the City's Department of Stormwater Management to implement the City's ordinances related to stormwater, and serves multiple purposes, including "providing application submission requirements and the approval process".

This memo is intended to give an overview of the City's permitting process from submittal through project closeout and highlight (highlighted areas denotes a change) the differences between the SWDSM adopted in 2010 with the most recent update in 2013 and the, recently, City Council approved manual to become effective July 1, 2020.

Permitting Process (SWDSM Chapter 4)

Applications

There are two identified tracks through which applications for project review are submitted, Technical Review Committee track (TRC) and non-TRC track. The TRC track has a separate application that is required in addition to the Construction Activities Application (CAA) **(SWDSM Section 4.4).** For an application package to be considered "Administratively Complete", it must include all applications, supporting documents, and associated fees.

The following link to the TRC Manual has information on which TRC track and category is most appropriate for a project:

https://www.charleston-sc.gov/DocumentCenter/View/20200/TRC-Projects-Requiring-Review?bidId=

Technical Review Committee Track

TRC categorizes projects as either Site Plan or Subdivision projects, and determine whether or not a project requires a TRC review. Projects requiring TRC review must submit the appropriate application based on project type:

- Site Plan: https://www.charleston-sc.gov/DocumentCenter/View/20150/TRC-Site-Plan-Application-January-2019?bidId=
- Subdivision: https://www.charleston-sc.gov/DocumentCenter/View/17219/TRC-Subdivision-Application---TRC--PC-June-2019?bidId=.

Non-Technical Review Committee Track

There are instances where a project does not require a review from the City. These exemptions remain unchanged and shall comply with the **City's Ordinance (Sec 54-604b)** and can also be found in **Section 2.2 of the TRC Manual**. Should a project not require TRC review and does not qualify for an exemption, it should be submitted directly to the Department of Stormwater Management via the Citizens Access Portal (CAP).

Construction Activity Application (SWDSM Section 4.4)

The definition of Construction or Construction Activity is unchanged and defined as an "activity involving clearing, grading, transporting, filling, or any other activity which causes land to be exposed to the danger of erosion, or which might create an alteration to an existing drainage way or other component of the City's stormwater management system or facility". The type of activity determines the required application to be submitted as part of the TRC application package. The application types and required supporting documentation are as follows:

- Single Family Residential (SFR) (SWDSM Section 4.5.1)
  - Completed Building Permit Application
  - Erosion Prevention & Sediment Control (EPSC) Certification form: https://www.charleston-sc.gov/DocumentCenter/View/5912/Erosion-Protection--Sediment-Control-Certification-Fill-in-Form?bidId=
- Small Construction Activity (Type I) (SWDSM Section 4.5.2)
  - Application for Small Construction Activities and Utility/Linear Projects form https://www.charleston-sc.gov/DocumentCenter/View/5910/Application-for-Small-Construction-Activities-and-Utility-Linear-Projects-Type1-Fill-in-Form?bidId=
  - EPSC Certification form (See SFR)
  - Completed Small Construction Activity Guidelines and Checklist (with applicable documentation)
  - Additional Permits (if required)
- Medium Construction Activity Application (Type II) (SWDSM Section4.5.3)
  - Application for Medium and Large Construction Activities form https://www.charleston-sc.gov/DocumentCenter/View/5909/Application-for-Medium-and-Large-Construction-Activities-TYPE23-Fill-in-Form?bidId=
  - Completed Medium and Large Construction Activity Guidelines and Checklist (with applicable documentation)
  - Comprehensive Stormwater Pollution Prevention Plan (C-SWPPP) with Stormwater Technical Report and Construction Plans
  - United States Army Corps of Engineers (USACE) Wetland Jurisdictional Determination
  - Additional permits (if required)
- Large Construction Activity (Type III) (SWDSM Section 4.5.4)
  - Application for Medium and Large Construction Activities form https://www.charleston-sc.gov/DocumentCenter/View/5909/Application-for-Medium-and-Large-Construction-Activities-TYPE23-Fill-in-Form?bidId=)
  - Completed Medium and Large Construction Activity Guidelines and Checklist (with applicable documentation)
  - C-SWPPP with Stormwater Technical Report and Construction Plans
  - USACE Wetland Jurisdictional Determination
  - Stormwater Masterplan
  - Phased EPSC Plan
  - Additional permits (if required).
  - Pre-Submittal Meeting with TRC is required
- Linear/Utility Activity (4.5.5)
  - Application for Small Construction Activities and Utility/Linear Projects form https://www.charleston-sc.gov/DocumentCenter/View/5910/Application-for-Small-Construction-Activities-and-Utility-Linear-Projects-Type1-Fill-in-Form?bidId=

The disturbed area thresholds criteria and application package requirements are unchanged from the previous edition of the SWDSM and can be found in **SWDSM Section 4.5**.

Applicants should be mindful of any additional permits and approvals required for Construction Activities. The City may request these approvals/permits prior to approving a CAA. These include, but are not limit to, South Carolina Department of Transportation (SCDOT) Encroachment Permit, USACE permits, South Carolina Department of Health Environmental Control (SCDHEC) Coastal Zone Consistency (CZC), and City of Charleston Design Review Board (https://www.charleston-sc.gov/294/Design-Review-Board-DRB).

Design Exemptions and Exceptions (SWDSM 4.10)

The City's policy on design exceptions remain unchanged and shall comply with the City's Ordinance. A design exception may be granted by the City if there is an exceptional circumstance applicable to the site exists, such that the adherence to the provisions of the SWDSM will not fulfill the intent of the SWDSM. A written request will be required by the City. The written request must contain:

- Specific exception sought
- Reason the exception is needed
- Supporting data
- An explanation why the exception should be granted by the City

Stormwater Review Fees (SWDSM Section 4.9.1)

Single Family Residential Properties with less than 0.5 acres of disturbance have a total review fee of $100. All other submittals have a base fee of $500 plus $200 per disturbed acre rounded up to the next whole acre (up to $5,000 maximum).

TRC fees based on review type still apply and can be found on the required application based on project type.

Submittal Process

Citizen Access Portal (SWDSM Section 4.4)

Since the last iteration of the SWDSM, the City has changed how applications and correspondence are handled. The City now uses the CAP where the application package and TRC application package is uploaded and distributed to the necessary City Departments for review. Department comments and/or approvals are also communicated via the CAP. The CAP notifies applicants when correspondence is ready for viewing from City Staff. **The CAP cannot be used without the applicant being registered**. For information on how to register for a CAP account, go to:

https://cap.charleston-sc.gov/energov_prod/citizenaccess/site/public/main

Technical Review Committee Track and Non-Technical Review Committee Track Submittal

Currently the CAP system is not fully implemented. Until full implementation occurs, TRC submittal shall be routed through the Zoning Division and non-TRC shall be routed through the Department of Stormwater Management. Once full implementation occurs, submissions should be through the CAP system.

City Review (SWDSM Section 4.7)

Technical Review Committee Track

The Technical Review Committee reviews site plans and subdivisions for compliance with City of Charleston codes. The TRC exists to help developers and designers with the design and permitting process in the most efficient manner possible. The City has a set of laws established by the City Council that are intended to protect the health and safety of its citizens. These laws are also for the purpose of improving the quality of design and construction in the City. Since there are multiple City departments responsible for administering these laws it is beneficial to have development review coordinated to avoid confusion and delay. The TRC Manual can be viewed at:

https://www.charleston-sc.gov/DocumentCenter/View/17190/TRC-Manual-Revised-December-2017?bidId=

In addition to the separate Stormwater and Engineering reviews, representatives from Americans with Disability Act (ADA)/Legal, Fire, Geographic Information Systems (GIS)/Addressing, Parks, Planning, Traffic and Transportation, and Zoning will perform independent reviews. Each department will provide respective comments to the applicant.

Non-Technical Review Committee Track

The review of the CAA and required documents will be completed by the Department of Stormwater Management. Comments will be provided to the applicant.

Revision/Resubmittal (SWDSM Section 4.7)

If review comments or requests for additional information are required or a denial is issued, a letter detailing the comments, requests, or reasons for the denial will be issued to the applicant. Prior to replying to this letter, a meeting between the City and the engineer/developer may be required to be scheduled and attended by the applicant. If a meeting is required, the applicant may submit a reply after the meeting has been held.

If the reply from the applicant does not contain the requested information, another letter will be issued by the City to the applicant. The applicant must then reply with the requested information. This process will continue until all information needed by the City has been received.

Dependent upon the track (TRC vs. non-TRC), comment responses will be submitted to the appropriate department(s).

Construction Activities Application Approval

Once all requested information has been submitted by the applicant, TRC and/or CAA Application approval will be granted, depending on applicable track (TRC vs. Non-TRC). Part of this approval includes the CAA/MS4 Approval Letter to be forwarded to SCDHEC along with the Notice of Intent for NPDES Construction General Permit (CGP) Coverage.

Changes After Approval (SWDSM Sections 4.8.1 & 4.9.2)

Changes after approval include revisions made to approved plans and/or construction documents or transferring construction activity responsibility. Any revisions made to approved plans or construction documents shall be submitted to the City in writing. It should be noted, implementation of changes shall not occur until it has been reviewed and approved by the City. Revisions include, but are not limited to:

- Pipe size and grade alterations affecting hydraulic capacity
- Easement boundary changes due to change in stormwater system components
- Changes in general grading plan that affect flow direction, rate, volume, or quality of stormwater runoff

Transfer of Responsibility (SWDSM Section 4.8.2)

$100 for each property ownership transaction. This fee also applies should there be a change in ownership during the construction activity.

Expiration of Approval (SWDSM Section 4.8.3)

A CAA Approval will remain valid for up to five years from the date of issuance, provided that the project is in compliance with the City of Charleston Ordinance and this SWDSM and is not inactive for a period of 24 consecutive months. Construction, development, and redevelopment activities shall be initiated within 24 months of issuance of the City approval. Failure to initiate these activities will render the approval invalid at the end of the twenty-fourth month.

Construction Activity (SWDSM Chapter 5)

Pre-Construction (SWDSM Section 5.2)

Technical Review Committee Track

The sequence of construction must be consistent with the City's TRC Pre-Construction Conference requirements. This involves the following first steps in the approval to initiation of construction activities phase of the project.

1. A mandatory TRC Pre-Construction Meeting including City representatives, owner or owner's representative, project engineer, and contractor shall be held prior to starting any work on the site. This is to occur once all TRC approvals have been obtained (after NPDES CGP certification of coverage issuance from SCDHEC), which is required prior to installation of any site improvements (including initial SWPPP controls and tree protection barricading). Stamped approved TRC plans will be provided by the City at the TRC Pre-Construction Conference Meeting. Please also note the TRC pre-construction conference does not necessarily replace any NPDES CGP Pre-Construction Meeting.
2. A mandatory NPDES CGP Pre-Construction Meeting with City representatives, owner or owner's representative, project engineer, and contractor shall be held at the required locations provided in the NPDES CGP Section 4.1.C.
3. After the TRC Pre-Construction Meeting, the meeting minutes (produced by the applicant) are then submitted to City Engineering Division (Kate Capps at 843-720-2536 or cappsk@charleston-sc.gov) and need approval by the City. After approval of the minutes by the City, the initial SWPPP inspection and tree barricade inspections can be requested from the City's Department of Stormwater Management and Zoning Division, respectively
4. Contractor shall identify all trees to be protected and install all tree protection barricading as indicated. Install all site perimeter sediment control measures, temporary construction entrance, and other required initial SWPPP controls.
5. Contact City Zoning Division (Eric Schultz at 843-724-3790 or schultze@charleston-sc.gov) for inspection and approval of tree protection barricading. Submit a City Department of Stormwater Management Initial SWPPP Inspection Request Form to the City's Stormwater Administrative Assistant (843-724-3761 or mitchellan@charleston-sc.gov) to request the initial SWPPP inspection.

After the initial SWPPP and tree protection inspections have been approved, construction on the project may begin.

Non-Technical Review Committee Track

1. A mandatory NPDES CGP Pre-Construction Meeting with City representatives, owner or owner's representative, project engineer, and contractor shall be held at the required locations provided in the NPDES CGP Section 4.1.C.
2. The initial SWPPP inspection and tree barricade inspections can be requested from the City's Department of Stormwater Management and Zoning Division, respectively
3. Contractor shall identify all trees to be protected and install all tree protection barricading as indicated. Install all site perimeter sediment control measures, temporary construction entrance, and other required initial SWPPP controls.
4. Contact City Zoning Division (Eric Schultz at 843-724-3790 or schultze@charleston-sc.gov) for inspection and approval of tree protection barricading. Submit a City Department of Stormwater Management Initial SWPPP Inspection Request Form to the City's Stormwater Administrative Assistant (843-724-3761 or mitchellan@charleston-sc.gov) to request the initial SWPPP inspection.

After the initial SWPPP and tree protection inspections have been approved, construction on the project may begin.

Inspection Fees

Inspection fees are required prior to beginning construction. It should be noted, the inspection fees from the last version of the SWDSM has changed and are as follows:

- $75 for less than 1-acre site
- $150 for 1 to 5-acre site
- $250 for 5.01 to 10-acre site
- $500 for 10.01 or more-acre site

These fees are only for the initial inspection and include two re-inspections at no additional costs. Construction shall not be authorized if after two re-inspections the BMPs aren't installed and operating per the approved construction plans. Additional inspection fees will be applied at the above rate schedule.

Construction (SWDSM Section 5.3)

EPSC BMPs shall be maintained throughout the entirety of construction in accordance to the Onsite Stormwater Pollution Prevention Plan (OS-SWPPP). The applicant/owner must conduct weekly SWPPP inspections and maintain these records as part of the OS-SWPPP.

Routine SWPPP inspections must be conducted a minimum of at least once every calendar week with no time period between inspections exceeding nine (9) days (**SWDSM Section 5.3.2**).

Operator must also be aware of any and all inspections associated with the CAA Permit. The permit can be viewed and requested through the CAP.

Notifications (SWDSM Section 5.4.6)

The applicant/owner shall notify the City based on the occurrence as follows (**SWDSM Table 5-1**):

Occurrence	Contact	Timeframe
Modifications to the construction sequence or timeframe	Onsite personnel	Immediately
Major modifications to the approved design or SWPPP	City and SCDHEC	Prior to Implementing modification
Transfer of responsibility	City and SCDHEC	14 calendar days
Dangerous spills or leaks	Minor: Onsite personnel Major: Contact 911 or local emergency response team	Immediately
Illicit discharge(s)	City	24 hours
Inspection reports	Personnel responsible for EPSC maintenance	Notify immediately, seven days to perform maintenance
Changes to permit status	Citizen Access Portal	Immediately
City enforcement as described in Section 7.2	Onsite personnel	Immediately

Post-Construction Activity (SWDSM Chapter 6)

At the conclusion of construction activities, the owner shall ensure the site is stabilized with permanent vegetation, paved areas, and stormwater conveyances are clean of debris and sediment, and that permanent stormwater controls are working properly. After which, the CAA Closeout Application (CAA COA) can be submitted to the Department of Stormwater Management. The COA can be found at:

https://www.charleston-sc.gov/DocumentCenter/View/5911/Close-Out-Application-Fill-in-Form?bidId=

The CAA COA and package contents are based construction activity type and consists of the following:

- **Single Family Residential**: CAA COA, Hydrostatic Testing Results (if applicable), Dye Testing Results (if applicable)
- **Site Plan**: CAA COA, SCDHEC NOT (copy), Record Drawings, Covenants for Permanent Maintenance of Stormwater Facilities (CPMSF) Agreement[+] (https://www.charleston-sc.gov/DocumentCenter/View/9545/Covenants-for-Permanent-Maintenance-of-Stormwater-Facilities_2014?bidId=), Hydrostatic Testing Results (if applicable), Dye Testing Results (if applicable), In-Situ Infiltration Testing Results (if applicable), Stormwater Inspection Video (if applicable for public infrastructure)
- **Subdivision/Road Construction Projects**: CAA COA, SCDHEC NOT (copy), Record Drawings, CPMSF Agreement[+], Hydrostatic Testing Results (if applicable), Dye Testing Results (if applicable), In-Situ Infiltration Testing Results (if applicable), Stormwater Inspection Video (if applicable for public infrastructure), Final Plat
- **Linear Projects**: CAA COA, SCDHEC NOT (copy)

*Required if project has a permanent structural stormwater measure.

[+]Recordation fee will be required prior to approval of closeout.

A PACKAGE IS CONSIDERED "ADMINISTRATIVELY COMPLETE" UPON RECEIPT OF ALL REQUIRED DOCUMENTATION BASED ON CONSTRUCTION ACTIVITY TYPE.

Hydrostatic Testing (SWDSM Section 6.8)

Hydrostatic testing may be required when stormwater infrastructure will be conveyed to the City. This doesn't apply for Site Plan projects, unless a public utility is located within an easement.

Dye Testing (SWDSM Section 6.8)

Dye testing is required for any new sewer connection.

In Situ Testing (SWDSM Section 6.9)

In Situ testing is required for any infiltration BMP.

Record Drawings (SWDSM Section 6.10)

Digital copies of Record Drawings must be submitted with a data structure compliant with the City of Charleston's GIS standards. The Record Drawing preparer should coordinate with the City of Charleston GIS Division. Record drawings shall be compliant with the City of Charleston Dedication Manual Record Drawing Review Section. The Dedication Manual can be found at:

https://www.charleston-sc.gov/DocumentCenter/View/14638/2017-Dedication-Manual-Final_031517?bidId=

After the package has been reviewed, the City will correspond with the applicant if there are any outstanding items or issues needing to be addressed. Once the City's comments have been addressed, an CAA Close-Out Approval Letter will be issued, and the construction process will be completed.

Stormwater Facility Warranty (SWDSM 6.7)

After the stormwater facilities have been inspected and approved by the City, a two-year warranty of the installed stormwater system shall be signed by the owner and submitted to the City. Any deficiencies, defects, or failures that occur during the warranty period shall be addressed by the owner/permittee. The City shall be notified, and a subsequent inspection will be required. Prior to the end of the warranty period, the City will re-inspect the stormwater facilities. Any deficiencies noted shall be addressed by the owner/permittee and a subsequent inspection will be required. Pipes shall be video inspected at the end of the two-year warranty period and will be subject to the same requirements as the initial video inspection outlined. The stormwater facility warranty MUST be signed and submitted along with the City's acceptance of the stormwater management system with its structural elements before issuance of any of the various types of Certificates of Occupancy.

A warranty will not be required for Utility or SFR projects and are, generally, applicable to Road Construction Plan Submittal.

Technical Procedure Document

Subject: Conceptual Planning for Stormwater and Low Impact Development

Introduction

As land changes from a wooded or vegetated condition to one with roofs, streets, and parking lots, the stormwater runoff generated from those sites also increases due to the reduction of infiltration, abstraction, and vegetation uptake. The increased stormwater runoff may lead to problems, such as flooding. This is especially true in coastal areas, such as Charleston, South Carolina, where other factors (tidal influence, storm surge, low-lying areas below sea level) contribute to the severity of flooding.

To address this flooding concern, a new approach is needed for site development. Site development can no longer be done envisioning stormwater as an afterthought in the development plan. Instead, the developer needs to work with the land available and stormwater needs to be viewed as a resource to be managed early in the design process. Designing the development from the beginning with stormwater and environmental considerations in mind will result in better site design and ultimately save the developer time and possibly money.

Principles of Low Impact Development

Low impact development (LID) employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product (US EPA, 2018). By employing these principles early in the conceptual planning process, developers and designers can produce aesthetically pleasing, low cost, and effective stormwater site design that complies with the local stormwater regulations. Below are the six fundamental principles of LID (MAPC, 2010).

Working with the Landscape

Working with the landscape integrates existing and natural systems as the framework for site planning. The designer identifies environmentally sensitive areas and important local features and outlines them in a development envelope to protect those areas. Other existing or natural features may be effective to convey stormwater, reducing the amount of hard stormwater infrastructure, and possibly reducing stormwater management costs.

Focus on Stormwater Runoff Prevention

While runoff may not be preventable, it can be minimized by reducing road widths and parking areas, using shared driveways, and disconnecting impervious areas. Clearing and regrading can be minimized by clustering and reducing building footprints. To aid in reducing runoff, techniques like green roofs can store and evaporate rainfall before it reaches the existing ground/grade.

Micromanage Stormwater

Creating smaller sub-watersheds on site will aid in micromanaging stormwater runoff through a series of small LID structures and maximize sheet flow to where there will be little to no runoff for low-intensity storms. The strategy is to manage stormwater where it falls instead of trying to convey it long distances.

Keep it Simple

Emphasize simple. Nonstructural, low-tech, and low-cost methods such as open drainage systems and filter strips, disconnection of roof runoff, rain barrels/cisterns, street sweeping, public education, and minimizing areas that are disturbed for development are the goal.

Practice Multi-tasking

Design and create a multifunctional landscape with stormwater management practices that provide filtration, treatment, and infiltration and assist with meeting other development requirements. Some of the additional ancillary benefits of LID can be wildlife habitat and reduced heat island effects.

Maintain and Sustain

Landscaping designs, especially associated with stormwater management, should incorporate native plants that are resistant to extreme conditions (wet and dry), are low maintenance, and have a deeper root system that promotes infiltration and vegetative update of stormwater and associated pollutants. Vegetation should be selected that reduces the use of pesticides, herbicides, and fertilizers. These lower maintenance designs are more likely to be maintained and result in improved water quality.

Conceptual Site Planning

There are many resources and references that can be used for conceptual site planning that involves LID. The City of Charleston (City) uses the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014) as a resource in the *City of Charleston Stormwater Design Standards Manual*. *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014) can be found on the South Carolina Sea Grant Consortium website at:

https://www.scseagrant.org/wp-content/uploads/LID-in-Coastal-SC-low-res.pdf

The following is a quick guide of how LID can be successfully incorporated into any development:

Early Site Recognition

Before a site is bought, a developer/designer should assess property with the **Principles of Low Impact Development** in mind. The developer/designer has the ability to consult with the City prior to investing in the property to make an initial estimate of developable land, specific permits, and any potential obstacles that may come up during development. By consulting with the City prior to buying the site, the developer can make a more informed and realistic estimate of investment return. After the investment has been made, a proper **Inventory and Site Evaluation** should be conducted to create a conceptual site design that is sustainable and cost effective.

Inventory and Site Evaluation

- Review Ordinances from all applicable City Departments (e.g., Department of Stormwater Management, Department of Planning, Preservation, & Sustainability)
- Locate environmentally sensitive resources: wetlands, mature trees, slopes, drainageways, permeable soils, waterway buffers to consider challenges, and opportunities for LID implementation
- Assess existing hydrology and soil characteristics on a watershed level. LID requires an understanding of the site in the context of the overall watershed.
  - Determine if the site is located in a Special Protection Area
  - Determine if the site drains to impaired waters or other waters with existing water quality sensitivities
  - Evaluate downstream flooding potential or run-on issues from neighboring properties

  - Assess planned future development in the area
  - Erodibility of the soil
  - Steepness of slopes
- Assess existing hydrology on a site-specific level
  - Hydrological functions of the site: surface water, groundwater, and tidal influences
  - Natural resource locations
  - Geotechnical evaluation: soils for potential infiltration and water table depth
  - Effect of project size and shape on stormwater management
  - Determine areas best suited for development and those that should be avoided.
  - Determine if areas exist where LID infiltration practices should be avoided due to historical land use and contamination.

Initial Concept Design Using Non-Structural BMPs

Develop an initial concept plan based on information gathered during the ***Inventory & Site Evaluation*** process. Be sure to incorporate non-structural BMPs such as woodland and wetland protection, clustering, and minimizing and disconnecting impervious surfaces.

Preliminary Site Plan Development Incorporating Structural BMPs

Incorporate structural BMPs to address site specific stormwater needs while developing the preliminary site plan.

- Define development envelope/locate potential site
  - Cluster buildings and reduce building footprints to minimize clearing/grading
  - Determine possible LID Best Management Practices (BMPs) for the site
  - Keep open space and wildlife habitat
  - Create small watersheds to route stormwater to a LID BMP
    - Use BMPs that promote filtration, treatment, and infiltration components
    - Use green rooftops and disconnection from rooftop to impervious areas
  - Maintain natural flow paths and use open drainage
  - Flatten slopes as much as possible to lengthen sheet flow
  - Reduce road widths
  - Use shared driveways/reduce parking areas with permeable paving
  - Align roads along grades
  - Minimize high maintenance lawn areas
- Draw the lot lines (for Residential Developments)

Maintenance

Developers and designers typically shy away from LID due to the estimated maintenance cost. Depending on the BMP, the maintenance cost can be very low and may even be rolled into the landscaping budget of the City or homeowners association (HOA). If maintenance cost is rolled into the landscaping budget, the landscapers need to be educated on where the LID BMPs are located to avoid accidental damages or creation of obstacles (e.g., filling in a bioretention cell, installation of trim guards around any BMP). Maintenance schedules for each BMP can be found in the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014).

If the responsibility of a site's BMP remains private and a HOA is responsible for maintenance, LID BMPs are typically more affordable and is more easily accessible for the HOA to maintain. It is easier for an HOA to maintain BMPs that are smaller and part of landscaping budget than it is to maintain and monitor a stormwater pond that requires a Pond Manager Certification. Below is a comparison of maintenance cost estimates for LID infrastructure and traditional stormwater infrastructure:

Table 1. Annual Maintenance Cost Comparison

Best Management Practice	Maintenance Cost
Wet Pond	$4,411
Wetland	$752
Bioretention Cell	$583

Source: Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Table 1.2-5) (Ellis et al., 2014)
Note: Estimates are for a 10-acre watershed with a CN = 80.

References

Ellis, K., C. Berg, D. Caraco, S. Drescher, G. Hoffmann, B. Keppler, M. LaRocco, and A.Turner. 2014. Low Impact Development in Coastal South Carolina: A Planning and Design Guide. ACE Basin and North Inlet – Winyah Bay National Estuarine Research Reserves, 462 pp. Available at http://www.northinlet.sc.edu/LID/

Metropolitan Area Planning Council (MAPC). 2010. LID Principles and Techniques. Metropolitan Area Planning Council, Massachusetts. Available at https://www.mapc.org/resource-library/lid-principles-and-techniques/

US EPA. 2018. Urban Runoff: Low Impact Development. U.S. Environmental Protection Agency. Available at https://www.epa.gov/nps/urban-runoff-low-impact-development

Oregon Sea Grant. Low Impact Development Fact Sheet, "*The LID Site Planning Process"*. Available at Oregon Sea Grant LID Site Planning Process

Technical Procedure Document

Subject: Peaking Factor

Introduction

In September 2007, the City of Charleston (City) passed a stormwater ordinance incorporating the federally mandated requirements of the National Pollution Discharge Elimination System (NPDES) Phase II stormwater program. Part of this ordinance included the authorization to develop and implement a Stormwater Design Standards Manual (SWDSM) to be used by the City when reviewing, approving, and permitting construction, development, and re-development projects. The SWDSM standardized engineering and construction practices serves multiple purposes, including "providing technical design standards to eliminate the implementation of sub-optimal design and installation practices". One of the parameters in the technical design standards included the requirement of using a hydrograph Peaking Factor of 323 to reflect the ability of watersheds to retain and delay runoff.

This Technical Procedure Document describes the City's justification for increasing the Peaking Factor to 484 as a design computation requirement in the new SWDSM.

Design Computation Requirements

Hydrologic Requirements (SWDSM Section 3.4.1)

Hydrologic computations shall be completed using volume/peak/duration-based hydrograph methods acceptable to the Department of Stormwater Management. The SWDSM uses a design storm duration based on the 24-hour design storm event with a NRCS Type III rainfall distribution and a 484 Peaking Factor. Typical hydrologic inputs include, but are not limited to, the following:

- Rainfall depth or intensity
- NRCS soil classification and hydrologic soil group
- Land use
- Time of concentration
- Initial abstraction (surface storage and/or vegetative capture)

Peaking Factor

When developing hydrographs (graphs of stormwater runoff rates versus time) using the Natural Resources Conservation Service (NRCS) method, the unit hydrographs are multiplied by a peaking factor. The peaking factor is based on a wide range of watershed characteristics and reflects the ability of the watershed to retain and delay flow. The peaking factor essentially controls the volume of water on the rising and recession limbs. This constant may not be consistently applicable to all watershed types.

Steep terrain and high impervious urban areas tend to produce higher early peaks and therefore values of the peaking factor are generally close to 600. In contrast, flat swampy regions tend to retain and store water, resulting in a delayed, lower peak with peaking factor values tending towards 300 or lower (Wanielista, et al. 1997). Various Peaking Factors based on general watershed characteristics are listed in **Table 1**.

Table 1. Hydrograph Peaking Factors and Recession Limb Ratios

General Descriptions	Peaking Factors	Limb Ratio (Recession to Rising)
Urban Areas, Steep Slopes	575	1.25
Typical SCS	484	1.67
Mixed Urban/Rural	400	2.25
Rural, Rolling Hills	300	3.33
Rural, Slight Slopes	200	5.5
Rural, Very Flat	100	12.0

Source: Wanielista, et al., 1997; NOAA 2005

Peaking Factor Value of 484

The peaking factor in the 2007 and 2013 versions of the SWDSM was 323, but the updated SWDSM requires a peaking factor of 484. The increase is based on the typical peaking factor used by NRCS, developed from land use classifications of mostly urban and moderate slopes (neither too steep nor flat). The shift to a more conservative Peaking factor and other design parameters is to consider the change in climate which includes the increased intensities and magnitude of storm events along with the response times of the watersheds within the City. In general, watersheds within the City are predominantly urbanized, have poorly drained or altered soils (increases the runoff potential), do not have significant surface storage, and high ground water tables. These factors contributed to the City's decision to increase the base Peaking Factor to 484 for hydrologic analyses and design computations.

Basin Specific Peaking Factor Determination

The City understands the variety of landscapes that exist within its jurisdictional boundaries. West Ashley is an example of a mixed-urban landscape with sub-urban residential subdivisions and highly impervious commercial areas. Downtown Charleston is considered an urban landscape that includes mixed-use multi-family residential and commercial areas that generally do not include storage areas for surface runoff. In contrast, Johns Island is a largely undeveloped rural area trending towards urban cores with mixed-use development and surrounding sub-urban residential subdivisions.

Because of the diversity of different areas, the City allows designers the opportunity to justify a lower peaking factor than 484. Justification must be included as part of the Stormwater Technical Report narrative that may include, but not limited to, topography, contributing drainage area, which includes the presence of wetlands, associated Zoning classification and/or impervious area determination with a resulting minimum peaking factor of 323. Designers should communicate with the City early in the design process if they intend to seek a different peaking factor.

Modified Peaking Factor Approval Process

This section details how the designers will justify a modified peaking factor for their project site (pre-development and post-development conditions) as well as the overall contributing watershed. There is no specific set of criteria that can be established for different peaking factor values since they are site specific and cannot be generalized. Because of this, communication with the City early in the design process about a modified peaking factor is key to avoid unnecessary delays.

If there is already a model developed, the peaking factor used in the model should be utilized because most of the models are analyzed based on Future Conditions/Built-out conditions. If a model is not developed for a specific watershed or the designer wishes to modify the peaking factor, then appropriate supporting documentation should be submitted to the City in order to justify a modified peaking factor. The following must be submitted to the City in the Stormwater Technical Report:

- Peaking Factor (Default peaking factor of 484 or a modified peaking factor (400 or 323) with justification)
- Model Assumptions, Inputs, and Outputs for Pre-development and Post-development conditions
- Any Record Drawings, Stormwater Technical Reports used to build the model
- Maps and Figures
  - For Overall Contributing Drainage Area
    - Watershed Boundary
    - Watershed Topography
    - Watershed Point of Discharge
    - Zoning Classification
    - Impervious Area
    - Groundwater Table Characteristics
  - For Site Specific Drainage Area
    - Site Drainage Area Boundaries
    - Site Topography
    - Site Point of Discharge
    - Slope Determination
    - Impervious Area (Pre and Post development conditions)
    - Groundwater Table characteristics

References

National Oceanic and Atmospheric Administration (NOAA). 2005. Unit Hydrograph (UHG) Technical Manual. NOAA National Weather Service Office of Hydrology. Available at https://www.nohrsc.noaa.gov/technology/gis/uhg_manual.html.

Natural Resource Conservation Service (NRCS) National Engineering Handbook. 2007. United States Department of Agriculture. Available at https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17755.wba

Wanielista, Martin, Robert Kersten, & Ron Eaglin, 1997. Hydrology: Water Quantity and Quality Control, 2nd Edition, Wiley and Sons, Inc., New York, NY.

Technical Procedure Document

Subject: 1 Percent Annual Exceedance Probability Storm Event Analysis

Introduction

The City of Charleston (City) has formalized a procedure to further explore any upstream and downstream stormwater runoff impacts associated with new development or re-development projects. For projects in an area in which a City stormwater master plan and model is available, the stormwater management analysis shall use the boundary conditions from the modeling provided by the City (see **Technical Procedure Document *City Watershed Modeling Data***) for the 1 Percent Annual Exceedance Probability (AEP) storm event analysis. For projects that are not located within an area without a completed City stormwater master plan and model, **Section 3.9.4 of the 2020 SWDSM** must be followed by the design engineer to complete the assessment of the watershed to establish reasonable boundary conditions for the 1 Percent AEP storm event analysis.

Circumstances often occur where even with a site meeting applicable stormwater management requirements for peak flow and volume control at a site's outfall, adverse upstream and downstream impacts can occur due to the shifting of the peak of the storm event to coincide with other peaking of the storm event within the overall watershed. This section of the SWDSM requires design engineers to examine upstream and downstream conditions to demonstrate a proposed development would not adversely impact upstream and downstream conditions. For this analysis, the water surface elevations and existing drainage system capacity will have to be examined from the top of the watershed to a point down system of the site where the site makes up 10% of the watershed area. The evaluation should also continue downstream for the project to identify any likely choke points. If any adverse impacts are indicated, the stormwater runoff peak flows and volumes discharging from the site must be reduced until such point that there are no adverse impacts.

Required Criteria

The required criteria of the 1 percent AEP storm event analysis for sites where a stormwater master plan and model are not available includes, but is not limited to:

- Using one of the following assumptions for all upstream and downstream undeveloped land parcels:
  - Current Zoning Conditions
  - For sites not located in an area of known flooding: Current Zoning Conditions with a theoretical pond that meets the discharge rate and volume stormwater requirements of the current Stormwater Design Standard Manual.
- Existing land use curve numbers for all developed areas outside the project
- Utilization of existing City watershed boundaries and LiDAR data to support overall watershed area delineations

- The weighted curve number for the proposed development site
- Flows shall be routed using a hydrologic and hydraulic method accepted by the City Department of Stormwater Management

Other criteria may be required by the Department of Stormwater Management based on the severity of potential impact and the location of the project. Any additional criteria will be outlined as much as possible during the initial planning stages of the project as part of the Technical Review Committee (TRC) process.

Procedure

The following steps are to be used for the 1 percent AEP storm event analysis:

1. Determine which watershed the project is located within and if the City has a master plan and model for that watershed.
2. If the city does not have a master plan and model for the watershed that the project is located within, then determine the watershed extents from available watershed boundary and terrain information (i.e. City watersheds https://data-charleston-sc.opendata.arcgis.com/search?groupIds=01e7dd3a8e8348ab9ad63e12170ff4bf; 2017 SCDNR LiDAR data available from http://portal.dnr.sc.gov/GIS/lidar.html). For watersheds not defined by the City or for which the design engineer would like to propose a modified watershed boundary, coordination with the Department of Stormwater Management should occur early in the design's stormwater management analysis.
3. Complete an analysis up to the top of the watershed and down to any perennial water of the State or to a point in which the project comprises 10% of the total contributing area, whichever occurs first. This includes the entire contributing watershed area.
    a. Example 1: A 5-acre project at the top (highest point) of the watershed will have to examine downstream until the total drainage area for the outfall channel or structure is at least 50 acres. If the total area of the watershed does not total 50 acres before reaching the ultimate outfall, then the entire watershed will be used.
    b. Example 2: A 5-acre project in the middle of the watershed will need to first determine how much upstream area is contributing to the outfall channel or structure before reaching the site. If the upstream area is equal or greater than 45 acres, then only the next downstream structure from the site will need to be analyzed (if the upstream area is greater than 45 acres then the entire upstream area must be included in the analysis of the next downstream structure from the site). However, if the upstream basin is less than 45 acres, then continue downstream of the site until the 10% requirement is met. Note that the evaluation should also continue downstream for the project to identify any likely choke points.
4. Locate all off-site downstream structures and open-conveyance cross sections for the outfall channel or structure within the total watershed area and include those features in the modeling analysis.
5. Determine the land-cover data and curve number information for the watershed by using zoning information. Undeveloped portions of the watershed shall be modeled as if in the built condition and according to the zoning classification.

6. Build a stormwater model to determine the impacts of the proposed development on all upstream and downstream conveyances until the 10% analysis point is reached as well as continue downstream for the project to identify any likely choke points The extent to which upstream drainage is routed through existing stormwater management systems will be up to the design engineer as the un-routed upstream system approach would yield more conservative 1 Percent AEP storm event water surface elevations. Additionally, the existing boundary conditions for this analysis must take into account either an elevation of 5.5' NAVD88 datum tailwater elevation as a minimum or elevations associated with any downstream constrictions (crown of pipe elevation), whichever is higher.

   Additionally, the modeling must take into account the displacement of any existing storage provided on the site that will be displaced as part of any fill associated with the development. This is often modeled treating the site as a pond to realize how much volume is available for storage between the seasonal high water table (SHWT) and the resultant 1 Percent AEP storm event elevation. This displaced storage volume must be accounted for in the 1 Percent AEP modeling to reflect the loss of storage on the site prior to the development. This displaced storage can be offset through the on-site stormwater management practices (i.e. runoff reduction measure or additional storage volume) or simply by completing a fill balancing approach.

   As a conservative approach to addressing fill displacement, the applicant can assume that the 1 percent AEP storm event peak elevation is 6" above the highest crown elevation of the adjacent roadway. This approach can only be used if the City does not have historical data to support a different elevation; Additional modeling as described elsewhere in this document will be required if historical flooding data does exist.

7. If any adverse impacts (i.e. increased water surface elevation greater than 0.04') are noted upstream or downstream, the design of the proposed site will need to be modified until all upstream and downstream impacts have been eliminated.

Required Output of Analysis

Results of the 1 Percent AEP storm event analysis are required to be presented in the Stormwater Technical Report prepared by a South Carolina Licensed Professional Engineer and submitted to the Department of Stormwater Management as part of the Construction Activity Application package. The required items for the 1 Percent AEP storm event analysis are:

- Discussion of the 1 Percent AEP storm event analysis approach and design assumptions, including, but not limited to the following:
  - Sources for watershed area delineations
  - Land-use curve number determinations
  - Any upstream routing considerations made in the analysis
  - Tailwater conditions and the basis for those tailwater conditions
  - How the displacement of storage on the site was offset in the analysis and site design approaches
- Summary table with Pre-development and post-development peak flowrates for the 1 Percent AEP storm event for the appropriate upstream and downstream analysis points

- Summary table with Pre-development and post-development runoff volumes for the 1 Percent AEP storm event for the appropriate upstream and downstream analysis points
- Summary table with Pre-development and post-development water surface elevations for the 1 Percent AEP storm event for the appropriate upstream and downstream analysis points
- Pre-development and post-development watershed mapping that includes contour data as well as the link-node diagram consistent with the modeling provided
- Pre-development and post-development model input
- Pre-development and post-development model output

Technical Procedure Document

Subject: City Watershed Modeling Data

Introduction

Hydrologic and hydraulic (H&H) models are commonly used for engineering analysis and to evaluate the benefits of proposed storm drainage infrastructure improvements. Hydrology represents the quantity and rate of water (runoff) generated from a specific area or watershed. Hydraulics deals with the physical properties of water, such as calculating the depth or velocity of flow in closed and open conveyance systems. A combined H&H model allows for the evaluation of effects of various infrastructure improvement scenarios and the benefits that would be achieved. The City has spent considerable time and resources in developing multiple H&H models for different watersheds across the City, including areas outside of the City limits. Where applicable, utilization of these H&H models is in the best interest of developers/designers to obtain the most-up to date, comprehensive, and accurate information for the watershed in which a proposed project is located. Furthermore, the use of the City's H&H modeling will streamline and facilitate both the design and review processes.

The purpose of this Technical Procedure Document is to provide an overview on what steps to follow when development is proposed within a watershed modeled by the City and how to use the watershed models. The memo details the type of modeling data available, how to request the data from the City, and what information must be submitted to the City to get the desired approval.

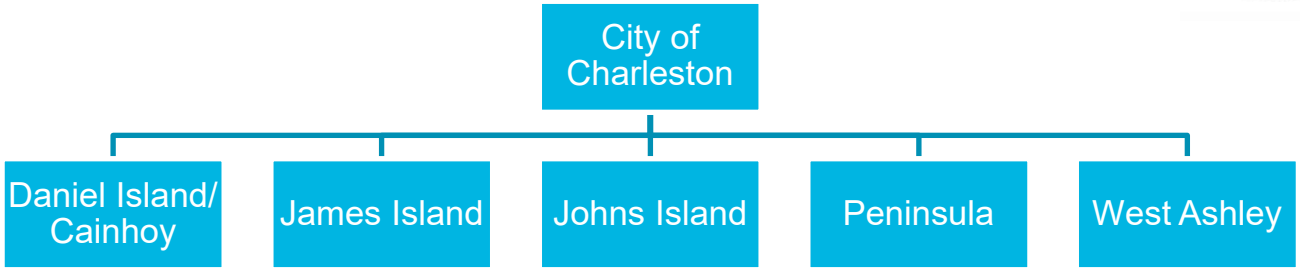
General Steps

General steps required to develop a site in any watershed within the City of Charleston includes:

1. Watershed and Special Protection Area (SPA) Determination
2. Determine Data Availability and Request
3. Describe Watershed Modeling Methods and Requirements
4. Submit Stormwater Technical Report

Watersheds and Special Protection Areas

The first step in the process is to identify the watershed where the development is planned. The City of Charleston is divided into five main geographic areas as shown below:



The City has delineated watersheds in each of the five main geographic areas. This information is available to the public and can be found the City's GIS data portal under the "Stormwater" heading. The GIS data portal can be accessed at:

https://data-charleston-sc.opendata.arcgis.com/

Within each geographic area, specific watersheds are identified as SPAs. If the new development or redevelopment project is located within a SPA, more stringent requirements are established in the **Stormwater Design Standards Manual (SWDSM) Section 3.6** and need to be referenced.

Within each geographic area, specific watersheds are identified as SPAs. SPAs for each watershed are determined based on a two-step process, generally outlined as follows.

1. Evaluation of existing datasets pertaining to each watershed. There are several types of datasets available for each watershed. The evaluation includes:

    a. Potential Flooding Locations

    b. Water Quality Concerns

    Some of the existing datasets evaluated include the following:

    a. City of Charleston 1984 Master Drainage and Floodplain Management Plan

    b. Stormwater Management Report/Studies that show the recommended improvements

    c. Historical flooding/standing water complaints from City's database

    d. Impaired 303(d) listed sites and locations of the monitoring stations along with Total Maximum Daily Load (TMDL) technical documents

2. Identifying SPAs based on Desktop Analysis. This is performed for several other basins within the watershed that do not have any available information. Results from the desktop analysis are used based on the following to determine SPA applicability:

    a. Percentage of the total area of the basin that floods is calculated based on the maximum stage in that basin and the DEM. If the calculated percentage of flooding is over a certain threshold, typically 50%, then the basin is identified as potential SPA.

While this is not a detailed analysis of the watershed, it does provide an aid to the City in determining whether a watershed has the potential to be designated as a potential SPA. The City can use the size and capacity of the hypothetical stormwater conveyance in this analysis and compare that against the capacity of the existing stormwater conveyance system to determine the potential for flooding in a watershed. The locations for which the capacity of the stormwater conveyance system is less than the capacity of the hypothetical calculated pipe can be further analyzed prior to designating a watershed as an potential SPA.

Both steps are performed concurrently and results from each step are consolidated, prioritized, and finalized to determine the potential SPAs. Determinations of the potential SPAs are currently underway for each watershed. Once the SPAs are approved and finalized by the City, they will be uploaded to the City's GIS Portal. From that information, the design community can identify where a potential development site is located and determine whether the site falls within an SPA.

Data Availability and Request

It is the responsibility of the developer/designer to request data for the watershed needed to perform appropriate analyses to attain City approval. Example available datasets that can be requested from the City include:

- Watershed H&H Model Files and/or Master Plan Reports/Drainage Studies
- Watershed Maps with SPA boundaries
- Record Drawings/As-builts
- GIS Datasets and Maps

Datasets pertaining to the watershed of interest must be formally requested from the City. To request the data, submit an e-mail to the City's Stormwater Development Manager (giraloa@charleston-sc.gov) with the applicable watershed name(s). As part of this correspondence, be sure to provide a general description on the type of information being requested and include the associated property information, project name, and City project identification number as applicable. The Stormwater Development Manager will then coordinate with the appropriate model manager to provide the City's H&H modeling data associated with the subject site.

Watershed Modeling Methods and Requirements (SWDSM Section 3.4.4.2)

The City may have completed a Stormwater Master Plan and/or H&H model of a specific watershed. The purpose of the H&H model is to assess areas with drainage issues, model existing storm drainage infrastructure, and identify potential projects to reduce flooding.

Stormwater H&H models that have been completed or are currently underway include:

- Barberry Woods (Johns Island)
- Calhoun West (Peninsula) (On-going)
- Central Park Watershed (James Island)
- Church Creek Watershed (West Ashley)
- Cooper-Jackson Watershed (Peninsula) (On-going)
- Dupont-Wappoo Watershed (West Ashley)

- Huger Street (Peninsula) (On-going)

If a Stormwater H&H model is available, the proposed development must use boundary conditions from the City maintained H&H model to as part of the site's stormwater management design. As stated in the **SWDSM Section 3.9.4.**

> *If a project is in an area that has a stormwater master plan and model, the analysis shall use the boundary conditions from the master plan model provided by the City. The model shall extend up to the top of the water and down to the project. If the modeling results indicate there is an impact [listed in SWDSM Section 3.9.4], then stormwater volume and flowrate leaving the site must be reduced until such a point that there are no impacts.*

H&H models include other parameters (curve numbers, time of concentration, and stage-storage relationships) which contribute to calculating the amount of runoff generated, peak flowrates, and maximum water depths. These parameters associated with the City's watershed modeling are developed and calibrated on an overall watershed scale. The developer/designer must carefully review all parameters when updating their site-specific model within a watershed. In general, the developer/designer must evaluate the parameters individually for the site and update the model for both pre-development and post-development conditions and then compare the results watershed wide to assure there are no adverse impacts upstream or downstream of the proposed development site.

If the project does not have a H&H model, then the analysis must be performed from the top of the watershed to a point downstream of the proposed project site where the site makes up 10% of the basin (see *Technical Procedure Document #4: 1% Annual Exceedance Storm Event Analysis*). The default Peaking Factor of 484 must be used unless the developer/designer can justify using a lower peaking factor (see *Technical Procedure Document #3: Peaking Factor*).

Designers may select an appropriate computer modeling program to calculate the pre-development and post-development site conditions. The City may use one specific computer modeling program for a watershed (the City recommends the designer use the same modeling program), but the designer may use a different modeling program for their project site so long as certain considerations are met (**SWDSM Section 3.4.4.2**):

- In circumstances where backwater, tailwater, and tidal conditions are not present, and for storm drainage systems with less than five (5) connections, programs using Manning's equations will be considered satisfactory.
- In circumstances where backwater, tailwater, and tidal conditions are present, or have five (5) or more connections in the stormwater drainage system, programs must incorporate Saint-Venant equations to better represent the hydrodynamic environment.

Designers may select a simplified model if a storm drainage system will not experience surcharging or backwater under design conditions. The terms "surcharge" and "backwater" are not synonymous. Surcharge results when flowrates entering a pipe are in excess of pipe's free flowing (Manning's) capacity. In a surcharge situation, hydraulic head will build up behind the pipe and force higher flowrates through the pipe at higher velocities. In a backwater condition, the water surface elevation at the downstream end of the pipe prevents the flow in the pipe from discharging freely ("free-outfall condition"). While the hydraulic grade line in the pipe will be above the pipe crown for both surcharge and backwater conditions, the velocity and flowrate will be lower (potentially much lower) in the backwater condition. Backwater conditions in Charleston may result as a result of submerged or tidal conditions at the outlet, obstructions or debris in the downstream system, or restriction in the hydraulic capacities of the downstream system. Surcharged systems will result when upstream watershed peak flowrates are greater than the hydraulic conveyance capacity of the system draining the watershed.

Backwater and surcharge conditions require considerations of both momentum and continuity equations as incorporated in models that solve the Saint Venant equations using the Dynamic Wave Flow routing method. These models include ICPR, InfoWorks ICM, SWMM Extran (public domain version provided by Environmental Protection Agency; enhanced versions available through private software companies), and DHI MIKE URBAN.

In circumstances where backwater or surcharging are not present, and for storm drainage systems with less than five connections, static programs using Manning's equations will be considered satisfactory. Also satisfactory are kinematic wave programs such as the simplified SWMM Transport hydraulic calculation option, Hydra, SewerCad, etc. The selected program and its associated computational methodologies and inputs must be listed in the Stormwater Technical Report narrative, which is part of the document submission process as detailed in the following section.

Stormwater Technical Report

Section 4.5 and in the **Guidelines and Checklist Appendices of the 2020 SWDSM** details the required contents of the Stormwater Technical Report. In addition to the aforementioned, the report must include:

- Model information including name, version, and methodology
- Input Report with the City-provided boundary conditions (upstream and downstream)
- Pre-Development Time Series Report for the upstream and downstream boundary nodes provided by the City
- Post-Development Time Series Report for the upstream and downstream boundary nodes provided by the City

Any updates required to the Stormwater Technical Report as a result of comments received from the City shall be resubmitted per the process outlined in *Technical Procedure Document #1: Stormwater Permitting Process*.

Record Drawings (SWDSM Section 6.3)

The Close-Out Application Package Process is in **Chapter 6 of the 2020 SWDSM** and in *Technical Procedure Document #1: Stormwater Permitting Process*. Part of this package includes a submittal of Record Drawings to the City in accordance to the Dedication Manual (https://www.charleston-sc.gov/DocumentCenter/View/14638/2017-Dedication-Manual-Final_031517?bidId=). The City will review Record Drawings and provide comments, and approval will be granted once all comments have been addressed to the City's satisfaction.

Final deliverables may require an updated project H&H model if the Record Drawings show design elements were not constructed in accordance with approved plans. Digital copies of the Record Drawings must be submitted with a data structure compliant with the City's GIS standards. The Record Drawing preparer should coordinate with the City's Stormwater Development Manager for the appropriate GIS data structure prior to submittal to the City.

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Technical Procedure Document

Subject: Wetland Systems Modeling and Baseline Functionality Documentation

Introduction

The City of Charleston (City) is a lowland coastal city with many wetland areas. Wetlands are important and must be protected and preserved as much as possible as they provide many benefits including providing habitat, preserving the ecosystem, enhancing water quality, and providing surface storage to hold floodwaters. Developers and designers must avoid impacting existing wetlands to the maximum extent practicable. To protect existing wetlands from over-inundation, scour, and other negative effects of development, the City prohibits the use of existing wetlands to meet applicable quantitative stormwater management requirements. Existing wetlands may only be used for stormwater conveyance purposes for a project. This Technical Procedure Document reviews the process of modeling wetland systems for conveyance of stormwater runoff for a new development or redevelopment project as well as accounts for how to document baseline wetland and stormwater conveyance conditions in and adjacent to the development site.

Stormwater Modeling Guidelines for Wetlands

Developers and designers must avoid negatively affecting natural wetlands and preserve the sensitive nature of the wetland systems. Wetlands can only be used as part of site development to convey stormwater runoff from the site once the required runoff has been routed through the appropriate BMPs for qualitative stormwater management. Design for stormwater conveyance through wetland systems must adhere to the following guidelines:

- Appropriate water levels must be maintained in all wetlands during dry conditions. In order to determine these levels and the baseline dry condition, it is recommended the designer/developer engage a wetlands scientist to determine baseline functionality. The baseline dry condition water level prior to the development of the site must be maintained post-development.
- The developer/designers must confirm and demonstrate that during post-development conditions stormwater conveyance does not cause adverse impacts upstream or downstream of the site.
- The modeling analysis must show that the volume of stormwater conveyed will not cause negative effects, such as over-inundation, and varies in each individual wetland system. It is important to engage a wetland scientist to determine baseline functionality and the Ordinary High-Water Mark (OHWM) for the wetland system. In general, the City expects the water surface elevation for a 24-hour AEP to return to OHWM within 24-72 hours.

The City will use the analysis to confirm that the existing wetlands are functioning properly and can be formally integrated as a part of the City's stormwater drainage infrastructure.

Modeling Existing Wetlands

General Parameters

There are general parameters that are required by the City to model existing wetlands. These parameters apply to each of the three scenarios: (1) discharging to wetlands when performing the 1% AEP Analysis, (2) discharging to wetlands on an adjacent property with an easement, and (3) discharge to wetlands on an adjacent property without an easement. In order to model existing wetlands, the following parameters must be used in the model:

- Individual wetlands must be modeled with a Curve Number of 98 unless documentation (i.e. geotechnical report and / or wetland analysis) can be presented that clearly shows the wetland does not typically have standing water present; If this documentation is provided and deemed acceptable then a curve number of 89 can be used.
- Wetlands must be modeled with an overland roughness coefficient to represent natural vegetation. This information can be obtained from the NRCS Urban Hydrology for Small Watershed - TR-55 technical document or similar hydrology document.
- Representative cross-sections should be used to model the conveyance through a wetland system that includes the main channel, the adjacent wetlands, secondary channels, and riparian zone.

Discharging to Wetlands when Performing the 1% AEP Analysis

When performing the 1% AEP Analysis, wetlands may have storage capabilities if the site warrants it (e.g., wetland portion onsite area is 1 acre, while the total wetland area is 1000 acres). Additional parameters that should be used when performing the 1% AEP Analysis includes:

- Model wetlands as conveyance/storage as the site warrants.
- Show that the entire basin does not have adverse impacts for the 1% AEP Storm Event.
- Maximum WSE in post-development should be less or equal to the pre-development WSE.

Discharging to Wetlands on an Adjacent Property with an Easement

Analyses are required for the site for various AEP storm events, in addition to the 1% AEP Analysis, required by the City listed **Chapter 3 of SWDSM**. If wetlands extend beyond the boundary of the project site, but an easement is in place for the wetlands, the following parameters are required for the model:

- Model the entire wetland as conveyance (no storage element)
- Make sure the post-development WSE is maintained to pre-development conditions
- No adverse impacts to the downstream system
- Does not require volume control from the wetland

- Requires water quality pre-treatment prior to the discharge to the discharge to the portion of the wetland within the project site

Discharging to Wetlands on an Adjacent Property without an Easement

For wetlands that extend past a project boundary, developer/designers must use the “glass wall method” to isolate wetlands associated with their development. The developer/designers must model the wetlands as if the wetlands do not extend past the site boundary. This is done so that water can properly be conveyed in the event that the wetlands adjacent to the site cease to exist in the future.

Representative cross sections generated from the surface should terminate at the property boundary. The water surface elevation shall not exceed the elevations associated with the property boundary. Should the OHWM established by a wetland scientist extend beyond the property boundary, the elevation associated with the property boundary shall be used as the metric for determining City compliance. Additional parameters that should be used in a model when discharging to a wetland where a portion of it is on the adjacent property of the site and the wetland is not within an easement:

- Model the wetland as conveyance within the site
- Make sure the post-development WSE is maintained to pre-development conditions
- No adverse impacts to downstream system
- Post-development volume and peak flow must be maintained the same or less than pre-development conditions
- Requires water quality pre-treatment prior to the discharge to the wetland within the project site

Baseline Functionality Documentation

The purpose of the Baseline Functionality Documentation is to document the baseline wetland and stormwater conditions. When a wetland is incorporated into the stormwater management system, baseline functionality of the wetland must be made known to the City for future maintenance accommodation. Documentation of the baseline functionality must be prepared with the aid of a wetland scientist and be submitted to the City. The following must be included in the documentation at a minimum:

1. Description and Background
    a. Acreage
    b. USGS Quadrangle
    c. Latitude/Longitude
    d. Purpose
    e. Physical Environment
    f. Ecological Features

g. Hydrological Features

h. Man-made Structure/Improvements

2. Appendices

a. Location Map

b. USGS Topographic Map with Tract Boundaries

c. Photo Location Map

d. Infrared Soils Map

e. Ecological Features Map

f. Flow Map

g. Photographic Data Sheet

h. Photographs from Photo Locations

Technical Procedure Document

Subject: Equalization Pipes and Submerged Systems

Introduction

As a result of low-lying areas of Charleston and the City of Charleston's (City) emphasis on preserving mature vegetation while minimizing the placement of fill material associated with new development and redevelopment projects, the City acknowledges that in some cases equalization pipes and submerged systems may be an appropriate design approach. Much debate has occurred over the past several years on how to balance the use of these systems while protecting the City from the increased cost and complexity of maintenance of such systems. In response to this matter, the new Stormwater Design Standards Manual (SWDSM) now allows the use of submerged systems as a design exception so long as provisions for inspection and maintenance are incorporated into the design.

The new SWDSM defines an equalization pipe as a pipe that maintains equal water surface elevation in all connected ponds in a closed system. Additionally, a submerged system is a system in which the permanent pool of water is above the flowline invert elevation of the outlet.

This Technical Procedure Document outlines the requirements for equalization pipes and submerged systems as accounted for in the SWDSM.

Design Requirements (SWDSM Sections 3.4.6.1.4 and 3.11)

Equalization pipes and submerged system requirements are included in **Sections 3.4.6.1.4 and 3.11 of the SWDSM**. The requirements are as follows:

- Isolator boxes must be installed at both ends of a conduit designed to be submerged to facilitate draining and for maintenance purpose as detailed by the City Engineering Division. These are provided by the Engineering Division, but not listed on the City website.
- For pipe runs of greater than 600 feet, the maximum distance between isolator boxes shall be 600 feet. Maintenance access points are required every 200 feet (SWDSM 3.4.6.1.13)
- The minimum pipe size shall be 24 inches in diameter

Design Exceptions (SWDSM 4.10)

Section 4.10 of the City's SWDSM accounts for how to present design exceptions from the SWDSM requirements. In order to obtain approval of a design exception from the City, an exceptional circumstance applicable to the site must exist, such that the adherence to the provisions of the SWDSM will not fulfill the intent of the SWDSM. A written request will be required by the City and must contain:

- Specific design exception(s) sought

- Rationale for the proposed design exception
- Supporting data

Per SWDSM Section 3.4.6.1.4, the design exception request for an equalization pipe or submerged system must also include the following at a minimum:

- Pretreatment for sediment loading into the submerged system must be provided in the post-construction conditions. This includes providing pretreatment for all storm drainage systems that tie into the submerged system in question. Additional information on acceptable pretreatment options can be seen in Technical Procedure Document #11.
- Description of the proposed construction method to replace the submerged system (including dewatering and excavation without the need for shoring). This includes the need to provide cross section details demonstrating the necessary easement width to accommodate replacement of submerged pipe system has been provided including excavation, dewatering, equipment location and other necessary items without the use of additional support of excavation materials. Examples of additional support of excavation materials would include sheet piling, trench boxing, etc.
- Description of the maintenance method for the submerged pipes and isolator boxes. This must include drawdown and be maintenance methods must be able to be completed within a day.

The City understands that the need for an exception may not be known during the planning stages and may only be evident after a portion of design work has been completed. The City intends to work with the developer and designers during the design process to find a resolution if the above items are adequately demonstrated.

Once an exception is approved, it must be fully documented and be included on the title sheet of the approved stamped construction drawings and project record drawings.

Technical Procedure Document

Subject: Low Impact Development and the Coastal SC LID Design Guide

Low Impact Development

What is Low Impact Development?

Low Impact Development (LID) is an integrated, comprehensive approach to land development or redevelopment that works with nature to manage stormwater as close to its source as possible (US EPA, 2014). LID practices aim to mimic the natural hydrology of an area through the use of stormwater best management practices (BMPs). These practices aim to recreate the predevelopment site conditions through techniques that promote evaporation, infiltration, localize storage, and runoff treatment. The general idea of LID is to have smaller BMPs throughout a development that can increase the water quality of stormwater and aesthetic appeal of a development while decreasing amount of stormwater runoff.

Principles of Low Impact Development

LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product (US EPA, 2018). Below are the six principles of LID (MAPC, 2010).

- ***Work with the Landscape:*** Use existing natural systems as the integrating framework for site planning. Identify environmentally sensitive areas and important local features and outline them in a development envelope to protect those areas.
- ***Focus on Prevention:*** While runoff may not be preventable, it can be minimized by reducing road widths, using shared driveways, and reduce parking areas. Clearing and regrading can be minimized by clustering and reducing building footprints. To aid in reducing runoff, techniques like green roofs can store and evaporate rainfall before it reaches the existing ground/grade.
- ***Micromanage Stormwater:*** Creating smaller sub-watersheds on site will aid in micromanaging stormwater runoff through a series of small LID structures and maximize sheet flow to where there will be little to no runoff for low-intensity storms.
- ***Keep It Simple:*** Emphasize simple. Nonstructural, low-tech, and low-cost methods such as open drainage systems and filter strips, disconnection of roof runoff, rain barrels, street sweeping, public education, and reduce construction disturbance.
- ***Practice Multi-tasking:*** Design and create a multifunctional landscape with stormwater management practices that provide filtration, treatment, and infiltration. In doing so, additional aesthetic features can be multifunctional such as open space can be used for wildlife habitat and reducing heat island effects.
- ***Maintain and Sustain:*** Landscaping design should be incorporate native plants that are resistant to extreme conditions (wet and dry) and low maintenance. Vegetation should be selected that reduces the use of pesticides, herbicides, and fertilizers. Stormwater management practices should be easily maintained.

Benefits

There are a wide variety of stakeholders that can benefit from incorporating LID practices and principles into design of developments and redevelopments (NCCE, 2009; US EPA 2013).

- ***Developers*** benefit by having reduced costs from land clearing, grading, infrastructure (streets, curbs, gutters, sidewalks), stormwater management, and environmental impact fees. Additionally, potential for increased lot yields and marketability.
- ***Municipalities*** benefit by protecting the native flora and fauna, balancing growth with environmental protection, reduces municipal infrastructure (streets, curbs, gutters, sidewalks, storm sewers), reduces system-wide operations and maintenance costs, reduces costs of combines sewer overflows, reduces runoff and flooding, and fosters public/private partnerships.
- ***Home Buyers and Residents*** benefit by preserving and protecting amenities that can translate into increased property value, lower energy costs for cooling due to increased shade from trees, reduced flooding, saves money through water conservation.
- The ***Environment*** can benefit through the preservation of ecological and biological systems, reduced demand on the water supply since natural groundwater recharge is encouraged, protects site and regional water quality by reducing sediment, nutrient, and toxic loads to water bodies, reduces impact on local terrestrial and aquatic plants and animals, preserves trees and natural vegetation, improves air quality through the addition of vegetation, reduces urban heat stress, and reduces sewer overflows
- ***Social*** benefits include enhanced aesthetics, stimulated economic development, creates green jobs, encourages more urban greenways, educates the public on their role in stormwater management, and reduces flooding.

Environmental Benefits

Various studies have shown the benefits of different types of LID practices. Some of these LID practices reduce runoff, while others reduce pollutants (Ahiablame et al., 2012). Compared to traditional methods, LID reduces runoff depth and peak discharges, and produces a longer lag time to peak discharge. Proper LID practices incorporated into design can produce little to no discharge for small rainfall events (Selbig and Bannerman, 2008). LID practices better mimic pre-development hydrology and natural systems to help reduce stormwater pollution (Hood et al., 2007).

The types of services that LID provides includes:

- ***Provisioning Services***: food, water, timber, fiber
- ***Regulating Services***: climate, floods, disease, wastes, water quality
- ***Cultural Services***: recreational, aesthetic, spiritual
- ***Supporting Services***: soil formation, photosynthesis, nutrient cycling

LID provides a host of “ecosystem services” that are not typically incorporated in cost-benefit analyses of projects. LID contributes to ecosystems services by reducing flooding, improving water quality, reducing ambient air temperatures, and improving air quality (ECONorthwest, 2007). LID also promotes infiltration with the benefit of sustaining stream baseflow and can reduce the number of combined sewer overflows incidences. Current development practices can short circuit hydrological processes, and thus produce faster and larger volumes of stormwater runoff, which in turn leads to flashy stream flow conditions (Callahan et al., 2011) and potentially increased flooding. Other benefits not typically considered is the restoration of habitats and vegetation that are important to wildlife.

Table 1. Stormwater Management Practice Performance

BMP	Pollutant Removal[1] (%)				
	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Metals	Pathogens
Bioretention	80-90	55-90	65-90	N/A	55-90
Permeable Pavement	80	60-80	60-80	N/A	45-75
Infiltration	80-95	65-95	55-90	N/A	65-95
Green Roofs	80	45-60	45-60	N/A	45-60
Rain Water Harvesting	Varies				
Disconnection	80	25-50	25-50	25-50	N/A
Open Channels	40	40-45[2]	20-35[3]	30	N/A[4]
Stormwater Filtering Systems	90	65	45	50	80
Dry Detention[5]	N/A	N/A	N/A	N/A	N/A
Wet Ponds	85	75	40	40	70
Wetlands	80	50	30	50	70

[1]expected annual pollutant removal
[2]range, with best removal for the wet or dry swales
[3]range, with best removal for grassed channels
[4]no data available, but expected poor pollutant removal
[5]available data suggest minimal pollutant removal

Source: Ellis et al., 2014

Economic Benefits

The United States Environmental Protection Agency (EPA) found that developers, property owners, and communities save money and protect and restore water quality when well-chosen LID practices are implemented (US EPA, 2007). In 2007, the EPA reviewed 17 case studies of developments that included LID practices and concluded that applying LID techniques could reduce project cost and improve environmental performance. In most cases, LID practices were shown to be both fiscally and environmentally beneficial to communities. In the vast majority of cases, significant savings were realized due to the reduced costs for site grading and preparation, stormwater infrastructure, site paving, and landscaping. Savings ranged from 15-80% when LID methods were used in a holistic approach to the design and planning process. Little to no savings were realized when LID methods were used sparingly within designs that had mostly conventional stormwater management practices. In these few cases, the cost of LID practices was higher than those for conventional stormwater practices (Ellis et al, 2014).

The table below is a BMP cost summary of both conventional and LID stormwater practices. The information presented in the table was determined from various design manuals (Greenville County Storm Water Management Design Manual (2013), North Carolina Department of Environment and Natural Resources Stormwater Best Management Practices Manual (2007), and the Maryland Department of the Environment Stormwater Design Manual (2000). Although these are standardized cost estimates, each BMP is tailored to the local site characteristics, such as type of soil, watershed size, and pollutant of concern (Wossink and Hunt, 2003). An example of this is the increased cost to construct a bioretention cell in clay soils compared to sandy soils, although a bioretention cell in clay soil may still produce better results for pollutant removal, runoff volume control, and peak flow attenuation than a wet or dry pond.

Table 2. BMP Cost Summary

BMP	Standard Size	Standardized Cost
Dry Pond	¼ Acre	$12,629
Wet Pond	¼ Acre	$16,271
Bioretention Cell	500 ft^2	$3,122
Bioswale	100 ft^2	$280
Buffer Strip	100 ft^2	$7
Constructed Wetland	1,000 ft^2	$8,016
Green Roof	100 ft^2	$1,732
Infiltration Trench	100 ft^2	$555
Porous Pavement	100 ft^2	$810
Interlocking Pervious Pavers	1,000 ft^2	$19,000
Rain Barrel (average)	55 gallons	$193
Sand Filter	100 ft^2	$3,490

Source: Greenville County Stormwater BMP Report

Initial costs for adopting and designing LID practices may be higher, there is evidence that LID practices are cost effective in the long term. Developers tend to see higher profits with subdivisions that have a design based with conservation efforts. These subdivisions tend be less expensive to build, sell more quickly, and the lots tend to have and retain higher property values than lots in a traditional conventional subdivision.

Low Impact Development in Coastal South Carolina: A Planning and Design Guide

What is Included?

The Low Impact Development in Coast South Carolina: A Planning and Design Guide (LID Design Guide) includes a variety of information that ranges from and overview of LID to planning and regulatory strategies to principles and site design to individual stormwater best management practices to case studies of area using LID practices.

Regulatory Strategies

The regulatory strategy to maintain the integrity of waterbodies is the National Pollutant Discharge Elimination System (NPDES) permitting program that is enforced by the EPA. South Carolina is authorized by the EPA to implement NPDES programs and is managed by the Department of Health and Environmental Control (SCDHEC). If a local program meets or exceeds the Federal and State, the State may delegate authority to the local stormwater water management programs. The City of Charleston (City) Department of Stormwater Management has received this authority from SCDHEC to discharge from the municipal separate storm sewer system (MS4) within city limits. Projects in an MS4 must design, construct, and maintain stormwater management practices that control rainfall on-site, and prevent the discharge of 1” of runoff from the site’s disturbed area (Construction General Permit Section 72-307 C).

Conventional design included hard-infrastructure, end-of-pipe, and site-focused practices that are dictated by the peak flow rate and suspended solids concentration control. Only consideration of design at the site-level without looking at the watershed or regional scale has been known to put more waterbodies on the impaired lists over time (US EPA, 2013). The increase in waterbodies can have negative economic impacts at local and state levels, which is why a comprehensive approach needs to be taken toward design (e.g., modeling stormwater impacts to where the project site is 10% of the total watershed as stated in Section 3.9.4 of the 2020 City of Charleston Stormwater Design Standards Manual (SWDSM)). The comprehensive approach to stormwater design should include an examination of a locality's land development regulations, policies, and ordinances to coincide with water quantity and quality goals.

Neighborhood Planning Considerations

When planning neighborhoods, strategies for improved stormwater management is to use innovative community and subdivision designs, such as compact development. Compact development generates less stormwater per unit development and provide opportunities to localize hydrologic impacts. The City currently has an existing Cluster Development Zoning to permit unique residential developments that:

- Utilize creative and flexible site design compatible with surrounding development patterns;
- Accommodate and preserve features of historical, cultural, archeological, and/or environmental significance;
- Provide common open space of high quality with multiple access points;
- Decrease stormwater runoff and nonpoint source pollution by reducing the amount of impervious surface in the development and incorporating LID;
- Reduce infrastructure costs by integrating predevelopment site hydrology into the stormwater management design for the development; and
- Maintain unobstructed scenic views or vistas, especially from street rights-of-way.

In an effort to progress the existing ordinance, the City is currently working through the final revisions to a Conservation Development Ordinance that will replace the existing Cluster Development ordinance. This ordinance utilizes the same LID site design principles and expands upon the previous Zoning Ordinance.

Additionally, any new development and redevelopment project can incorporate more LID approaches to control stormwater and improve the aesthetic appeal. For example, the City has recently permitted mixed use site plans that incorporate LID principles within the urban setting as well as residential subdivisions. For example, the Sea Aire Cluster Subdivision off Pearl Channel Loop on James Island utilizes bioswales for individual lot drainage and a bioretention area in the open space/common area of the subdivision that can be used for recreation during dry weather. Design guidance for roadways, sidewalks, driveways, parking surfaces, and landscaping can be found in the LID Design Guide.

Implementation of Planning and Design Guide

Integration into Existing Developments

LID can be incorporated into existing developments through retrofitting and redevelopment. Developments that have no or outdated stormwater controls are opportunities to incorporate LID

practices. As more impervious areas increase due to development, retrofitting existing watersheds with LID practices may be used address existing stormwater management problems. The Retrofit Reconnaissance Investigation manual (Schueler et al., 2007) is a nationally recognized and commonly used resources to assess stormwater retrofit potential in an area. The step by step process should be tailored to meet conditions in the City. Redevelopment has the opportunity to address areas where stormwater management problems occur by upgrading deteriorating and aging infrastructure and integrating LID techniques to reduce runoff and non-point source pollution.

In an effort to achieve greater reductions in runoff and non-point source pollution, the City has incorporated incentives into the design process. New development and redevelopment incorporating specific design practices, such as green roofs, will be able to use the compliance to reduce the post-development curve number, thereby reducing the post-development runoff volume and peak flow rates. The City has also incorporated a tiered approach in regards water quality control. Depending on the approach chosen, the developer/designer must capture a minimum rainfall depth for water quality control. Since LID and green infrastructure design techniques promote infiltration, those design elements will be sized to a lower rainfall depth and volume. For BMPs that solely promote a store and release approach, such as ponds, those practices will be sized to contain a higher rainfall depth and volume.

Table 3. Tiered approach rainfall depths based on a 24-hour duration storm event

Tier	Rainfall Depth (inches)
I – Green Infrastructure	1.0
I – Green Infrastructure with 1,000 feet of shellfish beds	1.5
II – Green Infrastructure with an Underdrain	2.0
III – Detention Practices	2.8
IV – Pass Through Devices	Peak flow from 2.8

Source: City of Charleston, 2020

Stormwater Best Management Practices

There are eleven types of BMPs listed in the LID Design Guide that are also listed in SWDSM Section 3.12: (1) bioretention, (2) permeable pavement systems, (3) stormwater infiltration, (4) green roofs, (5) rainwater harvesting, (6) impervious surface disconnection, (7) open channel systems, (8) stormwater filtering systems, (9) dry detention practices, (10) wet detention practices, and (11) stormwater wetlands. Every BMP listed in the LID Design Guide has the capability to meet State and local water quality standards. The site conditions, costs, and pollutant removal goals may dictate which BMP to use over another. The LID Design Guide includes ten (10) sections for each of the BMPs so that a designer/developer can make appropriate choices and effective designs.

These sections are:

1. Introduction of the BMP
2. Key Considerations for the BMP
3. Feasibility Criteria
4. Conveyance Criteria
5. Pretreatment Criteria
6. Design Criteria
7. Landscaping Criteria

8. Construction Sequence
9. Maintenance Criteria
10. References and Additional Resources

Compliance Calculator

A compliance calculator was created by the Center for Watershed Protection to allow a design to quickly analyze multiple LID options. With the different design requirements, equations, and standards for each LID BMP, the tool also allows the designer to check each option against state water quality requirements. The compliance calculator is not a model and should not replace fully designing a BMP, but it is a tool that can help find the best set of LID BMP options for a development. Detailed instructions on how to use the compliance tool can be found in Appendix A of the Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Ellis et al, 2014). Information to better utilize the compliance tool for each BMP can be found in their respective section in Chapter 4 of the Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Ellis et al, 2014). The compliance calculator can be found online at:

http://www.northinlet.sc.edu/compliance-calculator-for-sms4-and-statewide-regulations-april-2014/

There are differences in methodologies between the Compliance Calculator and the requirements in the SWDSM. The Compliance Calculator uses runoff volume to determine an appropriate water quality volume while the SWDSM uses a tiered approach (**Section 3.9.2**) depending on what category BMPs is being use on the project site. The Compliance Calculator can quickly give a general idea of the amount of volume and how much your site would be credited for specific BMPS to achieve the water quality volume detention to estimate in the conceptual design process, but it up to the designer to calculate the water quality volume through the tiered approached in the SWDSM for final designs and calculation submitted during the Permitting Process.

There are instances where the default or constant values in the Compliance Calculator will need to be verified to adhere to the 2020 SWDSM. In the Site data worksheet, the curve numbers need to be verified and updated, if appropriate. In the Flooding and Channel Protection worksheet, the Storm Event rainfall depths will need to be updated to the rainfall depths stated in the **SWDSM Section 3.4.2** to include a 10% factor of safety.

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Technical Procedure Document

Subject: Infiltration Rate and Seasonal High Water Table Determinations

Introduction

The use of Low Impact Development (LID), as described in Technical Procedure Document (TPD) #8, helps to reduce runoff from new and redevelopment sites by using best management practices (BMPs) that encourage infiltration, evaporation, capture, and reuse of stormwater runoff onsite. In order to design these practices, infiltration rates and seasonal high water table elevations must be properly determined. Information on the native soils in the City can be obtained from the NRCS Web Soil Survey website (https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm); however, this information should only be used as a starting point in conceptual planning and not as specific design or modeling input information.

The challenge with most of the soils in the City is that they are no longer native because they have been modified by development. The modifications may include compaction or import of non-native fill. The best way to understand the types of soils that are on a site is to hire professional engineers, geologists, or scientists. They can provide critical information such as soil types, depth to relatively impenetrable soil type, and depth to groundwater and infiltration ability. These are critical considerations when performing calculations for stormwater runoff and determining the ability to implement green infrastructure.

This Technical Procedure Document outlines the City's requirements for properly determining the infiltration rates and seasonal high water table elevations to be used for design purposes.

Design Requirements

The design requirements for infiltration rate and seasonal high water table (SHWT) elevation determinations are described below, which includes information from **Section 3.10.4 of the SWDSM**.

- Soils shall have adequate permeability to allow water to infiltrate. Infiltration practices are limited to soils having a field measured infiltration rate of at least 0.5 inch per hour. Initial consideration shall be based on a review of the appropriate soil survey and proposed depths of excavation or field testing. The survey or testing may serve as a basis for rejection. Onsite soil borings and textural classifications shall be accomplished to verify the actual site and seasonal high water table conditions when infiltration is used.
    - The infiltration rate must be determined at the location of the infiltration BMP and at the elevation of the proposed bottom elevation of the BMP. Please see table B.3-1 in Appendix B of the "Low Impact Development in Coastal South Carolina: A Planning and Design Guide" for minimum numbers of tests per practice area.
    - A minimum Factor of Safety of 2 must be used for determining the design infiltration rate from the field measured rate. For example, if the field measured rate is 2.0 inches per hour, the design rate must be no greater than 1.0 inches per hour. If the geotechnical report recommends a Factor of Safety higher than 2, that higher Factor of Safety number must be used.

- The maximum infiltration rate that can be used for design purposes is 3.0 inches per hour. If the designer wishes to use a higher infiltration rate for design purposes, a design exception request can be submitted per **Section 4.10 of the SWDSM**. The design exception request must include supporting geotechnical data and a detailed explanation of why the exception should be granted.
    - For design exception requests to use an infiltration rate higher than 3.0 inches per hour, the proposed rate must be a maximum of half of the minimum field measured rate (or less if recommended by the geotechnical report), with an absolute maximum of 10.0 inches per hour. The City will also take into account the designer's proposed pretreatments and forebays when considering to grant the request. The City will require a more conservative (lower) infiltration rate to be used in design for practices that do not have significant sediment pretreatment (e.g., exfiltration from the bottom of a pond that will experience clogging from both sediment and vegetative matter) or practices proposed in areas with shallow SHWT where continued high levels of infiltration are not expected throughout the duration of storm events. This determination will be at the discretion of the City.
- All practices that are proposed to use infiltration are to be designed to prevent clogging by fine material and for ease of maintenance through pretreatments and forebays (**Section 3.10 of the SWDSM)**.
- The bottom of infiltration practices shall be at least 0.5 feet above the seasonal high water table, whether perched or regional, determined by direct piezometer measurements, which can be demonstrated to be representative of the maximum height of the water table on an annual basis during years of normal precipitation (minimum one year of data collection required), or by the depth in the soil at which mottling first occurs as determined by an appropriately licensed individual.
    - A double ring infiltration test (DRI) is required for all infiltration determinations outside of those being used for conceptual design / permitting.
    - If the bottom of a BMP, including the bottom of all underdrain pipes and trenches, is proposed to be within 0.5 feet of the SHWT, an impermeable liner (i.e., 40 mil plastic membrane) must be installed to eliminate interaction between the practice and the groundwater. The liner must extend up to an elevation at least 0.5 feet above the properly determined SHWT elevation around the entirety of the practice.
- A geotechnical report, prepared by a licensed professional, with methodology and results discussions will be required to support compliance with the requirements outlined in this TPD and in the SWDSM. The report must also include data from all tests performed and a map showing the location of all tests.

Technical Procedure Document

Subject: Permeable Pavement

Introduction

The use of Low Impact Development (LID), as described in Technical Procedure Document (TPD) #8, helps to reduce runoff from new and redevelopment sites by using best management practices (BMPs), more specifically permeable pavement. Permeable pavement is an effective practice for meeting the SWDSM manual requirements for both water quantity and quality; however, there are various methodologies that exist when it comes to computing the runoff reduction and water quality treatment that permeable pavement provides as a stormwater practice.

This Technical Procedure Document outlines the City's requirements for properly computing the water quantity and quality benefits of permeable pavement in order to be used for design purposes.

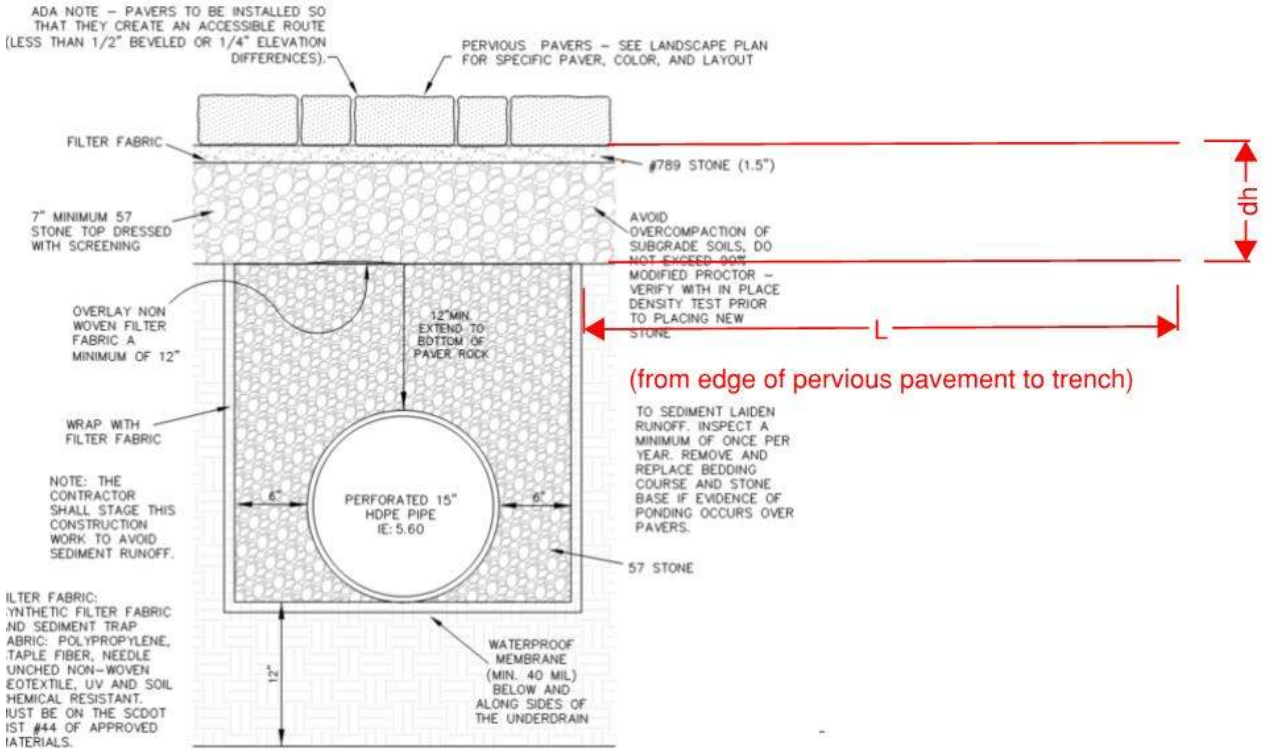
Design Requirements

The design requirements for Permeable Pavement Systems are described below, which includes information from **Section 3.12.2 of the SWDSM**. Please note that the designer is still required to meet all sections of the 2020 SWDSM as this document does not preclude them from any of the SWDSM's requirements.

- The City requires the design, installation, and maintenance requirements for permeable pavement systems to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Ellis et al. 2014).*
- Permeable Pavement systems shall be designed to completely drain within 72 hours
- The proportion of drainage area to permeable pavement footprint should be less than 10:1.
- An observation well shall be provided to allow for easy monitoring of the water level with the practice. The observation well shall be a 6-inch perforated PVC pipe with a removable and lockable cap.
- The City requires the design, installation, and maintenance requirements for permeable pavement systems to be as outlined in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Ellis et al. 2014).*
- Permeable pavement is able to provide multiple stormwater benefits that can be accounted for in the designer's proposed model. These benefits include **either** 1) an extended time of concentration (ToC) or 2) Storage within the voids of the base course and infiltration
    - An extended ToC for the area draining directly to and through the permeable pavement can be provided in the model as the time it takes water to travel through the proposed base course of the practice is normally a longer time when compared to the traditional

method of looking at surface / channelized flows. The City accepts the use of Darcy's Law ($V = \frac{K*i}{porosity}$) to determine the velocity of runoff where K is your hydraulic conductivity of the select gravel / media being used and i is your vertical gradient within the base course ($\frac{dh}{L}$ in the graphic below). Please note that an acceptable K value for 57 stone is 0.15 ft/s and an acceptable porosity is 0.40. **Please note that storage and infiltration cannot be accounted for if an extended ToC is being used in the model.**

Please also note that in order to account for an extended ToC through a permeable pavement, all areas that drain to the pavement will need to be shown in its own drainage area.



- The City allows for the use of documentable void space within the proposed base course based on the type of material being used. Typical aggregates vary between 20% and 40% void ratios. Please present gravel type and void spaces being used in the detail and note that material will need to verified during the as-built process.
- Infiltration must meet the requirements of the 2020 SWDSM Technical Procedure Document #9.

- Computations can show a reduced curve number (RCN) for permeable pavement only if projects 1) do not require underdrain for proposed permeable pavement systems 2) The permeable pavement system does not connect to the rest of the proposed site stormwater systems.

  The RCN values shall be based on the infiltration values measured within the location of the proposed practice as well as depth of base course. A RCN cannot be used if the geotechnical

analysis shows that the soils provide an infiltration of less than 0.5 in/hr. The RCN values must be in accordance with the table provided below:

Infiltration Values (inches per hour)	Reduced Curve Numbers (RCN) for 6” – 9” base course	Reduced Curve Numbers (RCN) for 9”+ base course
0.5 – 1	84	80
1 – 3	79	74
3+	69	61

*SHWT must be 0.5’ below the bottom of the proposed base course.

The designer may not account for any other runoff reduction benefits (extended ToC, storage or infiltration) if a RCN is being used as a part of their design.

- The designer must meet the water quality requirements of the 2020 SWDSM if this practice is to be used for water quality purposes.

Technical Procedure Document

Subject: Computer Modeling for Hydraulic Grade Line and Velocity Computations

Introduction

The City of Charleston Design Manual section 3.4.4.2 requires all pipe calculations to incorporate the Saint-Venant equations if backwater, tailwater, and/or tidal conditions are present, and the pipe run has five or more connections. If these conditions are not present, Manning's Equation may be used. The City of Charleston has performed an analysis of the HEC-22 program, and others, to determine if they are generally accepted approaches.

The critical piece of this review was the City's requirement in section 3.4.6.1 #2 of the 2020 SWDSM which states "*The minimum slope for storm drainage pipe shall be three tenths of 1 percent [0.003 ft/ft] where possible. The minimum flow velocity shall be 2 fps for pipes flowing full or half full. Often the controlling factor is velocity rather than grade. Pipes that have the purpose of equalization between two or more ponds do not have to meet this requirement. Maximum allowable flow velocity shall be 10 fps under any flow condition.*" The intent of this requirement is to provide adequate flushing velocities for all pipe runs to reduce sediment buildup within the piped system.

Design Requirements

1. HEC-22, as well as other hydraulic modeling programs which incorporate the Saint-Venant equations, are appropriate for pipe capacity analysis / design (i.e. Hydraulic Grade Line Determination). While programs differ from one another, they each provide adequate pipe sizing capabilities that meet the current SWDSM if applied correctly. These computations are to be performed using the 4% AEP storm event and can use either a constant or dynamic tailwater condition as long as it is representative of the downstream conditions.

2. The City has determined that if the proposed design can show that the minimum 2 fps flow velocity is met for the 4% AEP storm event or any storm event that will have a more frequent occurrence (i.e. 50%, 25%, 10%), then the intent of the SWDSM is considered to have been met for the proposed design.

3. For evaluating minimum pipe velocities, HEC-22 is not acceptable as the reported values are not correct for partially submerged pipes when the downstream depth is below the top of the pipe but above normal depth conditions within a pipe. Therefore, an alternate program will be required that provides more accurate results. These computations can use either a constant or dynamic tailwater condition as long as it is representative of the downstream conditions.

4. For situations where a hydraulic modeling program does not provide a minimum velocity at the pipe terminal, the City will require that a velocity of 2.5 fps be shown to ensure that the intent of the manual is still being met. Below is a quick summary of how some of the allowable hydraulic modeling programs currently report velocity:

a. HEC-22 is not suitable for reporting minimum velocity as described in item #3 above.
b. ICPR reports a velocity at both the upstream and downstream ends of the pipe based on the representative pipe flow area for the depth.
    i. Designer to show that the lower of the two velocity values be at or above 2 fps.
c. EPA SWMM calculates a velocity at the upstream, downstream, and middle of the pipe, however only the velocity at the middle of the pipe is reported with the output. The middle velocity is determined by the pipe's area based on an average depth from the upstream and downstream ends.
    i. Design to show that the middle velocity is at or above 2.5 fps.
d. Civil3D's Storm Sewer Analysis (SSA) is a modified version of EPA SWMM and also only reports the pipe velocity related to the middle of the pipe.
    i. Design to show that the middle velocity is at or above 2.5 fps.
    ii. If it can be shown that the program is able to provide velocities at the upstream and downstream ends of the pipe, then the design can show that the lower of the two velocity values are at or above 2 fps to satisfy this requirement.

5. A design exception request will be required if the proposed design is unable to meet the minimum flow velocity of the current SWDSM. The designer would need to show that the intent of the manual is still being met by the proposed design. This can be accomplished by providing pretreatment to all stormwater runoff prior to it entering the proposed closed storm drain system. Pretreatment practices can include, but are not limited to, the following:
    a. Open Channel Systems
    b. Green Infrastructure Practices
        i. Stormwater filtration Systems
        ii. Vegetated Filter Strips / Sheet Flow to Outfall Location
        iii. Pocket Rain Gardens

Technical Procedure Document

Subject: Areas with Known Flooding Requirements

Introduction

The City of Charleston Stormwater Design Manual section 3.6.1 requires that runoff reductions be met for sites located within a Special Protection Area of Known Flooding. One of the options to show compliance with these requirements it to provide a set volume of stormwater storage based off of the existing condition runoff volume of the site being analyzed. The purpose of this document is to provide additional information on how an applicant can show compliance with this section of the manual using the above-mentioned option.

Design Requirements

1. The compliance option listed in the manual is as follows:

   If it can be shown that the proposed work will generate no additional runoff volume or changes in discharge rate in the post-development condition for the 50 percent, 10 percent, and 4 percent AEP storm events, then the requirements can be met by providing storage equal to 50 percent of the existing condition runoff volume for the 4 percent AEP storm event. If the project utilizes City funding then only 40 percent of the existing condition runoff volume for the 4 percent AEP storm event must be provided. If Low Impact Development (LID) practices as defined by Table 4.1-1 in the Low Impact Development in Coastal South Carolina: A Planning and Design Guide (Ellis et al. 2014) are being utilized, then every 1 unit of storage for these practices can count as 1.1 units to meet the required storage volume.

2. Storage is defined as any provided volume within the stormwater practice at or below 0.5' above the 1% AEP Storm Event Water Surface Elevation as determined by showing compliance with other stormwater requirements.

3. The entire disturbed area must be routed to the proposed stormwater practices.

4. All other requirements of the proposed stormwater practices as defined in the *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al. 2014) must be met

5. All other requirements of the proposed stormwater practices as defined in Stormwater Design Standards Manual must be met. The subsections below help provide simplified methodology to some, but not all, of the requirements that must be met:

   a. Impoundment / Freeboard Requirements (Section 3.10.1): Compliance with the 0.5' of

freeboard above the 1 percent AEP, 24-hour storm high water elevation can be shown by using a conservative peak tailwater condition that peaks at hour 12 of the storm and fully drains within the following 48 hours. The applicant can assume that the peak elevation is 6” above the highest crown elevation of the adjacent roadway for all storm events. This approach can only be used if the City does not have historical data to support a different elevation.

b. Recovery Time (Section 3.10.2): The Recovery requirement can be shown by utilizing a conservative tailwater condition as described above (section 5.a).

c. Seasonal High Water Table (SHWT) Clearance: If an impermeable liner is not being utilized, a geotechnical analysis must be performed to determine the SHWT at the location of the stormwater practice.

d. 1 Percent Annual Exceedance Probability Storm Event Analysis (Section 3.9.4): Please see Technical Procedure Document #4 for information on how the requirements of this section can be met in relation to fill displacement.

6. A 3” low flow orifice must be utilized at the outlet control structure; All other orifices and weirs can be proposed as necessary to meet other requirements but may not be within 2 feet of the top of the low flow orifice and must be sized to maximize the time stormwater is being stored within the stormwater practice.