Stormwater Design Standards Manual

City of Bismarck, ND

Fall 2016

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4.0 POST-CONSTRUCTION PEAK DISCHARGE COMPLIANCE

The goal of this Chapter is to provide guidance on the design, performance, and analysis requirements of the City of Bismarck in regard to Peak Discharge Post-Construction Compliance.

4.1 Post-Construction BMP Performance Requirements

Projects that require a PCSMP are subject to Peak Discharge Control requirements and shall include peak discharge post-construction structural or non-structural BMPs to conform to the requirements of ***Table 4-1*** and ***Section 4.1.1*** of this SWDSM**.**

Note that these are underlying basic requirements and additional analysis and design requirements for specific components of the City's Public Storm Sewer System are provided within the following chapters of the SWDSM.

Table 4-1 *– Point of Discharge Peak Flow Compliance*

Point of Discharge Location	***Peak Discharge Control Requirement***
Public Storm Sewer System	Post Construction runoff resulting from the 2, 5, 10, and 100-year, 24-hour rainfall events shall not exceed the runoff rate of the pre-developed conditions.
Natural Drainage-Way	Post Construction runoff resulting from the 2, 10, 5 and 100-year, 24-hour rainfall events shall not exceed the runoff rate of the pre-developed conditions.

4.1.1 Hydrologic Requirements for Projects Within Master Planned Areas

Projects that require a PCSMP and are located in an area that has an adopted Stormwater Master Plan or previously approved PCSMP\SWMP shall provide documentation that the project meets the requirements for Peak Discharge Compliance by utilizing one of the scenarios described below.

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Scenario 1 Master Plan based on Current Rainfall and NRCS HSG

Scenario: Project is located in an area that has an adopted Stormwater Master Plan or previously approved PCSMP\SWMP and the following conditions are met:

1. Master Plan or PCSMP\SWMP utilized the Rainfall and Hydrologic Soil Groups required by Section 4.3.1 of the SWDSM; and
2. Master Plan or PCSMP\SWMP included regional or local post construction peak discharge BMPs that have been constructed; and
3. Proposed project includes less than or equal to the impervious percentage and maintains overall drainage boundaries that were assumed in the Master Plan or PCSMP\SWMP.

Requirement: Document the project percent impervious and drainage boundaries in the PCSMP application.

Scenario 2 Mater Plan based on Current Rainfall and NRCS HSG

Scenario The project is located in an area that has an adopted Stormwater Master Plan or previously approved PCSMP\SWMP and the following conditions are met:

1. Master Plan or PCSMP\SWMP utilized the Rainfall and Hydrologic Soil Groups required by Section 4.3.1 of the SWDSM; and
2. Master Plan or PCSMP\SWMP included regional or local post construction peak discharge BMPs that have been constructed; and
3. Proposed project includes ***greater than the impervious percentage and/or alters overall drainage boundaries*** that were assumed in the Master Plan or PCSMP\SWMP; then

Requirement:

1. Analyze the peak to each Point of Analysis utilizing the modeling parameters assumed in the Master Plan or previously approved PCSMP\SWMP. Parameters include impervious cover, CN, rainfall, HSG, and drainage boundaries; and
2. Analyze the peak flow to each Point of Analysis utilizing the proposed project impervious coverage and drainage boundaries; and
3. Provide an on-site post construction BMP to mitigate the difference between the peak flow rate and storm volumes calculated in Step 1 & 2.

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Scenario 3 Master Plan Based on TP 40 Rainfall and Old NRCS HSG

Scenario: The project is located in an area that has an adopted Master Plan or previously approved PCSMP\SWMP that utilized:

1. TP40 rainfall depths and\or
2. Old NRCS HSG; then

Requirement:

1. Analyze the peak to each Point of Analysis utilizing the impervious cover, CN, rainfall, HSG, and drainage boundaries assumed in the Master Plan or PCSMP\SWMP; and
2. Analyze the peak flow to each Point of Analysis utilizing the proposed project impervious coverage, drainage boundaries and the model parameters required by Section 4.3.1 of the SWDSM; and
3. Provide an on-site post construction peak flow BMP to mitigate the difference between the peak flow rate and storm volumes calculated in Step 1 & 2.

Scenario 4 Master Planned Regional Facilities Not Yet Constructed

Scenario: When the project is located in an area that has an adopted Master Plan or previously approved PCSMP\SWMP that included regional or local post construction peak flow mitigation that has not yet been constructed, then;

Requirement:

1. Provide an on-site post construction peak flow BMP that meets the requirements of Section 4.1.2 of the SWDSM; or
2. Construct the regional or local post construction peak flow BMP(s) required by the Master Plan or PCSMP\SWMP.

4.1.2 Hydrologic Requirements Projects Outside of Master Planned Areas

When a project is located is located in an area that has not been included in an adopted Master Plan or previously approved PCSMP\SWMP then provide the following analysis:

1. Analyze the predevelopment peak flow to each Point of Analysis utilizing the existing condition impervious coverage, drainage boundaries and the model parameters required by Section 4.3.1 of the SWDSM; and

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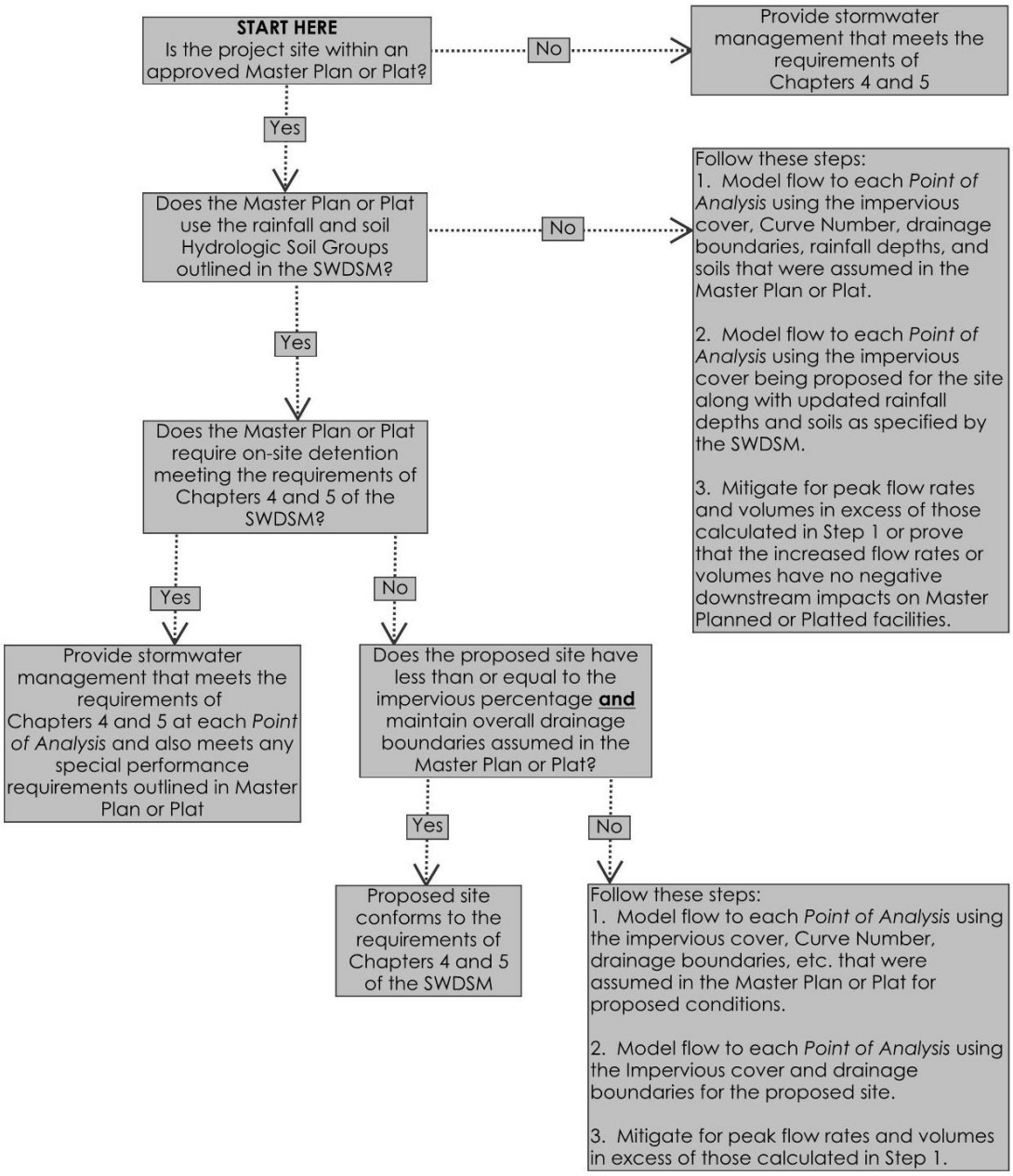
2. Analyze the post construction peak flow to each Point of Analysis utilizing the proposed project impervious coverage, drainage boundaries and the model parameters required by Section 4.3.1 of the SWDSM; and
3. Provide an on-site post construction BMP to mitigate the difference between the peak flow rate and storm volumes calculated in Step 1 & 2.

Figure 4-1 *Flow Chart for Determining Compliance with Peak Discharge Compliance with PCSMP & SWDSM*



4.1.3 Hydrologic Analysis & Reporting

All projects shall document following minimum information for the hydrologic analysis in the PCSMP application.

The SWMP shall include a description of each sub-basin by Point of Analysis that includes a brief description of the pre-development and post-construction conditions of the sub-basin.

The SWMP shall include a summary table for each Point of Discharge and/or sub-basin that documents:

1. Tributary Area (both onsite and off-site run-on);
2. Impervious Coverage Area;
3. Impervious Coverage CN
4. Pervious Coverage Area; and
5. Pervious Coverage Curve Number; and
6. Time of Concentration.

The SWMP shall include figures\exhibits that graphically document:

1. Delineation of Sub-Basins including unique identifier and area;
2. Imperious Coverages;
3. Pervious Coverages;
4. Time of Concertation Paths;
5. Other items noted on the PCSMP Application Checklist or applicable for review and approval of the application.

The SWMP hydrologic analysis and reporting shall account for and consider the following:

1. The project shall safely pass the 100-year 24-hour event without impacting of inundating any homes, structures or other buildings.
2. If the off-site contributing areas are greater than 50-percent of the sub-basin total provide a description of the impact of future development in the off-site watershed on the proposed post-construction stormwater BMPs and make any applicable recommendations.

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4.1.4 Detention Basins Analysis & Reporting

When detention basins are proposed as a post-construction BMP to mitigate for peak discharge compliance the following minimum performance standards shall be documented in the PCSMP application.

Engineered Outlets

All proposed detention basins shall include an outflow structure to limit the post construction peak flow discharge less than or equal to the predevelopment peak flow discharge for the events required by ***Table 4-1***.

The SWMP shall include a summary of the proposed outlet structure in a table that reports:

1. Outlet configuration including size and inverts; and
2. Outlet culvert discharge velocity and depth for all storm events required by ***Table 4-1;*** and
3. Calculated Water Surface Elevation for all storm events required by ***Table 4-1;*** and
4. Maximum available storage in the proposed pond (to emergency spillway or overflow elevation); and
5. Reference to where the Stage/Storage/Discharge report is contained in the SMWP.

The SWMP shall include an Outlet Structure Figure\Detail that includes a to-scale graphical representation of:

1. Outlet structure configuration including sizes of orifices, weirs and culverts; and
2. Invert elevations for all outlet orifices, weirs and culverts; and
3. Invert elevation for emergency spillway or overflow structure; and
4. Elevation of the top of embankment or pond structure; and
5. Calculated Water Surface Elevation for all storm events required by ***Table 4-1;***
6. Post-construction stabilization measures to limit the long term erosion of at the inlet and discharge points of the outlet structure, and
7. If applicable the elevation of nearest adjacent finished floor or other critical element.

The SWMP shall include as an appendix modeling results that includes:

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1. Inflow hydrographs for the predevelopment condition for each of the storm events listed in ***Table 4-1.***
2. Inflow and outflow hydrographs for the post-construction condition for each of the storm events listed ***Table 4-1.***

Infiltration as an Engineered Outlet:

When infiltration is used as an engineered outlet:

1. The applicant shall note on Mandatory Stormwater Scoping Sheet the proposed use of infiltration as a peak discharge compliance post-construction BMP and
2. The design engineer shall obtain City approval on approach, analysis method, and field investigation requirements as part of the Mandatory Stormwater Scoping Sheet; and

Emergency Spillway and\or Overflow Requirement

All proposed detention basins shall have an emergency spillway or overflow path that will allow overflows to pass without causing a catastrophic failure of the detention basin. The SWMP shall include the hydrologic and hydraulic summary demonstrating that the proposed emergency spillway\overflow is:

1. Is capable of passing the post-construction 100-year 24-hour event without overtopping the detention pond during a clogged outlet structure condition;
2. Is properly armored to resist the erosive forces during the post-construction 100-year 24-hour event; and
3. Will not be utilized during the normal function of the detention basin.

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4.2 Post-Construction BMP Minimum Design Standards

The following sections include minimum standards that Stormwater structures and BMPs shall meet in the City of Bismarck. The standards below do not replace judgement or standard of care for the design engineer.

4.2.1 Detention Basins

The following minimum design standards are provided as a general guide of small detention ponds associated with local and on-site post-construction BMPs. Design of large regional ponds and dams requires engineering experience and knowledge outside of the scope of this SWDSM. Design standards included in this SWDSM are not intended to replace engineering practice or judgement for large and\or complex projects.

Detention basis proposed as post-construction peak discharge BMPs shall meet the following minimum design requirements:

1. **Regulatory Permit Required**: Embankments shall have a height less than 10-feet and a maximum storage less than 25 acre-feet.
    a. Proposed detention basins that have an embankment in excess of 10-feet and\or have a maximum storage of greater than 25 acre-feet will require approval by the City and North Dakota office of the State Engineer.
    b. It is the Applicants responsibility to coordinate all required permits with the office of the State Engineer.
2. **Design and Construction Standards:** Public and private basins shall meet the requirements of the current edition of the City of Bismarck Construction Specifications and the following minimum construction standards:
    a. **Side Slopes and Slope Stability**: Slopes of detention ponds shall meet the following minimum requirements:
        i. **Maximum Side Slopes**: 3H:1V
        ii. **Minimum Bottom Grade**: 0.5 percent
        iii. **Maximum Bottom Grade**: 5 percent
    b. **Seepage Control**: A seepage control system should be provided for all embankments where a reservoir pool will be maintained for an appreciable length of time, regardless of the depth of pond, or embankment, or foundation materials.

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c. **Material and Compaction Requirements**: Fill material shall meet the following minimum standards:

   i. **Material Type**: Embankments shall consist of cohesive Material cons ting of Silts and Clays (CL and MH). Other materials may be approved by the City Engineer.

   ii. **Maximum Lift Depth**: 9-inch loose lift.

   iii. **Compaction Equipment**: All compaction shall be completed with a sheepsfoot or pneumatic rollers.

   iv. **Compaction Requirement**: 95% of Maximum as determined by ASTM D698 (Standard Proctor)

   v. **Moisture Requirement**: 0-+3% of optimum as determined by ASTM D698

d. **Freeboard**: Per ***Table 4-2***;

e. **Embankment & Pool Protection:** All exposed soil shall be stabilized by an appropriate method. The preferred stabilization is with vegetation. All vegetated slopes and pool areas shall include the installation of a layer of suitable plant growth material prior to seeding. Large detention ponds shall include protection from wind and wave action for the maximum pool surface.

   i. **Minimum Topsoil Depth:** 6-inches

   ii. **Seeding:** Per City Standard Specification

   iii. **Rip-Rap Stabilization:** Per City Standard Specification and ***Table 6-15***

3. **Engineered Outlets:** All basins shall have and engineered outlet that conforms to the following minimum standards:

   a. Minimum orifice size of 4-inches;

   b. Trash protection or all orifices and\or structural overflows; and

   c. A direct connection to the Public Storm Sewer System.

      i. It is the responsibility of the Applicant to obtain all necessary offsite easement to allow connection of proposed pond outlets to the Public Storm Sewer System at the point of discharge identified in the Mandatory Stormwater Scoping Sheet approval process.

      ii. Direct Connection can include pipe or open channel conveyance.

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4. **Infiltration as an Engineered Outlet**: Basins that utilize infiltration as an engineered outlet require an underdrain that consists at a minimum:
    a. 12-inch layer of drain rock underlying calculated maximum pool area;
    b. Drainage layer shall be located under the growing medium and shall not hinder the facilities ability to suitably vegetate;
    c. Drainage layer shall include properly sized underdrain perforated pipes to collect infiltrated water;
    d. Underdrain pipes shall have a direct connection to the Public Storm Sewer System.
5. **Outlet Protection**: Outlet culverts and conveyances shall include energy dissipation and armoring appropriate for the calculated velocities from the 100-year 24-hour event. Rip-rap sizing shall meet the recommendations of ***Table 6-15.***
6. **Easements Required**: Basins shall include drainage easements or be platted as an undevelopable lot to fully contain the detention basin maximum pool, embankment, outlet protection and other elements as required by the City Engineer.
    a. Easements shall be noted as "Public" (maintained by the City of Bismarck or other approved public entity) or "Private" (maintained by the applicant).
    b. Public Easements must be approved by the City.
    c. Private Easements must have a provision to allow access by the City to allow for maintenance of derelict BMPs.
    d. Post-Construction BMPs constructed on undevelopable lots will only be allowed when platted as Common Interest Lots that are attached to benefiting parcels. Use of Common Interest Lots must be approved by the City.
7. **Operation and Maintenance**: When utilizing detention basins, the PCSMP application shall include:
    a. Identification of the entity responsible for long-term maintenance and of all drainage facilities.
    b. All privately maintained post-construction BMPs shall include the submittal and approval of Operations and Maintenance Plan as part of the PCSMP application.

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Table 4-2 *– Detention Pond Minimum Freeboard Requirements*

Tributary Area	***Minimum Freeboard Requirement(1)***
One (1) Acre or Less	0.5 foot
Greater than One (1) Acre	1.0 foot

(1) Calculated from 100-year 24-hour water surface elevation to the lowest uncontrolled overflow structure

4.2.2 Geotechnical\Hydrogeologic Report Requirements

Geotechnical reports are required for sites where an infiltration system is proposed. In general, geotechnical reports are to include enough information in order to address the following site information requirements:

1. Types of soil and subsurface materials underlying the infiltration facility
2. Infiltration rates, locations, and test dates at the infiltration facility locations (e.g., generally within 50' of the facility unless the geotechnical professional provides an opinion that the substrate at the tested/observed location extends to the infiltration facility)
3. Permeability test method, reduction factor, and permeability of the soil and subsurface materials underlying the infiltration facility
4. Slope and geometry of the site
5. Proximity to surface water
6. Proximity of the seasonal high ground water table beneath the bottom of the infiltration facility
7. Proximity and classification of bedrock beneath the bottom of the infiltration facility
8. The infiltration rate shall be measured at a depth equal to the proposed bottom grade of the facility.

Geotechnical field work, test pit and boring requirements:

1. Dig a standard soil boring to a depth of 10 feet below the proposed facility bottom.
2. Determine depth to groundwater table (if within 10 feet of proposed bottom) upon initial digging or drilling, and again 24 hours later.

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3. Determine United States Department of Agriculture (USDA) or Unified Soil Classification (USC) soil characteristics and textures at the proposed bottom.

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4.3 Analysis Methodologies

The goal of this Section is to provide detailed requirements for the analysis of Peak Discharge Control Compliance. This section is not intended to provide instruction on how to use the various methodologies or software packages as it is assumed that a sufficient understanding of hydrologic and hydraulic analyses as they apply to urban stormwater management and drainage is a prerequisite to the use of this manual.

4.3.1 Hydrology (Computing Runoff)

The following list is intended to provide the design engineer with the City of Bismarck requirements for computing runoff.

1. **Acceptable Methods:**
    a. NRCS (SCS) Curve Number (CN) Method & Time of Concentration Methods.
    b. The Rational Method is not an accepted methodology for Peak Discharge Control Compliance.
2. **Separation of Impervious/Pervious:**
    a. Impervious and pervious cover must be separated in the analysis on a per sub-basin basis. Use of composite CN numbers will not be allowed. Refer to the following example.
    b. If the design engineer's chosen hydrology model software does not allow for direct entry of the sub-basin percent impervious, the sub-basin will need to be modeled as two sub-basins each with the same time of concentration and with the area attributed to the pervious and impervious areas.
    c. Pervious and Impervious area within the project site must be manually measured to reflect the actual site design.
    d. Modeling of offsite watersheds that are routed through a project site may utilize typical impervious percentages as provided in ***Table 4-3.***

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Example 4-1 *Separation of Impervious and Pervious Areas*

If a 10-acre site is 50 percent impervious with the pervious portion having a CN of 74, the site:

1. shall not be assumed to have a single, composite CN of 86; and
2. The runoff shall be computed using:
    a. A 5-acre sub-watershed with a CN of 98 for the impervious area; and
    b. A 5-acre sub-watershed with a CN of 74 for the pervious area; and
    c. Both sub-watersheds shall be assigned the same Tc.

Table 4-3 *– Typical Impervious Coverage for Offsite Drainage*

Land Use Type		***Impervious Cover***
Residential Developments	1/8 Acre Lots	65%
	1/4 Acre Lots	38%
	1/3 Acre Lots	30%
	1/2 Acre Lots	25%
	1 Acre Lots	20%
	2 Acre Lots	12%
Commercial		85%
Industrial		90%

3. **Minimum Impervious Coverage**:
    a. **Plats**:
        i. Development in the platting phase shall perform hydrologic analyses based on the minimum impervious coverage provided in ***Table 4-4***.
        ii. Higher assumed impervious amounts may be recommended or used by the design engineer during the platting process.

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iii. The approved plat SWMP will set the maximum impervious coverage for the development.

iv. Development of parcels inside of the approved plat SWMP to higher than planned for impervious percentages will require a modification of the approved SWMP.

b. **Site Plans**:

i. Shall use the actual impervious cover for the proposed project.

Table 4-4 – *Minimum Impervious Coverage*

Zoning Type		***Minimum Impervious Cover***
Residential Developments	RR	12%
	RR5	12%
	R5	35%
	RMH	50%
	R10	50%
	RM	75%
	RT	75%
Commercial		85%
Industrial		90%

4. **Hydrologic Soil Group (HSG)**:
   a. Shall be obtained from the NRCS Web Soil Survey;
   b. Complex soil groups shall be set to the Aggregation Method of "Dominant Condition" within the Advanced Options of the NRCS Web Soil Survey (See **Reference #1**);
   c. "Urban Land" shall be assigned a HSG of "C";
   d. Dual HSG classifications shall be assigned the HSG with the higher runoff potential (i.e. HSG B/D shall be assumed to be HSG D).
5. **CN Values:** CN values shall be obtained from ***Table 4-5***. Values different from those provided in ***Table 4-5*** must be approved by the City Engineer.

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a. The values in ***Table 4-5*** are the maximum allowable for pre-development conditions analysis.

b. The values in ***Table 4-5*** are the minimum allowable for post-construction conditions analysis.

Table 4-5 – *Runoff Curve Numbers*

Cover Type	***Curve Numbers for HSG Soil Groups***			
	HSG A	***HSG B***	***HSG C***	***HSG D***
Impervious	98	98	98	98
Gravel Surface	96	96	96	96
Grass (Lawn)	39	61	74	80
Brush	30	48	65	73
Pasture/Rangeland	39	61	74	80
Cropland	62	73	80	84
Meadow (not grazed)	30	58	71	78

6. **Time of Concentration (Tc):**
   a. **Minimum Tc:** 5 minutes
   b. **Sheet Flow:** Maximum length of 100 feet.
7. **Rainfall Depths: See Reference #2**
   a. **Rainfall Distribution**: SCS Unit Hydrograph Type II
   b. **Rainfall Event**: 24-Hour Storm, unless otherwise master planned or platted.
8. **Maximum Rainfall Hyetograph Time Increment**: 10 minutes
9. **Gravel Roadways and Parking Lots:** Shall be considered as part of the impervious area when separating and analyzing pervious and impervious area within a watershed

4.3.2 Hydraulic Routing

The following list is intended to provide the design engineer with City of Bismarck requirements for Hydraulic Routing.

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1. **Routing Method:**
    a. Storage Indication Method (also known as hydrologic routing) may be utilized for projects with unconnected ponds and free discharges.
    b. Dynamic Routing Methods (also known as hydraulic routing) shall be incorporated for all projects that include interconnected ponds, pump stations, tailwater or backwater conditions and other complex conditions that require a dynamic routing method.
    c. Rational routing methods shall not be allowed.
    d. Routing method requirements will generally be noted in the Mandatory Stormwater Scoping Sheet.
2. **Starting Water Surface Elevation:**
    a. For proposed ponds the starting Water Surface Elevation (WSE) in a detention facility shall be assumed to be equal to the invert of the lowest engineered outlet.
    b. Known tailwater or backwater conditions may require that the starting WSE be higher.
3. **Outlet Protection:**
    a. **Shear Stress:** Shall be calculated using the following equation:

$\tau = \rho\ g\ R\ S$

Where:

τ = Shear Stress (lbf)

ρ = Density of Water (lbm/ft^3)

g = Acceleration Due to Water (32.2 ft/s^2)

R = Hydraulic Radius (ft)

S = Surface Water Slope (Energy Grade Line)

~~4. **Infiltration as an engineered outlet:**~~

~~a. Use of infiltration as a Post-Construction SWMP BMP shall be noted by the applicant on the Mandatory Stormwater Scoping Sheet.~~

~~b. When infiltration is used as an engineered outlet, the design engineer shall obtain City approval on approach, analysis method, and field investigation requirements as part of the scoping letter process.~~

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~~c. All infiltration ponds within the City of Bismarck require an underdrain.~~

4.3.3 Acceptable Software

Acceptable software for the analysis of peak discharge is provided by ***Reference #3***.

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5.0 POST-CONSTRUCTION WATER QUALITY COMPLIANCE

The goal of this Chapter is to provide guidance on the design, performance, and analysis for Post-Construction Water Quality BMPs to meet the requirements as outlined in the City's MS4 permit (Reference #4).

5.1 Post Construction BMP Performance Requirements

Projects which require a PCSMP are subject to Post-Construction Water Quality requirements and shall propose permanent structural or non-structure BMPs that conform to the requirements of ***Table 5-1.*** Note that these are underlying basic requirements and additional analysis and design requirements for specific components of the City's Public Storm Sewer System are provided within the following chapters of the SWDSM.

Table 5-1 *– Water Quality Performance Requirement*

Situation	***Water Quality Requirement***
New Development & Imperious Areas	Prescriptive BMP sizing requirements per Reference #4.
Redevelopment & Retrofit	Design BMPs to treat the first 0.5 inches of runoff from impervious areas.
Alternative BMP Method	80% Total Suspended Solids (TSS) removal on an average annual basin shall be achieved.

5.1.1 Post-Construction Water Quality Requirements for Projects Within Master Planned Areas

Projects that require a PCSMP and are located in an area that has an adopted Master Plan or previously approved PCSMP\SWMP shall provide documentation that the project meets the requirements for Water Quality Compliance by utilizing one of the scenarios described below.

Scenario 1 - Master Plans with Water Quality Post Construction BMPs

Scenario: Project is located in an area that has an adopted Stormwater Master Plan and the following conditions are met:

1. Master Plan or PCSMP\SWMP included regional or local post construction water quality BMPs that have been constructed; and

2. Proposed project includes less than or equal to the impervious percentage and maintains overall drainage boundaries that were assumed in the Master Plan or PCSMP\SWMP; then

Requirement: Document that proposed project impervious percentage is less than or equal to that assumed in the Master Plan.

Scenario 2 - Master Plans with Water Quality Post Construction BMPs

Scenario: The project is located in an area that has an adopted Stormwater Master Plan or previously approved PCSMP\SWMP and the following conditions are met:

1. Master Plan or PCSMP\SWMP included regional or local post construction water quality BMPs that have been constructed; and
2. Proposed project includes ***greater than the impervious percentage and/or alters overall drainage boundaries*** that were assumed in the Master Plan or PCSMP\SWMP; then

Requirement: Provide on-site post-construction water quality BMP for the difference between the Master Planned and project proposed impervious percentage consistent with the requirements of ***Table 5-1***.

Scenario 3 – Master Plans without Post-Construction Water Quality BMPs

Scenario: The project is located in an area that has an adopted Stormwater Master Plan or previously approved PCSMP\SWMP that did not recommend or include regional or local post-construction water quality BMPs.

Requirement:

1. Retrofit the existing Regional or Local post construction peak discharge BMP to function as a post construction water quality BMP consistent with ***Table 5-1;*** *or*
2. Provide on-site post-construction water quality BMP consistent with the requirements of ***Table 5-1***.

Scenario 4 – Master Planned or Local Post-Construction Water Quality BMPs Not Yet Constructed

Scenario: When the project is located in an area that has an adopted Master Plan or previously approved PCSMP\SWMP that included regional or local post construction water quality BMPs that has not yet been constructed, then

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Requirement:

1. Construct the Master Plan proposed Regional or Local post-construction water quality BMPs; or
2. Provide on-site post-construction water quality BMP consistent with the requirements of ***Table 5-1***.

Scenario 5 - Master Plans Require Onsite Post-Construction Water Quality BMPs

Scenario: When the project is located in an area that has an adopted Master Plan or previously approved PCSMP\SWMP that included recommendations the onsite post-construction water quality BMPs be utilized, then

Requirement: Provide on-site post-construction water quality BMP consistent with the requirements of ***Table 5-1***.

5.1.2 Post-Construction Water Quality Requirements Projects Outside of Master Planned Areas

When a project is located is located in an area that has not been included in an adopted Master Plan or previously approved PCSMP\SWMP then provide the following:

1. Provide on-site post-construction water quality BMP consistent with the requirements of ***Table 5-1***.

5.1.3 Prescriptive BMP Analysis and Reporting

The following paragraphs summarize the analysis and reporting requirements for utilizing the Prescriptive BMPs defined in Reference #4. The items listed for each BMP shall be summarized in the PCSMP application required SWMP.

1. **Wet Detention Ponds:**
    a. Required Water Quality Volume (Vwqreq);
    b. Proposed Water Quality Volume in the form of a Stage-Storage relationship; and
    c. Calculated drawdown time.
2. **Dry Detention Ponds (w/Extending Detention):**
    a. Required Extended Detention/Water Quality Volume (Vwqreq);
    b. Proposed Extended Detention/Water Quality in the form of a Stage-Storage relationship; and
    c. Calculated drawdown time for Vwqreq

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3. **Infiltration**:
    a. Required Water Quality Volume (Vwqreq);
    b. Proposed Water Quality Volume in the form of a Stage-Storage relationship; and
    c. Calculated infiltration time.

5.1.4 Alternative BMP Method Analysis and Reporting

Post-Construction water quality BMPs other than the Prescriptive BMPs included in Reference #4 may be utilized when the analysis and sizing has been documented in the PCSMP application required SWMP. The following minimum information shall be provided:

1. Citation and reference to an accepted BMP Manual for the analysis requirements and design standards for the Alternative BMP;
2. Demonstration that the requirements of ***Table 5-1*** have been met; or
3. Demonstration of alternative performance requirements approved by the City Engineer have been met; and
4. The alternative performance requirements have been approved as a deviation prior to the submittal of the PCSMP application.

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5.2 Post-Construction Water Quality BMP Design Standards

The following sections include minimum standards that Stormwater structures and BMPs shall meet in the City of Bismarck. The standards below do not replace judgement or standard of care for the design engineer.

5.2.1 Detention Basins and Ponds BMPs

In addition to the minimum design standards presented in Section 4.2.1 detention basins and ponds proposed for post-construction water quality BMPs shall meet the following minimum design standards:

1. Minimum engineered outlet orifice size shall be 2-inches; and
2. The distance between inlets and the outlet shall be maximized to facilitate sedimentation and limit short circuiting of the water quality BMP:
    a. Minimum length to width ratio is 3:1 as measured at the maximum water surface elevation; or
    b. If project area constraints make obtaining this ratio unobtainable the design engineer shall incorporate baffles, islands or peninsulas to increase the flow path and limit short-circuiting.
3. Dry Detention Basins shall be divided into a minimum of two cells.
    a. The first cell (forebay) shall contain at a minimum 10-percent of the design surface area, measured at the maximum water surface elevations, and
    b. The forebay shall provide a minimum of 0.5 foot of dead storage for sediment accumulation.
4. Wet Detention Ponds shall be Divided into a minimum of two cells with the forebay containing a minimum of 10-percent of the design surface area measured at the maximum water surface elevation.
5. Vegetation and Plantings shall:
    a. Dry Detention ponds shall be stabilized with suitable native grass or other vegetative plantings that will allow for 100% coverage of the pond surface area;
    b. Wet Ponds shall include:
        i. appropriate stabilization below the normal pool elevation;
        ii. Suitable native grass or other vegetative plantings above the normal pool elevation;

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iii. Vegetation shall provide 100% coverage to the pond surface area over the normal pool elevation;

iv. Vegetative stabilization shall be selected from species suitable to grow and survive during periods of inundation.

c. Topsoil shall be used in the top 12-inch of the finished grade; or

d. The top 12-inches of soil shall be amended to achieve a suite plant growth medium.

5.2.2 Infiltration BMPs

Use of Infiltration and filtration BMPs will require approval by the City Engineer during the Mandatory Stormwater Scoping Sheet process.

When approved for use, infiltration and filtration BMPs shall meet the requirements of Geotechnical Report requirements of Section 4.2.2 and the following design standards:

1. ***Infiltration BMPs:***

   a. Located on sites with soils that drain freely and infiltrate 2-inches per hour or greater;

   b. Are separated from seasonal high groundwater levels by greater than 5-feet;

   c. Include an overflow to an approved Point of Discharge; and

   d. Meets the design requirements of the EPA National BMP Database or other BMP manual approved by the City Engineer.

2. ***Filtration BMPs:***

   a. Located on sites that infiltrate less than 2-inches per hour and/or are located within 5-feet of seasonal groundwater elevations;

   b. Includes a gravel underdrain and collection pipe the conveys filtered stormwater to an approved Point of Discharge;

   c. An overflow to an approved Point of Discharge; and

   d. Meets the design requirements of the EPA National BMP Database or other BMP manual approved by the City Engineer.

5.2.3 Flow Through BMPs

Flow Through BMPs are defined as proprietary mechanical treatment devices. Flow Through BMPs shall be to:

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1. Certified by the manufacture to provide treatment that meets or exceed the requirements of ***Table 5-1***; and
2. Designed to bypass peak flows of the water quality volume.

5.3 Analysis Methodologies

The goal of this Section is to provide detailed requirements for the analysis of Water Quality performance.

5.3.1 Water Quality Volume (V_{wq})

The water quality volume shall be determined using the method included in **Reference #4**.

5.3.2 Water Quality Drawdown Time

Drawdown time refers to the amount of time it takes for the V_{wq} to drain down to within 3 inches of the lowest engineered outlet. Depths under 0.25 feet (3 inches) may take an extensive amount of time to drawdown to the point of zero volume due to minimal head.

For the purposes of determining compliance with the drawdown time requirements, the method presented in **Reference #5** shall be used.

5.3.3 Alternate Methodology

In situations not clearly covered ***Reference #5***, such as multiple basins in series, alternate methodologies that explicitly model the build-up, wash-off, and trapping of Total Suspended Solids (TSS) may be applied as determined acceptable by the City in the scoping letter.

1. When using alternate methodologies, utilize the performance requirements shown in ***Table 5-1***; and
2. Example alternate methodologies are provided in ***Reference #6***.

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6.0 POST-CONSTRUCTION DRAINAGE AND CONVEYANCE COMPLIANCE

The goal of this Chapter is to provide guidance on the design, performance, and analysis requirements for Drainage and Conveyance within the City of Bismarck. Examples of drainage and conveyance facilities include storm sewer, drainage ditches, streets, open channels, culverts and other engineered systems intended to carry stormwater to a Point of Discharge.

6.1 Performance Requirements

6.1.1 Street Drainage

The criteria and procedures found in this section establishes the performance requirements for street drainage conveyance infrastructure including gutters, inlets, manholes, and storm sewers

Calculations relating to design of street drainage conveyance infrastructure shall be submitted with the PCSMP application for approval, with criteria sections of this Manual being referenced.

Hydrologic Requirements

The street drainage system shall be designed as an integral part of the Public Storm Sewer System. Performance standards for stormwater flows on City streets are separated into the following two categories: minor storms and major storms.

1. The objective of the managing the minor storm (and more frequent events) is to minimize nuisance flooding, protect against recurring minor damages and reduce maintenance costs for streets by removing frequent flows in an orderly and economic manner.
2. The objective of the managing the major storm is to minimize the potential for substantial property damage and loss of life by providing a defined drainage pathway for large rainfall events.

Street drainage performance standards are listed in ***Table 6-1.***

Table 6-1 *– Street Drainage Hydrologic Performance Requirements*

Storm Classification	***Recurrence Interval*** *(1)*
Minor Storm	5-year 24-hour rainfall event
Major Storm	100-year 24 hour rainfall event

Allowable Street Spread

Street spread performance requirements are applicable to situation when runoff is being conveyed longitudinal to the right-of-way.

In situations where runoff is conveyed perpendicular to the right-of-way the stream crossing and culvert crossing performance standards described in ***Section 6.1.3*** are applicable.

For the 5-year 24-hour storm the performance requirements are to limit the spread (encroachment into the travel lanes) and the depth (inundation) of stormwater conveyed longitudinally in the right-of-way to below acceptable limits during the design event.

The street spread performance requirements for the 5-year 24-hour and 100-year 24-hour storm events are provided in ***Table 6-2*** and ***Table 6-3.***

Table 6-2 *- Street Performance 5-Year 24-hour Storm Requirements*

Street Classification(1)	***Max Depth***	***Max Encroachment(2)***
Local Residential	No curb overtopping.	Flow may spread to crown of the street.
Local Commercial	No curb overtopping.	Flow may spread to crown of the street.
Collector – (All Sections)	No curb overtopping.	Leave 12-feet each side of centerline clear of encroachment.
Arterial (Principal & Minor) & Parkways (3)	No curb overtopping.	Flow spread shall be limited to 7.5-feet or less from the face of curb.
State Highways	Shall meet the requirements of the NDDOT.	

(1) Typical City urban street classification and geometry as defined by Title 14-09-05(1)(k) of the Zoning Ordinance.

(2) Where no curb exists, flow spread shall not extend past street right-of-ways.

(3) Maximum encroachment from interior raised median shall be less than 4-feet from the median curb.

(4) Performance Requirements for non-standard street sections and geometry shall be determined by the City Engineer during the Mandatory Stormwater Scoping Sheet.

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Table 6-3 *– Street Performance 100-Year 24-Hour Storm Requirements*

Street Classification(1)	***Max Depth***	***Max Encroachment***
Local Residential	6-inches at the crown	The inundated area shall not exceed the street right-of-way.
Local Commercial	6-inches at the crown	The inundated area shall not exceed the street right-of-way.
Collector – (All Sections)	6-inches at the crown	The inundated area shall not exceed the street right-of-way.
Arterial (Principal & Minor) & Parkways	3-inches at the crown	The inundated area shall not exceed the street right-of-way.
State Highways	Shall meet the requirements of the NDDOT.	

(1) Typical City urban street classification and geometry as defined by Title 14-09-05(1)(k) of the Zoning Ordinance.

(2) Performance Requirements for non-standard street sections and geometry shall be determined by the City Engineer during the Mandatory Stormwater Scoping Sheet.

Allowable Cross-Street Flow

Cross-street flow occurs when runoff flowing longitudinally in a gutter is allowed to cross the travel lane due to a lowered crown in the street section or a valley gutter in an intersection. Cross-flow is applicable to runoff contained in the street right-of-way and is not the same as allowable street overtopping for culverts crossing perpendicular to a street right-of-way.

Allowable cross-street flows for the 5-year 24 hour and 100-year 24-hour storm events are show in ***Table 6-4***.

Table 6-4 *– Street Allowable Cross Street Flow Requirements*

Street Classification	***5-year 24-Hour Criteria (1)***	***100-Year 24-Hour Criteria (1***
Local	6-inch Depth at Crown or in Valley Gutter	9-inch Depth at Crown or in Valley Gutter
Collector	3-inch Depth in Valley Gutter	6-inch Depth at Crown or in Valley Gutter
Arterial	None	3-inch Depth or Less at Crown no allowable Valley Gutter Flow

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6.1.2 Storm Sewer System

The Storm Sewer System is a series of underground pips designed to convey runoff to an outfall. This system includes inlets, pipes, manholes and other appurtenances necessary to efficiently collect and covey drainage from streets and surrounding properties. Design of the Storm Sewer System components shall be determined by a thorough analysis of the drainage area and streets involved in accordance with the provisions of this SWDSM.

The following section generally describes the performance standards for the analysis and design of a Storm Sewer System associated with a transportation system. These standards also be allied to Storm Sewer trunk mains or other drainage pipes not located under a road or street. Based on drainage area, the design engineer or City Engineer may determine that more stringent performance requirements may be necessary for specific projects.

Inlet Capacity and Spacing

Storm sewer inlets are a structure that intercept and capture surface runoff and direct the flow into the mainline pipe. All storm sewer inlets shall meet the following minimum performance requirements:

1. Storm Sewer inlets installed in public streets shall be designed with capacity and spacing such that the maximum street spread widths and cross flow requirements of ***Table 6-2***, ***Table*** 6-3 and ***Table 6-4*** are not exceeded.
2. Storm Sewer Inlets shall be designed to intercept the 5-year 24-hour design flow with the following allowable bypass as defined in ***Table 6-5*** Storm Sewer Inlets located in sag locations shall include the consideration of conveying flows greater than the design event in a manner that limits the potential for damage to adjacent property or structures.
3. The theoretical capacity of inlets and grates in sags or on grade shall be determined from manufacturers' or industry design charts or procedures utilizing the 5-year 24-hour event street spread criteria.
4. The capacity of the inlet lateral pipe shall exceed that of the theoretical capacity of the inlet for the 5-year 24-hour event.

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Table 6-5 *– Storm Sewer Inlet Bypass Flow Design Requirement*

Condition	***Allowable Bypass***
Sag Location	Storm Sewer Inlets shall be designed to intercept 100% of the 5-year 24-hour event. Provide a 100-year 24-hour event overflow path that minimizes the potential for damage to adjacent property or structures.
Streets on Continuous Grade	The final downstream inlet or inlets shall be designed to intercept no less than 50% of the 5-year 24-hour storm.
Temporary Dead End Streets on Down Grade	Unless otherwise approved by the City Engineer, final downstream Storm Sewer Inlets shall be designed to intercept no less than 100% of the 5-year 24-hour event.
Tee-Intersections on Down Grades and Low Points	Storm Sewer Inlets shall be designed to intercept no less than 100% of the 5-year 24-hour event design flow. Depending on downstream conditions, the City Engineer may require oversizing inlets at low points.

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Inlets Located on Sags with a Storm Sewer Outfall

In situation where a street drainage inlet and storm sewer system intercepts street runoff and discharges perpendicular to the right-of-way the final sag inlets shall be sized to intercept **100% of the 25-year 24-hour event** and a pipe shall convey this design flow to the Point of Discharge. Additionally, an open channel overflow path shall be provided to convey the 100-year 24-hour event from the street sump location to the Point of Discharge consistent with the requirements of ***Section 6.1.4 Open Channels***.

When storm sewer inlets are proposed for a project that requires a PCSMP application the SWMP or Basis of Design Report shall include the following information documenting the performance of the storm sewer system:

1. Location, type, size, rim elevation and depth of the proposed inlet; and
2. 5-year 24-hour design flow to the inlet; and
3. Inlet theoretical capacity; and
4. Depth of water in the gutter at the inlet; and

5. Flow intercepted and flow bypassed; and
6. Street drainage spread width.

Storm Sewer Pipe

All storm sewer pipe shall meet the minimum performance requirements for the 5-year 24-hour and 100-year 24-hour design events as shown in ***Table 6-6***.

Table 6-6 *– Storm Sewer Pipe Capacity Requirements*

Storm Classification	***Requirement***
5-Year 24-Hour Storm	HGL less than 0.5-foot above the crown of pipe as measured at the structure inlet point.
100-Year 24-Hour Storm	Storm sewer may be designed to surcharge during the 100-year 24-hour events; however, surcharging shall not result in a HGL elevation higher than the criteria listed in ***Table 6-2*** or ***Table*** 6-3.

All storm sewer pipe shall meet the velocity performance requirements listed in ***Table 6-7.***

Table 6-7 *– Storm Sewer Pipe Velocity Requirements*

Parameter	***Requirement***
Minimum Velocity	2 feet per second
Maximum Velocity	15 feet per second

Storm Sewer Pipe Outfalls or Points of Discharge

Storm sewer pipe outfalls or points of discharge to an open drainage way shall meet the requirements of culverts at described in

When storm sewer is proposed for a project that requires a PCSMP application the SWMP or Basis of Design Report shall include the following information documenting the performance of the storm sewer system:

1. Pipe calculations that state the design peak flow rates and design information for each pipe run, such as size, slope, length, material type, and Manning's coefficient; and
2. Velocities at design flow for each segment of proposed pipe; and

3. HGL at each inlet, manhole, angle point, and outlet; and
4. Depth from finish grade to pipe invert for each segment of proposed pipe; and
5. When there is a significant change in slope of the pipe through a manhole or other structure, the EGL at the structure assuming the velocity approaches zero.

6.1.3 Culverts

Requirements presented in this shall be used in the analysis and reporting for design of culverts for public streets, roads and highways. Culverts are defined as a closed conduit for the passage of water under an embankment, such as a road or canal. Water enters the culvert directly through the upstream opening in the conduit.

Calculations relating to design of culverts shall be submitted with the PCSMP application for approval, with criteria sections of this Manual being referenced. The following tables define the minimum performance requirements for the analysis and design of culverts.

Hydrologic analysis and capacity of culverts shall be determined using a combination of the design storm, the allowable headwater depth and allowable street overtopping. The headwater depth is measured from the invert of the culvert to the resulting inlet headwater elevation.

The proposed culvert size and/or slope shall be increased until the requirements of ***Table 6-8***, ***Table 6-9*** and ***Table 6-10*** have been met.

The allowable headwater requirements in ***Table 6-8*** are intended to apply to the majority of situations encountered in the City of Bismarck. All culvert crossing of the State Highway System shall also conform to the North Dakota Stream Crossing as defined by NDCC 89-14.

Table 6-8 *– Culvert Headwater Requirements*

Storm	***Allowable Headwater***
25-year 24-hour Event	1.5 times the culvert diameter or culvert rise
100-year 24-hour Event	***Table 6-9*** Overtopping Criteria shall not be exceeded

Culvert Rise is the height of the culvert for shapes other than round.

Allowable street overtopping for culverts installed perpendicular to road right-of-ways shall meet the criteria shown in ***Table 6-9.*** The street overtopping criteria is applicable to situations where the culvert headwater rises to a level were the

flow in the channel overtops the street embankment and flows over the street to the downstream outlet of the culvert. Culvert street over-topping is not the same as allowable street cross-flows.

Table 6-9 *– Culvert Allowable Street Overtopping Requirements*

Street Classification	***Storm***	***Requirement***
All Streets	25-year 24-hour Event	No Overtopping
Local	100-year 24-hour Event	6-inches measured to the highest point on the street section (1)
Collector & Arterial	100-year 24-hour Event	No Overtopping

(1) For local urban streets the highest point is typically the ROW line and for local rural road the highest point is the centerline of the ROW.

Analysis of the culvert shall consider the minimum velocity for cleansing and the maximum velocity for outlet protection. ***Table 6-10*** presents the minimum required cleaning velocity and allowable outlet velocities for typical types of protection. Outlet velocities in excess of 11-feet per second required an engineered energy dissipation or outlet armor calculations and design.

Table 6-10 *– Culvert Velocity Requirements*

Parameter	***Velocity of 25-Year 24-Hour Event***
Minimum Velocity (10-year 24-Hour))	2-feet per second
Vegetation and/or Permanent Turf Reinforcement Mat	< 5 feet per second
Rip-Rap Protection	< than 11-feet per second
Energy Dissipater Required	> 11-feet per second

When culverts are proposed for a project that requires a PCSMP application the SWMP or Basis of Design Report shall include the following information documenting the performance of the culvert:

1. Complete culvert calculations that state the design peak flow rates, culvert size, slope, inverts, length, material type, wall thickness, and Manning's coefficient

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2. Type of end treatment
3. Headwater depths and water surface elevations for the design storm events
4. Velocities at the inlet and outlet for the design storm events
5. Flow control type (inlet or outlet)
6. Roadway cross-section and roadway profile

6.1.4 Open Channels

Open channels in the City of Bismarck consist of two types; engineered channels and natural channels. Engineered channels are generally constructed to uniform lines and grades with lining materials to protect the channel from erosive forces. Natural channels include all watercourses that have been established by nature.

Requirements presented in this shall be used in the analysis and reporting for design of engineered open channels that convey runoff from developed area. Analysis and impact to natural channels shall conform to FEMA floodplain management requirements and other applicable local, state and federal regulations.

Calculations relating to design of engineered channels shall be submitted with the PCSMP application for approval, with criteria sections of this Manual being referenced. The following tables define the minimum performance requirements for the analysis and design of engineered open channels.

The design storm events for channels are defined in ***Table 6-11***.

Table 6-11 *– Engineered Open Capacity Hydrologic Requirements*

Storm Classification	***Requirement***
Minor Storm	5-year 24-hour Rainfall
Major Storm	100-year 24-hour Rainfall

Engineered channels shall meet the minimum freeboard requirements listed in ***Table 6-12*** for the 100-year 24-hour event. Excavated or incised channels are completed constructed below the existing grade and do not require levees or berms to contain the 100-year 24-hour design flows and freeboard requirements.

When berms are used to contain the 100-year 24-hour design flows a greater amount of freeboard is required to account for the increased risk of uncontrolled flows if the berms are breached.

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Levees are flood control structures that are intended to protect development from the 100-year or greater flood event. Flood control levees shall meet the requirements of the USACE and FEMA and are outside of the scope of this SWDSM.

Table 6-12 *– Engineered Channel Freeboard Requirement*

Channel Type	***100-Year 24-Hour Storm Minimum Freeboard***
Fully Excavated or Incised	1-foot below the easement or right-of way boundary.
Berms or Built-Up Channels (1)	2-feet below the easement or right-of way boundary.(2)

(1) City Engineer may require more stringent requirements for channels constructed with berms that could overtop and result in an uncontrolled discharge.

(2) Minimum top width of channel berms shall be 6-feet

Engineered open channels shall be designed to resist the erosive forces of both the 5-year 24-hour and 100-year 24-hour events. Each case will require the design engineer to select channel geometry and lining materials that meet the performance requirements of this section Channel lining design requires analysis of both the design velocity and predicted shear stress to select the proper lining material for individual channels.

Table 6-13 and Table 6-14 provide minimum performance requirements for engineered channels allowable velocity and shear stress.

Table 6-13 *– Engineered Channel Lining Requirements*

Condition	***Requirement***
Minor Storm V < 5 FPS	Grass Lined Channels
Minor Storm V > 5 FPS	Lining to Resist Calculated Shear Forces
Major Storm V < 5 FPS	Grass Lined Channel
Major Storm V > 5 FPS	Lining to Resist Calculated Shear Forces

V = Velocity

FPS = Feet per Second

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Table 6-14 *– Allowable Velocity and Shear Stress for Selected Materials*

Material Category	***Material Type***	***Allowable Velocity (ft/s)***	***Allowable Shear Stress (lb/ft2)***
Temporary Reinforced Erosion Control Product (RECP) (1)	Jute Net Straw w\ Net Coconut Fiber w\ Net Fiberglass roving	1-2.5 1-3 3-4 2.5-7	0.45 1.5-1.65 2.25 2
Nondegradable RECP (1)	Unvegetated Partially Established Fully Vegetated	5-7 7.5-15 8-21	3 4-6 8
Hard Surface (1)	Gabions Concrete	1-19 >18	10 12.5
Riprap (2)	D_{50} = 6-inches D_{50} = 12-inches		2.4 4.8

Source:

(1) *NRCS Part 654 Stream Restoration Design National Engineering Handbook*, Table 8-11.

(2) Kilgore, R. T. and Cotton, G. K. (2005). *Design of roadside channels with flexible linings. FHWA-NHI-05-114 Hydraulic Engineering Circular Number 15*, 3rd Edition, 153 pp.

When engineered open channels are proposed for a project the SWMP shall include the following information documenting the performance of the engineered open channel:

1. The size and shape of open channel conveyances shall be based on flow quantities calculated using the hydrologic methods set forth in Chapter 3.
2. Channels should be designed to avoid flows at critical depth or supercritical flows. The maximum Froude number shall be 0.7.
3. Calculations reporting the velocity and shear stress to support the channel lining material selection.
4. Graphical profile of the channel longitudinal section reporting the design slope and 5-year 24-24 and 100-year 24-hour storm HGLs.
5. Channels should be located such that they will not adversely affect existing infrastructure.
6. State, local, and federal laws shall be adhered to if modifications are proposed to natural channels.

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6.1.5 Outlet and Outfall Protection

Outlet and\or outfall protection of culverts shall be designed to resist the erosive forces of common events up to the 25-year 24-hour storm. For critical infrastructure the City Engineer may require that culvert outfalls be designed for 100-year 24-hour event.

Culvert outfalls shall be designed to resist the scour at the outlet and dissipate velocities to values that are appropriate for the downstream channel. For the majority of the installations utilization of properly sized rip-rap at the outlet will provide suitable protection against scour and sufficient energy dissipation.

Table 6-15 *– Maximum Allowable Design Velocities for Rip-Rap Outlet Protection*

Parameter		***Velocity of Design Event***
Vegetation and/or Permanent Turf Reinforcement Mat		< 5 feet per second
Riprap Size Classification	VL	6.5 feet per second
	L	8.0 feet per second
	M	9.5 feet per second
	H	10.5 feet per second
	VH	11.0 feet per second

When velocities exceed 11 feet per second for the 25-year 24-hour event, or the City Engineer requires a higher design standard for critical infrastructure, the design engineer shall include an engineered energy dissipation structure. Accepted structures include"

1. Short Stilling Basin (USBR Type II)
2. Baffled Apron Stilling Basin (USBR Type IX)
3. Impact Stilling Basin (USBR Type VI)

Energy dissipation structures shall meet the design requirements of the current United States Bureau Reclamation technical circular.

Other proprietary outlet protection measures may be proposed by the design engineer and approved at the City's discretion. **Articulated Concrete Block is not allowed as culvert outlet protection**.

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6.2 Minimum Design Standards

All design and construction for the extension of the City's Public Storm Sewer System shall conform the requirements of the current edition of the "Construction Specifications for Municipal Public Works Improvements Bismarck, North Dakota" (Standard Specification). Requirements of the Standard Specification are not reproduced or repeated in this SWDSM. It is the responsibility of the design engineer to cross-reference the requirements for the SWDSM and the Standard Specification.

6.2.1 Street Drainage

Street Layout

Street layout and design shall meet the requirements of Title 14-09-05 of the City zoning ordinance.

Curb & Gutter

Curb & Gutter shall be included on all new public and private streets proposed for development activities in the City of Bismarck.

Curb and gutter grades shall meet the minimum design requirements of Title 14-09-05 of the City's coning ordinance.

Public Streets shall have curb and gutter that conforms to Section 603 of the Standard Specification.

Valley Gutters

Where storm sewer is not required by street spread requirements or otherwise not justified, valley gutters may be installed to convey runoff through Local street intersections only. No valley gutters are allowed on Arterial or Collector streets except unless approved by the City Engineer.

Design considerations for valley gutters include:

1. The minimum grade of the valley gutter shall be 0.5 percent at the flow line.
2. When valley gutters are used to redirect surface flow greater than 90-degrees (change direction) the design engineer shall include an analysis of the HGL and EGL to determine if a significant change in water surface elevation occurs due to a reduction in velocity.

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6.2.2 Storm Sewer System

Storm Sewer Inlets

The primary purpose of storm sewer inlets is to intercept surface runoff and deposit it in a Public Storm Sewer System, thus reducing the potential for surface flooding. Storm Sewer inlets can be located along street and\or in landscaped areas. The following design requirements generally apply to storm sewer inlets located within public streets and right-of-ways. These general concepts can be applied to private collection systems located in parking lots, parks, athletic fields and other areas that have storm sewer pipes to collect excess runoff.

The inlet capacity governs both the rate of water removed from the gutter and the amount of water that can enter the storm drain system. Inadequate inlet capacity or poor inlet location may cause flooding which creates a safety hazard and may interrupt traffic or damage adjacent property.

Storm Sewer Inlets located within public streets are classified into two major groups: Sag inlets and On-Grade inlets. In addition, inlet types vary as well. A brief description of the inlet types follows:

I. Curb-opening inlets: These inlets consist of a vertical opening in the curb through which the gutter flow passes.

II. Grate inlets: These inlets consist of an opening in the gutter covered by one or more grates.

III. Combination inlets: These units consist of both a curb-opening and a grate inlet acting as a single unit.

IV. Catch Basin Inlets: These inlets consist of a flat grate opening intended to be installed in a parking lot or landscaped area.

Storm Sewer Inlets shall conform with the requirements of Section 1205 of the Standard Specification and applicable current details.

Storm Sewer Inlets shall be designed to intercept the design flow with the following allowable bypass from the s Storm Sewer Inlets located in sag locations shall include the consideration of conveying flows greater than the design event in a manner that limits the potential for damage to adjacent property or structures.

Following are minimum design standards for inlet situations:

1. **Parking Lots and Private Property**: Catch basins installed in parking lots or private pervious areas shall meet the following minimum requirements:

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a. **Catch Basin Capacity**: Provide 150% of the Minor Storm design flow at each inlet;

b. **Max Ponding Depth**: 18-inches during the Major Storm

c. Minimum Freeboard: 1-foot to adjacent buildings finished floor elevations during the Major Storm.

d. **Overflows**: No uncontrolled (overflow) discharge to the public street right-of-way during the Major Storm event.

2. **Private Streets**: Meet the requirements of Public Streets.
3. **Public Street Right-of-Ways**: Inlets installed in public street right-of-ways shall meet the following minimum design standards:

a. **On-Grade Inlets**:

i. Inlet Capacity: Can use 100% of the computed inlet capacity (i.e. ignore clogging); and

ii. Minimum Inlet Size: Type 36"

b. **Sag Inlets**:

i. Inlet Capacity: Provide 150% of the Major Storm capacity at the allowed ponding depth;

ii. Minimum Inlet Size: Type 72"

Storm Sewer Pipe

Storm Sewer Pipe design, material and construction shall conform to the requirements of Section 802 and current Standard Drawings of the Standard Specification.

All storm sewer pipes sizes shall conform to the requirements of ***Table 6-16*** unless approved by the City Engineer.

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Table 6-16 *– Storm Sewer Pipe Size Requirements*

Pipe Type	***Requirement***
Public Lateral	15-inch diameter
Public Mainline	18-inch diameter not decreasing in flow direction
Private Storm Sewer	12-inch
Private Foundation or Building Drain	4-inch

All storm sewer pipes shall be located consistent with the requirements ***Table 6-17*** of unless approved by the City Engineer.

Table 6-17 *– Storm Sewer Pipe Location Standards*

Situation	***Design Location***
Street Right of Way	Parallel storm sewers to the street and in the right-of-way should be placed beneath the traveled lanes, to fit specific manhole or intake connections. Storm sewers should be located in streets with 10-feet of separation from sanitary sewers and water mains.
Public Easements	30-foot minimum easement width. Easements located outside of street right of ways shall include a 20-foot wide all-weather access and maintenance path.
Private Easements	20-foot minimum easement width.

Pipes shall be designed to withstand anticipated loads in accordance with standard industry design procedures. AASHTO HS-20 loading may be assumed during design unless unique conditions of the site warrant a higher load capacity.

Minimum design coverage standards are listed in ***Table 6-18***. The design engineer shall confirm the minimum pipe cover for materials specified for individual projects.

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Table 6-18 *– Storm Sewer Pipe Cover Standards*

Situation	***Design Cover Standards(1)***
Minimum Cover Under Pavement	3.5 –feet for Pipes Parallel to the Travel Direction 1.5 –feet for Pipes Perpendicular to Travel Direction
Minimum Cover Outside of Pavement	3.5 –feet
Maximum Cover	Follow Manufacturer's Recommendations

(1) Cover is measured from the crown of pipe to finished grade.

(2) The design engineer shall confirm the minimum pipe cover for materials specified for individual projects

Manholes

Manholes or other maintenance access ports (tee manhole sections on large diameter pipe) are required whenever there is a change in direction, elevation, grade or the junction of two runs of storm sewer.

Manhole design, material and construction shall conform to the requirements of Section 1205 and current Standard Drawings of the Standard Specification.

Manholes shall be located such that the maximum spacing requirements of ***Table 6-19*** are not exceeded.

Table 6-19 *– Storm Sewer Manhole Spacing Standards*

Situation	***Maximum Manhole Spacing***
18" to 21" Storm Sewer Pipe	450-feet
24" to 30" Storm Sewer Pipe	500-feet
Over 30" Storm Sewer Pipe	600 –feet

(1) All pipe sized are in round diameters.

Manhole size (diameter) shall be sufficient for the size pipe entering and existing the structure. ***Table 6-20*** list design standards for typical reinforced concrete pipe and precast concrete manholes. The design engineer shall confirm that the minimum manhole size listed in ***Table 6-20*** are appropriate for the materials specified for individual projects and angles of pipe entering/exiting the manhole.

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Table 6-20 *– Storm Sewer Manhole Typical Minimum Sizes*

Situation	***Minimum Manhole Size***
18" to 24" Storm Sewer Pipe	48-inch Diameter Manhole
27" to 36" Storm Sewer Pipe	60-inch Diameter Manhole
42" Storm Sewer Pipe	72-inch Diameter Manhole
48" and larger Storm Sewer Pipe	Junction Box or Tee Manhole as approved by the City Engineer

(1) Sizing based on recommendations by Forterra. Design engineer to confirm manhole sizing from actual supplier

(2) All pipe sized are in round diameters. Design engineer to confirm minimum manhole size to other pipe shapes.

Elevation drop shall be provided in manholes per the requirements of ***Table 6-21***.

Table 6-21 *– Storm Sewer Manhole Drop Standards*

Situation(1)	***Minimum Manhole Drop***
Increase in Storm Sewer Pipe Size	Match Crowns of Pipes(2)
Same Size Pipe with less the 45-degree Change in Direction	Carry the Pipe Slope Through the Manhole Structure
Same Size Pipe with 45-degree or greater Change in Direction	Minimum of 0.2-foot Drop Through the Manhole

(1) All pipe sized are in round diameters. Design engineer to confirm minimum manhole size to other pipe shapes.

(2) In areas of flat topography City Engineer may waive the requirement to match crowns.

Easements

Storm sewer pipes constructed outside of the street right-of-way shall include drainage easements of a minimum of 30-feet in width.

1. Easements shall be noted as "Public" (maintained by the City of Bismarck or other approved public entity) or "Private" (maintained by the applicant).
2. Public Easements must be approved by the City.
3. Private Easements must have a provision to allow access by the City to allow for maintenance of derelict storm sewer pipes.

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6.2.3 Culverts

Culverts shall conform with the requirements of Section 1205 of the Standard Specification and applicable current details.

Minimum Size

Culverts shall meet the minimum design requirements of Title 14-09-05 of the City's zoning ordinance.

Table 6-22 *– Minimum Culvert Size Requirements*

Culvert Shape	***Minimum Size***
Round	18-inch Diameter
Arch	22-inch x 13-inch
Elliptical	23 –inch x 13 -inch
Box	3-foot x 5-foot

Design Considerations

Factors to be taken into consideration in culvert design include design flows, the culvert's hydraulic performance, the economy of alternative pipe materials and sizes, horizontal and vertical alignment, and environmental concerns. The following minimum design considerations shall be met when designing culverts:

1. The minimum size as listed by ***Table 6-22***.
2. The size, shape, and type of culvert crossings shall be based on flow quantities calculated using the hydrologic methods set forth in ***Section 6.1.3***.
3. The structural design of culverts shall conform to those methods and criteria recommended by the manufacturer for that culvert type and for the conditions found at the installation site. However, the minimum standards set forth in the current AASHTO standards shall be adhered to.
4. All inlet structures shall be designed to minimize entrance losses. All culverts shall be fitted with flared end sections, headwalls, wingwalls or other approved methods of entrance loss minimization. Projecting ends are not permitted.

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5. For large structures or where groundwater is a problem, the design shall include necessary provisions to resist hydrostatic uplift forces that could result in failure of the structure.
6. All culvert designs shall include an analysis that determines whether inlet or outlet control conditions govern.
7. Ponding above culvert inlets will not be allowed if such ponding will cause property or roadway damage, culvert clogging, saturation of fills, detrimental upstream deposits of debris, or inundate any other structure.
8. All culvert designs shall meet AASHTO HS-20 loading criteria.

Easements

Culverts extended outside of the street right-of-way shall include drainage easements of a width necessary to contain the 100-year 24-hour water surface elevation, required freeboard and maintenance access.

4. Easements shall be noted as "Public" (maintained by the City of Bismarck or other approved public entity) or "Private" (maintained by the applicant).
5. Public Easements must be approved by the City.
6. Private Easements must have a provision to allow access by the City to allow for maintenance of derelict open channels.
7. The minimum drainage easement width shall be 30-feet.

6.2.4 Open Channels

The use of open channels shall generally be limited to undeveloped areas that can conform to the requirements of the hydraulics, topography, and right-of-way limitations.

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Minimum Geometry Requirements

Table 6-23 *– Engineered Channel Geometry Requirements*

Parameter	***Minimum Value***
Longitudinal Slope of Channel	0.25 Percent
Side-Slopes	3 Horizontal to 1 Vertical or flatter
Cross Section Shape	Trapezoidal
Minimum Bottom Width	4-feet

Overland Flow

Overland flow occurs when excess precipitation runs off in sheet fashion prior to accumulating in a drainage way. Drainage ways may be either natural or man-made.

1. Overland flow will only be permitted within individual private lots or land parcels, natural drainage ways, and
2. In swales or small ditches (less than 2 feet deep).
3. Storm water runoff cannot be diverted, or channelized, from one private lot downstream though a separate lot unless appropriate easements are executed.
4. Private adjacent lots in common ownership are still required to dedicate easements.

Engineered Channels – Vegetated

In addition to the requirements stated in ***Section 6.1.4*** the following minimum design standards shall be met:

1. Drop structures may be used to control the grade in order to meet the velocity and shear stress requirements.
2. The design shall consider the channel material's ability to withstand projected channel velocities and shear stresses for the major storm event. Channel protection measures shall be designed where necessary.
3. Slopes greater than 3H:1V may be permitted if approved stabilization is utilized.

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4. All grass channels shall include the utilization of a biodegradable erosion control mat to resist the calculated shear stress until vegetation can be established.
5. The grass species selected for seeding shall conform to requirements set forth by the Standard Specification.

Engineered Channels – Lined

Lined channels may only be utilized when the conditions for vegetated channels cannot be met and when approved by the City Engineer. Additional requirements for lined channels include:

1. For supercritical design flows, concrete channels shall be continuously reinforced, both longitudinally and laterally.
2. Design of lined channels on bends or curves shall take into consideration the centrifugal and gravitational forces on the flow within the channel section.
3. Design and construction of lined channels shall consider the full range of expected climactic conditions (e.g. cold climate).
4. Lined channels shall be protected from hydrostatic uplift forces by the use of drain piping, weep holes, or appropriate footings.
5. The concrete shall be finished, as close as possible, to the degree of roughness used in the design of the channel.
6. Lined channels must have the bottom sloped so that the flow is channelized towards the center line.
7. When lined channels with high velocity flows enter unlined channels with subcritical flow, a structure for the purpose of reducing velocity and dissipating energy is required. Concrete, gabions, slope mattresses, riprap and other approved measures can be used.

Channel Protection

Channel protection is required if the velocity within a channel exceeds the maximum permissible shear stress for the soil or channel lining. The protection usually consists of an erosion-resistant material such as riprap, articulated concrete mats or reinforced soil mats.

The ability of riprap revetment to resist erosion is related to the size, shape, and weight of the stones. Riprap-lined channels are required to have filter fabric

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under the riprap. Riprap material shall be blocky in shape rather than elongated. The riprap stone shall have sharp, angular, clean edges.

FHWA's "Design of Roadside Channels with Flexible Linings" publication, HEC-15, Third Edition (hereafter referred to as HEC-15) is recommended for reference when designing channel protection measures.

Easements

Open channels shall include drainage easements of a width necessary to contain the 100-year 24-hour water surface elevation, required freeboard and maintenance access.

8. Easements shall be noted as "Public" (maintained by the City of Bismarck or other approved public entity) or "Private" (maintained by the applicant).
9. Public Easements must be approved by the City.
10. Private Easements must have a provision to allow access by the City to allow for maintenance of derelict open channels.
11. The minimum open channel drainage easement width shall be 30-feet regardless of the size of the channel.

6.2.5 Outlet and Outfall Protection

Culvert outlets and storm sewer pipe outfalls shall be placed on the same alignment and grade as the existing drainage way. They shall conform to the requirements of all federal, state, and local regulations. Erosion control is required at all storm drain outfalls.

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6.3 Analysis Methodologies

The goal of this Section is to provide the detailed requirements for the analysis of drainage and conveyance facilities.

6.3.1 Hydrologic Analysis

1. **Unit Hydrograph:** NRCS (formerly SCS) Curve Number (CN) & Time of Concentration (Tc) Methods discussed in Chapter 4 of the SWDSM.
2. **Rational Method**
    a. Intensity-Duration-Frequency (IDF) curves shall be from NOAA Atlas 14 using the Bismarck Municipal Airport station (***Reference #7***).
    b. Intensity (I) shall be based on the Time of Concentration (Tc) to the inlet(s). Note that multiple intensities may be needed for a single system.
    c. Runoff Coefficient (C) shall be determined based on the site cover and obtained from accepted literature. The source used to obtain the Runoff Coefficient(s) shall be stated in the SWMP.

6.3.2 Hydraulic Analysis

1. **Inlet Analysis:** Shall use the following methods:
    a. On-Grade:
        i. HEC-22 methodology.
    b. Sag (Low Point):
        i. HEC-22 methodology; or
        ii. Orifice/Weir Equation.
2. **Manning's n Coefficients:**
    a. Manning's n coefficients for commonly used materials and surfaces are provided in ***Table 6-24***.
    b. For surfaces not covered by ***Table 6-24***, values shall be obtained from accepted literature.
    c. The source(s) used to determine any coefficient(s) not provided in ***Table 6-24*** shall be stated in the SWMP.

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Table 6-24 *– Manning's Coefficients*

Material/Surface	***Manning's n Coefficient***
RCP	0.013 – 0.014
CMP	0.022 – 0.024
HDPE (smooth)	0.010 – 0.012
HDPE (corrugated)	0.021 – 0.023
PVC	0.010 – 0.012
Vegetated Channel (not mowed)	0.035 – 0.050
Maintained Ditch/Channel (mowed)	0.030 – 0.040
Concrete Channel	0.015
Street (Asphalt)	0.014 – 0.016
Street (Concrete)	0.013 – 0.015
Urban Overland	0.045
Rural Overland	0.060

3. **Entrance and Exit Coefficients:**
   a. Entrance and Exit Coefficients for common configuration are provided in ***Table 6-25***.
   b. For situations not covered by ***Table 6-25***, values should be obtained from accepted literature.
   c. The source(s) used to determine any coefficient(s) not provided in ***Table 6-25*** shall be stated in the SWMP.

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Table 6-25 *– Entrance and Exit Coefficients*

	Material	Design Scenario	Entrance Coefficient	Exit Coefficient
Pipe or Arch Culverts	RCP	Flared End Section	0.5	1.0
		Square Cut*	0.5	
		Socket or Rounded*	0.2	
	CMP or HDPE	Projecting	0.9	
		Mitered	0.7	
		Conforms to Fill	0.5	
Box Culverts	RCP	No Wingwalls	0.5	1.0
		Wingwalls (30° - 75°)	0.4	
		Wingwalls (10° - 25°)	0.5	
		Wingwalls (Straight)	0.7	

*Applies to Headwall or Projecting

4. **Storm Sewer Junction Losses**
   a. Minimum storm sewer junction losses are provided in ***Table 6-26***.
   b. For situations not covered by ***Table 6-26*** values should be obtained from accepted literature.
   c. The source(s) used to determine any coefficient(s) not provided in ***Table 6-26*** shall be stated in the SWMP.

Table 6-26 – *Storm Sewer Junction Losses*

Design Scenario	Entrance Coefficient	Exit Coefficient
Inlet Junction	0.2	0.5
Manhole Junction	0.1	0.3

5. **Inlet/Outlet Control:**
   a. Analysis method shall account for both the potential for inlet or outlet control conditions with the water surface based on the higher computed water surface elevation.

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b. Inlet/outlet control shall be computed at all surface entrances to storm sewer (e.g. ditch draining to a flared end section) and culverts."

6. **Inlet Analysis Clogging Factor:**
   a. Inlet clogging factors are not required.
   b. Inlet clogging has been accounted for in the maximum street spread widths.
   c. For situations that the design engineer determines inlet clogging factors are required, the source(s) used to determine any coefficient(s) shall be stated in the SWMP.
7. **Shear Stress:** Shall be calculated using the following equation:

$$\tau = \rho\ g\ R\ S$$

Where:

τ = Shear Stress (lbf)

ρ = Density of Water (lbm/ft^3)

g = Acceleration Due to Water (32.2 ft/s^2)

R = Hydraulic Radius (ft)

S = Surface Water Slope (Energy Grade Line)

6.3.3 Acceptable Drainage and Conveyance Models

See ***Reference #8***.

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7.0 CONSTRUCTION STORMWATER CONTROL

The goal of this Chapter is to provide guidance on the design, performance, and analysis of the Construction Stormwater Control requirements of the City of Bismarck. In general, the following sections describe the standards that are to be achieved to obtain Large Site CSMP for projects that meet the thresholds described in Chapter 3.

Projects that meet the impact threshold requirements for a Small Site CSMP can utilize the Small Site CSMP Application and Checklist available from the office of the City Engineer. All design and performance requirements for Small Site CSMP projects are contained in the Small Site SCMP Application and Checklist.

Uncontrolled stormwater runoff from construction sites has the potential to impact natural drainages and adjacent property in an adverse manner. All projects that exceed the land disturbance thresholds defined in Chapter 3 shall obtain the necessary Construction Stormwater Management Permit (CSMP) coverage from the City of Bismarck and if necessary, the State of North Dakota (ND General Construction Permit).

Obtaining coverage for construction activates consists of:

1) Applying for coverage; and
2) Preparation of a project specific Stormwater Pollution Prevention Plan (SWPPP). Preparation of the SWPPP consists of documenting the selection of Best Management Practices (BMPs) to reduce pollutants at the source to minimize the impact of stormwater discharged from the project during construction activities.

The SWDSM does not generally require specific BMPs for all projects or sites because practices should be selected on a case-by-case basis depending on the particular physical characteristics of the site, types and methods of construction activities, and the duration and schedule of the activities.

7.1 Performance Requirements

All projects requiring a CSMP shall develop and implement a site specific SWPPP including appropriate BMPs to limit the discharge of sediment-laden or otherwise contaminated stormwater until all construction actives are completed and the site has achieved final stabilization.

The following sections define the minimum performance requirements for the SWPPP, Minimum Controls, Monitoring & Record Keeping, and Final Stabilization. All Large Site CSMP permit applications shall consist of the materials defined in Chapter 3 meeting the performance requirements defied below.

7.1.1 Stormwater Pollution Prevention Plan Required

All construction projects that meet the disturbance thresholds listed in Chapter 3 are required to prepare a site specific Stormwater Pollution Prevention Plan (SWPPP) to obtain a CSMP.

Small Site CSMP projects utilize a simplified application and checklist that constitutes the required site specific SWPPP.

Large Site CSMP application shall include a site specific SWPPP that conforms with the requirements of the ND Construction General Permit.

7.1.2 SWPPP Minimum Controls

The SWPPP shall, at a minimum, address the following items:

1. Construction Site Management Controls
2. Erosion Controls
3. Sediment Controls
4. Runoff Controls
5. Waste Management & Illicit Discharge Controls
6. Restoration & Final Stabilization Controls

Construction Site Management Controls

The SWPP shall describe the Construction Site Management Controls with the minimum information:

1. **Project Description:** Each plan shall provide a description of the construction activity and potential sources of pollution as indicated below:
    a. Project type and construction activities;
    b. Total project area and total area of the site that is expected to be disturbed by construction activities;
    c. A description of the NRCS soil type and erosion potential for soils contained in the project area; and
    d. Location of the Point of Discharge to the Public Storm Sewer System for discharges leaving the site.
2. **Site Plan Map**: Meeting the requirements of the ND General Construction Permit
3. **Construction Site Management Narrative**: At a minimum describe:

a. The person (by name and relationship) who is responsible for the implementation of the CSMP BMPs, inspection and maintenance of the CSMP BMPs until a NOT is filed or the permit is transfer.

b. The installation, maintenance, and removal (if applicable) requirements of proposed Best Management Practices (BMPs) for each phase/stage of construction activity;

c. The rationale for the selection of all BMPs (calculations should be included if appropriate); and

d. Whether selected BMPs are temporary or permanent.

4. **Construction Operational BMPs:** The SWPP shall describe the BMPs used in the day to day operation of the project site that reduce the contribution of pollutants in stormwater runoff by identifying:

   a. Good housekeeping practices used to maintain a clean and orderly site.

   b. Preventative maintenance practices used to ensure the proper operation of erosion and sediment control devices (e.g., fiber rolls, erosion control blankets and silt fences) and equipment used or stored on site.

   c. Spill prevention and response procedures where potential spills can occur. Specific handling procedures, storage requirements, spill containment, cleanup procedures, and disposal must be identified. Storage structures for petroleum products and other chemicals shall have adequate leak and spill protection to prevent any spilled materials from entering waters of the state or storm sewer systems.

   d. Site operation BMPs to limit the exposed soil including construction sequencing, construction schedule and preservation of natural vegetation.

Erosion Controls

The SWPPP shall identify the minimum erosion control BMPs that are to be implemented to minimize the potential for soil to become mobilized into stormwater runoff. Erosion control BMPs consist of both avoidance measures, measures intended to limit the amount of area disturbed at the same time, and erosion control measures, measures that temporarily stabilize exposed soils. Erosion Control BMPs are a preferred method temporarily stabilizing exposed soils to limit sediment laden stormwater discharges.

Stabilized means the exposed ground surface has been covered by appropriate materials such as mulch, staked sod, riprap, erosion control blanket,

or other BMPs that prevents erosion from occurring. Grass seeding alone is not stabilization. Snow cover and frozen ground conditions are not considered stabilized.

The SWPPP shall address the following minimum requirements for Erosion Control BMPs

1. **Construction Phasing and Protection of Vegetation**: The SWPP shall address the following minimum construction practices shall guide the scheduling and phasing of the construction activities for the purpose of limiting exposed soils:
    a. **Phased Grading & Stabilization**: The SWPPP shall consider phasing of the project to minimize the area of exposed soil during the completion of the construction activities. Stabilization of the site shall occur as areas reach final lines and grades.
    b. **Protection of Existing Vegetation**: Areas not to be disturbed by grading activities shall be protected and utilized as natural buffers as allowed by the site conditions. The SWPPP shall strive to limit construction activities to active grading areas and locations to be disturbed.
    c. **Staging and Stockpile Areas**: Staging and Stockpile areas shall be noted on the SWPPP. When practical, staging and stockpiles areas shall be located in areas that require disturbance from grading or other construction activities.
2. **Minimum Stabilization Requirements**: The following minimum stabilization requirements shall guide the selection of erosion control BMPs for the project site:
    a. **Exposed Soils**: All exposed soil areas must be stabilized.
        i. Stabilization must be initiated immediately where activities have been permanently or temporarily ceased on any portion of the site and will not resume for a period exceeding fourteen (14) calendar days.
        ii. Stabilization must be completed as soon as practicable, but no later than fourteen (14) calendar days after the initiation of soil stabilization.
        iii. Temporary stockpiles without significant silt, clay or organic components (e.g., clean aggregate stockpiles, demolition concrete stockpiles, sand stockpiles) are exempt from this requirement.

b. **Exposed Soils on Steep Slopes**: For slopes with a grade of 3H:1V or greater, stabilization must be initiated immediately once activities have been completed or temporarily ceased. Stabilization must be completed as soon as practicable, but no later than seven (7) calendar days after the initiation of soil stabilization.

c. **Channels, Ditches and Swales**: The normal wetted perimeter of any temporary or permanent drainage ditch that drains water from a construction site, or diverts water around a site, must be stabilized at least 200 linear feet from the property edge, or from the point of discharge to any surface water. Stabilization shall be completed prior to connection with a surface water. Any remaining portion of the temporary or permanent drainage ditch must be stabilized within fourteen (14) calendar days for portions which construction activities have temporarily or permanently ceased.;

3. **Protection of Outlets:** Erosion control BMPs shall be installed at the inlet and outlet of all culverts, outfalls, roof drains and other sources of concentrated flow from a conduit.

Sediment Controls

The SWPPP shall identify the minimum sediment control BMPs that are to be implemented to limit sediment laden stormwater from discharging from the project area onto adjacent property or into the Pubic Storm Water System. Sediment Control BMPs are the last line of protection and should not be utilized as the primary method of construction site stormwater management.

The SWPPP shall meet the following minimum requirements for Sediment Control BMPs

1. **Design Storm**: Sediment Control BMPs are expected to withstand and function properly during precipitation events of up to the 2-year, 24-hour storm event. Visible erosion and/or off-site sediment deposition from such storm events should be minimal.
2. **Minimum Sediment Control BMPs**: Prior to the start of land disturbing activities, all projects shall have the following minimum sediment control BMPs in place and functioning:

   a. **Perimeter Control**: Consisting of silt fence, straw wattles, vegetative buffers or other applicable BMP at the down gradient perimeter of the project site;

   b. **Inlet Protection**: For all Public and Private Storm Sewer inlets or catch basins located within 600-feet (down-gradient) of the Point of Discharge(s) from the project site;

c. **Stabilized Construction Access:** All construction egress points that exit the project site to paved public or private areas shall have appropriate tracking prevention BMPs (note that sweeping alone does not constitute tracking prevention0; and

d. **Soil Stockpiles:** All soil stockpiles shall include perimeter sediment control BMPs.

3. **Sediment Traps or Basins:** Temporary sediment basins or traps shall be utilized at all points of discharge from the project site where the tributary area to the point of discharge is equal to or greater than 10-acres.

4. **Natural Buffers:** A 50-foot natural buffer or equivalent erosion and sediment controls must be provided when a project is within 50 feet of a surface water and stormwater flows to the surface water. If equivalent erosion and sediment controls are used, rationale for using equivalent controls must be provided in the SWPPP.

5. **Soil Stockpiles:** Are both temporary and permanent collections of soil material that has been excavated or hauled to the site. Generally, soil stockpiles consist of material that will be utilized in subsequent phases of the project. All soil stockpile locations shall be noted on the SWPPP and utilize the following minimum BMPs.

   a. Perimeter sediment controls shall be installed at the base of all soil stockpiles;

   b. Temporary stabilization of all piles where no construction activities will occur for seven day or longer; and

   c. Final Stabilization is required of all stockpiles that are to be left onsite and not utilized as construction materials for future phases.

Runoff Control

The SWPPP shall identify the minimum construction stormwater Runoff Control BMPs that are to be implemented to minimize the potential for erosion of soils and impact to open water drainages or natural drainages on and adjacent to the project site.

The SWPPP shall address the following minimum requirements for the section of applicable Runoff Control BMPs:

1. **Design Storm**: Construction Drainage Management BMPs shall meet the following requirements for design storms:

   a. **Check Dams**: Are expected to withstand and function properly during precipitation events of up to the 2-year, 24-hour storm event.

b. **Temporary Stormwater Diversions**: Are expected to withstand and function properly during precipitation events of up to the 5-year, 24-hour storm event;

c. **Permanent Stormwater Diversions**: Shall meet the requirements of Chapter 6 for the Post-Construction stormwater management.

2. **Overflow Paths**: The SWPPP shall identify construction stormwater overflow paths for events greater than the design storm and shall include a description for how runoff ultimately gets to an established natural or artificial waterway. Construction scheduling and phasing shall consider conveyance of construction stormwater to the point of discharge that minimizes the potential for damage to adjacent property or structures.

Waste Management & Illicit Discharge Control

The SWPPP shall identify the minimum Waste Management & Illicit Discharge Control BMPs that are to be implemented to minimize the potential for a non-stormwater discharge from the project site.

The SWPPP shall address the following minimum requirements for the selection of applicable Waste Management & Illicit Discharge BMPs:

1. **Concrete Washout**: All projects shall have a designated concrete truck washout location to eliminate the potential for concrete or concrete wash water to be discharged from the project site. Maintenance and disposal of Concrete Washout Areas shall be the responsibility of the permittee.
2. **Vehicle Washing Areas**: All projects that will include on-site vehicle washing shall have designated vehicle and equipment wash areas with BMPs to eliminate the potential for wash water to discharge from the project site.
3. **Spill Prevention and Control Plan:** All projects shall have BMPs for chemical, fuel, lubricant and other non-stormwater spills and cleanup.
4. **Waste Disposal:** All projects shall provide designated waste management collection areas. All waste collected shall be disposed of at a facility licensed or approved for the material to be disposed.

Restoration and Final Stabilization

The SWPPP shall identify the schedule and type of final stabilization for all areas disturbed by construction activities.

7.1.3 Monitoring and Record Keeping

The permittee is responsible for self-monitoring and reporting. Copies of the CSMP, SWPPP, monitoring reports and maintenance records shall be kept on the project site during normal operating hours for review by City Staff.

All site that require coverage under the ND Construction General Permit shall following the monitoring and record keeping requirements of the required permit. These records shall be kept onsite for review by City Staff.

Projects that require a Large Site CSMP and do not meet the threshold of the ND Construction General Permit shall meet the following monitoring and record keeping requires:

1. Inspections shall be performed by or under the direction of the permittee at least once every 14 calendar days and within 24 hours after any storm event of greater than 0.25 inches of rain per 24- hour period.
2. Inspections are only required during normal working hours. The permittee shall use a rain gauge on-site or utilize the nearest National Weather Service precipitation gauge station. Rain gauge locations or stations must be representative of the site.
3. "Within 24 hours after any storm event greater than 0.25 inches rain per 24-hour period" means that the permittee is required to conduct an inspection within 24 hours once a storm event has produced 0.25 inches, even if the storm event is still continuing. If there is a storm event at your site that continues for multiple days, and each day of the storm produces 0.25 inches or more rain, you are required to conduct an inspection within 24 hours of the first day of the storm and within 24 hours after the end of the storm.
4. There may be times when a site inspection may not be practical at the specified time. Adverse climatic conditions, such as flooding, high winds, tornadoes, electrical storms, site access constraints, etc., may prohibit inspections. The permittee must include a description of why the inspection(s) could not be performed at the designated time in the next inspection record. If an inspection is delayed due to adverse weather conditions or rain events outside normal working hours, an inspection must be conducted during the next working day, or as conditions allow.
5. Some erosion and sediment control measures may require more frequent inspection based on location (e.g., sensitive areas or waters of the state) or as a result of recurring maintenance issues. Erosion or sediment control measures found in need of maintenance between inspections must be repaired or supplemented with appropriate measures as soon as

practicable. Erosion and sediment control measures which require more frequent inspection based on location or as a result of recurring maintenance issues must be identified in the SWPPP.

6. Records of each inspection activity shall include:
    a. Date and time of inspections
    b. Name of person(s) conducting inspections;
    c. Findings of inspections, including recommendations and schedule for corrective actions;
    d. Date and amount of all rainfall events greater than 0.25 inches in 24 hours;
    e. Documentation that the SWPPP has been amended when changes are made to BMPs in response to inspections.
7. Records for corrective action and maintenance activates shall include:
    a. BMP corrected;
    b. Date and time of corrective action;
    c. Name of person(s) performing corrective actions;
    d. Corrective actions taken.
8. Completed areas that have been stabilized but do not meet the criteria for final stabilization may be inspected once per month. Inspections may be suspended for parts of the construction site that meet final stabilization requirements. The SWPPP must update to identify any areas which meet this condition.

7.1.4 Final Stabilization and Termination of Coverage

Termination of coverage for a CSMP requires that the project achieve final stabilization as described below.

Small Site Final Stabilization is achieved when:

1. All soil disturbing activities for the project have been completed and all soils have been stabilized by a permanent surface covering. For "grass" vegetated areas, soils will be considered stabilized when a uniform perennial vegetative cover with a density of 70 percent is achieved;
2. Down gradient perimeter control for individual lots has been implemented and the residence has been transferred to the homeowner; and

3. The permittee has distributed a "Stormwater Fact Sheet" to the homeowner to inform the homeowner of the lot specific need for drainage patterns and maintenance of the final stabilization.

Large Site CSMP Final stabilization is achieved when:

1. All soil disturbing activities for the project have been completed and all soils have been stabilized by a permanent surface covering. For "grass" vegetated areas, soils will be considered stabilized when a uniform perennial vegetative cover with a density of 70 percent is achieved;
2. All drainage ditches, constructed to drain water from the site after construction is complete, have been stabilized to preclude erosion;
3. All temporary erosion prevention and sediment control BMPs (such as silt fence) have been removed and disposed of in a proper manner; and
4. All sediment has been removed from conveyances and temporary sedimentation basins that will be used as permanent water quality management basins. Sediment must be stabilized to prevent it from being washed into basins, conveyances or drainage ways discharging off-site, or to surface waters or adjacent properties. The cleanout of permanent basins must be sufficient to return the basin to design capacity.

7.2 BMP Minimum Design Standards

BMPs are a key component of the SWPPP required by this SWDSM and the ND Construction General Permit for construction activities that exceed the land disturbance thresholds that trigger permit coverage. BMPs are measures or controls that reduce the transport of pollutants, including sediment, from the project site. These practices can also be used to divert runoff away from areas of exposure to pollutants, or to treat stormwater runoff before discharge to receiving waters. BMPs are designed to address the quality of a site's practices with respect to stormwater leaving the site, and to meet environmental water quality standards or benchmarks. BMPs are most effective when organized into a comprehensive SWPPP.

Selection of BMPs for site specific SWPPP is outside of the scope for this SWDSM. There are numerous sources for construction stormwater BMP manuals that are acceptable sources of selection and design criteria. Examples include:

1. EPA National Menu of Best Management Practices (BMPs) for Stormwater
2. North Dakota Department of Transportation Erosion and Sediment Control Handbook
3. International Stormwater BMP Database
4. Minnesota Pollution Control Agency
5. Wisconsin Department of Natural Resources

The following sections provide basics BMP design standards that can be used to supplement the recommendations of accepted BMP manuals.

7.2.1 Work in the Public Right-of-Way

All work performed under City of Bismarck construction contracts or within the public right-of-way shall conform with the "Construction Specifications for Municipal Public Works Improvements".

7.2.2 Construction Site Management Controls

The following list is the key concepts to use when selecting BMPs for the site specific SWPPP:

1. Minimize the open area by phasing or sequencing construction and preserving existing vegetation where possible.
2. Divert stormwater away from disturbed or exposed areas when possible.
3. Install BMPs to limit the potential for soil to become mobilized in stormwater runoff (erosion control.)

4. Install BMPs to capture soil that becomes mobilized in stormwater runoff prior to discharging from the project site (sediment control).
5. Inspect the site regularly and properly maintain BMPs, especially after rainfall, high winds, and snowmelt events.
6. Revise the SWPPP as site and climatic conditions change during the construction and if BMPS are not effectively controlling erosion and sediment.
7. Keep the construction site clean by putting refuse in proper containers, keeping storage bins covered and preventing or removing excess sediment on roads or other impervious surfaces.

7.2.3 Erosion Controls

Erosion control BMPs identified in the SWPPP or utilized for the project site shall meet the following minimum design standards:

1. **Channel Erosion Control Mats:** When erosion control mats are utilized to stabilize proposed and existing stormwater channels, swales, or ditches during construction and final stabilization establishment, the following minimum design standards shall be met:
    a. Erosion control mat is a protective cover of exposed soils consisting of straw, wood, coconut bier fiber or other suitable fiber formed into a mat, usually with a permanent or photodegradable plastic or biodegradable mesh on one or both sides. Erosion mats are rolled products available in many varieties and combination of materials and with varying life spans.
    b. Temporary Mat shall be selected to resist the calculated shear stress for the 2-year 24-hour design flow.
    c. Permanent mat shall be selected based on the calculated velocity and shear as described in Chapter 6. …
    d. Mat shall be installed after all top soiling, fertilizing and seeding has been completed, unless the manufacturer requires otherwise.
    e. Mats shall extend for whichever is greater: upslope one-foot minimum vertically from the ditch bottom or 6 inches higher than the design flow depth.
    f. The mat shall be in firm and continuous contact with the soil. It shall be anchored, overlapped, staked and entrenched per the manufacturer's recommendations.
    g. Temporary Mats shall be selected so that they last long enough for the grass or other vegetation to become densely established.

h. It may be difficult to establish permanent vegetation and adequate erosion protection in a channel with continuous flow. Consider riprap or other lining method of the channel.

i. Once a gully has formed in a channel, it is difficult to stabilize due to loss of soil structure. Even when the gully is filled with topsoil and reseeded, the soil has a tendency to dislodge in the same pattern. If gully formation continues to be a problem the design should be reevaluated, including other mat classes, energy dissipation such as ditch checks or riprap.

2. **Non-Channel Erosion Control Mats**: When erosion control mats are utilized to stabilize exposed soils on slopes or other areas of high potential for erosion during the establishment of final stabilization shall meet the following minimum design requirements:

   a. Erosion control mat is a protective cover of exposed soils consisting of straw, wood, coconut bier or other suitable fiber formed into a mat, usually with a photodegradable plastic or biodegradable mesh on one or both sides. Erosion mats are rolled products available in many varieties and combination of materials and with varying life spans.

   b. The purpose of this practice is to protect the soil surface from the erosive effect of rainfall, and prevent sheet erosion during the establishment of grass or other vegetation, and to reduce soil moisture loss due to evaporation.

   c. Only 100% biodegradable or photodegradable mats shall be utilized.

   d. Mat shall be selected to resist the calculated shear stress for the 2-year 24-hour design flow.

   e. Mat shall be installed after all top soiling, fertilizing, and seeding has been completed.

   f. The mat shall be in firm and continuous contact with the soil. It shall be anchored, overlapped, staked and entrenched per the manufacturer's recommendations.

3. **Mulching**: Mulching is the application of organic material to the soil surface to protect it from raindrop impact and overland flow. Mulch covers the soil and absorbs the erosive impact of rainfall and reduces the flow velocity of runoff. When mulching is used, the following minimum requirements must be met:

a. This practice may be applied on exposed soils as a temporary control where soil grading or landscaping has taken place or in conjunction with temporary or permanent seeding.

b. Mulching is not allowed in channels or areas of concentrated flow.

c. Mulching is not allowed in detention or retention ponds.

d. Mulch shall consist of natural biodegradable material such as plant residue (including but not limited to straw, hay, wood chips, bark and wood cellulose fiber), or other equivalent materials of sufficient dimension (depth or thickness) and durability to achieve the intended effect for the required time period.

e. Mulch shall be environmentally harmless to wildlife and plants. Materials such as gravel, plastic, fabric, sawdust, municipal solid waste, solid waste byproducts shredded paper, and non-biodegradable products shall not be used.

f. Mulch shall be free of diseased plant residue, noxious weed seeds, harmful chemical residues, heavy metals, hydrocarbons and other known environmental toxicants.

g. Straw and hay mulch that will be crimped shall have a minimum fiber length of 6 inches.

h. Wood chips or wood bark shall only be used for sites that are not seeded.

    i. Wood products typically absorb available soil nitrogen as they degrade, thus making it unavailable for seed.

i. Mulch Anchoring Methods: Anchoring of mulch shall be based on the type of mulch applied, site conditions, and accomplished by one of the following techniques:

    i. Crimping

    ii. Biodegradable Netting

    iii. Tackifier

j. Considerations:

    i. The use of mulch behind curb and gutter may not be desirable unless anchored by netting, because air turbulence suitable as wind generated from nearby traffic can displace the mulch. Consider the use of erosion mat or sod as an alternative.

ii. In areas where lawn type turf will be established, the use of tackifiers is the preferred anchoring method. Crimping will tend to leave an uneven surface and plastic netting can become displaced and entangled in mowing equipment.

iii. Concentrated flows above the site where mulch is applied should be diverted.

iv. Mulch should be placed within 24 hours of seeding.

v. Materials such as gravel may be effective for erosion control but are not considered mulches.

7.2.4 Sediment Controls

Sediment control BMPs identified in the SWPPP or utilized for the project site shall meet the following design standards:

1. **Perimeter Control**: Sediment control practices installed generally at the perimeter of a project site or disturbed area. Perimeter control BMPs shall be:
    a. Installed per the manufactures recommendations and applicable City of Bismarck Standard Construction Details;
    b. Silt Fence, Straw Wattles, Weight Fiber Roll and similar perimeter control BMPs shall be embedded as directed by the manufacturer, or standard detail, to limit the potential for runoff to short circuit underneath the installed BMP.
    c. Perimeter BMPs shall be installed along topographic contours to promote the natural dispersion of runoff. Installation across contours without consideration for the dispersion of flow will not be allowed.
    d. Removal of sediment collected behind BMPs shall occur before the accumulation reaches 1/3 of the height of the BMP and per manufactures recommendations.
2. **Inlet Protection**: A temporary device installed in or around a storm drain inlet, drop inlet, or curb inlet. All inlet protection BMPs shall be:
    a. Installed and maintained per the manufactures recommendations;
    b. Allow for high flows to enter the inlet and storm sewer system;
    c. Be maintained on a regular basis to remove accumulated sediment and debris; and
    d. When installed in a public street right of way, meet the requirements of the City's Standard Specification.

3. **Stabilized Construction Access:** Consists of a stabilized pad of stone aggregate located at any point where traffic will egress a construction site. Stabilized construction access pods shall meet the following minimum design standards:
    a. The construction access pads shall be installed prior to any traffic leaving the site;
    b. The aggregate for construction access pods shall be 3 to 6 inch clear or washed stone with all material retained on a 3-inch sieve;
    c. The aggregate shall be placed in a layer at least 12 inches thick. On sites with a high water table, or where saturated conditions are expected during the life of the practice, stone tracking pads shall be underlain with a separating geotextile fabric to prevent migration of underlying soil into the stone;
    d. The construction access pods shall be the full width of the egress point and a minimum of 50 feet long; and
    e. Surface water must be prevented from passing through the construction access pads. Flows shall be diverted away from construction access pods or conveyed under and around them by using a variety of practices, such as culverts, or other similar practices.
    f. Any sediment tracked onto a public or private road should be removed by street cleaning, not flushing, at a minimum before the end of each working day or sooner as weather and safety may require.
4. **Sediment Traps or Basins:** Temporary or permanent sediment basins or traps shall be sized to meet the following requirements:
    a. Shall be designed to:
        i. for a calculated volume of runoff from a 2-year, 24-hour storm per acre drained to the basin and provides not less than 1,800 cubic feet of sediment storage below the invert of the outlet pipe from each acre drained to the basin; or
        ii. Shall be sized to provide 3,600 cubic feet of sediment storage below the invert of the outlet pipe per acre drained to the basin if calculations are not performed.
    b. Outlets must be designed to avoid short-circuiting and the discharge of floating debris. Basins must be designed with the ability to allow complete basin drawdown for maintenance activities. Basins must release the storage volume in at least 24 hours.

c. Outlet structures must be designed to withdraw water from the surface, unless not practicable. If not practicable, rationale must be provided in the SWPPP. The basin must have a stabilized emergency overflow to prevent failure of pond integrity. Energy dissipation must be provided for the basin outlet.

5. **Vegetative Buffers**: When vegetative buffers are utilized as perimeter sediment control the following minimum design standards shall be met:

   a. Vegetated buffers must have a minimum width of 1 foot for every 5 feet of disturbed area that drains to the buffer.

   b. The width of the buffer shall have a slope of 5 percent or less and the area draining to the buffer shall have a slope of 6 percent or less.

   c. Concentrated flows should be minimized throughout the buffer.

   d. Buffers shall consist of dense grassy vegetation, 3 to 12 inches tall with uniform coverage over 90 percent of the buffer. Woody vegetation shall not be counted for the 90 percent coverage. No more than 10 percent of the overall buffer may be comprised of woody vegetation.

7.2.5 Runoff Controls

Runoff control BMPs identified in the SWPPP or utilized for the project site shall meet the following minimum design standards:

1. **Check Dams:** Are temporary dams constructed across a swale or drainage ditch to reduce the velocity of water flowing in the channel. Check Dams can be constructed out of stone, a double row of straw bales or from engineered products. Check Dams shall meet the following minimum design standards:

   a. This BMP applies where grading activity occurs in areas of channelized flows and a temporary measure is needed to control erosion of the channel until permanent stabilization practices can be applied.

   b. Under no circumstance shall check dams be placed in an intermittent or perennial stream without approval of a USACE 404 Permit.

   c. Height:

      i. Installed, the minimum height of ditch checks shall be 10 inches and shall not exceed a maximum height of 16 inches

for manufactured or biodegradable materials and 36 inches for stone (or other inorganic materials).

ii. Installed with the center lower than the sides forming a weir to prevent scour along the edge of the channel.

iii. Stone check dams shall have a minimum top width of 2-feet measured in the direction of flow with maximum slopes of 2:1 (2 horizontal to 1 vertical) on the upslope and downslope sides.

d. Placement:

i. At a minimum, install one check dam for every two feet of drop in the channel.

ii. Check dams shall be placed such that the resultant ponding will not cause inconvenience or damage to adjacent areas.

e. Materials shall be in accordance with the requirements of the City of Bismarck Standard Specification or as approved by the City Engineer.

f. Ditch checks shall be utilized during rough grading and shall be removed once the final grading and channel stabilization is applied, unless intended to be part of a permanent stormwater management plan.

g. Ditch checks installed in grass lined channels may kill the vegetation if water is ponded for extended periods or excessive siltation occurs. Proper maintenance is required to keep areas above and below the ditch check stabilized.

h. When placing ditch checks in swales adjacent to roadways, consider designating a 'clear zone' free of obstacles posing a threat to out of control vehicles.

2. **Temporary Stormwater Diversions**: Are a temporary berm or channel constructed for the purpose of intercepting, diverting and safely conveying run-on into construction sites around exposed soils or the project area. Temporary stormwater divisions shall meet the following minimum design standards:

a. This practice is applicable to construction sites where temporary surface water runoff control or management is needed. Locations and conditions include:

i. Upstream of disturbed areas, to limit runoff onto the site.

ii. Across slopes to reduce slope length.

iii. Below slopes to divert excess runoff to stabilized outlets.

iv. To divert sediment-laden water to sediment control facilities.

v. At or near the perimeter of the construction area to keep sediment from leaving the site.

b. Permanent diversions shall meet the requirements of Chapters 4-6 of this SWDSM.

c. Sediment-laden runoff from disturbed areas shall be diverted into a sediment control BMP.

d. When diverting clean water, the diversion channel and its outfall shall be immediately stabilized for the 2-year frequency, 24-hour duration storm. Build and stabilize clean water diversions before initiating down slope land-disturbing activities.

e. Diversions shall be protected from damage by construction activities. At all points where diversion berms or channels will be crossed by construction equipment, the diversion shall be stabilized or shaped appropriately. Temporary culverts of adequate capacity may be used.

f. For diversions that are to serve longer than 30 days, the side slopes including the ridge, and down slope side the diversion shall be stabilized as soon as they are constructed. The diversion channel should be stabilized with an erosion control mat or other suitable lining that can stay in place for the service time of the division.

g. For diversions serving less than 30 days, the down slope side of the diversion shall be stabilized as soon as constructed.

h. The channel cross section may be parabolic, or trapezoidal. The use of "V" channels is generally discouraged due to potential erosion problems.

i. Check dams may be used to enhance sediment removal and provide energy dissipation.

7.2.6 Waste Management & Illicit Discharge Controls

Waste Management & Illicit Discharge control BMPs identified in the SWPPP or utilized for the project site shall meet the following minimum design standards:

1. **Concrete Washout:** A designated area on the project site for the washout of concrete trucks to prevent or reduce the discharge of pollutants to stormwater. All sites that utilize concrete as a construction material shall have a designated concrete washout that meets the following minimum design standards:

a. Locate washout area at least 50 feet from sensitive areas such as storm drains, open ditches, or other natural and man-made water bodies, including wetlands.

b. The minimum sized washout pit shall be 10-feet x 10-feet x 3-feet (LxWxD) and shall be lined with a 15-mil plastic liner.

c. Have signs directing concrete trucks to the designated wash out area.

d. Allow convenient access for concrete trucks, preferably near the area where the concrete is being poured.

e. On large sites with extensive concrete work, washouts may need to be placed in multiple locations for ease of use by concrete truck drivers.

f. Concrete washout facilities shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

g. Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per applicable solid waste regulations. Dispose of hardened concrete on a regular basis.

2. **Vehicle Wash Area**: A tire washing station located at any point where traffic will egress a construction site where a stabilized construction access pad is not sufficient to limit tracking or non-stormwater discharge. When a vehicle wash BMP is utilized, the following minimum design standard shall be met:

   a. The washing station shall be located onsite in an area that is stabilized and drains into suitable sediment trapping or settling device.

   b. The wash rack shall consist of a heavy grating over a lowered area. The rack shall be strong enough to support the vehicles that will cross it.

7.2.7 Restoration & Final Stabilization Controls

Restoration and final stabilization control BMPs identified in the SWPPP or utilized for the project site shall meet the following minimum design standards:

1. **Exposed Soils**: All soils disturbed and or exposed by the construction activities shall be permanently stabilized by either:

   a. Creation of permitted impervious surface; and

b. Permanent vegetation consisting of final landscaping. Temporary seeding of exposed areas between phases in the project (for example subdivision mass grading and home site development) is not considered final stabilization.

2. **Permanent Seeding**: Consists of final vegetative cover of the site for the purpose of achieving final stabilization of exposed soils. Permanent seeding shall meet the minimum design standards:

   a. Topsoil installation shall be completed prior to permanent seeding.

   b. Permanent seeding requires a seedbed of loose topsoil to a minimum depth of 4 inches with the ability to support a dense vegetative cover.

   c. Application rates of fertilizer or lime shall be based on soil testing results.

   d. Prepare a tilled, fine, but firm seedbed. Remove rocks, twigs foreign material and clods over two inches that cannot be broken down.

   e. The soil shall have a pH range of 5.5 to 8.0.

   f. Seed material and seeding rates shall meet the requirements of the City Standard Specification.

7.3 Analysis Methodologies

The goal of this section is to provide specific analysis methodologies for Construction Stormwater Control as required by the North Dakota Construction General Permit and the City's MS4 General Permit (***Reference #9***). Note that Small Site CSMP applications do not need a hydrologic or hydraulic analysis.

7.3.1 Hydrology (Computing Runoff)

1. **Computing Runoff:** Runoff calculation methods shall be consistent with those discussed in Chapter 4.
2. **Newly Graded Ground:** A minimum CN of 90 shall be used for all newly graded ground regardless of Hydrologic Soil Group.

7.3.2 Hydraulic Analysis

Hydraulic analyses shall be made using the methods described below unless otherwise approved by the City Engineer.

1. **Velocity:** Shall be obtained using one of the acceptable methods presented in ***Reference #8.***
2. **Shear Stress:** Shall be calculated using the following equation:

   $\tau = \rho\ g\ R\ S$

   Where:

   τ = Shear Stress (lbf)

   ρ = Density of Water (lbm/ft^3)

   g = Acceleration Due to Water (32.2 ft/s^2)

   R = Hydraulic Radius (ft)

   S = Surface Water Slope (Energy Grade Line)

3. **Capacity of Swales and Ditches:** Shall be analyzed using one of the methods presented in ***Reference #8***.