



City of Clemson
Stormwater Design Manual (SWDM)

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*Prepared in accordance with the City of Clemson
Stormwater Ordinance*

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Section 1. Definitions

For the purpose of this manual, definitions contained in South Carolina regulation 61-9.122.2 and 72-301 are incorporated herein by reference. Where the same words are defined in both the aforementioned regulations, but are not the same, the definition contained in R.61-9.122.2 shall be used for the purpose of this manual. Additional terms, phrases and words shall have the meanings given below or included in the following document.

Accelerated Erosion – erosion caused by development activities that exceeds the natural processes by which the surface of the land is worn away by the action of water, wind, or chemical action.

Applicant – a property owner or agent of a property owner who has filed an application for a stormwater management permit.

Authorized Signature – Any: officer, corporation director, senior management official of a corporation, partnership, or business association that is an applicant; Property owner who has commissioned the work to be done; and, designer or professional who has taken responsibility for the project.

Best Management Practices (BMP) – schedule of activities, prohibitions or practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMP's also include treatment requirements, operating procedures and practices to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Building – any structure, either temporary or permanent, having walls and a roof, designed for the shelter of any person, animal, or property, and occupying more than 120 square feet of area.

Certified Erosion Prevention and Sediment Control Inspector Training (CEPSCI) – training that provides compliance inspector certification to individuals who complete CEPSCI course and passed the qualification exam.

Channel- a natural or artificial watercourse with a definite bed and banks that conducts continuously or periodically flowing water.

Control measure – refers to any BMP or other method used to prevent or reduce the discharge of pollutants to waters of the United States.

Commencement of Construction Activities – the initial disturbance of soils associated with clearing, grading, or excavating activities or other construction-related activities (e.g. stockpiling of fill material).

Construction – any building or erection of a structure, or any physical site preparation for the building or erection of a structure.

City Engineer – The City of Clemson Engineer or his authorized representative(s)

City of Clemson Engineering Department – may include but not limited to any employee from the Storm Water Utility, City of Clemson Planning Office, City of Clemson Public Works, or City of Clemson Engineering Department or any authorized persons.

Dedication – The deliberate appropriation of property by its owners for general public use.

Detention Facility – A detention basin or alternative structure designed for the purpose of temporary storage of stream flow or surface runoff and gradual release of stored water at controlled rates.

Developer – Any person acting on his own behalf as a property owner, or as an agent for a property owner, who makes application for plan approval and a grading permit under the provisions of this manual.

Development – Any of the following actions undertaken by a public or private individual or entity:

- a) any land altering activities associated with the division of a lot, tract or parcel of land into two (2) or more lots, plots, sites, tracts, parcels or other divisions by plan or deed, or
- b) any man-made change, including clearing, tree removal, grubbing, stripping, dredging, grading, mining, drilling, excavating, paving, transporting and filling of land,

Discharge – activities that cause, contributed to, or result in storm water point source pollutant discharges, including but not limited to: excavation, site development, grading and other surface disturbance activities; and measures to control storm water including the sighting, construction and operation of best management practices to control, reduce or prevent storm water pollution

Disturbance – see land disturbing activity.

Drainage – A general term applied to the removal of surface or subsurface water from a given area either by gravity via natural means or by systems constructed to remove water, commonly applied to surface water.

Drainage Channel – Any natural or man-made conveyance for surface water, including open channels, enclosed storm sewers, streams, rivers, lakes, ponds, or marshes.

Drainage Easement – a legal right granted by a landowner to a grantee allowing the use of private land for stormwater management purposes.

Drainage System – the surface and subsurface system for removal of water from the land, including both the natural elements of streams, marshes, swales, and ponds whether of an

intermittent or continuous nature; and the manmade elements such as improved open channels, culverts, retention facilities, and enclosed storm sewers.

Easement – A grant or reservation by the owner of land, for the use of such land by others for a specific purpose or purposes, and which must be included in the conveyance of land.

Embankment or Fill – a deposit of soil, rock, or other material placed by man.

Erosion – the general process by which soil and rock fragments are detached and moved by the action of wind, water, ice, and gravity, either naturally or induced.

Erosion and Sediment Control Plan – a plan, which adequately describes necessary land management practices and control measures, including a timetable or schedule for their installations, which will effectively minimize soil erosion and sedimentation; prepared and approved as provided herein for application to a particular land area.

Final Stabilization:

- 1) All soil disturbing activities at the site have been completed and either of the two following criteria are met:
 - a. A uniform (e.g., evenly distributed, without bare areas) perennial vegetative cover with a density of 70 percent of the native background vegetative cover for the areas has been established on all unpaved areas and areas not covered by permanent structures, or
 - b. Equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.
- 2) When background native vegetation will cover less than 100 percent of the ground (e.g. arid areas, beaches) a determination by the Stormwater Manager or his authorized representatives to the required coverage percentage for the property.
- 3) For individual lots in residential construction (not in larger common development), final stabilization means that either:
 - a. the homebuilder has completed final stabilization including perimeter,
 - b. The homebuilder has established temporary stabilization including perimeter controls for an individual prior to occupation of the home by the homeowner and informing the Stormwater Utility and homeowner by written letter of the need for, and benefits of, final stabilization.
- 4) For construction projects on land used for agricultural purposes (e.g. pipelines across crop or range land, staging areas for highway construction, etc.), final stabilization might be accomplished by returning the disturbed land to its preconstruction agricultural use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to “waters of the United States,” and areas which are not being returned to their preconstruction agricultural use must meet the final stabilization criteria (1), (2), or (3) above.



Flood – A general and temporary condition of partial or complete inundation of normally dry land areas, caused by the overflow of a watercourse or the unusual and rapid accumulation of surface water runoff from any source. For the purpose of this chapter, a flood shall be construed to be any inundation that has a return frequency of one hundred (100) years or less.

Floods:

- 10-year flood: the flood having a ten percent (10%) chance of being equaled or exceeded in any given year.
- 25-year flood: the flood having a four percent (4%) chance of being equaled or exceeded in any given year.
- 50-year flood: the flood having a two percent (2%) chance of being equaled or exceeded in any given year.
- 100-year flood: the flood having a one percent (1%) chance of being equaled or exceeded in any given year.
- 500-year flood: the flood having a two-tenths percent (.2%) chance of being equaled or exceeded in any given year.

Grading – Any displacement of soil by stripping, excavating, filling, stockpiling, or any combination thereof, and shall include the land in its excavated or filled state.

Grading Permit – A certificate issued by the City to perform work pursuant to approved Erosion and Sediment Control Plan prepared under the provisions of this manual.

Group Development – The development of two (2) or more structures designed or intended for separate occupancy or use on a site that is not subdivided into lots, blocks, and streets, and is subject to the city’s land development regulations; such as shopping centers, office buildings, industrial sites, manufactured home parks, apartment complexes, and condominium complexes.

Hotspot – an area where land use or activities generate highly contaminated runoff, with concentrations of pollutants in excess of those typically found in stormwater.

Hydrologic Soil Group (HSG) – a Natural Resource Conservation Service classification system in which soils are categorized into four runoff potential groups. The groups range from A soils, with high permeability and little runoff production, to D soils, which have low permeability rates and produce much more runoff.

Illicit Connection – any man-made conveyance connecting an illicit discharge directly to a small municipal separate storm sewer (SMS4).

Illicit Discharge – any discharge to the City Stormwater System that is not composed entirely of stormwater, except:

- a) Discharges pursuant of an NPDES permit (other than the NPDES for the city); and



b) Discharges resulting from firefighting activities.

Impervious cover – those surfaces that cannot effectively infiltrate rainfall (e.g. building rooftops, pavement, sidewalks, driveways, etc.)

Industrial Stormwater Permit – a National Pollutant Discharge Elimination System permit issued to a commercial industry or group of industries, which regulates the pollutant levels, associated with industrial stormwater discharges or specifies on-site pollution control strategies.

Infiltration – the process of percolating stormwater into the subsoil.

Infiltration Facility – any structure or device designed to infiltrate retained water to the subsurface. These facilities may be above grade or below grade.

Jurisdictional Wetland – an area that is inundated or saturated by surface water or groundwater at a frequency and durations sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation.

Land – any ground, soil, or earth, including marshes, swamps, drainage-ways, and areas not permanently covered by water.

Land Disturbance Activity – any activity involving the clearing, grading, transporting, filling, and any other activity, which causes the land to be exposed to the danger or erosion.

Landfill – a disposal facility or part of a facility where solid waste (Municipal Solid Waste, Construction debris, land clearing debris, etc. as defined by SCDHEC Regulation 61-107.19) is placed in or on land, and which is not a land treatment facility, a surface impoundment, or an injection well.

Landowner – the legal or beneficial owner of land, including those holding the right to purchase or lease the land, or any other person holding proprietary rights of the land.

Larger Common Plan of Development (LCP) – is a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules under one plan. The larger common plan of development or sale also applies to other types of land development such as industrial parks or well fields.

Large Construction Activity – defined by 40 CFR § 122.26(b)(14)(x) and incorporated here by reference. A large construction activity includes clearing, grading, and excavation resulting in a land disturbance that will disturb equal to or greater than five acres of land or will disturb less than five acres of total land area but is part of a larger common plan of development or sale that will ultimately disturb equal to or greater than five acres.

Low Impact Development (LID) – a stormwater management strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection objectives and fulfill environmental regulatory. LID employs a variety of natural and

built features that reduce the rate of runoff, filter out its pollutants, and facilitates the infiltration of water into the ground. By reducing water pollution and increasing groundwater recharge, LID helps to improve the quality of receiving surface waters and stabilize the flow rate of nearby streams. Examples of LID include but are not limited to: bioretention, dry wells, filter strips, vegetated buffers, grasses swales, infiltration trenches, inlet devices, and rain barrels

Municipal Separate Storm Sewer System (MS4) – refers to either large, medium, or small municipal separate storm sewer systems. The term is used to refer to either the system operated by a single entity or a group of systems within an area that are operated by multiple entities.

- The City of Clemson is considered a small MS4 of SMS4, that is the sole operator of the storm sewer system

Municipal Separate Storm Sewer – a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

- i. Owned or operated by a state, county, parish, district, city, town, borough, association, or other public body (created by or pursuant of state law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other waste, including special districts under state law such as 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 State,
- ii. Designed or used for collecting or conveying stormwater,
- iii. Which is not a combined sewer, and
- iv. Which is not part of a Public Owned Treatment Works (POTW) as defined by the South Carolina Water Pollution Control Permits Regulation 61-9 122.2

Maintenance Agreement – a legally recorded document that acts as a property deed restriction, and which provides for long-term maintenance of storm water management practices.

National Pollutant Discharge Elimination System (NPDES) – the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcement permits, and imposing and enforcing pretreatment requirements, under section 307, 402, 318 and 405 of the Clean Water Act.

New Construction – structures for which the first placement of permanent construction commenced on or after the effect date of this chapter.

Nonerosive velocity – a speed of water movement that is not conducive to the development of accelerated soil erosion.

Nonpoint Source Pollution – pollution from any source other than from discernible, confined, and discrete conveyances, and shall include, but not be limited to, pollutants from agricultural, silviculture, mining, construction, subsurface disposal and urban runoff sources.

Off-Site Facility – a stormwater management measure located outside the subject property boundary described in the permit application for land development activity.

On-Site Facility – a stormwater management measure located within the subject property boundary described in the permit application for land development activity.

Outfall – a point source as defined by section 122.2 of SC R.61-9 at the point where a municipal separate storm sewer discharges to waters of the State and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the State.

Point Source – any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

Pollutant – a partial listing includes: dredged spoil, solid waste, sewage, garbage, sewage sludge, chemical waste, biological materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial or municipal waste.

Rain Gardens –landscape features that require less maintenance and fewer chemicals than traditional landscape. Rain gardens capture runoff from impervious areas such as roofs and driveways and allow it to seep slowly into the ground. Most importantly, rain gardens help preserve nearby streams and lakes by reducing the amount of runoff and filtering pollutants.

Recharge – the replenishment of underground water reservoirs.

Redevelopment – a land disturbance activity that alters the current use of the land, the City of Clemson views redevelopment as two categories:

- 1) “Type 1 redevelopment” – any repair, maintenance or other that does not alter the current impervious footprint;
- 2) “Type 2 redevelopment” – all other redevelopment;

Type 2 Design Requirements

- The Predevelopment Curve number for the entire impervious area shall be as if the current impervious area on the site is a Pasture in poor conditions the curve numbers below should be used.

Hydrologic Soil Group	A	B	C	D
Curve Number	65	79	86	89

- All design factors must be based off of these numbers. If a history of downstream flooding is known the predevelopment curves numbers may be required to be lower to mitigate flooding issues, a map of areas with known flooding and associated curve numbers may be found on the Cities website.
- These design factors may not be used when designing construction stormwater runoff.

Runoff coefficient – the fraction of total rainfall that will appear at the conveyance as runoff.

Small Municipal Separate Storm Sewer System (SMS4) – all small separate storm sewer systems that are owned or operated by the United States, a state, county, parish, district, city, town, borough, association, or other public body (created by or pursuant of state law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other waste, including special districts under state law such as 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.

Stop Work Order – an order issued that requires that all construction activity on a site be stopped.

Storm Water – storm water runoff, snowmelt runoff, and surface runoff and drainage.

Stormwater Pollution Prevention Plan – a plan that is designed to minimize the accelerated erosion and sediment runoff at a site during construction activities.

Stormwater Management – the use of structural or non-structural practices that are designed to reduce storm water runoff pollutant loads, discharge volumes, peak flow discharge rates and detrimental changes in stream temperature that affect water quality and habitat.

Stormwater Retrofit – a stormwater management practice designed for an existing development site that previously had either no stormwater management practice in place or a practice that inadequately meet the stormwater management requirements of the site.

Stormwater Runoff – flow on the surface of the ground, resulting from precipitation.

Stormwater Treatment Practices (STPs) – structural or non-structural measures, that are determined to be most effective, practical means of preventing or reducing point source or nonpoint source pollution input to stormwater runoff and water bodies.

Subdivision – all divisions of a tract or parcel of land into two (2) or more lots, building sites, or other divisions, or parcels less than five (5) acres, for the purpose, whether immediate or future, of sale, legacy or building development, or includes all division of land involving a new street or a change in existing streets, and includes resubdivision and, where appropriate, in the context, shall relate to the process of subdividing to the land or area subdivides.

Water Quality Volume (WQ_v) – the storage needs to capture and treat 90% of the average annual stormwater runoff volume. Numerically WQ_v will vary as a function of long-term rainfall statistical data.

Waters of South Carolina, or Waters of the State (WoS) – 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 stalk, 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 CWA are not waters of South Carolina. This exclusion applies only to manmade bodies of water, which neither were originally created in water of South Carolina (such as disposal areas in wetlands) nor resulted from the impoundment of waters of South Carolina.

Waters of the United States or Waters of the U.S. means

- a) all waters, which are currently used, were used in the past, or may be susceptible to sue in interstate or foreign commerce, including waters, which are subject to the ebb and flow of tide.
- b) all interstate waters, including interstate “wetlands”
- c) all other waters such as interstate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, 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:
 - 1) which are or could be used by interstate or foreign travelers for recreations or other purposes

- 2) from which fish or shellfish are or could be taken and sold in interstate commerce; or
- 3) which are used or could be used for industrial purposes by industries in interstate commerce
- d) all impoundments of waters otherwise defined as waters of South Carolina under this definition; tributaries of waters identified in paragraphs (a) through (d) of this definition; the territorial sea; and Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraph (a) through (d) of this definition.

Watercourse – a permanent or intermittent stream or other body of water, either natural or man-made, which gathers or carries surface water.



Introduction

This manual had been developed to assist in the design and evaluation of stormwater management facilities within the City of Clemson, South Carolina. It provides engineering design guidance to:

- engineers responsible for the design of stormwater management structures,
- developers involved in site planning and design,
- others involved in the stormwater management at various levels who may find the manual useful as a technical reference to define and illustrate engineering design techniques.

Application of the procedures and criteria presented in the manual should contribute toward the effective and economical mitigation and solution of local drainage and flooding problems. Application of the procedures should also contribute to more uniform design and analysis of stormwater management facilities throughout the City of Clemson.

Engineering design methods other than those included in this manual may be used if approved by the City of Clemson's Stormwater Utility Department. Complete documentation of these methods may be required for approval. This manual presents technical and engineering procedures and criteria needed to comply with the City of Clemson's Stormwater Ordinance.

This Design Manual is intended to be a dynamic document. As design technology and criteria evolve, the Manual may and/or will require updates, modification and improvements. As updates are made, they will be available for download from the City of Clemson's website. It will be each user's responsibility to maintain a current edition of the Design Manual. The website format will allow the user to easily obtain or update new Design Manual Information.



Section 2. General Provision

A. Finding of the Facts

It is hereby determined that:

- a) Land development projects and associated increases in impervious cover alter the hydrologic response of local watersheds and increase storm water runoff rates and volumes, flooding, stream channel erosion, and sediment transport and deposition. This storm water runoff contributes to increased quantities of water-borne pollutants. Storm water runoff, soil erosion and nonpoint source pollution can be controlled and minimized through the regulation of storm water runoff from development sites,
- b) Therefore, the City of Clemson establishes this set of water quality policies applicable to all surface waters to provide reasonable guidance for the regulation of storm water runoff for the purpose of protecting local water resources from degradation. It is determined that the regulation of stormwater runoff discharges from land development projects and other construction activities in order to control and minimize increase in storm water runoff rates and volumes, soil erosion, stream channel erosion, and nonpoint source pollution associated with storm water runoff is in the public interest and will prevent threats of public health and safety.
- c) Stormwater runoff is a source of pollution of waters of the State, and may add to existing flooding problems. The implementation of a city storm water management and sediment control program will help prevent additional water quantity and water quality problems and may reduce existing problems.
- d) Stormwater management and sediment control plan approvals are necessary prior to engaging in any land disturbing activity related to residential, commercial, industrial or institutional land use which are not specifically exempted or waived by this manual.
- e) The City of Clemson is required by federal law to obtain a NPDES permit from the South Carolina Department of Health and Environmental Control (DHEC) for storm water discharges from the City of Clemson's Stormwater System. The NPDES permit required the City of Clemson to impose controls to reduce the discharge of pollutants in storm water to maximum extent practicable using management practices, control techniques and system design and engineering methods, and such other provisions, which are determined to be appropriate for control of such pollutants.
- f) Additionally, certain facilities that discharge storm water associated with an industrial activity, including land disturbing activities, are required to obtain a NPDES permit(s). Also, the South Carolina Storm Water Management and Sediment Reduction Act [S.C. Code 48-14-10 et seq.] requires a permit for certain land disturbing activities.

B. Purpose

The purpose of this manual is to establish minimum storm water management requirements and controls to protect and safeguard the general health, safety, and welfare of the public

residing in watersheds within this jurisdiction. This manual seeks to meet that purpose through the following objectives:

- a) Minimize increase in storm water runoff from any development in order to reduce flooding, siltation, increases in stream temperature, and stream bank erosion and maintain the integrity of stream channels;
- b) Minimize increases in nonpoint source pollution caused by storm water runoff from development, which would otherwise degrade local water quality;
- c) Minimize the total annual volume of surface water runoff, which flows from any specific site during the following development to not exceed the pre-development hydrologic regime to the maximum extent practicable;
- d) Reduce storm water runoff rates and volumes, soil erosion and nonpoint source pollution, wherever possible, through storm water management controls and to ensure that these management controls are properly maintained and pose no threat to public safety;
- e) Minimize point source pollutants by requiring redevelopment sites to comply with all new stormwater controls and BMP's;
- f) It is further the purpose of this manual to comply with the Federal and corresponding state storm water discharge (NPDES) regulations (40 CFR 122.26 and SC R.61-9.122.26) developed pursuant to the Clean Water Act and to assure the City of Clemson the authority to take any action required by it to obtain and comply with its NPDES permit for storm water discharges. Among other things, these regulations require the City of Clemson to establish legal authority; which authorizes or enables the City of Clemson at a minimum to:
 - I. Control the contribution of pollutants to the City of Clemson's SMS4 and receiving waters by stormwater discharges associated with residential, commercial, industrial, and related facilities activity and the quality of storm water discharged from sites of residential, commercial, industrial, and related facilities activity;
 - II. Prohibit illicit discharge to the City of Clemson's SMS4 and receiving waters;
 - III. Control the discharge to the City of Clemson's SMS4 and receiving waters of spills, dumping and disposal of materials other than stormwater;
 - IV. Control, through intergovernmental agreements, contribution of pollutants from one municipal storm water system to another;
 - V. Require compliance with conditions in manuals, permits, contracts or orders;
 - VI. Carry out all inspections, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions including the prohibition of illicit discharges to the City of Clemson's SMS4 and receiving waters.



The application of this manual and the provision expressed herein shall be the minimum stormwater management requirements and shall not be deemed a limitation or repeal of any other powers granted by statute. In addition, if site characteristics indicate that complying with these minimum requirements will not provide adequate designs or protection for local property or residents, it is the owners and operator's responsibility to exceed management practices, control techniques, system design and engineering methods and such other programs and controls as a required by the City of Clemson's NPDES permit. This manual is to be construed to further its purpose of controlling and reducing pollutant discharges to the City of Clemson SMS4 and to the Waters of the State to assure the obligations under its NPDES permit issued by SCHDHEC as required by 33 USC 1342 and 40 CFR 122.26.



Section 3. Stormwater Management Plans

3.1 Purpose

The purpose of the Stormwater Management Plan is to ensure that stormwater management is considered and fully integrated at the early planning stages of the site-development process. This involves a more comprehensive approach to site planning and a thorough understanding of the physical characteristics and resources associated with the project site. Site designers are encouraged to develop comprehensive Storm Water Management Plans for proposed development. This planning includes addressing each of the following categories separately:

- Stormwater quantity controls;
- Erosion and sediment controls;
- Stormwater quality controls;
- Stormwater conveyance controls; and,
- Pollution abatement controls.

The result of this planning is a comprehensive report that contains technical information and analysis to submit to the City of Clemson Engineer to determine if a proposed development meets the City of Clemson's storm water regulations and the standards contained in this Design Manual.

3.2 Steps for Successful Stormwater Management Plans

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

- Pre-design meeting;
- Review of site development requirements;
- Detailed Site analysis;
- Creation of a Stormwater Concept Plan (for innovative techniques);
- Creation of a preliminary site development plan; and,
- Completion of final site development plan.

3.2.1 Pre-Design Meeting

One of the most important actions that happens at the beginning of the land-development process is a pre-design meeting between the City of Clemson Engineering staff, developer/owner and design professional. This meeting allows all of the entities involved in the land development process to understand the stormwater management requirements and identify the areas on the site that will require the most attention to meet the requirements of the regulations and identify the areas on the site that will require the most attention to meet the requirements of the regulations. Major incentives for the pre-submittal site meeting are establishing a partnership between all of the entities involved through the entire development process, and increasing the chances of faster City of Clemson Stormwater Management Permit

Approval through an early understanding of the permitting and plan requirements. It shall be left to the discretion of the City of Clemson Engineering staff if this meeting shall or shall not be required for a specific project.

3.2.2 Review of Site Development Requirements

The Stormwater management plan design professional should be familiar with the City of Clemson's Stormwater Management Permit requirements that are given in this Design Manual. Most of this guidance can be obtained at the pre-design meeting.

The plan design professional must also be familiar with other regulatory requirements and ordinances such as but not limited to the following:

- Zoning ordinances;
- Subdivision regulations;
- Road, SCDOT and utility requirements;
- SCDHEC Land Disturbance Regulations;
- Land Development regulations;
- Other Local, State, and Federal regulatory requirements and ordinances.

3.2.3 Detailed Site Analysis

To better understand the existing topography, hydrology and hydraulics of the proposed development, the design professional should personally make a field site visit. During this visit, the design professional should collect as much information as necessary to create an accurate existing condition map of the proposed site. If the design professional has a good understanding of the existing site conditions, it should be easier to implement a stormwater management plan that will effectively protect downstream water quantity and quality impacts. An actual site visit also gives the design professional an initial vision of how the potential storm water management system can fit with the natural surroundings. Items to be recorded during the site visit shall include, but not limited to the following:

- Topography of the site especially very steep sloped areas (may indicate that guardrail locations and/or profile views may need to be provided);
- Natural drainage patterns, swales, and detention areas;
- Natural perennial flowing streams and intermittent streams;
- Existing floodplain locations and elevations;
- Soil types and evidence of eroded and/or non-eroded soils;
- Existing vegetation including the corresponding density of each type of vegetation:
 - Trees
 - Grasslands
 - Various Ground covers
- Existing development including roads, buildings, utility easements, parking areas, and ponds;

- Existing stormwater facilities including ditches, storm sewer systems, and detention ponds;
- Adjacent property characteristics and stormwater outfall points;
- Wetlands;
- Critical habitat areas;
- Boundaries of existing wooded areas; and,
- Existing buffer areas along natural drainage ways and channels.

3.2.4 Creation of a Stormwater Concept Plan for Innovative Practices

The Stormwater concept plan involves the overall layout of the site including the stormwater management system layout. This Concept Plan is an optional step which gives the design professional the opportunity to propose several potential site layout possibilities to the developer/owner and the City of Clemson Engineer. A concept plan may be needed if the design professional is proposing innovative design approaches not currently outlined in the design manual or if deviations from the design manual are proposed. Deviations will require a written request for exemptions or waivers. Innovative methods and technologies are encouraged and shall be accepted providing there is sufficient documentation to prove the effectiveness and reliability of the proposed approach.

Upon concurrence of the Concept Plan, the applicant shall create and submit a Final Site Development Plan. However, concurrence in the concept stage will not prevent the City Engineer from rejecting the Site Development Plan during the formal review process if it is determined that the plan does not comply with federal, state, or local laws and regulations including the City of Clemson’s ordinances.

3.2.5 Minimum Preliminary Site Development Plan Requirements

All Preliminary site development plans shall include as a minimum the following:

- A vicinity map indicating a north arrow, scale, boundary lines of the site and other information necessary to locate the development site;
- The existing and proposed topography of the development site except for individual lot grading plans in single-family subdivisions, shown in 1 foot contours.
- Pre-development hydrologic analysis and calculations that determines the existing stormwater runoff volumes, peak flow rates and flow velocities, for the 2, 10 and 100 year storm events;
- Post-development hydrologic analysis and calculations that determines the stormwater runoff volumes, peak flow rates and flow velocities, for the 2, 10, and 100 year storm events;
- Location, dimensions, elevations, and characteristics of all storm water management facilities. As a minimum, easements shall have the following characteristics:
 - Provide adequate access to all portions of the drainage system and structures;



- Provide sufficient land area for maintenance equipment and personnel to adequately and efficiently maintain the drainage system and all stormwater facilities; and,
- Restriction on easements shall include prohibiting all fences and structures which would interfere with access to the easement areas and/or maintenance function of the drainage system.
- All areas within the site which will be included in the land disturbing activities shall be identified and the total disturbed area calculated;
- The location of temporary and permanent vegetative and structural stormwater management control measures;
- An anticipated starting and completion date of various stages of land disturbing activities and the expected date of the final stabilization will be completed;
- Plans must meet all other applicable plan requirements in effect at the time of submittal;
- To prevent water quality degradation and to improve the water quality aspects of the drainage system, the plan shall include best management practices to control the water quality of the runoff during the land disturbing activities and during the life of the development. The plan shall include all engineering calculations needed to design the system and associated structures including pre- and post-development velocities, peak rates of discharge, inflow and outflow hydrographs of stormwater runoff at all existing and proposed points of discharge from the site;
- Description of site conditions around points of all surface water discharge including vegetation and method of flow conveyance from land disturbing activity;
- Construction and design details for structural controls;
- The expected timing of flood peaks through the downstream drainage system shall be assessed when planning the use of detention facilities;
- All stormwater management facilities and all major portions of the conveyance system through the proposed development (i.e. channels, culverts) shall be analyzed, using the 2, 10 and 100-year design storm, for design conditions and operating conditions which can be reasonably be expected during the life of the facility. The results of the analysis shall be included in the hydrologic-hydraulic study;
- If the site development plan and/or design report indicates that there may be a drainage or flooding problem at the exit of the proposed development or at any point downstream as determined by the City Engineer, the City Engineer may require:
 - Water surface profiles plotted for the conditions of pre- and post-development for the 2-year through 100-year design storm;
 - Water surface profiles plotted for conditions of the pre-and post-development for the 100-year design storm; and,
 - Elevations of all structures potentially damaged by the 2-year through 100-year flows.



- All plans submitted for approval shall comply with the applicable requirements of Divisions 3, 4, 5, 6, 7, and 8 of the City of Clemson’s Stormwater Ordinance;
- All plans submitted for approval shall contain certification by the person responsible for the land disturbing activity that the land disturbing activity will be accomplished pursuant to the approved plan and the responsible personnel will be assigned to the project;
- The site development plan shall contain certification by the applicant that all land clearing, construction, development and drainage will be done according to the site development plan or previously approved revisions. Any and all site development permits may be revoked at any time if the construction and/or maintenance of storm water management facilities are not in strict accordance with approved plans;
- All plans shall contain certification by the person responsible for the land disturbing activity of the right City Engineer to conduct on-site inspections; and,
- The plan shall not be considered approved without the inclusion of an approval stamp with a signature and date on the plans by the Planning and Codes Department. The stamp of approval on the plans is solely an acknowledgement of satisfactory compliance with the requirements of these regulations. The approval stamp does not constitute a representation or warranty of the applicant or any other person concerning the safety, appropriateness or effectiveness of any provision, or omission from the site development plan.

3.2.6 Completion of the Final Site Development Plan

The Final Site Development Plan shall include, and add further detail to the preliminary stormwater management plan if needed. This plan shall reflect any changes or modifications requested or required by the City Engineer. The Final Site Development plan shall include all of the revised elements from the preliminary site Development Plan and shall contain all of the Technical Report Submission Requirements. The completed Final Site Development Plan shall be submitted to the City of Clemson Engineering Department, Attn: Stormwater for final review and approval prior to initiating any construction activities on the proposed development site.

3.3 Submittal Requirements for Sites with less than One Disturbed Acre

The person or entity responsible for any land disturbing activity, including commercial and industrial sites, and is not part of a larger common plan development but is under 1 acre, shall submit a Grading Permit Application. This application does not require preparation or certification by a professional designer.

A general guideline for the requirement for requirement of application of a Grading Permit is as follows:

- If more than 20 tons of soil is being moved on site;
- If pipe larger than 8” is being installed on the site;
- Residential home construction and/or addition;



- Major landscaping project;
- Commercial development under 1 acre*;

3.3.1 Grading Permit Application

The Grading Permit Application Control Plan shall contain the following:

1. A sketch to accompany the narrative containing the following with applicable:
 - Site location drawing of the proposed project showing project location in relation to roadways, jurisdictional boundaries, streams, rivers and boundary lines of the site to be developed, major distances shall be listed as need;
 - All areas within the site that will be included in the land disturbing activities shall be identified and the total disturbed area shall be calculated;
 - Topographic map of the site with 2 ft contours, unless they do not adequately show potential problems;
 - Anticipated starting and completion dates of the various stages of the land disturbing activities and the expected date of final stabilization shall be noted;
 - Location of temporary and permanent vegetative and structural sediment control and stormwater management control measures (i.e., grassing, planting beds, silt fence and any other device used).
 - Location of sediment control devices and ensure they follow SCDHEC BMP prescribed installation requirements.
2. The Grading Permit Application shall contain certifications by the person(s) responsible for the land disturbing activities that the activities will be accomplished pursuant to the plan; and,
3. All Grading Permit Applications shall contain notes from Appendix F on the submitted plan.

3.4 Stormwater Management Design Standards

It is an overall goal of this Design Manual to address stormwater management to provide effective water quantity and water quality solutions due to the impact of runoff from land development. The following set of criteria shall be followed in the absence of designated specific watershed master plan criteria.

3.4.1 Hydrologic Computations

All hydrologic computations shall be completed using acceptable volume based hydrograph methods. The design storm durations for these computations shall be the 24-hour storm event and a SCS Type II distribution with a 0.1-hour duration time increment. Typical hydrologic inputs includes but is not limited to the following:

- Storm frequency and duration;
- Rainfall depth or intensity;
- United States Geological Survey (USGS) soil classification and hydrologic soil group;

- Land use;
- Time of concentration; and,
- Abstractions.

The software used to do the calculations as well as the inputs and outputs should be listed.

3.4.2 Water Quantity Control

Water quantity control is an integral component of overall storm water management. The following design criteria in Chapter 8 are established for water quantity control unless a waiver is granted on a case-by-case basis.

3.4.3 Water Quality Control

All development and redevelopment projects disturbing .75 acre or more shall meet the requirements section 8 for water quality control.

3.4.4 Waivers and Variances

If the 2- and 10-year, 24-hour post-developed flow rates do not exceed the pre-developed rates, waivers from detention maybe granted in accordance with State Regulation 72-302(B) and the City of Clemson Stormwater Management Ordinance Section 8, on a case-by-case basis. Every applicant shall provide for review by the City Engineer a written request containing descriptions, drawings and any other information that is necessary to evaluate the proposed activity. A separate written waiver request shall be required if there are subsequent additions, extensions or modifications which would alter the approved stormwater management characteristics to the activity receiving a waiver. Request to waive the stormwater management plan requirements shall be submitted to the City of Clemson’s Engineer.

Waivers

A project may be eligible for a Waiver of stormwater management requirements if the applicant can demonstrate that:

- The proposed project will have no significant adverse impact on any receiving natural waterway or downstream properties; or,
- The imposition of peak control requirements for rates of stormwater runoff would aggravate downstream flooding.

Variances

The City Engineer may grant a written variance from any requirement of this article if there are exceptional circumstances applicable to the site such as that strict adherence to the provisions of this article will result in unnecessary hardship and not fulfill the intent of this article. A written request for a variance shall be provided to the City Engineer and shall be provided to the City Engineer and shall state the specific variances sought and the reasons with supporting



data for their granting. The City Engineer shall not grant a variance unless and until sufficient specific reason justifying the variance are provided by the applicant.

3.4.5 Exemptions

The following development activities are exempt from the provisions of this Manual however this should not be construed to mean that they are exempt from BMP nor provisions of the Clean Water Act or other State and Federal Regulations.

- Land disturbing activities for the production of plants and animals useful to man, including but not limited to: forages and sod crops, grains and feed crops, tobacco, fruits, vegetables, production of ornamental plants, cotton, and peanuts; dairy animals and dairy products; livestock including beef cattle, sheep, horses, ponies, mules, or goats, including the breeding and grazing of these animals; bees, fur animals and aquaculture, except that the construction of any agricultural structure of one or more acres, such as broiler houses, machine sheds, repair shops and other major buildings and which require the issuance of a building permit shall require the submittal and approval of a drainage plan prior to the start of the land disturbing activity.
- Land disturbing activities undertake on forestland for the production and harvesting of timber and timber products. Though all Best Management Practices from the South Carolina Forestry Commission shall be followed and implemented.
- Activities undertaken by person who are otherwise regulated by the provisions of Chapter 20 of Title 48, the South Carolina Mining Act.
- Certain land disturbing activities undertaken by persons who are exempt from the provisions of the Stormwater Management and Sediment Reduction Act as set forth in Section 48-14-40 of the 1976 Code of Laws of South Carolina as amended.
- Land disturbing activities that are conducted under another State or Federal environmental permitting, licensing, or certification program where the State or Federal environmental permit, license, or certification is conditioned on compliance with the minimum standards and criteria developed under this Design Manual.
- Any land disturbing activities undertaken by an entity that provides gas, electrification, or communication services, subject to the jurisdiction of the South Carolina Public Service Commission.
- Emergency repairs of a temporary nature made on public or private property that are necessary for the preservation of life, health, or property and are made under circumstances where it would be impracticable to obtain a Storm Water Management Permit.

3.5 Erosion and Sediment Control Design Standards

It is the overall goal of this design manual to address erosion and sediment control to provide effective water quality solutions due to the impact of runoff from land development. The



following set of criteria shall be followed in the design of erosion and sediment control solutions.

3.5.1 Design Removal Efficiency Goal

All sediment control structures shall be designed and installed to accommodate the anticipated sediment loadings from all land disturbing activities.

3.5.2 Design Requirements

A sediment detention basin is required when five or more acres of disturbed land area drain to a single outlet point, shall be maintained until the entire site has been stabilized. Such basins shall be designed to have a minimum design removal efficiency of 80 percent TSS or 0.5 ml/L settleable solids effluent standards using a 10-year 24-hour design storm, whichever is less, and control the 10-year 24-hour storm event to pre-development conditions and successfully pass the 100-year 24-hour storm event. The person responsible for the activity shall submit a full Stormwater Application which shall be prepared or certified by a registered engineer, landscape architect, or Tier B land surveyor.

Land disturbing activities that create between one and five acres of land area that do not drain to a single outlet point may incorporate other practices other than a sediment basin to achieve the equivalent removal efficiency of 80 percent TSS or 0.5 ml/L settleable solids effluent standard, whichever is less using a 10-year 24-hour design storm. The person responsible for the activity shall submit a full Stormwater Application which shall be prepared or certified by a registered engineer, landscape architect, or Tier B land surveyor.

Additional design requirements for erosion and sediment control are as follow:

- Development shall be fitted to the topography and soils so as to create the least erosion potential;
- Natural vegetation shall be retained and protected wherever possible;
- Natural vegetation and non-structural methods shall be employed to the extent possible, for streambank stabilization and erosion control in place for structural methods wherever possible;
- Only the smallest practical area shall be exposed and then only for the shortest practical period of time;
- Erosion control practices such as interceptor ditches, berms, terraces, contour ripping, soil erosion checks, and sediment basins shall be installed to minimize soil and water losses;
- Temporary vegetation or mulching shall be used to protect areas exposed during the time of development;
- During and after development, stormwater management practices shall be utilized to effectively accommodate increased runoff caused by changes in soil and surface conditions, and to avoid siltation of receiving streams;

- Permanent vegetation and structures shall be installed in the development as soon as the weather permits;
- The design of outlet channels for the discharge of storm runoff shall be based on the runoff from predicted storm frequency and shall include the vegetative or structural measures required to protect the channel from scour and erosion;
- Waterway stabilization structures such as drop structures, grade stabilization structures, and channel liners shall be utilized to dissipate the energy of flowing water by holding the waterway slopes and velocities within non-erosive limits;
- Sediment basins and traps:
 - Sediment shall be removed mechanically when the sediment basin behind the temporary barrier or the dam becomes filled to an elevation shown on the plan or when the design capacity has been reduced by 50%. The structure may be removed once stability is reached in the development area; and,
 - A sediment basin or sediment trap may be required to be enclosed or protected, in the discretion of the City Engineer, when necessary to ensure public safety;
- Cut and fill slopes and other exposes areas shall be planted or otherwise protected from erosion before the release of the permit obligations. The responsibility shall remain with the permittee or owner until the planning is well established;
- Fill may not be deposited beyond the mean high-water line unless fill is used for marsh creation or shore restoration and does not extend beyond the mean low-water line or the fill is placed behind a structural shoreline erosion control device;
- Calculations for design of all BMP's for sediment control must be included as part of the permit application. Locations and timing of installation of sediment control BMP's must be shown on the Sediment and Erosion Control Plan and included as part of the SWPPP;
- Description of measures to prevent the discharge of solid materials, including building materials, to waters of the State and the United States, except as authorized by a permit issued under section 404 of the Clean Water Act;
- Description of measures to minimize, to the extent practicable, off-site tracking of sediments onto paved surfaces and the generation of dust;
- Description of construction and waste materials expected to be stored on-site, updated as appropriate, and controls, including storage practices, to minimize the exposure of the materials to storm water;
- Description of spill prevention and response practices;
- All sediment laden diversion channels and ditches shall be designed such that applicable shear stress and velocities are non-erosive. The design storm event that should be used is the 10-year 24-hour event;
- All BMP's installed to control sediment and erosion control shall follow SCDHEC's recommended schedule of clean out and be recorded on the on-site SWPPP of replace, repair, and clean-out; and,



- The surface of stripped or disturbed areas shall be permanently or temporarily stabilized within 14 days after final grade is reached or when left idle for more than 14 days. Temporary erosion and sediment control measures shall be maintained continuously until permanent soil erosion control measures have reached final stabilization.

3.5.3 General Erosion and Sediment Control Plan submittal items

The following items shall be included in the submittal package for a Stormwater management Permit:

- Location of all erosion and sediment control structures;
- Provisions to preserve topsoil and limit the amount of total disturbed area;
- Details of site grading;
- Design details and computations for all erosion and sediment control structures;
- List of trapping efficiency of each sediment control structure;
- Calculation of required sediment storage volumes;
- Explanation of any computer models or software used with highlights of the output data; and,
- Description of required clean-out frequencies and maintenance schedules.

3.6 Larger Common Development (LCD) Requirements

A stormwater management permit must be submitted for single-and multi-family developments which meet the requirements above to obtain a Stormwater Management Permit. In addition to the requirements of the submittal package highlighted in this Section of the Design Manual, the following is a list of the minimum requirements for the submittal package for single-and multi-family developments where applicable:

- Legal description of all properties located on the plans including tax map numbers;
- The exact legal street names and addresses for the properties;
- The dimensions and borders of the lot parcels;
- The address of the parcels;
- The minimum finished floor elevations in flood areas;
- Maintenance responsibilities shall be defined in a maintenance agreement with the City for permanent water quality and quantity structures such as ponds, easement, and buffers;
- Digital files compatible with the City's geographic information system (GIS) must be submitted after completion of work; and,
- Calculations and narratives must be submitted documenting compliance with total maximum daily loads (TMDL) requirements as appropriate.

In developing plans for residential subdivisions, individual lots shall be required to obtain and comply with a general permit and the residential subdivision development, as a whole, shall be considered a single land disturbing activity requiring a permit. Hydrologic parameters that

reflect the ultimate subdivision development shall be used in all engineering calculations. Individual builders who are constructing in the LCD can obtain secondary coverage under the Primary Permittee (developer) if the developer allows.

If individual lots or sections of a subdivision are being developed by different property owners, all land disturbing activities related to the subdivision shall be covered by the approved drainage plan (the developers SWPPP) for the entire subdivision. Individual lot owners or builders shall sign a certificate of compliance that all activities on that lot will be carried out in accordance with the approved drainage plan for the residential subdivision before work begins. The Developer will carry all responsibility for installation and maintenance of common BMP's and installation of infrastructure for the LCD.

When the Larger Common development reaches the condition where it is fifty (50) percent built the following actions must be taken:

- Where a detention pond is installed, as-built certification and drawings are due to the City Engineer;
- The detention pond shall be cleaned and stabilized;
- Home owners associations documents must be filed with the City Engineer defining the responsible party for maintaining the detention pond and any water quality devices installed in the subdivision, along with a proposed maintenance schedule; and,
- When the subdivision development is developed to a point between fifty (50) and eighty (80) percent built; individual lot controls as well as other erosion and sediment control BMP's in addition to the sediment/detention pond shall provide the sediment control to meet eighty (80) percent trapping efficiency rather than only the detention pond. Once the subdivision is eighty (80) percent or greater built and the disturbed areas are stabilized according to the requirements of SCR10000 and 72-300 (SC Code of Regulations) then the permittee may file a request for Notice of Termination of the permit coverage for the subdivision, this does not eliminate the requirement for coverage of the final lots.

3.7 100-Year Floodplain

The goal of this section of the Design Manual is to provide an overview of the requirements and procedures for proposed land development occurring in the 100-year floodplain. Development is defined as any manmade change to improved or unimproved real estate including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations or storage of equipment or materials. City of Clemson Code of Ordinances Chapter 5, Article II (Flood Damage Prevention) is administered by the City Building Official and provides a comprehensive set of requirements for developing in the floodplain. This section is not intended to replace or supersede the requirements of that ordinance.

- The new construction must comply with all State and Federal regulations.

FEMA Region IV

3003 Chamblee Tucker Road
Atlanta, Georgia 30341
(770.220.5400)

The South Carolina Department of Natural Resources

Flood Mitigation Program
2221 Devine Street, Suite 222
Columbia, South Carolina 29205
(803.734.9103)

3.8 Stormwater Facility Ownership and Maintenance

3.8.1 Ownership

All permanent storm water management facilities shall be privately owned and maintained unless the City of Clemson accepts the facility for City ownership and maintenance. The owner of all private facilities shall grant the City of Clemson a perpetual, non-exclusive easement that makes the facility accessible for public inspection and emergency repair. The City of Clemson requires all permanent stormwater management facilities to be registered annually.

3.8.2 On-going Inspection and Maintenance

A permanent maintenance plan for each permanent stormwater management facility shall be included in the Site Development Plan. Requirements for on-going inspection and maintenance of permanent stormwater management facilities are as follows:

- Stormwater management facilities and practices, included in a site development plan, which are subject to an inspection and maintenance agreement, must undergo ongoing inspections to document maintenance and repair needs and ensure that maintenance is completed in compliance with the SWPPP, any agreements and the City's stormwater management ordinance. For development's, which establish a POA or HOA, provisions for long term maintenance, as outlined in SWPPP, must be defined in a maintenance agreement. The provisions of this agreement must also identify a source of funding to support future required maintenance and upkeep activities, and a responsible party. The maintenance agreement shall be recorded in the Pickens County Register of Deed's Office and shall constitute a covenant running with the land and all heirs, successors, and assigns. The City Engineer must be notified of changes in status and personnel or contract information for record keeping and inventory purposes in accordance with its SMS4 permit requirements;
- Subdivision site runoff storage areas, and stormwater facilities not located in dedicated right-of-way or easement, shall be granted or dedicated to and accepted by a public entity, or shall be conveyed by plat as undivided equal interests to each lot in the subdivision or to dedicated entities approved by the City Engineer. Included in the

dedication shall be a plan for continued management, operation, and maintenance of the stormwater facility, including designation of the person or persons responsible for long-term operational management and dedicated funding sources. If title to the land underlying site runoff storage areas and stormwater facilities is conveyed by agreement to each of the lots in the subdivision, then:

- A covenant on the face of the plat shall be provided; and,
 - Subdivision property owners shall establish a property owner's association to provide for the maintenance of site runoff storage areas and stormwater facilities. The association shall be duly incorporated and the property owners' association agreement shall be recorded for all the lots in the subdivision; and,
 - The proposed property owners' association by-laws and declarations shall provide for long term maintenance agreement.
 - The engineer shall also provide a cost estimate on permanent maintenance to at least the first major refurbishment, in the property owner's association by-laws to allow for adequate funds to be budgeted.
- A stormwater management facility or practice shall be inspected on a periodic basis by the responsible person in accordance with the approved inspection and maintenance agreement. In the event that the stormwater management facility has not been maintained and/or becomes a danger to public safety or public health, the City shall notify the person responsible for carrying out the maintenance plan by registered or certified mail to the person specified in the inspection and maintenance agreement. The notice shall specify the measures needed to comply with the agreement and the plan and shall specify the time within which such measures shall be completed;
- Inspection programs by the City may be established on a reasonable basis, including but not limited to: routine inspections; random inspections; inspections based upon complaints or other notice of possible violations; and joint inspections with other agencies inspecting under environmental or safety laws. Inspection may include, but are not limited to: reviewing maintenance and repair records; sampling discharges, surface water, groundwater, and material or water in stormwater management facilities; and evaluating the condition of stormwater management facilities and practices; and,
- Parties responsible for operation and maintenance of a stormwater management facility shall provide records of all maintenance, repairs, and as-built plans to the City.

3.9 Technical Report Submission Requirements

Failure of an applicant to provide all of the information detailed in this section may result in the denial of receiving a Stormwater Management Permit from the City of Clemson. The items listed as the technical report submission requirements shall be used as a checklist to verify that all required items are properly submitted.



The general submission requirements for all projects requiring a Stormwater Management Permit approval shall include the following information when applicable:

1. Standard completed Grading application form;
2. Evidence of acquisition of all applicable local, State, and Federal Permits;
3. Anticipated starting and completion dates of the various stages of land disturbing activities and the expected date of final stabilization;
4. A vicinity map indicating north arrow, scale, boundary lines of the site, and other useful information to successfully locate the property where the land development is to take place. It shall include at least one major roadway intersection for reference.
5. A plan with an appropriate written and graphical scale (not less than 1-inch = 200 ft.) accompanied by a design technical report indicated at least:
 - a. The location of the property where the land development is to take place on a Pickens County GIS map or a United State Geological Survey (USGS) 7.5-minute topographic map;
 - b. The location of the soils show on a Pickens County GIS map or United State Department of Agriculture (USDA) soils map, with the major USDA soil types and Hydrologic Soil Groups Identified;
 - c. Existing and proposed contour lines except for individual lot grading in single-family subdivisions;
 - d. Existing and proposed physical structures on-site including buildings, roads, easements, and parking areas;
 - e. Proposed grading and land disturbance information including:
 - i. Surface area of entire project in acres;
 - ii. Surface area of planned land disturbance project in acres; and,
 - iii. Limits of grading.
 - f. Drainage area maps including:
 - i. Existing off- and on-site drainage areas including flow paths; and,
 - ii. Proposed off- and on-site drainage areas including flow paths.
 - g. Stormwater management facilities water quality (temporary and permanent) including:
 - i. Location;
 - ii. Dimensions;
 - iii. Elevations;
 - iv. Maintenance plan; and,
 - v. Calculations:
 - Pre- and post-development flow rates,
 - Pre- and post-development velocities,
 - Hydrographs,
 - Stage storage volume information,



- Stage discharge information.
 - h. Erosion and sediment control plans including:
 - i. Location;
 - ii. Dimensions;
 - iii. Elevations; and,
 - iv. Calculations:
 - Hydrographs;
 - Stage storage volume information;
 - Stage discharge information;
 - Trapping efficiencies.
- 6. Compliance with the City of Clemson’s Flood Damage Prevention ordinance and FEMA flood maps and Floodplain study material where applicable;
- 7. Right-of-way and easements:
 - a. Location of easements; and,
 - b. Designation of Easements that require inspection and maintenance.
- 8. Landscape plan:
 - a. Vegetation to be used for streambank stabilization, erosion control, sediment control, aesthetics, and water quality; and,
 - b. Special requirements to preserve the natural aspects of the drainage system.
- 9. Description of conditions around points of all surface water discharge;
- 10. Construction details for all stormwater management controls;
- 11. Downstream impact analysis;
- 12. Federal and State wetland maps, where appropriate;
- 13. Federal and State endangered or protected species maps, where appropriate;
- 14. Appropriate fees for the project; and,
- 15. Any additional information required by the City Engineer deemed necessary to complete the project review.

3.10 Digital Submittal Requirements

Plans that have received approval shall be followed by the submittal of an electronic copy in accordance with the City of Clemson’s Electronic Submission Standards and Procedures.

The only use of electronic information will be for the anonymous inclusion into the City of Clemson GIS. Disclaimers and limiting statements may be placed in electronic submissions, provided such disclaimers do not direct liability to the City or create indemnification by the party submitting electronic files.

Electronic submission standards and procedures are as follows:

1. Drawings will be submitted as a drawing file in .DWG or .DXF format to the City on a standard storage media approved by the City of Clemson. Such media include CD-ROM, DVD-ROM disk and USB memory sticks. The use of alternative media requires City



approval prior to submission. PDF format is acceptable for notes and details. All Physical devices must be surrendered to the City of Clemson;

2. The submitted media shall be legibly labeled with the drawing or plan name, filename, drawing type (construction plan), project contact information (name, affiliation, phone number, and email address), and submittal and file creation dates;
3. Coordinate datum shall be the current South Carolina State Plane Coordinate System as specified in the South Carolina Code of Laws.
4. South Carolina State Plane Coordinates shall be inherent to the submitted drawing file. That is, the submitted drawing file shall contain South Carolina Plane coordinates, not local grid or paper space coordinates;
5. Survey requirements for this section shall be consistent with the State Minimum Standards published by the State Board of Registration for Professional Engineers and Land Surveyors unless more stringent requirements are specified herein;
6. The vertical accuracy of surveys submitted for this section shall be \pm one-half of the elevation contour interval shown on the approved plan. The vertical datum shall be the North American Vertical Datum of 1983 (NAVD 1983);
7. The submitted drawing file must be clearly named and not exceed 27 characters. For example, Cedar Cove Phase II would be named CedarCovePhII.dwg (or .dxf) and the Cliffs Valley, Stone Creek Phase II; Lots 42 thru 25 would be named CliffsVa!StnCrkPHII!Lts42-45.dwg. Long subdivision names may be abbreviated as long as there is a clear relationship to submitted plan name;
8. The submitted drawing file will include features and text classified by the standard layer and naming convention as shown in ESRI Local Government data Model. Drawing features and associated text shall not be combined in one layer. Text included in drawing files will use standard fonts that can be read without third-party software;
9. Closure is critical in converting CAD features to GIS features. All linear and polygon features must be snapped closed, when applicable, and free of symbols (Circles at property corners) that break line continuity;
10. A metadata text file with the same name as the drawing file (drawing_file_name.txt) is required with each electronic submission. This text file will provide technical parameters and contract information for the survey.
11. A Portable Document Format (PDF) file shall be included in the submittal for each approved plan drawing. The file(s) shall have the same name as the drawing file followed by a number that begins with 1 for the first file (drawing_file_name1.pdf) and increase sequentially for subsequent files (drawing_file_name2.pdf, drawing_file_name3.pdf, etc.)

The Grading permit will not be terminated until the As-built electronic submittal has been received and approved by the City. A completed metadata sheet must accompany the drawing file in the electronic submission.



3.11 Plan Submittal, Review and Approval Process

3.11.1 Plan Submittal

A Stormwater Management Permit submittal flow diagram is provided in Appendix A.

When the City of Clemson Engineering Department receives the initial submittal package it shall be reviewed by a certified plan reviewer for compliance. After the plans have been reviewed to determine compliance with the regulations set forth by this Design Manual the plan reviewer will contact the applicant/design professional and request any necessary changes or notify the applicant/design professional that the plans are in compliance. A copy of all correspondence shall be sent to the owner.

3.11.2 Plan Review Period

Upon receipt of a completed application for a Stormwater Management Permit and submittal of the Final Site Development Plans, the City of Clemson Engineering Department shall accomplish its review and have either the approval or review comments transmitted to the applicant within twenty (20) working days.

The City of Clemson Engineering Department shall conduct its review or review comments of a waiver or variance submitted by the applicant within ten (10) working days of the submittal. Failure of the Review Agency to act on the waiver by the end of ten (10) working days will result in the automatic approval of the waiver or variance.

3.11.3 Incomplete Stormwater Management Permit Applications

Engineering design plans, grading permit application, specifications, and submittal packages submitted to the City's Engineering Department that do not meet the minimum requirements of Chapter 3 of the Design Manual shall be handled in the following manner:

- If the original Stormwater Management Permit application submittal package has all of the major components in accordance with Chapter 3 but is missing some information, a written notice will be sent to the applicant with a copy to the owner.
- The written notice from the City Engineering Department shall state the following:
 - The specific information that must be re-submitted to the Engineering Department in order for the permit application to be considered complete for review and processing;
 - The Stormwater Management Permit application has been removed from the review process;
 - Re-submittal of the application with all the required modifications shall return the application to the review process;
 - The City Engineering Department shall hold the incomplete plan for a period of 60 working days from the date of written notice; and,

- If an adequate response is not received within 60 working days, the submittal shall be rejected, no refund issued, and the entire submittal process must be initiated again.
- If the original Storm Water Management Permit Application submittal does not contain the major required components, it shall be returned to the applicant for re-submittal without review.

3.12 Plan Approval and Final Submittal

When the plans have been determined to be in compliance, then the applicant/design professional shall send four (4) additional copies for stamp approval. One set of plan is for the applicant/design professional, one is for the owner of the development project, one is for the contractor and must be available on site at all times, and one copy is for the City of Clemson Engineering Department.

Approved plans remain valid for up to five (5) calendar years or the time period stated on the grading permit application, at the discretion of the applicant, from the date of approval whichever is less. Extensions or renewals of the approved plans shall be granted by the City Engineer upon written request by the person responsible for the land disturbing activity, if work has not begun before the request for extension/renewal the permit must comply with all current regulations.

The Final Stormwater Drainage Plan shall be considered approved without an approval stamp with a signature and date on the plans by the City Engineer. The stamp of approval on the plans is solely an acknowledgement of satisfactory compliance with the requirements of the Stormwater Management Ordinance. The approval stamp does not constitute a warranty to the applicant or any other person concerning safety, appropriateness or effectiveness of any provision, or omission from the Drainage Plan.

Approval of land disturbing activities that were approved prior to the effective date of this Design Manual shall remain in effect for the original term of the approval. For land disturbing activities which were not initiated during the original term of approval, the person responsible for the land disturbing activity shall re-submit the Site Development Plan including the Sediment Control Plan to City Engineer for review and approval subject to the requirements of this Design Manual.

3.12.1 Notification of Work

A Stop Work Order (SWO) shall be issued on all project proceeding without the required pre-construction meeting and issuance of a grading permit.

3.13 Construction Requirements

3.13.1 Deviations from Approved Plans

Substantial deviations from the approved site development plans and specifications shall not be made on-site without written approval from the City Engineering Department. Realistically and



practically, there are always minor variations to the proposed plan during land development activities. These minor variations will be allowable without the need for approval from the Engineering Department, though sound engineering judgment should be exercised in assessing the impacts of these minor changes. Substantial deviations shall be submitted to the City Engineering Department as soon as possible and shall not be constructed until approval has been given.

Examples of substantial deviations that would require written approval from the City Engineering Department include, but are not limited to the following:

- Pipe size changes;
- Pipe grade changes that will affect the hydraulic capacity of the stormwater facility;
- The movement of storm water facility that would put them outside of specific easements and right-of-ways
- Changes in grade on-site which would affect the direction of stormwater flows, flow velocities, flow volumes, or other hydrologic impacts that would cause the existing plans to fail in protecting water quantity and water quality impacts.

3.13.2 As-Built Requirements

The Permittee shall submit an as-built plan certification by a registered professional upon the completion of the construction of the stormwater management control structures submitted in the Final Stormwater Management Site Plan. The registered professional shall certify the following:

- The facilities have been constructed as shown on the As-built plans;
- The facilities meet the approved site plan and specifications or achieve the function they were design to perform;

Acceptable as-built plans shall be submitted prior to the following:

- The use or occupancy of any commercial or industrial site;
- Final acceptance of any road into the City of Clemson's Official road inventory; and,
- Release of any bond held by the City of Clemson.

The City Engineer may perform a final inspection upon completion of the installation of stormwater management structures to determine if the work is completed and constructed in accordance with the Final Storm Water Management Site Plan.

3.14 Stormwater Infrastructure Bond

A monetary performance guarantee for every new development using permanent stormwater infrastructure will be required to present a Bond to the city. This guarantee will provide assurance that all exposed soil surfaces will be stabilized and any other areas of the stormwater management and sediment control deficiency are addressed, in the event a development discontinuous or proper control measures are not installed and/or maintained and the City of

Clemson cannot through no fault of its own require a listed responsible party to complete site stabilization.

Prior to the issuance of any grading and/or NPDES permit for a development or phase of development, applicants may be required to bond the City of Clemson monies to complete stormwater infrastructure.

Bond monies can be used to complete proposed site improvements including but not limited to the following:

- Storm drain pipe, culverts, manholes, and box inlet installation;
- Site filling and grading, including the construction of open drainage swales and detention facilities;
- Establishment of erosion and sediment control;
- Re-grading of the site to minimize the erosive effect of stormwater runoff;
- Temporary or permanent seeding and stabilization of disturbed areas to minimize the erosive effect of stormwater runoff; and,
- Maintenance and cleaning of sediment control structures.

Bond Fees are as a minimum as follows:

Infrastructure Items	Cost	Units	Minimum Cost
Mobilization	\$500	Acres	\$1,000
Site stabilization	\$2,000	Acre	\$2,000
Drainage Swells	\$25	LF	\$2,000
Storm drain Pipe	\$125	LF	\$2,500
Detention Pond	\$15,0000	Acre	\$20,000
Innovative Products	Cost of Items	Per	Cost of Item + 10%

3.15 Application Fees

Grading Permits authorized by the provisions of this Design Manual shall be effective only upon the payment of the appropriate fees. The current fees schedule can be found on the City of Clemson website.

Any land development project disturbing one or more acres or must obtain either NPDES general permit coverage or an NPDES permit. There is an additional NPDES fee for these projects. There are no exemptions from this fee, therefore local, State and Federal entities must submit the NPDES fee as part of their Stormwater Management Permit Submittal Package.



Section 4. Easements

4.1 Purpose

All public storm sewer, stormwater conveyance drainage systems and open channels must be constructed on public right-of-ways, easements, publicly owned or City of Clemson owned properties. No approval will be given for the construction or improvement of any public storm sewer, stormwater conveyance system or open channels without provision of suitable permanent easement or right-of-way. Restriction on easements shall include prohibiting all fences, trees and structures that would interfere with access to the easement areas and/or the maintenance function of the drainage system.

Any increase of runoff volume from or across the easement shall be calculated and reported to the City of Clemson Engineering Department during the technical report submission. The City of Clemson, adjacent property owners and affected utilities shall be in agreement with any increase in runoff volume from a stormwater easement before the easement will be granted. Larger Common Plans (LCP's) shall include easements for connections of separate properties with ownership going between all properties.

All stormwater systems shall be designed to have no increase in velocity, peak flow, water surface elevation in relationship to upstream, adjacent, and downstream property in the 100-year storm, unless an adequate permanent drainage easement is obtained.

4.2 Existing Easements

Each existing easement to be used shall be shown on the plans included with the Stormwater Management Permit submittal package. The information on the plans shall include the Deed Book and page number of the recorded instrument. All restrictive clauses as to the use of the easement shall be noted on the plan adjacent to a specific easement. The restriction may include but are not limited to:

- Utility (gas, electric, telephone, and water) purposes only;
- Drainage purposes only; and,
- Sanitary sewer purposes only.

Construction of stormwater conveyance drainage systems will not be permitted in existing exclusive gas, electric, water, telephone, or sanitary easements unless a drainage easement is acquired overlapping the existing easement with approval from the City of Clemson and the affected utility.

4.3 Temporary Construction Easements

Temporary construction easements may be required to be adjacent to stormwater conveyance drainage easements when necessary for development operations. Temporary construction easements may be required for structure removal, access roads, stockpiling, and other common

land development activities. Sufficient area shall be provided for movement of equipment and materials to accomplish the intended activity within the temporary construction easement.

Temporary construction easements should not be acquired on adjacent private property when the proposed permanent easement is not located on the adjacent property.

4.4 Easement Widths

The total width, permanent plus any temporary requirements, should be sufficient to allow the contractor to have flexibility in the method of construction. However, easements shall not have excessive widths requiring needless clearing and cutting of wooded or vegetated areas. The City of Clemson, as a minimum, request that easements have the following characteristics:

- Provide adequate access to all portions of the drainage systems and structures;
- Provide sufficient land area for maintenance equipment and personnel to adequately and efficiently maintain the drainage system and all stormwater facilities;
- Restriction on easements shall include prohibiting all fences and structures and non-design placement of trees which would interfere with access to the easement areas and/or the maintenance function of the drainage system.

Table 4-1 list suggested minimum widths of drainage easements and temporary easements using trench construction for pipes. Table 4-2 list suggested easements required for open storm drainage channels. In no case shall the suggested width guidelines be substitute for sound engineering judgement.

Table 4-1. Minimum Pipe Easement Widths

Pipe Size (inches)	Minimum Easement Width (feet)		
	Permanent	Temporary	Total
≤ 12	15	15 on each side	30
15 < 24	15	15 on each side	30
24 < 54	20	25 on each side	50
≥ 54	30 min.	30 on each side	60 Min.

Table 4-2. Minimum Open Channel Easement Widths

Drainage Area (acres)	Minimum Easement Width* (feet)
0-45	20
45-120	30
120-500	40
>500	Top width of Channel + 25 feet (40 feet min.)

*For open channels, the minimum easement must contain the width of the stream from top of bank to top of bank



4.5 Easement Plat Criteria

Final plats, summary plats and easement plats shall be used for property having an easement or other type of applicable acquisition of land. All plats shall have the title block in the lower right hand corner of the plat describing the type of easement. A land surveyor certification and seal shall be located in the lower left hand corner of the plat. No other format shall be submitted or accepted. Many times easements are not granted to the City of Clemson but are simply a reciprocal agreement between property owners to convey their drainage or to convey drainage of others across their property.

Permanent easements shall be hatched on all plans for clarity, while temporary easements shall have no hatching or shading added to identify them.



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Section 5. Hydraulics

The purpose of this section is to clarify any items which the City of Clemson wishes to be specified concerning flow and how flow can be calculated. The minimum requirements if not specified in the follow section can be found in SCDHEC's Stormwater BMP Handbook.

5.1 Storm Drainage Design Requirements

This section provides the design requirements for various storm water drainage system components including:

- Design Storms,
- Design velocities; and,
- Design Pipe sizes.

5.1.1 Storm Drainage Systems Requirements

Storm drainage systems include all storm drainage structures and pipes that do not convey runoff under public roadways. These systems are commonly referred to as lateral closed systems.

These storm drainage systems shall be designed based upon the following criteria:

- 2- to 10- year 24-hour design storm event capacity for pipe design.
- 2- to 10- year 24 hour design storm event capacity for inlet structure design.
- 25-year 24-hour design storm event capacity for drainage channels.
- 50-year 24-hour design storm event capacity for sump inlets, unless overflow facilities are designed.
- 100-year 24-hour storm event shall be used to check all drainage designs used for local flooding, and possible flood hazards to adjacent structures and/or property.
- The rational method and SCS method for peak runoff flow rates are acceptable.

When a storm drainage system has less than 20 connections, Mannings' Equation shall be acceptable for sizing the capacity of drain pipes for non-submerged conditions where the free water surface elevation is below the crown of the pipes.

5.1.2 Pipe Size, Fill, and material Requirements

The minimum pipe size to be used in a storm drainage system is 15-inches in diameter. The minimum fill cover on all pipes shall be 1 foot. No storm water pipe installed in the City of Clemson shall be made out of corrugated metal, all other materials will be reviewed at the time of permit review. The maximum cover shall be based on the design loads which are calculated from pipe shape, pipe size, pipe materials and location.

5.1.3 Flow Velocity and Pipe Slope

- The minimum design velocity for pipe flow shall be 2.0 ft/sec at the design flow or 2.5 ft/sec at full flow, whichever requires the greater slope.

- The maximum design velocity shall be 20 ft/sec.
- The minimum slope of storm drain systems shall be 0.5 percent.
- Storm drainage systems shall be designed to convey storm water runoff by gravity flow unless otherwise approved.

For very flat flow lines, flow velocities shall increase progressively throughout the system. Upper reaches of the pipe system may have flatter slopes than the lower end of the system. Progressively increasing slopes keep solids moving towards the outlet and inhibit the settling of particles.

5.1.4 Catch Basin and Inlet Design

The design methodology utilized to compute the capacity of storm drain inlets and grates shall apply weir, orifice and pipe flow characteristics as needed. The following design requirements shall be followed:

- Inlets shall be designed to convey the 10-year 24-hour storm event;
- The maximum depth in which the water may pond above or around an inlet must not inundate surrounding permanent structures or public facilities including vehicular or pedestrian traffic;
- Inlets placed in sump conditions shall have emergency overflow points designed;
- Inlets placed in roadway gutter lines must be spaced to prevent flow from entering public road intersections:
 - Maximum spread of 6-feet in the travel lane.
 - Valley gutter shall have a maximum allowable spread of 7-feet.
 - Standard 2-foot 6-inch curb and gutter is allowed a total maximum spread of 8-feet from the face of curb.
- In depth design procedures for inlet design may be referenced in the [American Association of State Highway and Transportation Officials \(AASHTO\) Model Drainage Manual, 1991](#)

5.1.5 Roadway Culvert Design

Roadway culvert design shall include all cross drainage facilities that transport storm water runoff under roadways. These systems shall be designed based upon SCDOT requirements where applicable. For non-SCDOT roads, the following criteria shall be followed:

- All cross-drain culverts shall be designed to pass the 25-year 24-hour design storm event without overtopping the road.
- All interior culverts shall be design to pass the 10-year 24-hour design storm event without overtopping the road.
- Additional hydraulic capacity shall be required as necessary to prevent backwater effects that may adversely impact upstream property or structures.

5.2 Open Channel Design

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

- Channels shall be designed to carry the 10-year 24-hour design storm event;
- Major channels may be designed for greater storm frequencies if directed by the City of Clemson;
 - Off site storm runoff which may cause on-site issues;
 - Areas which are known to be prone to flooding or causing flooding downstream;
- The minimum channel slope shall be 0.5 percent, unless supporting calculations show that there will be no pools or standing water areas formed in the channels at smaller slopes;
- Except for roadside ditches, the side slopes of grassed lined channels with Erosion Control Blankets or Turf Reinforcement Matting shall be no steeper than 3H to 1 V;
- Manning's Equation may be used to design open channels and swales where backwater effects created from obstructions and/or tail water is not present;
- Channels may be designed with multiple stage levels with a low flow section to carry the 2-year storm event and a high flow section to carry storms of larger frequencies; and,
- Maximum flow velocities shall be determined based on the channel bottom material and bank slope material. Table 7-2 contains an expanded list of permissible velocities from various different types of channel vegetation and slopes.

5.2.1 Vegetated Channel Design

The allowable velocities and tractive forces for non-vegetated (erodible) channels are relatively small and the design requires wide, shallow channels to carry the design flow rates. Vegetation protects the channel material from the erosive action of design flows and binds the channel material together. Vegetated channels can be used to carry storm runoff but are generally not recommended to carry sustained base flows because most vegetation cannot survive continual submergence or saturation of the root zone.

The design of vegetated channels shall be performed for the following two design conditions:

Stability/permissible velocity: This design process involves evaluating how the channel will respond under low vegetation resistance conditions. The condition is defined when vegetation is cut low or lies down, producing a lower Manning's n value, lower flow depths, and higher flow velocities. The limiting factor for stability design is the permissible velocity of the flow in the vegetated channel.

Capacity: This design process involves evaluating how the channel will respond under high vegetation resistance conditions. This condition is defined when vegetation is not maintained or is very long and rigid, producing higher Manning's n value, higher flow depths, and lower

flow velocities. The limiting factor for capacity design is the cross sectional area of the vegetated channel.

The design of vegetated channels may be done using the techniques discussed in this section, or by using computer software that is capable of designing for stability and capacity.

5.2.2 Vegetation Resistance Classes

Vegetation used for channel design has been divided into five resistance classes designated as being A, B, C, D, and E. Tables 5-2 and 5-3 list each vegetation resistance class with corresponding species and stand heights

Table 5-2, Maximum Permissible Velocities for Vegetated Channels

Cover	Permissible Velocity (ft/sec)*					
	Erosion Resistant Soils % Slope			Easily Eroded Soils % Slope		
	0-5	5-10	>10	0-5	5-10	>10
Bermuda Grass	8	7	6	6	5	4
Bahia						
Buffalo Grass						
Blue Gamma						
Centipede Grass	7	6	5	5	4	3
Tall Fescue						
Kentucky Bluegrass						
Red Canary Grass						
Grass-legume Mixture	5	4	NR	4	3	NR
Lespedeza Sericea						
Weeping Lovegrass						
Kudzu	3.5	NR	NR	2.5	NR	NR
Alfalfa						
Small Grains						
Temporary Vegetation						

* Allow velocities over 5ft/sec only where good cover and maintenance will be provided. If poor vegetation exist due to shade, climate, soils or other factors, the permissible velocity shall be reduced by 50 percent

NR = Not Recommended



Table 5-3, Vegetated Resistance Classes based on Vegetation

Resistance Class	Vegetation	Condition
A	Red Canary Grass Weeping Lovegrass Yellow Bluestem Ichaetum	Excellent Stand, tall (average 36-inches) Excellent Stand, tall (average 30-inches) Excellent Stand, tall (average 36-inches)
B	Bermuda Grass Native grass mixtures Tall fescues Lespedeza Sericea Grass-legume Mixture Red Canary Grass Alfalfa Weeping Lovegrass Kudzu Blue Gamma	Good stand, tall (average 12-inches) Good stand, uncut Good stand, uncut (average 18-inches) Good stand, not wood, tall (average 19-inches) Good stand, uncut (average 20 inches) Good stand, mowed (average 12- to 15-inches) Good stand, uncut (average 11-inches) Good stand, uncut (average 13-inches) Dense growth, uncut Good stand, uncut (average 13-inches)
C	Bahia Crabgrass Bermuda Grass Common Lespedeza Grass-legume Mixture Centipede Grass Kentucky Bluegrass	Good stand, uncut (6- to 8-inches) Fair stand, uncut (10- to 48-inches) Good stand, mowed (average 6-inches) Good stand, uncut (11-inches) Good stand, uncut (6- to 8-inches) Very dense cover (average 6-inches) Good stand, headed (6-12 inches)
D	Red Fescue Bermuda Grass Common Lespedeza Buffalo Grass Grass-legume Mixture Lespedeza Sericea	Good stand, uncut (3-6 inches) Good stand, cut to 2.5 inches Excellent stand, uncut (average 4.5 inches) Good stand, headed (12- to 18-inches) Good stand uncut (4- to 5-inches) Very good stand, mowed (2-inches)
E	Bermuda Grass Bermuda Grass	Good stand, cut to 1.5 inches burned to stubble

Source: Soil Conservation Service Engineering Field Manual, 1979



Chapter 6. Stormwater Detention Design and Downstream Criteria

6.1 Hydrologic and Hydraulic Design Criteria

All design of detention systems utilized for stormwater quantity control shall be submitted with a design summary report when applying for a Stormwater Management Permit. The following design criteria shall be implemented for water quantity control unless a waiver is granted on a case-by-case basis.

- Post-development discharge rates from the entire development area shall not exceed pre-development discharge rates for the 2-, 10-year frequency 24-hour duration storm events.
 - Multi-stage control structures may be required to control the 2-, 10-year storm events.
 - The same hydrologic procedures shall be used in determining both the pre-development and post-development peak flow rates.
- Post-development discharge velocities in receiving channels shall be non-erosive flow velocities or shall be equal to or less than the pre-development 10-year 24-hour storm even flow velocities.
- Emergency spillways shall be designed to safely pass the post-development 100-year 24-hour storm event without overtopping any dam structures.
- All dam structures must be located on virgin soils and spillways must be able to withstand at least a 100-year 24-hour storm event.
- All dry detention basin volumes shall be drained from the structures within 72 hours.
- Watersheds that have well-documented water quantity problems may have more stringent or modified design criteria as determined by the City Engineer, including but not limited to:
 - Post-development discharge rates from the entire development area not exceeding pre-development discharge rates from storm frequencies greater than the 10-year frequency 24-hour duration storm event.
 - Post-development discharge volumes from the entire development area not exceeding pre-development discharge volumes.
 - Reduction of peak flow rates from pre-development to post-development.
 - Reduction of total volume released from pre-development to post-development.
 - Downstream channel, culvert or property improvements.
- A project may be eligible for a waiver from the stormwater management requirements for water quantity control if the applicant can justly verify that:
 - The proposed project will not create any significant adverse effects on the receiving natural waterway downstream of the property;

- The imposition of peak flow rate control for stormwater management would create, aggravate, or accelerate downstream flooding.

6.1.1 Accepted Detention Structural Controls

Detention structural controls are used for providing water quantity control and are typically used downstream of other minor structural controls. These structures are designed to provide channel protection, overbank flood protection, and any adverse downstream impacts that are related to the increase in peak flow rates and flow volumes from development. Detention structural storm water controls can be classified into several categories as shown in Table 6-1.

Table 6-1, Detention Structural Controls

General Structural Control	Description
<p>Dry Detention/Dry Extended Basins</p>	<p>Dry detention basins and dry extended detention basins are surface storage facilities intended to provide temporary storage of stormwater runoff and releasing it at a designed flow rate to reduce downstream water quantity impacts. These structures are designed to completely drain to a dry condition within 72 hours.</p>
<p>Wet Stormwater Detention Basins</p> <ul style="list-style-type: none"> ● Wet Pond ● Wet Extended Detention Pond ● Micropool Extended Detention Pond ● Multiple Pond System 	<p>Wet detention basins are constructed stormwater basins that have permanent pool or micropool of water. Runoff from each rain event is detained above the permanent pool and released at a designed flow rate to reduce downstream water quantity impacts.</p>
<p>Multi-purpose Detention Areas</p>	<p>Multi-purpose detention areas are used for one or more specific activities such as parking areas and rooftops. These areas are used to provide temporary storage of runoff. Some of the multi-purpose area such as infiltration trenches or bio-retention areas may also be used for water quality purposes.</p>
<p>Underground Detention</p>	<p>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 enough adequate land to provide the required detention volume. The underground storage utilizes tanks, vaults, and buried pipes to supply the required storage volume.</p>



6.2 Detention Structure Design Parameters

The construction of detention structures usually requires excavation or the placement of earthen embankments to obtain a required storage volume. This section discusses the design criteria of detention structures to ensure the long term function of the structure while minimizing maintenance responsibilities.

6.2.1 General Design Criteria

1. Basins on Slopes: When basins are created by cutting and filling a slope, care should be taken that the seasonal groundwater table on the slope above the basin is not exposed, thus creating a seasonal spring. Groundwater flow or spring flow into a basin may be accomplished by installing subsurface interceptor drainage system. To prevent destabilization from groundwater seepage, riprap may be needed.
2. Inlet and outlet locations: The inlets and outlet should be as far apart as possible, with a minimum of a 2:1 ratio of length to width between the inlet and outlet. Runoff should have to travel the longest distance possible through the basin before being discharged. The use of interior embankments within the basin should be considered to extend the period which runoff can be expended through the outlet.
3. Inlet Design: The inlet must be designed with riprap or other energy dissipaters, such as:
 - Baffles below the inflow structure
 - Permanent water energy dissipaters
 - Flow restrictors located upstream of the Inlet
4. All inlets will be design with a sediment fore bay for post-construction water quality and shall be designed with a minimum length to width ration of 2:1.
5. The basin bottom shall be located above the seasonal high groundwater table to avoid standing water in the basin.
6. Prevention of scour at the inlet is necessary to reduce maintenance problems and prevent damage to basin floor vegetation. The velocities of flow through the inlet sediment control structure and basin should not exceed 2.5 ft/sec. Energy dissipation should be provided at the inlet and outlet to prevent scour and reduce the velocity of stormwater.
7. Access:
 - Maintenance access shall be planted with grass and at least 10 feet wide with a maximum slope of 15 percent and a maximum cross sectional slope of 3 percent. Sufficient land areas for equipment access for the basin maintenance should be provided. This access shall extend to the fore bay, micropool and outlet structure. It should never cross the emergency spillway, unless the spillway has

been designed for that purpose and to the extent feasible, be designed to allow for vehicle turnaround.

- Provide a flat maintenance shelf/berm with a minimum width of 10-foot around the perimeter of the basin. The pond berm must provide load bearing capability for industrial maintenance mowers.
8. Outflow from the basin must be directed to a stable channel.
 9. The minimum buffer/setback for the detention structure shall be 25 feet horizontal from the basin easement to any dwelling and 5 feet vertically from any dwelling.
 10. A safety fence or vegetative barrier is required where a detention structure interior side slopes are steeper than 3H:1V or when the impoundment is a wall greater than 24 inches in height. If the wall is adjacent to a walk way or street a railing may be required as well. The gate must be a minimum of 42" in height with a self-locking gate. This will be reviewed on a case-by case basis. A variance can be requested for review by the City of Clemson.

6.2.2 Surface Detention Basin Criteria

1. Basin vegetated side slope embankments shall be less than 15-feet in height and shall have side slopes no steeper than 3H:1V. Embankments protected with Erosion Control Blankets or Turf Reinforcement Matting shall be no steeper than 2H:1V. In this case, at a minimum, one interior side slope must be 3H:1V to provide access into the basin. Geotechnical slope stability analysis is required for slopes greater than 10-feet in height and embankments that have steeper slope than those indicated above. A variance may be applied for if site conditions dictate necessary.
2. Provide a long and narrow basin shape, with a minimum length to width ratio of 2:1, a 3:1 is requested. Length to width ratio can be increased by designing an irregularly shaped basin or by using baffles to create a longer path of flow. The allowable dead storage space of a basin is limited to a maximum of 20%. Any structures placed within the basin should not be overtopped by the 2- and 10-year 24-hour storm.
3. Dry Detention bottom slopes shall be graded towards the outlet structure to prevent standing water conditions and be stabilized to prevent scour. A low flow or pilot channel constructed across the facility bottom from the inlet to the outlet is required to prevent standing water conditions when the pond bottom may be subject to non-storm flow from groundwater, footing drainage, storm sewer acting as underdrain and sump discharge. A minimum 2 percent bottom slope is recommended for both cross slope and longitudinal slope.
4. If the 2 percent grade cannot be obtained an acceptable alternative is to install an under drain. The under drain shall be constructed of the following manner:
 - Should be one of the last items to be installed to eliminate any sediment build-up that would cause the under drain to not function properly;
 - A non-woven geotextile fabric shall be laid in the excavated trench first;
 - The perforated drainpipe shall be covered with washed stone; and,

- Both stone and drain shall be then wrapped with the non-woven geotextile and backfilled with sandy porous material
- 5. The maximum depth of permanent storage facilitates shall be determined by site conditions, design constraints, and environmental needs. The facility should provide a permanent pool of water with a depth sufficient to discourage weed growth without creating undo potential for anaerobic bottom conditions. A depth of 6 to 8 feet is reasonable unless fishery requirements dictate otherwise. Aerating may be required for permanent pools to prevent anaerobic conditions. Wildlife experts shall be contacted were aquatic habitat is required.
- 6. Emergency spillways shall be designed to convey the routed runoff of the 100-year 24-hour design storm while maintaining at least one foot of freeboard between the high water elevation and the top of the embankment crest. Overflow must discharge to a stable channel or established wetland area.
 - Emergency spillways shall be located on undisturbed, non-fill soil wherever possible. If the spillway must be located on fill soils, then it must be horizontally offset at least 20 feet from the principal outlet and be designed with some type of lining (i.e.: riprap, reinforced turf, concrete, or non-flexible lining)
 - The maximum grade of the spillway’s exit channel may not exceed 20 percent unless a non-flexible lining is used to control erosion with the channel. All linings must be evaluated for stability at the channel grade chosen (flexible linings include: vegetation, reinforced turf, riprap and modular blocks)
- 7. A dam is defined as being an artificial barrier that impounds water to a depth of 15-feet or greater and has a maximum storage volume of 10-acre feet or greater; therefore, impoundment depths greater than 15-feet are subject to the requirements of the Safe Dam Act unless the facility is excavated. Several exemptions are allowed from the Safe Dams Act and any questions concerning specific designs applications should be addressed by SCDHEC. If an exemption is being pursued a written letter from SCDHEC shall be obtained and presented with the Stormwater Management Permit Application.
- 8. Principal Spillways:
 - All basin outlets must have a trash rack to control clogging by debris and to provide safety to the public. The surface area of each rack must be at least four times the outlet opening it is protecting. The spaces between rack bars must be no more than six inches or one-half the dimension of the smallest outlet opening behind it, whichever is less. Trash racks should be inclined to be self-cleaning;
 - All pipes that extend through an embankment should have anti-seep collars or filter diaphragms to control the migration of soil materials and, so prevent potential embankment failure from “piping” within the backfill soil along the conduit. All smooth outlet pipes greater than eight inches and all corrugated outlet pipes greater than 12 inches must have seepage controls to prevent the migration of soils along the outside of the pipe; and,



- All outlets employing a riser structure must be designed to prevent the riser floating.

6.2.3 Subsurface Detention Basin Criteria

1. Emergency spillways must discharge to a stable channel.
2. All subsurface systems must include pretreatment for the removal of sediments and oils prior to entering the detention structure.
3. Subsurface detention systems must have an observation port for monitoring sediment and debris levels and determining when rehabilitation is necessary. This should be installed to the bottom of the system.
4. Access to the subsurface system must be provided to allow for the removal of accumulated sediment and debris.
5. The preferred subsurface basin is a vault with the cleanout elevation clearly marked and easily seen.

6.2.4 Landscaping Criteria

In order to ensure that the ponds' engineering function is protected, the following criteria for landscaping plan stormwater ponds has been established:

1. Do not place landscaping within 10 feet of inlet or outlet pipes or other manmade structures such as spillways;
2. Do not place trees or berms that impound water, only shrubs that have fibrous roots may be planted on berms;
3. Do not plant trees on steep slopes or berms in order to prevent damage from blowdowns that can lead to failure of the dam/berm;
4. Side slopes and berms should be build no steeper than 3H:1V so that standard riding lawnmowers can be used to maintain them;
5. Ensure that there is enough space between plantings and structures to allow room for an industrial mower to maneuver (a minimum of six foot is needed for the mower);
6. Use drought tolerant species or assure watering from the HOA if non-drought tolerant perennials, trees, shrubs, or vines are part of the design;
7. Plant in clumps or "landscaping island" rather than rows. Clustering allows for mowing around clusters but not necessarily within them;
8. Avoid planting perennials where committed care is not guaranteed. Perennials may look like meadow weeds and be accidentally mowed if not cared for;
9. Provide ongoing maintenance to keep weeds at bay until any ground cover or cluster planting become well established;
10. Avoid planting berms with thick, shrubby ground cover which could mask rodent activity that could weaken the berm, piping of water along living or dead roots that could lead to dam failure;
11. Plant on cut slopes which pose little threat in blowdown or piping conditions;

12. Use good soil by amending native soil with at least 2" of compost tilled into the subgrade to a depth of at least six inches to ensure the plants succeed.
13. Trees or shrubs with a mature height over 4 feet tall may not be planted on the embankment or allowed to grow within 15 feet of the toe of the embankment and 24 feet from the principal spillway structure of wet ponds;
14. On wet ponds side slopes along the shoreline of the pond should be 3H:1V or flatter to facilitate maintenance and to reduce public risk of slipping and falling into the water and should extend three foot deep to ensure a safe landing to help any persons that have falling into the wet pond escape; and,
15. A shallow water bench, which is home to most of the aquatic plant life, should be established around the perimeter of the permanent pool to promote the growth of emergent vegetation along the shoreline and deter individuals from wading.

6.3 Downstream Analysis Criteria

A downstream analysis may be required by the City Engineer.

The downstream analysis shall determine whether the design storm events of interest cause or increase flooding, drainage, or erosion impacts to downstream properties or road crossings.

The analysis criteria shall include but is not limited to:

- Existing land use curve numbers shall be used for developed areas upstream. Where areas upstream are known to be developed the City Engineer may require these areas to be considered developed in a future land use condition.
- The weighted curve number for the proposed development site shall be used for all undeveloped upstream areas.
- Existing land use for downstream areas of interest may be used, but future land use, when applicable, is recommended for conservative results.
- Routing of flows using an accepted hydrologic and hydraulic method.
- Hydraulic step-backwater calculations (Corps of Engineers HEC-2 or HEC-RAS models or equivalent) shall be performed to determine flood elevations of any downstream impacted areas.
- The effect of any upstream and proposed storm water quantity or quality structures.

6.3.1 Improvement Options

If the downstream analysis determines that the development of a particular site does contribute to flooding, drainage, or erosion problems, then at least one of the following improvements shall be implemented:

- On-site water quantity control;
- Off-site water quantity control; and/or,
- Improvements to the downstream stormwater conveyance system.

6.3.2 On-Site Water Quantity Control

The design professional may select to implement on-site water quantity control structures. These structures may consist of nonstructural controls such as swales, natural drainage ways, wetlands, and low areas within the site terrain. These structures may also consist of structural approaches such as engineered detention facilities.

6.3.3 Off-Site Water Quantity Control

The design professional may use an off-site publicly or privately owned facility to prevent adverse downstream impacts. The use of off-site facilities must meet the following requirements:

- The facility to be used must be functional when the Stormwater Management Permit application is submitted;
- The owner/entity had agreed to accept runoff from the proposed development site;
- The owner has an implemented maintenance agreement for the facility;
- The facility is sized to effectively handle increased flow rates and flow volumes;
- The facility is located downstream or adjacent upstream to the proposed site; and,
- There are no significant adverse impact between the outlet and the proposed development site and the inlet to the off-site facility;

Off-site facilities do not need to be physically connected through a pipe conveyance system but if the facility provides retardance of stormwater within the sites sub-basin then this can be a method the design professional uses. Facilities must be located downstream from the site.

6.3.4 Improvements to the Downstream Stormwater Conveyance System

The design professional may perform and provide supporting calculations that indicate that the best solution is to upgrade the downstream system. This option may be implemented under the following requirements;

- The downstream property owner of the facilities to be improved has granted temporary construction easements;
- The downstream improvements are economically feasible;
- The downstream improvements must be shown to be completed before construction on the site can begin; and,
- The improvement will not cause any other significant problems downstream.

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Section 7. Erosion and Sediment Control

Natural erosion has been occurring since the earth was formed. This process, which generally occurs at a relatively slow rate, has shaped and molded the earth's surface in the form we recognize today. Manmade erosion, on the other hand, occurs at a quicker rate.

Manmade erosion caused by inappropriate management of stormwater runoff from development sites contributes greatly to urban land breakdown and water pollution. It is estimated that erosion on unprotected construction sites may average up to 30 tons per acre per year. Construction-generated stormwater runoff often contains sediment, toxic chemicals, oil and grease, pesticides (herbicides, insecticides, or rodenticides), trace metals, and other contaminants which serve as a significant source of water pollution and threatens public health, fisheries and other wildlife. Nutrients carried by sediment can also promote weed and algae growth making water areas unattractive for recreational activities. The resulting water and environmental damage caused by construction-related erosion is often extensive, long-term, costly and time consuming to correct.

7.1 Erosion Prevention Measures

One or more measures and BMP's should be utilized as appropriate during the project's construction phase. Such measures may include phasing and construction sequencing.

In addition to site-specific erosion control measures, the grading plan should include the following general measures as a minimum;

- The finished cut and fill slopes be vegetated should not be steeper than 3H:1V. The finished grade of cut and fill slopes be vegetated and vine/or groundcovers should not be steeper than 1H:1V.
- Cut and fills should 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 damages.
- Subsurface drainage should be provided in areas having high water table to intercept seepage that would affect slope stability, 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.
- All borrow and disposal areas should be included as part of the grading plan.
- Adequate channels and floodways should be provided to safely convey increased runoff from the developed area to an adequate outlet without causing significant channel degradation, or increased off-site flooding.

The SCDHEC BMP Handbook has technical specifications and details for Erosion Prevention Measures, Sediment Control Measures and can be found on their website.

7.2 Report Development

Specific requirements for the erosion and sediment control section of the Stormwater Management Permit Application shall include, but is not limited to the following items:

- The plans shall contain a description and location of the predominant soil types on the site;
- The plans shall show the location and delineation of vegetative covers that are not to be disturbed;
- The plans shall contain the location and dimensions of all stormwater drainage and natural drainage systems on, and adjacent to the development site;
- The plans shall contain both existing and planned site topography;
- The plans shall contain the location and dimensions of all land disturbing activities;
- If applicable, the plans shall contain potential locations for soil stock-piles and the related stabilization structures or techniques for these stock-piles;
- The plans shall include details, dimensions and descriptions of all temporary and permanent erosion and sediment control measures;
- Notes contained in the erosion and sediment control plan shall state that all erosion and sediment controls be inspected at least every seven calendar days, or within 24-hours after any storm event that produces greater than 1-inch of rainfall during any 24-hour period;
- Notes contained in the erosion and sediment control plan shall state that when construction and land disturbance activates have temporarily ceased on any portion of a site, temporary site stabilization measures shall be required as soon as practicable, but no later than 14 calendar days after the activity has ceased;
- Notes contained in the erosion and sediment control plan shall state that final stabilization of the site shall be required within 14 calendar days of the completion of construction;
- Specifications for a sequence of construction operations shall be contained on all plans describing the relationship between the implementation and maintenance of sediment controls including permanent and temporary stabilization and the various phases of each disturbance and construction. The specifications for the sequence of construction shall contain at a minimum, the following:
 - Clearing and grubbing for those area necessary for installation of perimeter controls;
 - Installation of sediment basins and traps;
 - Construction of perimeter controls;
 - Remaining clearing and grubbing;
 - Road grading, and installation of road base (safety requirement from fire marshall);
 - Grading for the remainder of the site;

- Utility installation and whether storm drains will be used or blocked until the completion of construction;
- Final grading, landscaping, or stabilization; and
- Removal of sediment control structures.
- Design computation for all erosion and sediment control structures:
 - List of trapping efficiency of each sediment control structure;
 - Calculations of required sediment storage volumes;
 - Explanation of any computer models or software used with highlights of the output data; and,
 - Description of required clean-out frequencies and maintenance schedules.



Section 8. Water Quality

The section and design guidelines set forth in this chapter of the Design Manual for water quality controls are provided to aid the design professional in planning and designing appropriate water quality BMP's relative to target pollutants, function, ease of maintenance, aesthetics, and safety. The design professional is responsible for designing water quality BMP's to function properly for each specific site. It is equally important to locate the source of these pollutants so source controls can be applied to eliminate these pollutants from entering receiving water bodies. Table 8-1 lists typical urban stormwater runoff pollutants and their sources, and the list is by no means exhaustive.

Table 8-1, Pollutants and Sources in Urban Landscape

Pollutant Source	Pollutant of Concern
Erosion	Sediment and attached soil nutrients, organic matter, and other adsorbed pollutants.
Atmospheric deposition	Hydrocarbons emitted from automobiles, dust, metals, and other chemicals released from industrial and commercial activities
Construction materials	Metals, paint, and wood preservatives
Manufactured products	Heavy metals, phenols and oils from automobiles, Zinc and Cadmium from tire wear
Landscape Maintenance	Fertilizer and pesticides. Generally as impervious area increases, nutrients build up on surfaces and runoff transport capacities rise resulting in high loads.
Plants and Animals	Plant debris, animal excrement.
Septic Tanks	Coliform bacteria, nitrogen, NO ₃
Non-Stormwater Connections	Sanitary sewage, industrial wastewater, commercial discharge, and construction activities
Accidental Spills	Pollutants of concern depend on nature of the spill
Animal Waste Management	Fecal coliform, nitrates and phosphorus
Pesticide Applications	Pollutants of concern depend on the pesticide being used and the time of crop.
Land Disturbance Agriculture	Sediment and attached soil nutrients, organic matter, and other adsorbed pollutants
Fertilizer Applications	Nitrogen and phosphorus

*Source: U.S. Environmental Protection Agency, June 1992

8.1 Characterization of Urban Stormwater Runoff Quality

8.1.1 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. Suspended solids increase the turbidity of the receiving water, thereby reducing the penetration of light, resulting in decreased activity and growth of photosynthetic organisms. Combined sewer



overflows typically contain high suspended solids concentrations. The solids that settle in the receiving water pose long-term threats resulting from their oxygen demand and gradual accumulation of toxic substances. Sedimentation and other forms of physical separation are often an effective means of removing suspended solids from stormwater.

Sediment is derived from a variety of sources, including:

- Erosion from disturbed areas;
- Wash-off of sediment deposited on impervious areas; and,
- Detachment of sediment due to the increased stream power.

Models are available to predict total suspended solids (TSS) contributions from “clean” sediment, but few of the models have parameters specific to urbanized areas. Most of the models were developed to deal with agricultural soils, and their application to urban areas is limited.

8.1.2 Oxygen Demanding Matter and Bacteria

Sufficient levels of dissolved oxygen (DO) in the water column are necessary to support and maintain aquatic life, growth, and reproduction. The introduction of stormwater containing oxygen demanding organic matter can impair the receiving water quality by reducing the DO levels. Bacteria enter the storm water system typically from the wash-off of animal feces. Occasionally, bacteria may enter the drainage system through residential sanitary lateral connections, and industrial/commercial drains, though such practices are typically illegal and punishable. Pathogenic bacteria’s and virus 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.

Currently the City of Clemson is responsible for being at or less than the TMDL of 18 Eighteen Mile Creek for Fecal Coliform.

8.1.3 Nutrients

Nitrogen and phosphorus are plant nutrients that promote the growth of plants and Protista such as algae and are the second leading stressor of impaired rivers and streams and leading stressor of impaired lakes (US EPA, 1997). The nutrients that are washed into Waters of the State increase the growth of oxygen demanding organic matter which then lead to a decrease in dissolved oxygen in the bodies of water.

Typical contributing sources of nutrients into stormwater runoff:

- Agricultural runoff;
- 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 is later washed into stormwater.

Model studies indicate that the increase in nutrient loadings due to increased imperviousness will be dramatic. Nutrients can be removed from stormwater prior to discharge through biological uptake such as by plantings in stormwater quality control ponds.

8.1.4 Pollutant Loading

Estimating the pollutant for a particular development site is commonly calculated based on the general land use category of the site. Primary land use contributors are streets, roads, highways, residential areas, commercial areas, industrial areas, and site under development.

The control of urban runoff can be classified in two categories:

- **Runoff Quantity Control:** techniques are well established and are based on the physical laws of conservation and momentum. Such measures seek to attenuate peak runoff flow rates and to reduce hydrograph volumes to mitigate flooding and the potential for erosion downstream.
- **Runoff Quality Control:** this problem is confounded by the intermittent nature of rainfall, the variability of rainfall characteristics, such as volume and intensity, and the variability of constituent concentrations.

The following tables list several published pollutants.

Table 8-2: Concentrations for use with the Simple Method (mg/l)

Pollutant	Residential	Mixed	Commercial	Open/Non-urban
BOD (5-day)	10.0	7.8	9.3	--
COD	73	65	57	40
TSS	101	67	69	70
Total P	0.383	0.263	0.201	0.121
Soluble P	0.143	0.560	0.800	0.250
TKN	1.900	1.288	1.179	0.965
Nitrate	0.736	0.558	0.572	0.543
Cooper	0.144	0.114	0.104	0.030
Lead	0.033	0.027	0.029	--
Zinc	0.135	0.154	0.226	0.195

Source: NURP (U.S. Environmental Protection Agency, 1983)



Table 8-3 Estimated Pollutant Loading for Various Land Uses (lbs/ac-yr)

Land Use	Estimated Pollutant Loading (lbs/ac-yr)					
	TSS	Total Phosphorus	Total Nitrogen	Pb	Zn	Cu
Road	447	0.95	2.14	0.70	0.28	0.05
Commercial	717	0.71	4.63	2.79	2.94	1.90
Single-Family, Low Density	178	0.49	3.56	0.05	0.12	0.16
Single-Family, High-Density	287	0.58	4.57	0.09	0.20	0.27
Multi-Family Residential	395	0.62	5.01	0.62	0.30	0.30
Forest	77	0.10	1.75	0.02	0.02	0.02
Grass	301	0.12	3.71	0.06	0.09	0.03
Pasture	305	0.12	3.71	0.09	0.09	0.03

Source: Terrene Institute, 1994

BOD = Biochemical Oxygen Demand	TKN = Total Kjeldahl Nitrogen
COD = Chemical Oxygen Demand	NO ₂ /NO ₃ = Nitrates/Nitrites
TSS = Total Suspended Solids	Pb = Lead
TDS = Total Dissolved Solids	Cu = Copper
TP = Total Phosphorus	Zn = Zinc
DP = Dissolved Phosphorus	Cd = Cadmium

8.2 Water Quality Requirements

At a minimum, permanent water quality must be addressed on all projects over .75 acre and part of a larger common plan.

8.2.1 Treatment

All stormwater runoff generated from a site shall be adequately treated before discharge. It shall be presumed that a stormwater management system complies with this requirement if:

1. Permanent water quality ponds and detention structures having a permanent pool elevation are designed to store and release the first ½-inch of runoff from the site over a minimum period of 24-hours. The water quality storage volume of these water quality structures shall be designed to accommodate at least ½-inch of runoff from the entire site;
2. All non-single family home sites must have a manned wheel wash station;
3. Permanent water quality structures not having a permanent pool elevation shall be designed to store and release the first 1-inch of runoff from the site over a minimum period of 24-hours;
4. Permanent water quality infiltration practices shall be designed to accommodate at a minimum the first 1-inch of runoff from impervious areas located on the site;

5. When existing wetlands are intended to be water quality structures, the Stormwater Management Permit shall not be implemented until all necessary Federal and State permits have been obtained;
6. Appropriate structural stormwater controls or nonstructural practices are selected, designed, construction or preserved, and maintained according to the specific criteria in the SCHDHEC BMP handbook; and,
7. Runoff from hotspot land uses and activities identified by the City of Clemson are adequately treated and addressed through the use of appropriate structural stormwater controls and pollution prevention practices.

8.2.2 Stream Channel Protection

Stream bank stabilization is used to prevent stream bank erosion from high velocities and quantities of stormwater runoff. Typical methods include the following:

1. Riprap-large angular stones placed along the stream bank;
2. Gabion-Rock filled wire cages that are used to create a new stream bank;
3. Reinforced concrete- concrete bulkheads and retaining walls that replace natural stream banks and create a non-erosive surface;
4. Bioengineering Stabilization-live cuttings of native plants to establish a manageable stream bank;
5. Grid Pavers-Pre-cast or poured in-place concrete units that are placed along stream banks to stabilize the stream bank and create open spaces where vegetation can be established; and,
6. Cribb Walls-logs with vegetation used to create new stream banks.

All stream bank stabilization methods shall comply with all regulations concerning the U.S. Army Corp and Section 404 of the Clean Water Act that regulates the modification of stream banks. Measures for stream bank protection should be installed according to a unique plan and adapted to the specific site. Design should be developed according to the following principles:

- Bottom scour should be controlled, by either natural or structural means; before any permanent type of bank protection can be considered feasible;
- Any modification to the stream bank must not negatively affect properties downstream adjacent to the stream;
- Waters of the U.S./State are not used for permanent water quality control;
- Specific attention should be given to maintaining and improving habitat for fish and wildlife; and,
- Structural means must be effective for the design flow and capable of withstanding greater flow without serious damage.

8.2.3 Structural Stormwater Controls

All structural stormwater management facilities shall be selected and designed using the appropriate criteria from the SCDHEC Stormwater BMP handbook. All structural stormwater controls not included in the SCHDE Stormwater BMP handbook, or for which pollutant removal rates have not been provided, the effectiveness and pollutant removal of the structural control must be documented through prior studies, literature reviews, or other means and receive approval from the City of Clemson before being included in the design of the Stormwater Management System. In addition, if hydrologic or topographic conditions, or land use activities warrant greater control than that provided by the minimum control requirements, the City of Clemson may impose additional requirements deemed necessary to protect upstream and downstream properties and aquatic resources from damage due to increased volume, frequency, and rate of stormwater runoff or increased nonpoint source pollution loads created on the site in question.

8.2.4 Drainage System Guidelines

Stormwater conveyance facilities, which may include but are not limited to culverts, stormwater drainage pipes, catch basins, drop inlets, junction boxes, headwalls, gutter, swales, channels, ditches, and energy dissipaters shall be provided when necessary for the protection of public right-of-way and private properties adjoining project sites and/or public right-of-ways. Stormwater conveyance facilities that are designed to carry runoff from more than on parcel, existing or proposed, shall meet the following requirements:

1. Methods to calculate stormwater flows shall be in accordance with this Design Manual; and,
2. All culverts, pipe systems and open channel flow systems shall be sized in accordance with this Design Manual and standard engineering practices.

8.2.5 Retention/Detention Basin

All stormwater retention/detention Basins shall be design to the requirements of this Design Manual. If a project disturbed more than 25 acres and/or the stormwater discharges directly into an impaired waterbody listed on the State's 303(d) List, the City of Clemson must have assurance that the stormwater runoff from the site will not cause or contribute to further degradation of the waterbody.

8.2.6 Dam Design Guidelines

Any land disturbing activity that involves a site which proposes a dam, shall comply with the South Carolina Safe Dams Act and Rules for Dam Safety as applicable.

8.3 First Flush Water Quality Volume

The water quality volume is the storage needed within a water quality control BMP to control the "first flush" of runoff during a storm event. Studies have shown that the highest pollutant

concentrations are found in the initial runoff period known as the “first flush” volume has been design to be:

- The preferred method to size the water quality capture device to trap 80% of TSS based on annual loading. (A model such as USEPA overflow model or similar may be used to design BMP's to meet this criteria.)
- As an alternative as a default criteria, the device may be designed to capture the first inch of runoff from the impervious area of the site and discharge it over a twenty-four (24) hour period.

8.4 Water Quality Pollutant Removal Mechanics

The removal of pollutants from urban runoff by BMP facilities such as stormwater management ponds and filter strips can occur in a number of ways which include:

- Sedimentation
- Decay and biological uptake
- Filtration
- Adsorption
- Nitrification/Denitrification, and
- Plant uptake

Pollutant removal in stormwater management ponds and detention facilities occurs primarily through the sedimentation of suspended solids. Pollutant removal by decay or biological uptake may also occur under long detention times and favorable environmental conditions.

8.5 Non-Structural Water Quality Controls

8.5.1 Open Vegetated conveyance systems:

Are associated as conveyances can be designed and installed as an alternative curb and gutter and hard piping stormwater conveyance systems. Open vegetated conveyance systems improved water quality by providing partial pollutant removal as water is filtered by the vegetation and by the opportunity to infiltrate into the soil. Open vegetated conveyances can also be designed to reduce flow velocities when compared to hard piping systems.

Design Standards

- Can be incorporated into moderate to low density development sites;
- Land surface should be gently sloping (less than 5%);
- A dense cover of strong rooted vegetation, such as tall fescue, shall be called for on the plans;
- Soils must be able to withstand design tractive forces and flow velocities; or,
- Application of Turf Reinforcement Mat or Erosion Control Blanket shall be designed to protect the open conveyance.

8.5.2 Water Quality Stream Buffers:

Are associated with areas along shoreline, wetland or streams 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. The City of Clemson recommends a planted buffer of at least 10 feet away from streams which is not grass which would require a broadcast fertilizer.

8.5.3 Disconnected Rooftop Drainage to Pervious Areas:

Are associated with the reduction of runoff flow rates from developed areas. The disconnection involves directing stormwater runoff from rooftops towards pervious areas where it is allowed to filter through vegetation and other landscaped material and infiltration into the soil. This practice is best suited for development having less than 50 percent impervious area. Disconnection is not applicable to large buildings where the volume of runoff from the rooftops will cause erosion or degradation to receiving vegetated areas: further benefits include:

- Increased the time of concentration by disconnecting runoff from any structural stormwater drainage systems.
- Provides water quality benefits by allowing runoff to infiltration into the soil. Downspouts from rooftops should discharge to gently sloping, well-vegetated areas, vegetated filter strips, or bioretention areas. Erosion control devices such as splash blocks or level spreaders may be required at the downspout discharge point to transfer the flow from concentrated flow to sheet flow.

8.5.4 Cluster Development to Conserve Natural Areas

Cluster development practices concentrate development away from environmentally sensitive areas such as:

- Streams
- Steep slopes
- Wetlands, and,
- Mature wooded areas.

The clustering of development in one area reduces the amount of roadways, sidewalks, and drives required when compared to development sprawled over the entire land area. Clustering and conservation of natural area practices shall be installed at least to some extent on all development sites not only to reduce the impact to natural resources by minimizing disturbance and impervious area, but also to maintain some natural beauty of the site. Also reducing the area of disturbance reduces the amount of water quantity and quality control required to be treated at the site and may reduce the amount of state and federal permits required to build on the site.

8.5.5 Grass Paving or Alternative Paving Surfaces:

Are associated with paving technology that allows for the reduction of paved areas that are infrequently used, such as fire lanes and over flow parking. Grass paving units are designed to carry vehicular loading and may be composed of different types of materials. The pavers are typically covered with sod to make the areas indistinguishable from other grassed areas. The grass pavers also provide a more aesthetically pleasing site and reduce the impact of complete asphalt surfaces, and should not be used for frequently parked areas.

8.6 Structural Controls

Structural water quality control structures are recommended for a wide variety of land uses and development types, to effectively treat runoff volume and reduce the amounts of pollutants discharged downstream. Structural stormwater quality controls are classified into the following categories:

Table 8-4. Structural Controls

General Structural Control	Description
Dry Ponds	A dry detention basin does not maintain a permanent pool and is intended to manage both the quantity and quality of stormwater runoff before discharging off-site.
Wet Ponds	Wet stormwater ponds are constructed stormwater basins that have permanent pool or micropool of water. Runoff from each rain event is detained and treated in the pool, and released at a designed rate.
Stormwater Wetlands	Stormwater wetlands are constructed wetlands 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.
General Structural Control	Description
Gravel Wetland Systems	Gravel wetlands use wetland plants in a submerged gravel or crushed rock media to remove stormwater runoff pollutants. Use these mid- to high- density environments where other structural controls will utilized.
Bioretention Areas	Bioretention areas are shallow stormwater basins or landscaped areas that utilized engineered soils and vegetation to capture and treat stormwater runoff. Runoff may be returned to the conveyance system or partially infiltrate into the soil.
Sand Filters	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 or partially exfiltrate into the soil.
Infiltration Trench	An infiltration trench is an excavated trench filled with stone aggregate used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the trench.
Infiltration Basin	Infiltration basins are shallow, impounded areas designed to temporarily store and infiltrate stormwater runoff. The size and shape can vary and designs can be one large basin, or multiple smaller basins throughout a site.
Enhanced Grassed Swales	Enhanced swales are vegetated open channels that are explicitly designed and constructed to capture and treat stormwater runoff within dry or wet cells formed by check dams or other structures
Stormwater Manufactured Treatment Devices (MTDs)	MTDs use the movement from stormwater runoff through a specially designed structure to remove target pollutants. They are typically used on smaller commercial sites and urban hotspots. There are numerous commercial vendors of these structures, but there is limited data on the performance of these structures. These structures may require monitoring to verify specific pollutant removal efficiencies.

8.6.1 Innovative Technologies

Innovative technologies are encouraged and shall be accepted providing there is sufficient documentation as the effectiveness and reliability of the proposed structure and approved by the City. Sufficient documentation may include:

- Monitoring of pollutant removal efficiency of the structure;
- Trapping efficiency of the structure in other applications;
- Testing that the company has provided and has been certified.

If satisfactory results are obtained, the innovative water quality structure may be used and no other monitoring studies shall be required. If the control is not sufficient, in the case of monitoring of pollutant removal efficiency, other onsite and/or downstream controls shall be designed to trap the required pollutants.

8.7 Anti-degradation Rules for Impaired Waters

We require that Anti-degradation Rules are implemented from activities that contribute nonpoint source pollution to adjacent waterbodies. The Anti-degradation Rules are specifically formulated to ensure that no new activities will further degrade waterbodies that are not presently meeting water quality standards. The City of Clemson shall implement the Anti-



degradation rules when issuing NPDES permits for point source and nonpoint source loadings into impaired waters. The activities of primary concern are land development project that are immediately adjacent to and discharge runoff of stormwater into impaired waters. These projects may also be required to obtain a Special Pollution Abatement Permit as discussed below in Section 10.9.

8.7.1 Impaired Waterbodies

Every two years SCDHEC is required by Section 303(d) of the Clean Water Act to identify waterbodies that are not meeting water quality standards despite the implementation of technology based controls. The listings of the impaired waters list each waterbody by name, monitoring station number, hydrologic unit, basin, and all impairments and cause identified for each water body.

8.7.2 Applicability

Large scale development projects with more than 25 acres of disturbed land which have stormwater discharges directly into an impaired body via structures or ditches must have assurance from the design engineer that the stormwater runoff will not cause or contribute to degradation to the receiving waterbody. The concern of water quality applies to runoff during construction and after the project has been complete.

8.7.3 Water Quality Impairment

The techniques and controls discussed in Section 10 shall be utilized to provide the removal of any harmful pollutants. Though the City does not specify the methodology for determining BMP's required to comply with Anti-degradation Rules, calculations and descriptions must show that the water quality BMP's to be installed that will ensure runoff from the site will not cause or contribute to further degradation of the impaired waterbody.

For pollutants causing impairments for which numeric a water quality standard has been adopted by DHEC (fecal coliform, pH, metals), calculations shall be performed and submitted showing that the pollutants in the runoff from the development site will not exceed the applicable in-stream water quality standards. The runoff discharged through the last water quality BMP shall have a water quality better than in-stream standard. The design professional shall provide insurance in a different manner when the water quality impairment is not a pollutant itself, but is affected by a pollutant that can be regulated such as dissolved oxygen levels are affected by biochemical demand. In these situations, a reasonable approach to show that runoff will not further degrade the adjacent impaired waterbody is to show that the post-development loading of a particular pollutant is less than or equal to pre-development loading. This insures that there will be no net increase of loading that particular pollutant and no further lowering of the stream quality standard.

In most cases, the effectiveness of the designed water quality BMP's will not require water quality sampling. For certain situations, it may be required for the applicant or landowner to collect monitoring data to confirm the effectiveness of the BMP's.

Section 9. Ownership and City Participation

The following policies apply to unpolluted stormwater (clear runoff). Stormwater carrying silt or any other pollutant is the responsibility of the property owner releasing the pollutant.

The City will have the responsibility for stormwater under these conditions, as long as the issue is not caused by planned development for which the responsibility to upgrade will fall solely on developer:

- Inadequate crossroad piping on a City road or right-of-way for current conditions;
- Inadequate or poorly maintained storm drains on the City right-of-way;
- Inadequate or poorly maintained ditches on the City right-of-way; and
- Drainage from the Cities properties or right-of-way.

The City will not be responsible for these stormwater conditions:

- Water that crosses City properties or right-of-way;
- Privately owned stormwater retention basins or structures;
- Stormwater in excess of 10 year rainfall event; and,
- Drainage problems originated on private road or private property.

9.1 Stormwater Facility Ownership

1. All stormwater management facilities shall be privately owned and maintained unless the City accepts the facility for City ownership and maintenance. The owner of all private facilities shall grant the City, a perpetual, non-exclusive easement that allows for public inspection and emergency repair.
2. All stormwater management measures relying on designated vegetated areas or special site features shall be privately owned and maintained as defined on the drainage plan;
3. When the City of Clemson determines that additional storage capacity beyond that required by the applicant for on-site stormwater management is necessary in order to enhance or provide for public health, safety and general welfare, to correct unacceptable or undesirable existing conditions or to provide protection in a more desirable fashion for future development, the City may:
 - a. Require that the applicant grant any necessary easements over, through or under the applicant's property to provide access to or drainage for such a facility;
 - b. Require that the applicant attempt to obtain from the owners of the property over, through or under where the stormwater management facility is to be located, any easements necessary for the construction and maintenance of same (and failing the obtaining of such easements the City may, at its option, assist in such matter by purchase, condemnation, dedication or otherwise, and subject to below, with any cost incurred thereby to be paid by the City); and/or,

- c. Participate financially in the construction of such facility to the extent that such facility exceeds the required on-site stormwater management as determined by the City Council.
4. To implement this provision both the county and developer must be in agreement with the proposed facility that include the additional storage capacity and jointly develop a cost-sharing plan, which is agreeable to all parties.



Section 10. Maintenance and Inspection

10.1 Maintenance

All stormwater management facilities shall be maintained by the owner(s) in such a manner as to:

- Maintain and enhance the general health, safety and welfare;
- To reduce and minimize damage to public and private property;
- To reduce and minimize the impact of such facilities on land and stream channel erosion;
- To promote the attainment and maintenance of water quality standards; and,
- To maintain, as nearly as possible, the pre-development runoff characteristics of the area.

All maintenance of privately owned stormwater management facilities shall be at the sole cost and expense of the owner(s) of such facilities. If the owner(s) fail to maintain the facility in such a manner that the facility creates a danger to the general health, safety and welfare to the citizens of the City of Clemson, then the City of Clemson may enter the property and perform maintenance activities required to bring facilities up to standards the cost of work performed by the City of Clemson will then be assessed (inspection, labor, materials and equipment). The cost shall be collected from any bonds that are in place to cover the cost, or shall become a lien on the property, and shall be collected in the same manner as City taxes.

- If the City assists private owner(s) with the design of stormwater management facilities, this does not imply any maintenance responsibilities by the City. The maintenance of all such facilities shall be the sole responsibility of the property owner(s).

10.2 Stormwater Management Inspection Authority and Enforcement

The City Engineer and/or his delegates shall be authorized to inspect and enforce the requirements of this Design Manual. The inspectors shall be:

- Authorized to conduct inspections and file reports for periodic inspections as necessary during construction of stormwater systems to assure compliance with the approved plans;
- Authorized to furnish the permittee or agent the results of inspections in a timely manner after the completion of each inspection;
- Authorized to issue a Correction Order to the permittee or agent when any portion of the work does not comply with the approved plans;
- Authorized to issue a Notice of Violation (NOV) to the permittee or agent when any portion of the work does not comply with the approved plans;
- Authorized to Issue a Stop Work Order as the result of unsafe conditions, working without a permit, unsatisfactory work, progress, or other non-compliance;



- Authorized to issue a Civil Citation as a result of unsafe conditions, non-compliance with a Stop Work Order, unsatisfactory work, progress or other non-compliance; and,
- Authorized to perform a final inspection upon the completion of the stormwater system to determine if the completed work is constructed in accordance with the approved stormwater design plan, approved “as-built” plan certified by the permittee’s registered professional engineer.

10.3 Permittee Inspector Responsibility

- Inspection of the construction site occur to ensure BMP’s are implemented and maintained in a timely manner as required and illustrated in the pre-, during, and post construction drawings or their approved modifications.
 - Required modifications, additions, and omission of BMP’s making a plan more effective is permitted.
 - However, when BMP’s are not installed as illustrated on the pre-, during, and post-construction drawings or their modifications, the inspector must provide written justification in an inspection report as to why omissions and/or changes were allowed to occur, this report shall be submitted to the City Engineer for review.
 - Inspections of installed Stormwater BMP’s that need maintenance should also include a timeline such as:
 - 24 hours for critical maintenance items (inlet protection, failed silt fence, etc)
 - 72 hours for items that require general maintenance (clean out sediment behind silt fence, clean check dams, etc)
 - 1 weeks for items that are soon to be requiring general maintenance (clean sediment out of sediment basins, bent silt fence stakes, etc)
- Inspectors shall make inspections as hereinafter required and either shall approve that portion of the work completed or shall notify the permittee wherein the work fails to comply with the Sediment and Erosion Control Plan as approved by the City of Clemson;
- Plans for grading, stripping, excavating, and filling work bearing the stamp of approval of the City of Clemson shall be maintained at the site or an approved off-site location during the progress of the work;
- After pre-construction meeting has been completed, inspections must be conducted at a minimum of at least every 7 calendar days, and within 48 hours of the end of a storm event of 1 inches or greater.
- Inspection frequency may be reduced to at least once every month for portions of the site that have been stabilized;
- On a case-by-case basis any permittee who has coverage under the NPDES General Permit for Stormwater Discharges from Large and Small Construction Activities permit



may be required to conduct inspections on a more frequent basis than prescribed above;

- Inspections must be conducted to assess the effectiveness of any sediment and erosion control measure selected to control the quality of stormwater discharges from the construction activity. This person must be either the preparer of the Stormwater Management Plan or an individual who is under the direct supervision of the preparer of the approved SWPPP and who meets the requirements in this paragraph. Inspections may be conducted by a person with a registration equivalent to the registration of the preparer of the SWPP and who meets the qualification of this paragraph or an individual who is under the direct supervision of the equivalent person and who meets the requirements in this paragraph or by a CEPSCI inspector (Certified Erosion Prevention Control Inspector.)

10.4 Construction Activity, Owner, and Operator Inspection Responsibilities

In accordance with any applicable local, state, and federal stormwater requirements including, but not limited to the NPDES Construction General Permit (CGP), owner/operators are responsible for conducting construction, development and re-development and post-construction, post-development and post re-development site inspections. Records of all inspections shall be kept for a minimum of five (5) years and shall be made available to the City of Clemson upon reasonable request.

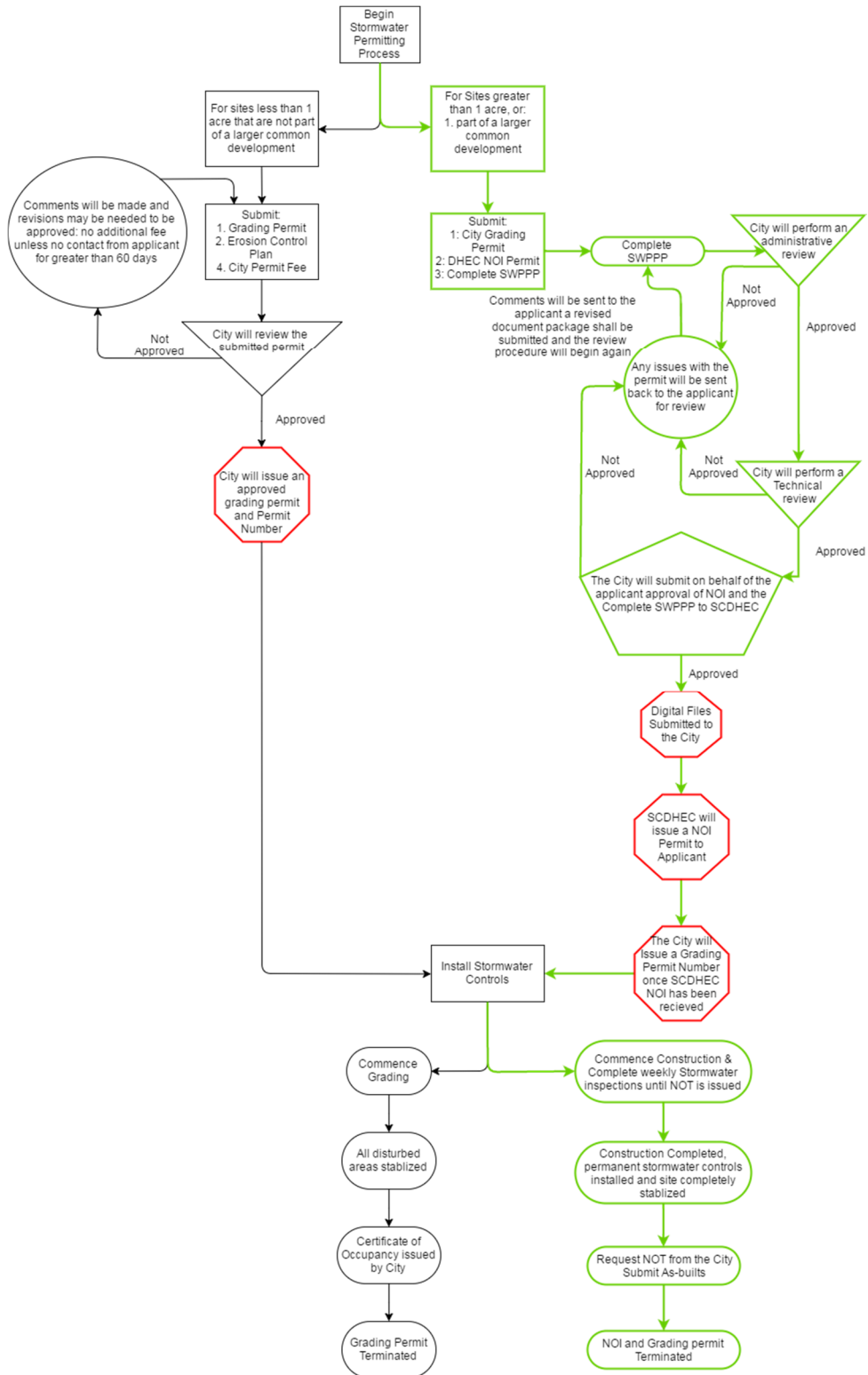
10.5 Enforcement Procedures

Follows City of Clemson Enforcement Response Plan (ERP)



Appendix A:

Stormwater Review Procedures



Appendix B

City Grading Permit Application



SCDHEC Stormwater NOI Application

Can be found at the following:

<http://www.scdhec.gov/library/d-2617.pdf>



Stormwater NOT Application

Can be found at the following:

<http://www.scdhec.gov/library/d-2610.pdf>



Appendix C

Clemson Stormwater Management and Sediment and Erosion Control Plan Review Checklist for Design Professionals

This Plan Review Checklist for Design Professionals has been developed to aid those who prepare Stormwater Pollution Prevention Plans (SWPPPs). Adjacent to the headings for most sections are references from the corresponding portions of the NPDES General Permit for Stormwater Discharges from Construction Activities (SCR100000), which was issued on October 15, 2012 and the Clemson Stormwater Design Manual which was issued on September, 1, 2017. SWPPP preparers should not utilize this checklist as a substitute for the language in the permit and should review the permit itself for more information on each specific requirement. SCR100000 can be found at:

<http://www.scdhec.gov/environment/water/swater/docs/CGP-permit.pdf>

and the Clemson Design Manual can be found:

In the space provided please indicate the location and page number(s) where each item below can be found in your SWPPP or supporting calculations. If an item is not applicable, put N/A. The Department reserves the right to modify this checklist at any time. Requirements for the Coastal Zone are not applicable for the City of Clemson.

Project Information: *(To be filled out by Contractor)*

Project Name: _____

County: _____

Checklist Completed by: *(To be filled out by the City of Clemson)*

Printed Name: _____

Signature: _____

Date: _____



Plans and Maps

1. Current Completed Application Forms

- Original Signature of individual with signatory authority for the applicant according to requirements set for in R.61-9.122.22
- All Items in both SCR100000 and Clemson Grading Permit completed and answered
- Fee Schedule
- *Note: Local projects are not exempt from the plan review fee.*

2. Copies of Plans and Calculations

- Plans Stapled together.
- For Initial Review all projects require a minimum of **ONE** set of plans and supporting documentation (report, calculations, maps, etc.)
 - Upon Review:
 - For projects less than 1 acre not part of a Larger Common Plans (LCP): **ONE** set of plans and supporting documentation (may be initial submittal if not major edits required)
 - For projects greater than 1 acre but not larger than 2 acres: **THREE** sets of plans and supporting documentations
 - For projects greater than 2 acres: **THREE** sets of plans and supporting documentations.
- If additional approved sets are required please reference the Fee Schedule.

3. Location Map

Location in C-SWPPP: _____

- North arrow and Scale
- Outlined project location
- Labeled road names

4. Project Narrative

Location in C-SWPPP: _____

- Scope of project outlined, including a brief description of pre- and post-development conditions)
 - If a Type 2 re-development the pre-development curve must be as specified in the City of Clemson Design Manual
- Summary table of pre- and post-development flows (at least 2- and 10-year, 24-hour storm events)
- Existing flooding problems in the surrounding area described.
- Disturbed area calculations included for subdivision projects or LCP disturbing 1 or more acres:
 - For subdivisions if the sites is not to be mass-graded, the following formula should be used to determine the amount of disturbance:
Amount of Disturbance = 2[Max Restricted Building Size][Number of Lots] + Right of Way (ROW) areas*

- ROW areas – include clearing for roads, sidewalks, utilities, easements etc.

○ If this equation is to be used, include a note on the plans stating: “The site is not to be mass-graded. Only 2 times the footprint is to be cleared as the lots are developed. The assumed disturbance on each lot is _____”

5. Topographic Map **Location in C-SWPPP:** _____

- Project Boundary outlined
- Route of runoff from the site to nearest waterbody shown
- Road names adjacent to site labeled

6. Soils Information **Location in C-SWPPP:** _____

- Project Boundary outlined
- Predominate soil types found at the site identified on the plans or on a separate map
- *Note: Soils information is available from the Natural Resource Conservation Service through their website:*
<http://websoilsurvey.nrces.usda.gov/app/HomePage.htm>

7. Floodway/Floodplains **Location in C-SWPPP:** _____

- Project boundary outlined, if in close/proximity to floodplain/floodway
- Approval from the City of Clemson Building official must be obtained before the review process will continue past this point. If Approval has already be obtained please include in the C-SWPPP
 - *Note: Army Corp. of Engineers may be required as well, the City of Clemson permit may be issued independent other required permits.*

8. Site Plan Checklist: **Location in C-SWPPP:** _____

- Location map with site outlined on first plan sheet (map should have enough detail to identify surface waters of the state within 1 mile of the site)
- North arrow and scale
- Property lines and adjacent landowner’s names
- Legend
- Registered engineer’s signed and dated seal
- Engineers Firm’s Certificate of Authorization seal
- If the SWPPP has been developed by a Registered Professional Engineer, Registered Landscape Architect or Tier B Land Surveyor, the following statement must be included on the site plans;
 - *“I have placed my signature and seal on the design documents submitted signifying that I accept responsibility for the design of the system. Further, I certify to the best of my knowledge and belief that the design is consistent with the requirements of Title 48, Chapter 14 of the Code of Laws of SC, 1976 as amended, pursuant to Regulation 72-300 et seq. (if*



applicable), and in accordance with the terms and conditions of SCR100000.”

- Existing and proposed contours for entire disturbed area
- Limits of disturbed area
- Locations of off-site material, waste, borrow, or construction equipment storage areas, excluding roll-off containers (Note: Some off-site disturbed areas may require a separate application for NPDES coverage)
- Location and identification of any stormwater discharges associated with industrial activity (not construction)
- Location of Concrete Washout and other Pollution Prevention Measures
- Easements
- Road profiles with existing and proposed ground elevations (if no contours are shown on the plans)
- Grassing and stabilization specifications (temporary and permanent)
- Standard notes
- Temporary and permanent control measures (provide details of all sediment and erosion control measures used; make sure the label or legend on the plans matches the name on the detail)
- Locations of fuel and temporary restroom locations shall be located on the plans and located in areas where if spill may happen will not enter storm drainage or streams
 - Note: Maintenance requirements for each BMP should be listed on the detail.
 - Note: If details from the BMP Handbook are used, then the inspection frequency must be changed to be in accordance with the new CGP (see Standard note 3).

9. Navigable Waters

Location in C-SWPPP: _____

- Extra plan sheet showing impacts to navigable water and description of activity including in S.C. Navigable Waters (SCNW) crossing and separate SCNW permit has not been obtained for all activities
 - *Note: for NOI's submitted to the City of Clemson, if the project has SCNW crossing and if separate SCNW permit has not be obtained for this crossing, then this item will be reviewed by SCDHEC before NPDES coverage will be granted.*

10. Construction Sequence

Location in C-SWPPP: _____

- Construction Sequence should accurately reflect the nature and timing of construction activities for the site.



- Sequence should begin with the installation of perimeter controls and end with the removal of sediment and erosion control measures once the site has been finally stabilized.
- Address conversion of any temporary sediment control structures to permanent measures (i.e. , conversion of a sediment basin to a permanent detention basin)
- Sequence should reflect implementation and transition between each phased plan.

11. Phased Sediment & Erosion Control Plans **Location in C-SWPPP: _____**

- Phased Sediment and Erosion Control Plans are not required when land-disturbance is less than 5 acres, the plan does need to show how the project shall be stabilized and protect downstream properties through erosion control.
- For land-disturbance between 5 and 10 acres, a two-phased stormwater management and sediment and erosion controls plan is required for all non-linear projects. Each phase must be shown on a separate plan sheet. Plans should address the transition between phases.
 - Phase 1: Initial Land Disturbance – must include perimeter sediment and erosion control BMPs required prior to initial/mass clearing and other appropriate BMPs needed to maintain compliance with the permit. On some sites, this may include appropriate MP's for demolition of existing structures.
 - Phase 2: Stabilization – Sediment and erosion control BMP's required during the remainder of grading and construction. Must also include appropriate BMPs for stabilization – grassing, inlet protection, etc.
- For land-disturbance greater than 10 acres, a three-phased stormwater management and sediment and erosion control plan is required for all non-linear projects. Each phase must be shown on a separate plan sheet. Plans should address the transition between phases.
 - Phase 1: Initial Land Disturbance – Must include perimeter sediment and erosion control BMPs required prior to initial/mass clearing and other appropriate BMPs needed to maintain compliance with the permit. On some sites, this may include appropriate BMPs for demolition of existing structures.
 - Phase 2: Construction – Sediment and erosion control BMPs required during the majority of grading and construction activities.
 - Phase 3: Stabilization – Sediment and erosion control BMPs required near the completion of the construction project. Must also include appropriate BMPs for stabilization – grassing, inlet protection, etc.

12. Waters of the State, Including Wetlands **Location in C-SWPPP: _____**



- Delineation of all Waters of the State (WoS), including wetlands, shown and labeled on plans (delineation not required if a 100-ft undisturbed buffer can be maintained between the WoS and all land-disturbing activities)
- Additional, separate plan sheet that shows all WoS on the site and the impacted areas with a description of the activity(s), whether it is permanent or temporary, and other relevant information.
- If impacts to WoS, outlined areas of impacts and labeled that no work can begin in this area until all necessary USACOE permits, and SCDHEC 401 Certifications have been obtained and are effective.
 - *Note: If there are proposed impacts to WoS, then it is advised that you contact USACOE (866-329-8187) and/or SCDHEC Water Quality Certification, Standards & Wetlands Program Section (803-898-4300) to determine additional requirements before submitting the Notice of Intent (NOI)*
 - *Note: If WoS are to be impacted, work cannot be performed in these designated areas until all necessary permits have been acquired.*
 - *Note: If a USACOE permit is required for construction or access to a temporary or permanent stormwater management structure, NPDES permit coverage cannot be granted until the USACOE permits and SCDHEC 401 Section certifications are obtained.*

13. Buffers

Location in C-SWPPP: _____

- Select Compliance Option A, B, C in Section 3.2.4.C of SCDHEC CGP and provide appropriate documentation:
 - Double row of silt fence provided in all areas where a 50' undisturbed buffer cannot be maintained between the disturbed area and the WoS
 - Minimum 10' maintenance buffer provided between las row of silt fence and WoS; or, if buffer not provided, then statement from P.E. on plans indicating how silt fence will be installed and maintained without impacts to WoS.
- Ensure discharges into a buffer zone are non-channelized and non-concentrated to prevent erosion, and first treated by the construction site's sediment and erosion controls
- Ensure any velocity dissipation measures implemented within a buffer zone comply with SCDHEC CGP 3.2.4.C.III.(d)

14. Flow Control

Location in C-SWPPP: _____

- Control stormwater volume and velocity within the site during construction to minimize erosion within the site
- Control stormwater rates and volume at outlets during construction to minimize erosion to downstream channels and streambank.

15. Sedimentology and Sediment Basin/Trap Design **Location in C-SWPPP:** _____



- Provide a drainage area map outlining the area contributing to sediment basins, traps, and rock sediment dikes
- Trapping efficiency calculations showing that all sediment basins/traps are capable of achieving a sediment trapping efficiency of at least 80% for the 10 year, 24-hour storm event
- Sediment basins provide storage for the 10-year, 24-hour storm event for disturbed conditions or 3600 ft³/ acre draining to the basin, if more than 10 disturbed acres drain to a common point (stream, lake, property line, etc.)
- Sediment traps only used for drainage basins of less than 5 acres.
- Sediment traps storage calculations, showing that 1800 ft³/total acre draining to each trap is provided below the spillway
- If trapping efficiency calculations are required for sediment traps, then provide peak outflow, q_{po} , calculations; the 10-year 24-hour storm event for construction conditions cannot overtop the trap's spillway
- Sediment basins and traps designed for total area draining to them
- Curve number for construction analysis needs to reflect construction/disturbed conditions. Curve numbers for newly-graded areas are at a minimum:
 - Hydrologic Soil Group "A": 77
 - Hydrologic Soil Group "B": 86
 - Hydrologic Soil Group "C": 91
 - Hydrologic Soil Group "D": 94
- Drainage area map outlining the area drainage to each basin/trap.
- Sediment basins must dewater via an outlet structure that pulls water from the surface. Options for this include skimmers and flashboard risers. Surface dewatering is not required for traps.
- Three rows of porous baffles must be provided in sediment basins.
- Forebays must be installed, unless infeasible.
- Public Safety should be taken into consideration as a factor in design of sediment basins. Alternative BMPs must be utilized where a construction site limitations would preclude a safe design.
- Silt fence only used in areas with drainage areas less than ¼ acre per 100 LF of fence and not used in areas with concentrated flows or not in front of slopes greater than 2:1.
- Clean-out stake, marked at ½ the designed sediment storage depth, provided in all sediment basins/sediment traps.
 - *Note: Consult the SCDHEC BMP Handbook for information on the design of these devices*
 - *Note: The Design Aids in the SCDHEC BMP Handbook cannot be used to determine the trapping efficiency 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.

- *Note: SedCAD users please refer to the SCDHEC memo regarding the input and outlet structures.*

16. Conveyance Measures and Stable Channels **Location in C-SWPPP:** _____

- All channels and diversion ditches able to handle the 10-year storm event with non-erosive velocities of less than 5 feet per second during construction (use appropriate CN for disturbed areas) and the post-construction (if velocity exceed 5 ft/s, then permanent measures to reduce the velocity to a non-erosive rate must be provided)
- Stabilization of Conveyance channels is to be completed within 7 days of channel construction
- Rock check dams provided in temporary diversions
- Manufactures Installation detail for erosion control blanket (ECB) or turf reinforcement matting (TRM) if ECBs or TRMs to be used)
- Temporary conveyance channels should be utilized to divert concentrated stormwater flows from running onto and within the disturbed area

17. Inlet Protection **Location in C-SWPPP:** _____

- Provided at all inlets (existing and proposed)
- Inlet protection details provided for pre-paving and after roadways have been paved
- Hay bales are not acceptable
- Steel post and buried fabric shown for filter fabric inlet protection
 - *Note: The Department recommend that an inlet not have more than one (1) acre draining to it.*

18. Energy Dissipaters/Outlet Protection **Location in C-SWPPP:** _____

- All outlets stabilized with appropriately sized riprap apron or other structure
- Riprap detail shows apron dimensions and stone sizes for each pad or each pipe diameter
- Filter fabric installed beneath all riprap
 - *Note: All appropriate outlet protection and energy dissipation is also required for post-construction*

19. Slopes and/or Embankments **Location in C-SWPPP:** _____

- All slopes stabilized
- Minimize disturbance to Steep Slopes (3H:1V) or greater
- Divert concentrated flows around steep slopes using slope drains or temporary diversions



- Utilize appropriate measures to prevent erosion (erosion control blankets, surface roughing, terracing, etc.)
- Slope drains designed in accordance with SCDHEC BMP Handbook.
- Slope Drains provided where concentrated flows discharge onto a fill slope
 - *Note: Measures, in addition to grassing or hydroseeding, including 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, the Department recommends a 10' buffer at allow for construction and maintenance. If a 10' buffer is not provided, then provide permissions from the adjacent property owner for possible land-disturbing activities on his property.*

20. Utility Lines

Location in C-SWPPP: _____

- Limits of disturbance include areas necessary for installation of all utilities (cable, electrical, natural gas, water and sewer), as appropriate
- For instances where the location of cable, electrical, and natural gas has not been determined at the time the SWPP is developed, SWPPP preparer may include a note that the installation of these is to be within the permitted limits of disturbance and that installation outside these areas will require a modification to the permit.
- Inlet protection provided at all existing inlets that receive flows from the disturbed areas; also add this as a note on the plans
- For all utility lines crossing WoS, narrative and detail showing sediment and erosion control measures provided on plans.
 - *Note: for construction entrances to be provided at all locations where construction traffic accesses a paved roadway*

21. TMDL/ 303d Impaired Waterbodies

Location in C-SWPPP: _____

- List the nearest SCDHEC Water Quality Monitoring Station (WQMS) that the site drains to: _____ and, the waterbody on which it is located: _____
- Qualitative and quantitative assessment (described in Section 3.4C of SCDHEC SCR100000), if nearest WCMS listed on the current 303(d) List of Impaired Waters – and if the site disturbed 25 acres or more
- Evaluation of selected BMPs if nearest WQMS listed on the current 303(d) List of Impaired Waters and if site’s stormwater construction discharges contain the pollutant of impairment and if site disturbs less than 24 acres
- Pollutants of concern include:
 - Turbidity
 - Bio (Macroinvertebrate)
 - TP (Total Phosphorus)



- TN (Total Nitrogen)
- Chlorophyll-A
- May use SCDHEC Water Quality Information Tool
- If an approved TMDL developed for nearest WQMS and if the site's stormwater construction discharges contain the pollutant of impairment, show that measures and controls on SWPPP met assumptions and requirements of TMDL (may need to contact SCDHEC Watershed Manager for assistance)
- For Turbidity and Bio (Macro invertebrate) consider inclusion of BMPs to reduce sediment load such as: sediment traps and basin designed to meet 80% sediment removal efficiency (regardless of size), additional measures to stabilize site, limit clearing and grading
- For TP (Total Phosphorus), TN (Total Nitrogen), and Chlorophyll-A consider inclusion of BMPs to reduce nutrient load. This could include clearing and grading, soil samples to determine nutrient requirements during grassing
 - *Note: To ensure sufficient Water Quality Monitoring Stations are selected to assess all of the identified parameters for construction stormwater, include monitoring stations that contain assessments for the first twelve parameters. Some stations only assess one parameter and should not be relied upon for the entire 303*d).TMDL assessment for construction stormwater discharges. In addition nutrients and/or chlorophyll must be assessed in lakes/reservoirs.*

22. Hydrologic Analysis

Location in C-SWPPP: _____

- Pre- and Post-development hydrologic analysis calculations for the 2- and 10-year, 24-hour storm events at each outfall point
- Drainage area maps that clearly correspond to the calculations (pre- and post-development)
- Analysis points for comparing runoff rates and the total drainage area analyzed do not change from pre- to post-development, although the immediate drainage areas contributing to each analysis point might shift.
- Post-development discharges less than pre-development discharges for each outfall point (if not, then see “Detention Waiver” section below)
- Analysis performed using SCS 24-hour storm (Rational method is not acceptable)
- Rainfall data from SCDHEC Stormwater BMP handbook used in all calculations, or Precipitation Frequency Data Server from the National Oceanic and Atmosphere Administration (Full print out is required for report)
 - *Note: the curve number for open water, marshes, ext. should be 98.*
 - *Note: the curve number must follow the rules for a type 2 re-development if applicable*

23. Post Construction Hydrologic Analysis

Location in C-SWPPP: _____



- Pre- and post-developed hydrologic analysis calculations for the 2- and 10-year, 24-hour storm events at each outfall point
- Drainage area maps that clearly correspond to the calculations (pre- and post-development)
- Analysis points for comparing runoff rates and the total drainage area analyzed do not change from pre- to post-development, although the immediate drainage areas contributing to each analysis point might shift.
- Post-development discharges less than or equal to pre-development discharges for each outfall point (if not, then see “Detention Waiver” section below)
- Analysis performed using SCS 24-hour storm (Rational method is not acceptable)
- Rainfall data from South Carolina DHEC Storm Water Management BMP Handbook (BMP Handbook) or other appropriate source used in all calculations
 - *Note: The curve number for open water, marshes, etc. should be 98.*
 - *Note: If a Type 2 redevelopment follow statement guidelines in the Design Manual*

24. Discharge Points

Location in C-SWPPP: _____

- Storm drainage or pond outfalls carried to an existing drainage outfall such as a pipe, ditch, etc.
- No new point discharges onto adjacent property where there was not a point discharge previously, unless written permission from adjacent property owner(s) is provide
- Level spreaders, plunge pools, etc. provided when the proposed outlet is near the property line and not directed to an existing outfall, such as a creek or ditch
- Twenty (20)-foot minimum buffer is provided between the property line and the discharge point
- Outlets shall not discharge on fill slopes
 - *Note: this requirement also applies during construction*

25. Detention Analysis/Design

Location in C-SWPPP: _____

- Pond routing using a volume-based hydrograph for the 2- and 10-year, 24-hour storm event (Drain:Edge, ICPR, HEC-1, SedCAD, HYDROFLOW, etc. perform full pond routings; TR55 does not perform full pond routings; 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 detention structure (results of analysis will determine the need to modify the detention design or eliminate the detention requirement – see note 2 below)
- Inputs and Outputs from analysis program



- Summary table of the peak inflows, peak outflows, discharge velocities, and maximum water surface elevations (WSE) for the 2- and 10-year, 24-hour storm events for each detention structure.
- Stage-storage-discharge relationship for the outlet structure of each detention structure
- If a rating curve for the outlet structure must be generated externally from the analysis program (Drain:Edge, HEC-1, etc.), data and equations used to rate the outlet structure.
- As-built of existing detention pond if the site drainage to an existing detention pond
 - *Note 1: SedCAD users please refer to the SCDHEC memo regarding the input of outlet structures.*
 - *Note 2: The City Engineer recommends using the 10% rule in performing analysis. The hydrologic analysis should be conducted for the larger drainage area, where the site in question encompasses 10% of the total drainage area. For example, if your site is 10 acres, then the hydrologic analysis should be performed at the point downstream where the contributing drainage area, including your 10-acre site, is approximately 100 acres.*

Design

- Detail of outlet structure and cross-section of the dam/berm or pond bank, including elevations and dimensions that correspond to the calculations
- Orifice constructability should be considered (do not specify orifice diameters with increments of less than 1/4")
- Small orifices (those less than 3") are prone to clogging
- Maximum WSE for the 10-year storm event below the emergency spillway with 0.5-ft of freeboard between maximum WSE for the 10-year storm event and the emergency spillway
- Maximum WSE for the 100-year storm event below the embankment with 0.5-ft of freeboard between maximum WSE for the 100-year storm and the embankment.
- Dewatering time calculations for the 10-year storm event (dry ponds must drain completely within 72 hours)
- Bottom of all detention and retention ponds graded to have a slope of not less than 0.5%
- If the pond is to be used for sediment control during construction, temporary horseshoe-shaped riprap berm in front of any low level outlets should be provided during construction and shown on the pond detail

- Permanent maintenance access to all permanent detention structures (easements may be needed for structures surrounded by lots)
- Infiltration systems designed in accordance with S.C. Reg. 72-307.C(11) [specify how items a-j have been addressed]
 - a) *Areas draining to these practices must be stabilized and vegetated filters established prior to runoff entering the system. Infiltration practices shall not be used if a suspend solids filter, there shall be, at least a 20 foot length of vegetative filter prior to stormwater runoff entering the infiltration practice;*
 - b) *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;*
 - c) *The infiltration practice shall be designed to completely drain of water within 72 hours;*
 - d) *Soils must have adequate permeability to allow water to infiltrate. Infiltration practices are limited to soils having an infiltration rate of at least 0.30 inches per hour. Initial consideration will be based on a review of the appropriate soil survey, and the survey may serve as a basis for rejection. On-site soil borings and textural classifications must be accomplished to verify the actual site and seasonal high water table conditions when infiltration is to be utilized;*
 - e) *Infiltration practices greater than three feet deep shall be located at least 10 feet from basement walls;*
 - f) *Infiltration practices designed to handle runoff from impervious parking area shall be a minimum of 150 feet from any public or private water supply well;*
 - g) *The design of an infiltration practice shall provide an overflow system with measures to provide a non-erosive velocity of flow along its length and at the outfall;*
 - h) *The slope of the bottom of the infiltration practice shall not exceed five percent (5%). Also, the practice shall not be installed to fill material as piping along the fill/natural ground interface may cause slope failure;*
 - i) *An infiltration practice shall not be installed on or atop a slope whose natural angle of incline exceed twenty percent (20%)*
 - j) *Clean outs will be provided at a minimum, every 100 feet along the infiltration practices to allow for access and maintenance.*

- Low Impact Development (LID) measure, bioretention cells, infiltration, and other post-construction practices should be installed only after the drainage area of these practices has been stabilized
 - a) *Note 3: Emergency spillways should not be built on fill slopes;*
 - b) *Note 4: the City Engineer recommends installation of a trash rack or other debris-screening device on all pond risers.*
 - c) *Note 5: The City Engineer recommends a maximum slope of 3:1 on pond embankments to allow for ease of maintenance.*
 - d) *Note 6: The City Engineer recommends installation of sediment forebay at each outfall into the detention/sediment basin. This is a requirement during construction.*

26. As-Builts

Location in C-SWPPP: _____

- Provided for all previously approved detention ponds that will receive flows from new construction
- Prepared by a South Carolina Licensed Land Surveyor
- Grades/Contours/Depths for pond
- Elevations and dimensions of all outlet structures, including:
 - Pipe and orifice inverts and diameters
 - Weir elevations and dimensions
 - Risers dimensions and elevations
 - Emergency spillway dimensions and elevations
 - Locations and inverts for all pipes discharging into the pond
- If the elevations of dimensions of the structures listed above do not mate those used in the approved plans, certifications statement signed by the project's Registered Engineer indicating that the pond, as built, will function within all applicable standards provided [new analysis of the pond (routing) may be necessary]
- *Note 1: As-built survey and/or analysis must be submitted and accepted by the City Engineer before Notice of Termination (NOT) is submitted.*
- *Note 2: As-built survey must comply with Section 4.10 Digital submittal requirements of the City of Clemson Stormwater Design Manual*

27. Permanent Stormwater Management Structure Maintenance

Location in C-SWPPP: _____

- Signed agreement from the responsibility parting accepting ownership and maintenance of the structure (with proof it has been recorded with the registers of Deeds of the appropriate county and for properties that the structures are located on)
- If maintenance agreement responsibility is transferred after NPDES coverage is granted, an updated agreement should be submitted with the Notice of Termination



- Description of maintenance plan to be used
- Schedule of maintenance procedures (e.g., every 6 months)
- Detailed or manufacturer-specific maintenance items for proprietary control devices (oil-water separators, etc.), underground detention structures, exfiltration systems and non-traditional stormwater controls (constructed wetlands, bioretention, etc.)
- Typical maintenance items to be addressed:
 - Grass to be mowed;
 - Trees to be removed from within the pond and on the embankment;
 - Trash and sediment to be removed from inside of and around the pond outlet structure;
 - Orifice to be cleaned and unclogged;
 - Outlet pipe to be cleaned, inspected, and repaired;
 - Sediment accumulations to be removed from pond;
 - Pond Bottom to be regraded to provide proper drainage towards the outlet discharge point;
 - Energy dissipater to be cleaned and repaired;
 - Erosion on side slopes, if present, to be addressed; and,
 - The City Engineer shall be notified in writing of any changes in maintenance responsibility for the stormwater devices at the site.
 - *Note 1: IF the entity or person with maintenance responsibility changes, then a new maintenance agreement, signed by the new person responsible for maintenance, must be provided to the City. If a new, signed maintenance agreement is not provided to the City, then the entity/person who signed the most recent maintenance agreement on file with the City will be considered the responsible entity.*
 - *Note 2: If any proprietary items are used the recorded statement needs to include "If the proprietary item(s) used in our private storm sewer system is ever discontinued or changed the new proprietary item(s) will first be approved by the City of Clemson as an equal replacement to the existing item(s) before installation/replacement" Please include a list of all proprietary item(s) that are used to control water quality/quantity in the project in the deed recorded maintenance agreement.*

28. Detention Waiver

Location in C-SWPPP: _____

- Justification and a written request, including the following statement: *"the increased flows will not have a significant adverse impact on the downstream/adjacent properties."*
- A project may be eligible for a waiver or variance of stormwater management for water quantity control if the applicant can demonstrate that:



- The proposed project will have no significant adverse impact on the receiving natural waterway or downstream properties; or,
- The imposition of peak control requirements for rates of stormwater runoff would aggravate downstream flooding
- Waiver should be signed by the project's Professional Engineer
 - *Note 1: If the 2- and 10-year, 24-hour post-development flow rates exceed the pre-development rates, waivers from detention may be granted in accordance with regulation 72-302(B) on a case-by-case basis*
 - *Note 2: See note 2 in checklist Item 27 regarding the 10% rule*

29. Permanent Water Quality Requirements **Location in C-SWPPP:** _____

- Permanent Water quality addressed (all projects or LCP):
 - Wet ponds designed to catch the first 1/2" of runoff from the entire area draining to the pond and release it over at least a 24-hour period;
 - Dry ponds designed to catch the first 1" of runoff from the entire area draining to the pond and release it over at least a 24-hour period;
 - Infiltration Practices designed to accept, at a minimum, the first 1" of runoff from all impervious areas and designed in accordance with S.C. Reg. 72-307.C(11) [specifically addressing how items a-j have been addressed]; and,
 - For areas not draining to a pond or infiltration practice, show how permanent water quality requirements were addressed.
- Water quality orifices should be a size that is conducive to proper operation and maintenance. Orifices less than 3" in diameter are prone to clogging
- Waters of the U.S./State are not used for permanent water quality control (alternative means of treatment must be used if an existing pond is to be used for water quantity control).
 - *Note 1: Other non-traditional stormwater controls such as Bioretention areas, constructed wetlands, etc. may be used. Consult the SCDHEC BMP Handbook for information on the design of these devices.*
 - *Note 2: 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, preferably from a third-party testing company. Type of system selected should be based on the ability to remove the pollutants of concern in that area/situation (bacteria, hydrocarbons, etc.)*



Appendix D

Standard Notes for Site Plans

1. If necessary, slopes which exceed eight (8) vertical feet should be stabilized with synthetic or vegetative maps, 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.
2. 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 has ceased, except as stated below.
 - Where stabilization by the 14th day is precluded by snow cover or frozen ground conditions stabilization measures must 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 Site.
3. All sediment and erosion control devices shall be inspected once every calendar week. If periodic inspection or other information indicates that a BMP has been inappropriately or incorrectly installed, the Permittee must address the necessary replacement or modification required to correct the BMP within 48 hours of identification.
4. Provide silt fence and/or other control devices, as may be required, to control soil erosion during utility construction. All disturbed areas shall be cleaned, graded, and stabilized with grassing immediately after the utility installation. Fill, cover, and temporary seeding at the end of the day are recommended. If water is encountered while trenching, the water should be filtered to remove sediment before being pumped back into any waters of the State.
5. All erosion control devices shall be properly maintained during all phases of construction until 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.
6. The contractor must take necessary action to minimize the tracking of mud onto paved roadway(s) from construction areas and the generation of dust. The contractor shall daily remove mud/soil from pavement, as may be required.
7. Residential subdivisions require erosion control features for infrastructure as well as for individual lot construction. Individual property owners shall follow these plans during construction or obtain approval of an individual plan in accordance with S.C. Reg. 72-300 et seq. and SCR100000

8. Temporary diversion berms and/or ditches will be provided as needed during construction to protect work areas from upslope runoff and/or divert sediment-laden water to appropriate traps or stable outlets.
9. All Waters of the State (WoS), including wetlands, are to be flagged or otherwise clearly marked in the field. A double row of silt fence is to be installed in all areas where a 50-foot buffer can't be maintained between the disturbed area and all WoS. A 10-foot buffer should be maintained between the last rows of silt fence of all WoS.
10. Litter, construction debris, oils, fuels, and building products with significant potential impact (such as stockpiles of freshly treated lumber) and construction chemicals that could be exposed to stormwater must be prevented from becoming a pollutant source in stormwater discharges.
11. A copy of the SWPPP, inspection records, and rainfall data must be retained at the construction site or nearby location easily accessible during normal business hours, from the date of commencement of construction activities to the date that final stabilization is reached.
12. Initiate stabilization measures on any exposed steep slope (3H:1V or greater) where land-disturbing activities have permanently or temporarily ceased, and will not resume for a period of 7 calendar days.
13. Minimize soil compaction and, unless infeasible, preserve topsoil.
14. Minimize the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other wash waters. Wash waters must be treated in a sediment basin or alternative control that provides equivalent or better treatment prior to discharge;
15. . Minimize the discharge of pollutants from dewatering of trenches and excavated areas. These discharges are to be routed through appropriate BMPs (sediment basin, filter bag, etc.).
16. The following discharges from sites are prohibited:
 - Wastewater from washout of concrete, unless managed by an appropriate control;
 - Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds and other construction materials;
 - Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance; and
 - Soaps or solvents used in vehicle and equipment washing
17. After construction activities begin, inspections must be conducted at a minimum of at least once every calendar week and must be conducted until final stabilization is reached on all areas of the construction site.
18. If existing BMPs need to be modified or if additional BMPs are necessary to comply with the requirements of this permit and/or SC's Water Quality Standards, implementation must be completed before the next storm event whenever practicable. If implementation before the next storm event is impracticable, the situation must be

documented in the SWPPP and alternative BMPs must be implemented as soon as reasonably possible.

19. A Pre-Construction Conference must be held for each construction site with an approved On-Site SWPPP prior to the implementation of construction activities. For non-linear projects that disturb 10 acres or more this conference must be held on-site unless the Department has approved otherwise.
20. No hay bales should be used to slow or stop water as they can break-up easily and clog the storm drains down stream



Appendix E

Grading Permits Under 1 Acre Standard Notes

1. Silt fence shall be properly installed before any mass clearing takes place, refer to SCDHEC BMP handbook for proper silt fence installation
2. If downhill side of property drains directly to waterway a double row of silt fence is required, with a minimum of 20-foot separation from waterway.
3. If downhill side of property drains directly to roadway ditch, entrenched sediment tubes shall be placed at a minimum of every 100 ft in the roadway ditch to act as a ditch check.
4. Silt fence cannot collect runoff from a distance greater than a 100 ft uninterrupted.
5. Construction entrances shall be a minimum of 6-inches thick, 24 feet wide, and 100 feet long, with material consisting of D_{50} diameter ranging from 2 to 3 inches and be lined by a non-woven geotextile fabric under the stone.
6. Construction tracking onto the roadway shall be cleaned daily.
7. The site shall be graded to promote positive drainage away from all structures located on the property.
8. The grading shall not create a concentrated flow or erosion issues on adjacent properties.
9. All Sediment, Erosion Control, and Runoff Control BMPs shall be maintained and cleaned out to SCDHEC BMP Handbook standards.
10. No hay bales should be used to slow or stop water as they can break-up easily and clog the storm drains down stream