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DEPARTMENT OF TRANSPORTATION

The Nebraska Department of Transportation Drainage Design and Erosion Control Manual Chapter Three, "Stormwater Treatment", April 2018, has been approved for use.

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The information contained in Chapter Three: Stormwater Treatment, dated April 20, 2018 has been updated to reflect the **June 2026 Errata**. The errata addresses errors, changes in procedure, changes in NDOT department titles, changes in other Drainage Manual and Roadway Design Manual chapters and other reference material citations occurring since the latest publication of this chapter.

This chapter replaces Chapter Three: Stormwater Treatment, dated September 2013. The Nebraska Division of the FHWA approved this chapter for use on the National Highway System and other federal projects on April 20, 2018.

Chapter Three
Stormwater Treatment

WITHIN MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) COMMUNITIES

This Chapter provides roadway designers with the necessary guidance for incorporating Water Quality Stormwater Treatment Facilities (STFs) into **Nebraska Department of Transportation** (**NDOT**) projects. Specifically, this chapter details the selection, placement and design of STFs.

Stormwater treatment policies, procedures, and guidelines are subject to amendment as conditions warrant. They are not intended to be, nor do they establish, legal standards. Special situations may call for variations from these requirements, subject to approval from the **Roadway Design Unit Head** (**Unit Head**) or **Assistant Design Engineer** (**ADE**). The proper documentation of drainage decisions is important for project records and archiving.

SELECTED DEFINITIONS
(See the Glossary for additional information)

De minimis - De minimis means of minimum importance. It refers to something that is so small or trivial that law does not consider it and is often used to describe exemptions in government rules and regulations.

Discharge Point – A Discharge Point is a location where concentrated flows of stormwater runoff discharge directly into a water resource or exits from the Right-of-Way.

Ephemeral Stream - A stream that flows only during and immediately after precipitation events.

Impervious Surface - A hard surface area that prevents or retards the entry of water into the soil.

Intermittent Stream - An intermittent or seasonal stream is one that has a consistent base flow for only part of the year.

Land Disturbance - Areas of exposed erodible soil, including stockpiles, that are within the limits of construction which result from construction activities.

Linear Facility – A roadway.

MS4 Community - An urbanized area with a population of 10,000 or greater and a population density of at least 1,000 people/square mile (See Appendix O: Regulated MS4 Communities in Nebraska, of this manual).

MS4 Pavement – MS4 Pavement is defined as additional impervious surfacing beyond the projects' existing pavement footprint where none previously existed.

MS4 Permit - An MS4 Permit (NPDES Permit) is the Environmental Protection Agency's' (EPA's) program to control the discharge of pollutants to waters of the United States.

Non-Linear Facilities - Rest Areas, Maintenance Yards, Offices, etc.

Perennial Stream – A stream or river (channel) that has continuous flow in parts of its bed all year round during years of normal rainfall.

Receiving Water - Creeks, streams, rivers, lakes, estuaries, or other surface water bodies into which stormwater is discharged.

Priority Discharge Point – A Priority Discharge Point is a discharge point that collects water from a drainage area containing a minimum of 5,000 sq. ft. of MS4 Pavement.

Stormwater Treatment Facility (STF) - A STF is a measure that is implemented to protect water quality and reduce potential for pollution associated with stormwater runoff.

Total Suspended Solids (TSS) - TSS is the weight of particles that are suspended in water.

Wetland - Areas that are inundated or saturated by surface or ground water at a frequency or duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

ACRONYMS AND ABBREVIATIONS

3R	Resurfacing, Restoration, and Rehabilitation
ADE	Assistant Design Engineer in the Roadway Design Division
CN	Curve Number
DPO	Design Process Outline
DWEE NE	Nebraska Department of Water, Energy, and Environment
EDU	Environmental Documents Unit in PDD
EPA	Environmental Protection Agency
Form A	Stormwater Treatment within MS4 Communities/Form A – Project Evaluation
Form B	Stormwater Treatment within MS4 Communities/Form B – STFs
Form C	Stormwater Treatment within MS4 Communities/Form C – Maintenance
LPA	Local Public Agency
MS4	Municipal Separate Storm Sewer System
NDOT	Nebraska Department of Transportation
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PDD	Project Development Division
ROW	Right-of-Way
RDC	Roadside Development & Compliance Unit in PDD
STF	Stormwater Treatment Facility
T_C	Time of Concentration
TMDL	Total Maximum Daily Loads
TSS	Total Suspended Solids
Unit Head	Roadway Design Unit Head
WQV	Water Quality Volume

1. STORMWATER TREATMENT OBJECTIVE

Stormwater Treatment is a condition of **NDOT's** Municipal Separate Storm Sewer System (MS4) permit. The objective of stormwater treatment is to minimize the discharge of potential pollutants from a highway's post project stormwater runoff to waters of the state. **NDOT** will accomplish this objective by evaluating projects and implementing stormwater STFs as appropriate.

STFs are a combination of permanent structural and/or non-structural best management practices used to improve stormwater quality throughout the functional life of the roadway. Structural STFs include practices that remove pollutants from stormwater runoff by the settling of particulate matter, filtration, biological uptake, and soil adsorption. Examples include:

- Storage practices (e.g. extended-detention ponds)
- Filtration practices (e.g. filter strips)
- Grassed swales
- Bio-retention
- Sand filters
- Infiltration practices (e.g. infiltration basins and infiltration trenches)

Non-structural measures are typically source control measures, designed to reduce the level of contaminants before they are carried away in stormwater runoff. Examples include:

- Policies and ordinances which provide requirements and standards to direct growth to identified areas
- Protection of sensitive areas, such as wetlands and riparian areas
- Maintaining and/or increasing open spaces
- Providing buffers along sensitive water bodies
- Minimizing impervious surfaces
- Minimizing disturbance of soils and vegetation

2. LEGAL AND REGULATORY

2.A <u>Municipal Separate Storm Sewer System (MS4) Permit</u>

NDOT is a regulated MS4 and is required to meet the conditions of its' National Pollutant Discharge Elimination System (NPDES) MS4 permit. This permit is administered by the **Nebraska Department of Water, Energy, and Environment** (**DWEE NE**) and requires **NDOT** to:

- Develop and implement strategies which include a combination of structural and/or non-structural STFs
- Have a policy requiring the implementation of STFs to the extent allowable under **State**, **Tribal**, or **Local** law
- Ensure adequate long-term operation and maintenance of STFs

2.A.1 Local Public Agencies

A **Local Public Agency** (**LPA**) that is permitted as a MS4 operates under its own NPDES permit. An **LPAs**' requirement to establish stormwater treatment controls is guided by that specific permit and is subject to review only by the **DWEE NE** and the **Environment Protection Agency** (**EPA**). **NDOT's** stormwater treatment program does not supersede an **LPA's** stormwater treatment program or act as a minimum standard except when an **LPA** project is being constructed on a State or Federal Highway located within a MS4 Community. In those instances, the **LPA** may utilize its own program as long as it meets the minimum requirements established in this Chapter. For additional information on **LPA** projects, contact the **Local Assistance Division** of **NDOT**.

2.B Total Maximum Daily Loads (TMDLs)

Under Section 303(d) of the Clean Water Act (Environmental Protection Agency - Clean Water Act), **DWEE NE** is required to compile a list of impaired waters that fail to meet the applicable water quality standards or that cannot support their designated or existing uses. This list, known as the 303(d) list, is submitted to the **EPA** every two years. **DWEE NE** may then develop a TMDL for pollutants causing impairment of a water body on the list. Included within the TMDL is a treatment standard designed to reduce the level of the restricted pollutants to which all entities discharging into the stream must adhere.

Highways that have stormwater discharge points into receiving waters for which TMDLs or other water quality requirements have been established may be subject to additional water quality treatment requirements. Receiving water bodies that have a treatment standard based on TMDLs may also require more stringent analysis and treatment regimens. Therefore it is important to be cognizant of all treatment requirements when designing projects. Additional information on the TMDL program and 303(d) list is provided on the **DWEE NE** website: (Home Page | DWEE NE).

Treatment must be provided within a TMDL watershed when discharging into receiving waters for which TMDLs or other water quality requirements have been established and **NDOT** has been named as a contributor and assigned a Waste Load Allocation.

The **Roadside Development & Compliance Unit** (**RDC**) in the **Project Development Division** (**PDD**) will notify project designers of any potential TMDLs after its' "Preliminary Erosion Control & Landscape Review". This review is completed during *Initial Project Review and Setup* (Clarity Task 5282, see the Design Process Outline (*DPO*), Ref. 3.1, https://dot.nebraska.gov/business-center/design-consultant/), and will be documented on the Stormwater Treatment within MS4 Communities/Form A - Project Evaluation (Form A). Form A will be the primary document to evaluate projects for STFs and other water quality requirements. Form A is initiated by **PDD RDC**, who places it on OnBase, and will be finalized by the roadway designer prior to the *Plan-in-Hand Visit* (Clarity Task 5380, see the *DPO*, Ref. 3.1). It is important that this form and other forms included in this chapter are completed and maintained with the project file.

2.C Platte River Depletion

In 2006, the **State of Nebraska** signed an agreement and enacted legislation to restrict water use in the Platte River basin in an effort to comply with the Endangered Species Act (Endangered Species Act | U.S. Fish & Wildlife Service). The goals of the restrictions are to reduce shortages, to target flows in the central Platte River, and to obtain and restore critical habitat for the target species (whooping crane, interior least tern, piping plover, and pallid sturgeon).

Stormwater treatment activities conducted within the regulated area may be subject to restrictions if they constitute new surface water or hydrologically connected groundwater actions which may affect the quantity or timing of water reaching the associated habitats of the target species. Two examples of such activities would be those that expose the groundwater table to the atmosphere and those that will impound water such as ponds and wetlands. If a project is being constructed within this regulated area, **PDD RDC** will notify the roadway designer during the Project Evaluation Process as detailed in Section 3 of this chapter. Additional information on this program can be obtained by contacting the **Environmental Documents Unit** (**EDU**) in **PDD**.

2.C.1 *De Minimis* Threshold for Platte River Species Depletions Consultations

The **U.S. Fish and Wildlife Service** has adopted a policy that water-related activities in the Platte River basin resulting in less than 0.1 acre-foot/year of depletions in flow to the nearest surface water tributary to the Platte River system do not affect the Platte River target species and thus do not require consultation with the **U.S. Fish and Wildlife Service** for potential effects on those species.

Similarly, detention basins designed to detain runoff for less than 72 hours and temporary withdrawals of water (e.g., for hydrostatic pipeline testing) that return all the water to the same drainage basin within 30 days' time are considered to have no effect and may not require consultation.

A *de minimis* determination is made only by **EDU** in **PDD**.

2.D Legal, Regulatory and Environmental Issues Related to Drainage

Many of the legal, regulatory, and environmental issues identified in Chapter One: Drainage, of this manual, also pertain to activities completed in this Chapter. The roadway designer should familiarize him/herself with the corresponding section in Chapter One.

2.E Designation of STFs

STFs are engineered stormwater treatment facilities and will be designated as such on both Design and ROW Plans. Many of these measures will capture and hold water for some period of time and may develop wetland characteristics. This could occur naturally or as a designed feature of the STF. Regular maintenance activities, changes to the STF design, and/or relocation of the facility due to future construction may occur at any time at the discretion of **NDOT** (See Sections 7.A.6.a and 8.D of this chapter).

3. PROJECT EVALUATION PROCESS

This section provides guidance to evaluate a project for STFs. The entire process outlined in this chapter is graphically represented in EXHIBITS 3.1 & 3.2.

A preliminary project evaluation will be completed for every project by **PDD RDC** using the project criteria provided in Section 3.B. After receiving the preliminary project evaluation, the roadway designer will complete a final project evaluation to determine if the project requires STFs. Coordination between **PDD RDC** and the **Roadway Design Division** (**Roadway Design**) will occur several times throughout the project schedule, as determined by the **Unit Head**, to address the stormwater treatment requirements. Specifically, this will occur at the Environmental Coordination Meetings (See the *DPO*, Ref. 3.1) but communication can and should occur as needed throughout the project design. Form A will be used to document this process.

3.A General Project Criteria

When all three of the criteria outlined below are encountered, the project must be evaluated for STFs.

1. Project Location – The project is located within or partly within the boundary of a regulated MS4 Community in Nebraska (See Appendix O of this manual for a list of regulated MS4s).
2. Project Size – The project results in a land disturbance $\geq$ 1 acre (including projects that disturb < 1 acre if part of a common plan of development).
3. Project Nature – The project is classified as a New and Reconstruction project or as a Resurfacing, Restoration and Rehabilitation (3R) project with a net increase of at least 5,000 square feet of MS4 Pavement.

MS4 Pavement is defined as additional impervious surfacing (a hard surface area that prevents or retards the entry of water into the soil, causing water to run off the surface in greater quantities and at an increased rate of flow) which is beyond the projects' existing pavement footprint where none previously existed.

3.A.1 3R and New and Reconstruction Projects

Stormwater treatment is not required unless a project meets the project nature criteria for 3R and New and Reconstruction as stated below.

- 3R projects must result in a net increase of at least 5,000 square feet of MS4 Pavement. This includes, but is not limited to, adding turn lanes, paving shoulders, trench widening, driveways, sidewalks, and side streets. This also includes redevelopment work completed for non-linear facilities such as maintenance yards and rest areas that result in the net increase of at least 5,000 square feet of MS4 Pavement.
- New and Reconstruction projects must result in the placement of MS4 Pavement or building(s). This also includes the development of new non-linear facilities such as maintenance yards and rest areas.

3.B Preliminary Erosion Control & Landscape Review

During *Initial Project Review and Setup* (Clarity Task 5282, see the *DPO*, Ref. 3.1), **PDD RDC** will complete a Preliminary Erosion Control & Landscape Review and will document this review in Clarity (Clarity Task 5278) for each project. If it is determined that an evaluation for STFs is not required for the project, the process will stop, no further consideration will be required. If the Preliminary Erosion Control & Landscape Review determines further review is needed, **PDD RDC** will initiate Form A, containing the Preliminary Project Evaluation, and place the file on OnBase. A copy will also be forwarded to the roadway designer to complete the Additional Project Evaluation section, if necessary, as discussed in Section 3.C of this chapter.

PDD RDC will utilize the following criteria when completing the Preliminary Erosion Control & Landscape Review:

- **Are there TMDLs or other water quality requirements within project limits?**
  Construction projects that discharge into a receiving water for which a TMDL or other water quality requirement has been established may be subject to additional water quality regulations, such as the Platte River Depletion Implementation Program.
- **Is the project within an MS4 area?**
  Projects and activities within MS4 areas may require the incorporation of STFs. Projects that cross an MS4 boundary may require STFs beyond the MS4 area where factors justify their use, such as watershed drainage, land use, etc.
- **Does the project disturb ≥ 1 acre of soil.**
  Any project that results in a land disturbance equal to or greater than 1 acre. Land disturbance includes any areas where the bare soil will be exposed to weather for any period of time. The 1-acre value is compared to the cumulative total of exposed soil.
  - **Is the project part of a Common Plan of Development?**
    Projects that disturb less than 1 acre and are part of a larger Common Plan of Development whose total land disturbance activities are 1 acre or more, are considered to meet the ≥ 1 acre disturbance criteria. Additionally, **DWEE NE** can designate projects as part of a common plan of development.
- **Is the project classified as 3R with ≥ 5000 sq. ft. of MS4 Pavement or as New and Reconstruction?**
  Stormwater treatment may be required for 3R projects (with at least 5,000 square feet of MS4 Pavement) and New and Reconstruction projects (where MS4 Pavement or building(s) are placed in areas currently devoid of such surfacing or which completely remove and replace existing pavement).

3.C Additional Project Evaluation

If the Preliminary Project Evaluation determines that STFs are to be determined, the roadway designer will perform an Additional Project Evaluation and complete the corresponding section of Form A, creating the Final Project Evaluation. This should be completed prior to Project Coordination Meeting 30 (Clarity Task 5315 (see the *DPO*, Ref. 3.1), that conceptual STF designs can be completed and placed within the PIH Plans (See Chapter Eleven: Highway Plans Assembly, Section1.A, of the Roadway Design Manual (*RDM*), Ref. 3.3, https://dot.nebraska.gov/business-center/design-consultant/rd-manuals/). Upon completion of the Final Project Evaluation, the roadway designer will forward Form A to his/her **Unit Head** with a recommendation for or against STFs in the project. The **Unit Head** will be responsible for reviewing the recommendation and signing off on the form. The Final Project Evaluation will consider the following items:

- **Is this project classified as 3R and has ≥ 5000 sq. ft. of MS4 Pavement?**
  3R projects that result in a net increase of at least 5,000 square feet of MS4 Pavement require assessment for stormwater treatment needs. Projects redeveloping non-linear facilities such as maintenance yards and rest areas which result in the net increase of at least 5,000 square feet of MS4 Pavement or building(s) also require assessment.
- **Does the project disturb ≥ 1 acre of soil.**
  Any project which results in a land disturbance of equal to or greater than 1 acre. Land disturbance includes any areas where the bare soil will be exposed to weather for any period of time. The 1-acre value is compared to the cumulative total of exposed soil.
    - **Is the project part of a Common Plan of Development?**
      Projects that disturb less than 1 acre and are part of a larger Common Plan of Development whose total land disturbance activities are 1 acre or more, are considered to meet the ≥ 1 acre disturbance criteria. Additionally, **DWEE NE** can designate projects as part of a common plan of development.

Upon completion of his/her review, the **Unit Head** will forward a copy of the signed Form A to **PDD RDC** and return the original to the roadway designer. If STFs are not required to be considered for the project, the form will be closed out and placed in the project file.

If STFs need to be considered for the project the roadway designer shall complete the Stormwater Treatment within MS4 Communities/Form B - STF (Form B). Form B will be used to document the design decisions made under Section 4 of this Chapter. For additional information see *Stormwater Treatment Within MS4 Communities* in the *DPO* (Ref. 3.1).

3.D PDD RDC Coordination with Adjacent MS4 Community

PDD RDC will contact the adjacent MS4 Community as part of the preliminary project evaluation, notifying them of the potential for STFs on the highway project. This contact will also be used to query the MS4 Community concerning preferences in STFs. Information provided to **PDD RDC** by the MS4 Community will be provided to the roadway designer on Form A.

3.E Change in Project Scope

A change in project scope that affects one or more of the criteria or considerations given in Sections 3.A. and 3.B of this chapter requires a re-evaluation of the project for STFs. The roadway designer must contact the **PDD RDC Highway Environmental Project Manager** as soon as possible. A re-evaluation will be completed by **PDD RDC** and **Roadway Design**; Form A will be updated to reflect any changes.

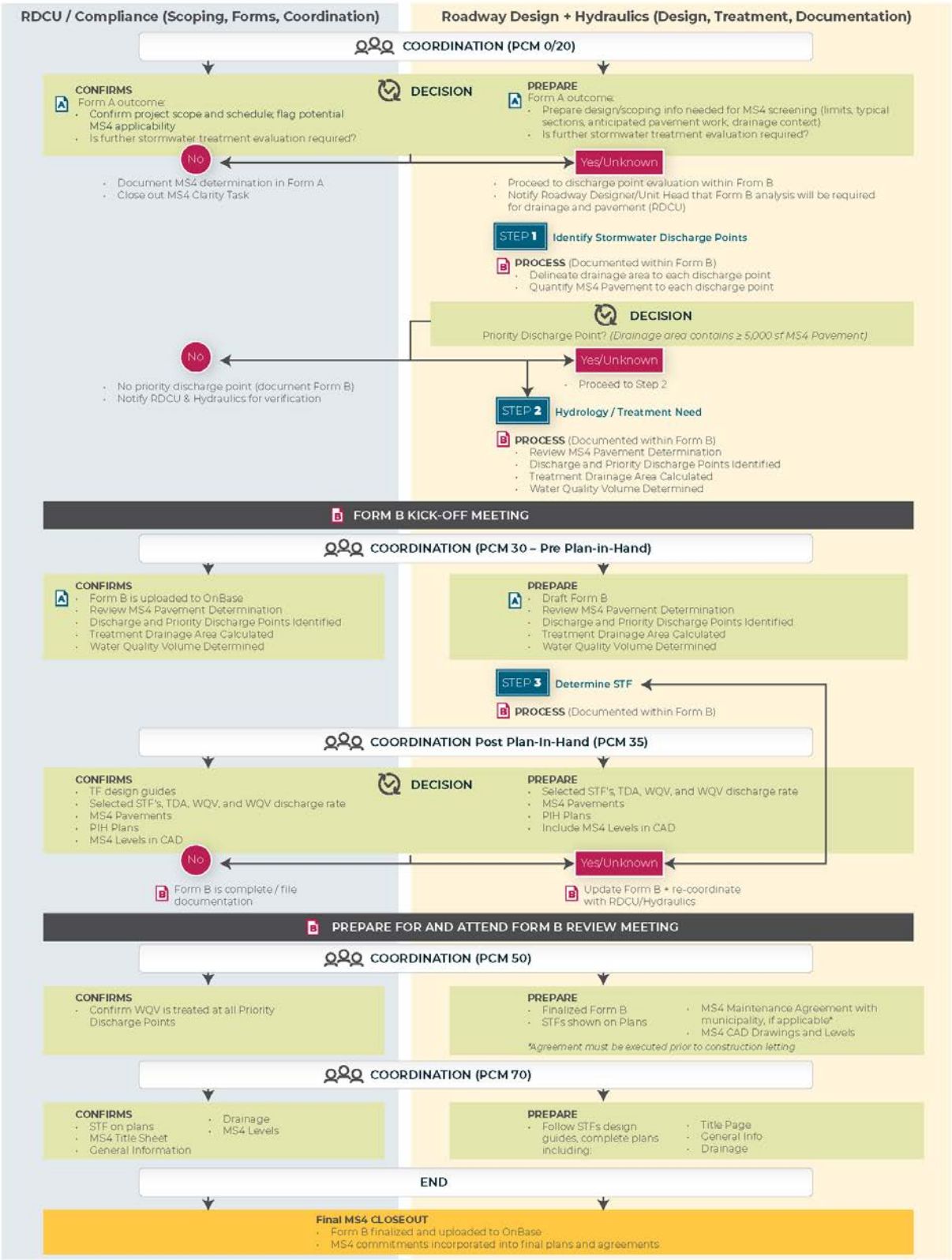

Exhibit 3.1 MS4 Flow Chart

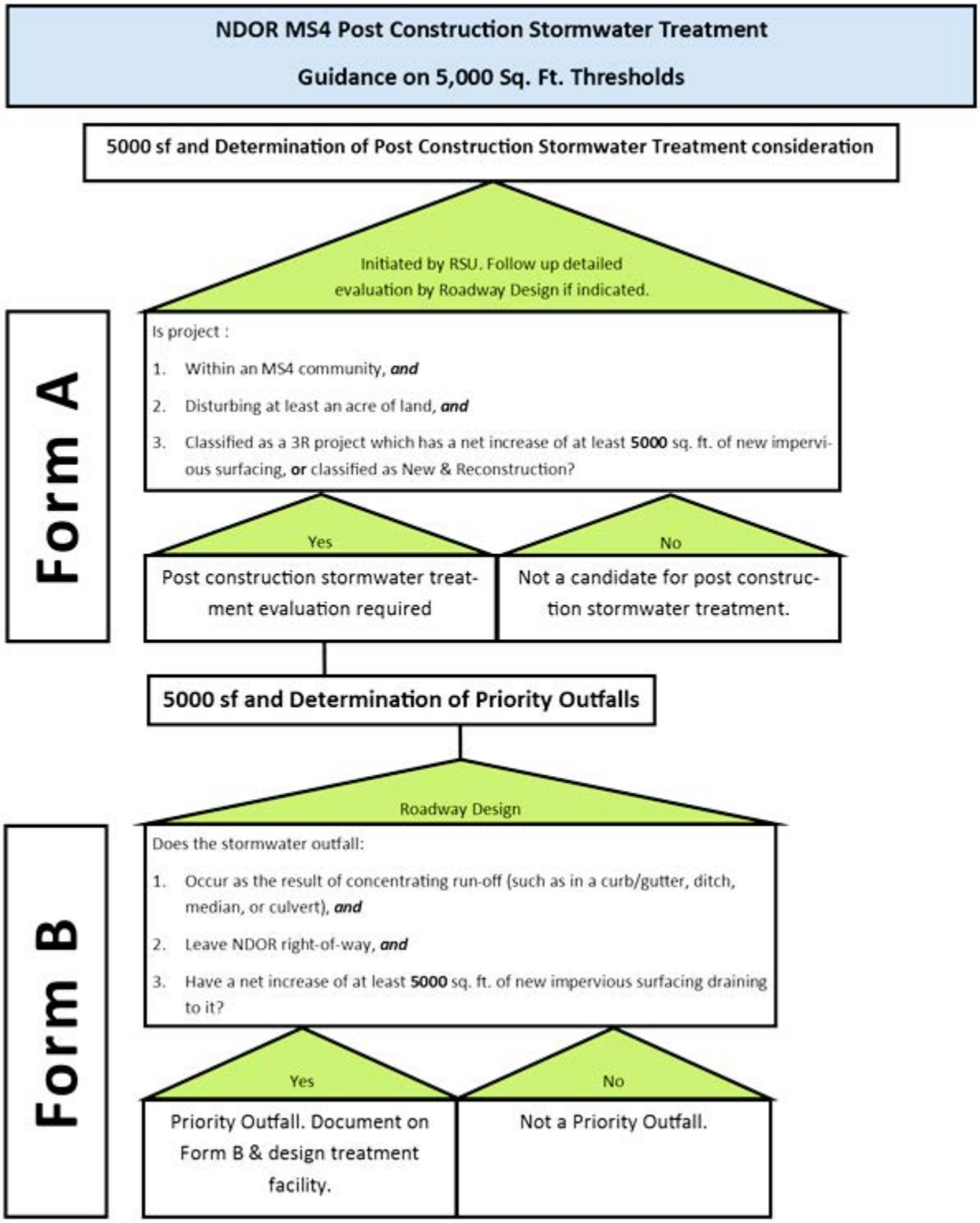

Exhibit 3.2 Guidance on 5,000 Sq. Ft. Thresholds

4. STORMWATER TREATMENT FACILITY DESIGN PROCESS

Stormwater Treatment Facility (STF) Design is a four-step process. This process is outlined here and discussed in detail in the following sections. The roadway designer is responsible for completing and documenting the four steps on Form B.

4.A Roadway Design (PIH)

During Roadway Design (Clarity Task 5350, see the *DPO*, Ref. 3.1) the roadway designer will complete the first three steps of the STF Design Process. These steps are:

Step 1. Identify all Stormwater Discharge Point locations and determine which of these qualify as Priority Discharge Points, as detailed in Section 5 of this chapter. Document Priority Discharge Points on Form B.

Step 2. Calculate the Water Quality Volume and Discharge Rate at each Priority Discharge Point location identified in Step 1, as detailed in Section 6 of this chapter. Document on Form B.

Step 3. Select appropriate STF (s) and complete preliminary design at each Priority Discharge Point identified in Step 1, as detailed in Section 7 of this chapter. Document on Form B.

During *Stormwater Treatment Within MS4 Communities* (See the *DPO*, Ref. 3.1) the roadway designer will complete the final step in the STF Design Process. This step is:

Step 4. Complete design, as detailed in Section 8, including details for STF(s) at each Priority Discharge Point identified in Step 1. Document any changes on Form B.

5. STORMWATER DISCHARGE POINTS

5.A Stormwater Discharge Points

Step 1 in the STF design process is to complete an assessment of the highway's post project drainage and to identify all stormwater discharge points located both within the project limits and the MS4 boundary. All of the stormwater discharge point locations that are located must then either be recorded on Form B or labeled on a project map/plan sheet/aerial.

To complete this task it is important to understand what is considered a stormwater discharge point, therefore definitions are provided, along with the **NDOT** interpretation of those definitions.

Within this chapter the terms discharge point and priority discharge point refer to points where flow discharges from **State** right-of-way, as defined in Sections 5.A.1 and 5.B of this chapter. These terms are not intended to meet the definition of priority discharge point as defined in **NDOT's** Illicit Discharge Detection and Elimination program.

5.A.1 Definitions

DWEE NE defines a stormwater discharge point as:

> *A point source at the point where a facility and/or municipal separate storm sewer discharges to waters of the state.*

NDOT interprets this definition to mean that a stormwater discharge point occurs anywhere that intentionally collected stormwater flow exits the right-of-way (ROW) and discharges to a water of the state.

DWEE NE defines Waters of the State as:

> *Waters within the jurisdiction of the state including all streams, lakes, ponds, impounding reservoirs , marshes, wetlands, water courses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulation of water, surface and underground, natural or artificial, public or private, situated wholly or partly within or bordering upon the state.*

5.B Priority Stormwater Discharge Points

Due to the linear nature of highway projects, discharge point locations may occur at numerous locations along a project and may not directly discharge stormwater to waters of the state. In order to utilize **NDOT** resources as efficiently as possible, the stormwater treatment program will focus its efforts at Priority Stormwater Discharge Points. The following definition shall be used to designate an discharge point as a priority:

NDOT defines priority stormwater discharge points as:

> Concentrated stormwater flow locations from areas with a net increase of at least 5,000 sq. ft. of MS4 Pavement (including bridge surfaces) directly discharging from **State** ROW to the following locations within the MS4 boundary:
>
> - Streams – Perennial and Intermittent
> - Lakes and Ponds
> - Wetlands
> - Municipal Separate Storm Sewer System
> - Ephemeral drainage that directly discharges to one of the above, located beyond the ROW line and within the distance identified in Appendix N of this manual

Utilizing these criteria, the roadway designer documents which discharge points, listed on Form B or shown on the project map/plan sheet/aerial, are considered to be priority stormwater discharge points. Priority stormwater discharge points must be documented on Form B.

There are two separate 5,000 sq. ft. thresholds that require distinction by the roadway designer.

1. Preliminary project evaluation of 3R projects includes a 5,000 sq. ft. of MS4 Pavement threshold as described in Section 3.A of this chapter.
2. Determination of priority discharge points is based on a threshold of a 5,000 sq. ft. of MS4 Pavement discharging from State ROW as described in this section.

EXHIBIT 3.2 shows the distinction between these thresholds within the **NDOT** MS4 process.

5.B.1 Priority Stormwater Discharge Points Off Project

Discharge point locations may occur on or off the project site. Concentrated stormwater runoff from a project must be followed to the point that it leaves State ROW, regardless of whether or not that point is within the project boundary. Once the concentrated stormwater runoff leaves State ROW, on or off the project site, the determination is then made as to whether the discharge point is a priority discharge point. If it is determined that the discharge point location is a priority discharge point, treatment must be addressed per this chapter, preferably at a treatment point on the project.

5.C Example Cases of Stormwater Discharge Points

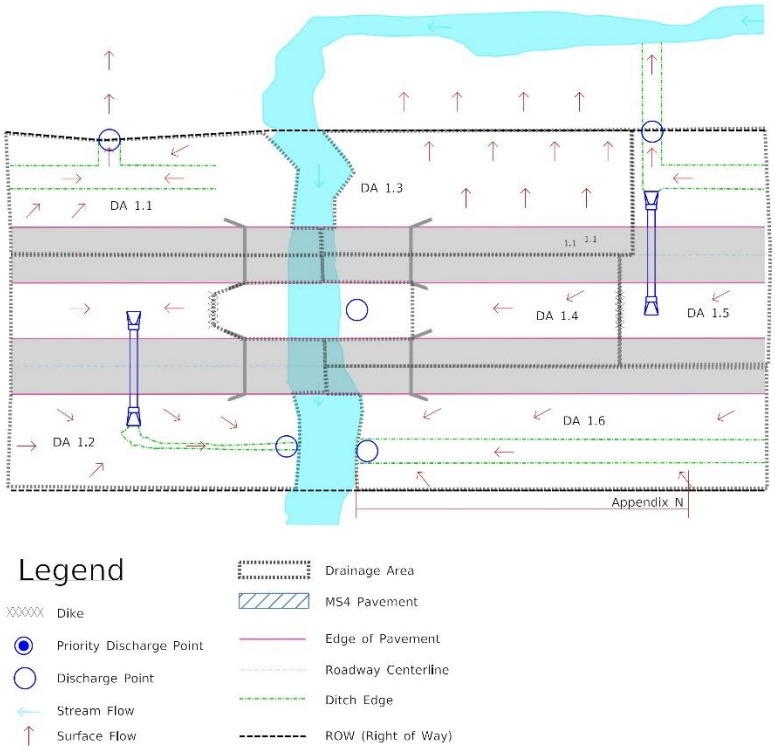

Exhibit 3.3a: Examples of Stormwater Discharge Point Locations

Case 1

EXHIBIT 3.3A illustrates a four-lane highway system with two bridges crossing a stream. The project scope includes guardrail replacement, abutment repairs, and a 1-inch mill and 1-inch overlay at both bridges, as well as replacement of two culvert flared ends. The project is located within an MS4 Community boundary and includes more than one acre of soil disturbance. Due to limited design detail at this stage of project development, the MS4 Pavement status is identified as *Unknown*.

Result:

This project triggers completion of Form A because it is located within an MS4 Community and exceeds one acre of disturbance. Because pavement work is occurring and MS4 Pavement cannot be confirmed at this stage, a Form B Kick-off Meeting will be scheduled by the roadway designer in coordination with the **Bridge Division 408 & Roadway Design Hydraulics Unit** and with **PDD RDC**. Through completion of Form B, the roadway designer will identify all Discharge Points within the project limits to verify whether any paved areas represent new impervious surface not previously present.

If MS4 Pavement is identified and equals or exceeds 5,000 square feet (0.115 Acres), the associated Discharge Point would be designated as a Priority Discharge Point and require stormwater treatment. In this example, all Discharge Points have been identified; however, none meet the criteria for Priority Discharge Points. Drainage Area 1.3 does not include a concentrated discharge point, as the drainage occurs entirely as sheet flow. Therefore, stormwater treatment facilities would not be required for this project.

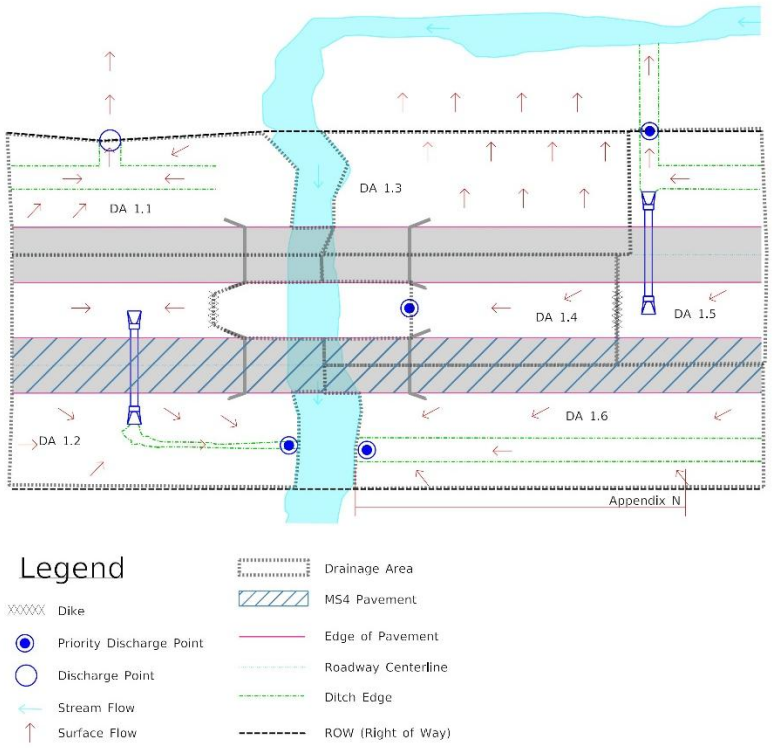

Exhibit 3.3b: Examples of Priority Stormwater Discharge Point Locations

Case 2

EXHIBIT 3.3B illustrates a two-lane highway expanding to a four-lane highway system with construction of a new bridge crossing a stream. The project scope includes grading and paving for two additional lanes to become the new east bound lanes, construction of a new bridge, and a new culvert. The existing lanes will receive a 2-inch overlay within the existing pavement footprint. The project is located within an MS4 Community and includes more than one acre of soil disturbance.

Result:

The project triggers completion of Forms A & B and, due to the use of multiple paving strategies, Form B is required to identify all Discharge Points and MS4 Pavement within the project limits.

The analysis of the pavement footprints shows that the 2-inch overlay on this project does not create new impervious surface. Therefore, the overlay (in this example) is not considered MS4 Pavement. The addition of new travel lanes creates new impervious surface that was not previously paved, therefore qualifies as MS4 Pavement. A Form B Kick-off Meeting will be scheduled by the roadway designer in coordination with the **Bridge Division 408 & Roadway Design Hydraulics Unit** and with **PDD RDC**. Through completion of Form B, the roadway designer will identify the Discharge Points, MS4 Pavement, and Priority Discharge Points. In this example Drainage Points 1.2, 1.4, 1.5, and 1.6 all have greater than 5,000 sq ft of MS4 Pavement and are designated as Priority Discharge Points.

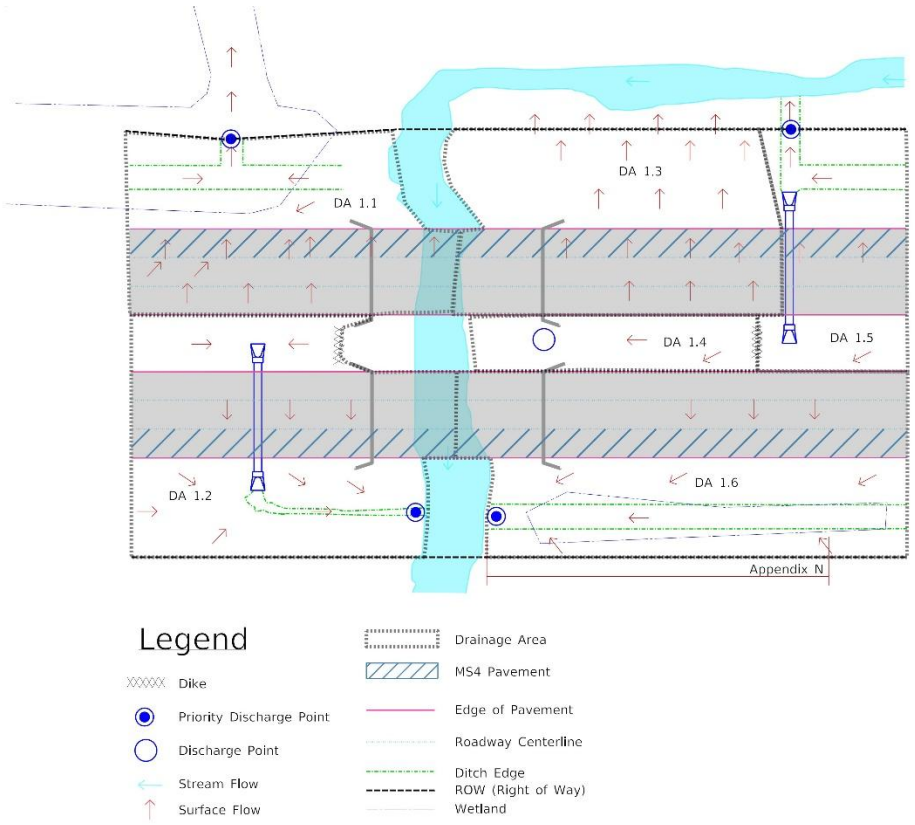

Exhibit 3.3c: Examples of Priority Stormwater Discharge Point Locations

Case 3

EXHIBIT 3.3C illustrates a four-lane highway expanding to a six-lane highway with bridge widening over a stream. The project scope includes grading, demolition of existing lanes, reconstruction of a six-lane roadway for both eastbound and westbound lanes, bridge widening and culvert extensions. The project is located within an MS4 Community boundary, includes more than one acre of soil disturbance, and involves construction of new impervious surface.

Result:

The project triggers Forms A & B because it is located within an MS4 Community, exceeds one acre of soil disturbance, and is creating new impervious surfaces. Through completion of Form B, the roadway designer will identify the Drainage Areas, Discharge Points, MS4 Pavement, Priority Discharge Points and associated stormwater treatment requirements.

The pavement for the new lanes is a tangent section, so most of the pavement drainage runs to the outside ditches. In this example, the discharge points 1.1, 1.2, 1.5, and 1.6 are designated as Priority Discharge Points and will require stormwater treatment facilities. Although drainage area for 1.3 includes MS4 Pavement, runoff from this area occurs as sheet flow and does not discharge to a concentrated point. Discharge point 1.4 is not a priority because the drainage at this location does not contain any pavement and therefore cannot contain any MS4 Pavement.

6. STF HYDROLOGY

The second step in the STF design process is to calculate the WQV and WQV Discharge Rate of the stormwater runoff from the Treatment Drainage Area at each stormwater discharge point classified as a priority discharge point in Step 1. To assist in this task **NDOT** has established definitions for the water quality volume and water quality discharge rate, which are provided below. Also provided is a short discussion of how those values were determined.

The roadway designer determines the water quality volume and water quality discharge rate during Roadway Design, Clarity Task 5350, (See the *DPO* (Ref. 3.1) for each of the priority stormwater discharge points. These values are recorded on Form B.

6.A Water Quality Volume (WQV)

WQV is defined as the amount of storm water runoff from a given storm that should be captured and treated in order to remove a majority of storm water pollutants on an average annual basis.

NDOT has determined that the WQV is the first ½ inch of runoff from the Treatment Drainage Area (See Section 6.A.1 of this chapter). The calculation for this volume is provided in the following equation.

WQV = ½ in. x Treatment Drainage Area (ft^2) ÷ 12 = cu ft of Runoff Requiring Treatment (III.1)

The WQVs for drainage areas up to 5 acres have already been calculated by **NDOT** (See EXHIBIT 3.4). The roadway designer should use these values when sizing STF for these drainage areas.

6.A.1 Treatment Drainage Area

The Treatment Drainage Area is defined as the area of MS4 Pavement placed on the project.

The Treatment Drainage Area may be increased due to run-on intermingling with the runoff from the areas defined above. Run-on is further discussed in Section 6.C of this chapter.

6.A.2 Selection of Water Quality Volume

In establishing treatment criteria, **NDOT** is following guidance provided in the EPA document National Management Measures to Control Nonpoint Source Pollution from Urban Areas (Ref. 3.3, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, November 2005, EPA-841-B-05-004). This document recommends reducing the post development loadings of Total Suspended Solids (TSS) by a minimum of 80% of the average annual TSS loadings. TSS is a measure of the concentrations of sediment and other particles suspended in water.

The 80% TSS removal criteria for STF selection is based on several factors:

- TSS can be an indirect measure of other pollutants carried by runoff, because organic compounds, metals, and nutrients such as phosphorus are typically attached to sediment particles
- Research has shown that many STFs or combinations or STFs can achieve the 80% removal goal

NDOT has determined that the 80% goal can be obtained by collecting and treating either the WQV discussed above, or the WQV Discharge Rate discussed in Section 6.B of this chapter.

6.B Water Quality Volume Discharge Rate

The WQV Discharge Rate is the peak stormwater discharge generated by the water quality volume rainfall event using the **Natural Resources Conservation Service** (**NRCS**) Curve Number (CN) procedure. The water quality volume rainfall event is the ¾ inch 24-hour rainfall, assuming a CN value of 98 (pavement) and a Time of Concentration (Tc) of 5 minutes.

The WQV Peak Discharges for drainage areas up to 5 acres have already been calculated by **NDOT** (See EXHIBIT 3.4). The roadway designer should use these values when sizing STFs for these drainage areas.

To determine a WQV peak discharge for drainage areas greater than 5 acres, the **NRCS** CN procedure must be used. The roadway designer can either assume the entire area is pavement, with a CN value of 98, or use the weighted Q method of the CN procedure. The weighted Q method calculates the runoff from each land cover and soil complex individually and then sums the runoff peaks.

Example: A 10-acre residential neighborhood with ¼ acre lots in hydrologic soil group B soils.

Weighted Q Method

The residential neighborhood is assumed to have 38% impervious area, 3.8 acres at CN of 98, and 6.2 acres of 62% grass cover at CN of 61. Using the WQV rainfall event, 24-hour Rainfall = ¾ inch, and the assumed Tc = 5 minutes, calculate the peak discharge for each area (impervious area and grass cover) independently:

Area	Discharge
Impervious area	3.4 cfs
Grass area	0.02 cfs
Add Hydrographs	3.4 cfs (WQV Peak discharge)

Standard Method (Weighted CN Method)

The residential neighborhood is assumed to have 100% ¼ acre lots, 10 acres at CN of 75. Using the WQV rainfall event, 24-hour Rainfall = ¾ inch and the assumed Tc = 5 minutes, calculate the peak discharge for entire area.

Area	Discharge
Residential ¼ Acre	0.0 cfs.

The weighted Q method calculates a WQV peak discharge as 3.4 cfs. This compares to the standard method of Weighted CN which calculates a discharge rate of 0 cfs. Empirical evidence and common sense both dictate that a ¾ inch rainfall will generate at least some runoff, therefore the Weighted CN method can be rejected. Under small rainfall rates the Weighted Q method more accurately estimates the peak discharge rates that will be experienced.

Drainage Area (Acres)	WQV ½ inch Runoff (cubic feet)	WQV Discharge Rate (cfs)	Drainage Area (Acres)	WQV ½ inch Runoff (cubic feet)	WQV Discharge Rate (cfs)
0.1	182	0.10	1.25	2269	1.10
0.2	363	0.20	1.5	2723	1.30
0.3	545	0.30	1.75	3176	1.60
0.4	726	0.40	2.0	3630	1.80
0.5	908	0.45	2.5	4538	2.20
0.6	1089	0.50	3.0	5445	2.70
0.7	1271	0.60	3.5	6353	3.10
0.8	1452	0.70	4.0	7260	3.60
0.9	1634	0.80	4.5	8168	4.00
1.0	1815	0.90	5.0	9075	4.40

The values used in EXHIBIT 3.4 were calculated using the **NRCS** CN procedure.
The assumptions for the WQV peak discharges were a 5-minute Tc and a CN value of 98.

Exhibit 3.4 Water Quality Volumes and Peak Discharges for Selected Acreages

6.C Addressing Stormwater Run-On

Stormwater run-on is defined as any stormwater which intermingles with the Treatment Drainage Area runoff prior to treatment. This can occur as either overland flow or underground flow via culvert or storm sewer pipe. **NDOT** projects can receive stormwater run-on from both adjacent properties and other parts of the highway or right-of-way.

Stormwater run-on which is allowed to intermingle with the Treatment Drainage Area runoff must be included in the WQV to be treated. Intermingling can occur:

- At the source, such as when existing lanes drain across a new lane
- Along the conveyance path, such as when multiple inlets drain to the same pipe or ditch
- At the treatment point, such as when multiple outlets flow into the same basin

The additive nature of stormwater run-on is necessary both as a regulatory compliance measure and to avoid over-flowing an under-sized STF system because volumes higher than the design volumes/flow rates are directed to it.

Stormwater run-on which can be diverted from intermingling with the Treatment Drainage Area runoff does not require treatment.

Stormwater run-on may be problematic for roadway designers, for instance a widening project where the Treatment Drainage Area drains into the roadside ditch. The stormwater then intermingles with a significant amount of stormwater run-on from a nearby development that is also draining into the **NDOT** ditch. Any number of small, low cost STFs may have been sufficient to treat the Treatment Drainage Area runoff; however, when the additional run-on from the development is factored in, a larger more expensive STF may be required to treat the ½-inch water quality volume.

During Roadway Design (Clarity Task 5350, see the *DPO*, Ref. 3.1), the roadway designer in consultation with their **Unit Head** may choose to either separate stormwater run-on from the Treatment Drainage Area's stormwater runoff or allow it to intermingle at some point. When stormwater run-on is kept separate from the Treatment Drainage Area runoff, the roadway designer can choose to treat only the Treatment Drainage Area run-off WQV. However, when the two are allowed to intermingle, the WQV of both the run-on and runoff shall be addressed. EXHIBIT 3.5 provides a flow chart showing when stormwater run-on must be treated. See EXHIBIT 3.6 for an example of dealing with stormwater run-on.

The roadway designer documents on Form B the locations where stormwater run-on enters and exits the project and whether and how the stormwater run-on will be separated from project runoff if discharging to a priority stormwater discharge point. The **Unit Head** verifies that any off-site run-on has been accurately accounted for. Appropriate methods for dealing with the off-site run-on can be discussed during Environmental Coordination Meeting 30 (See the *DPO*, Ref. 3.1).

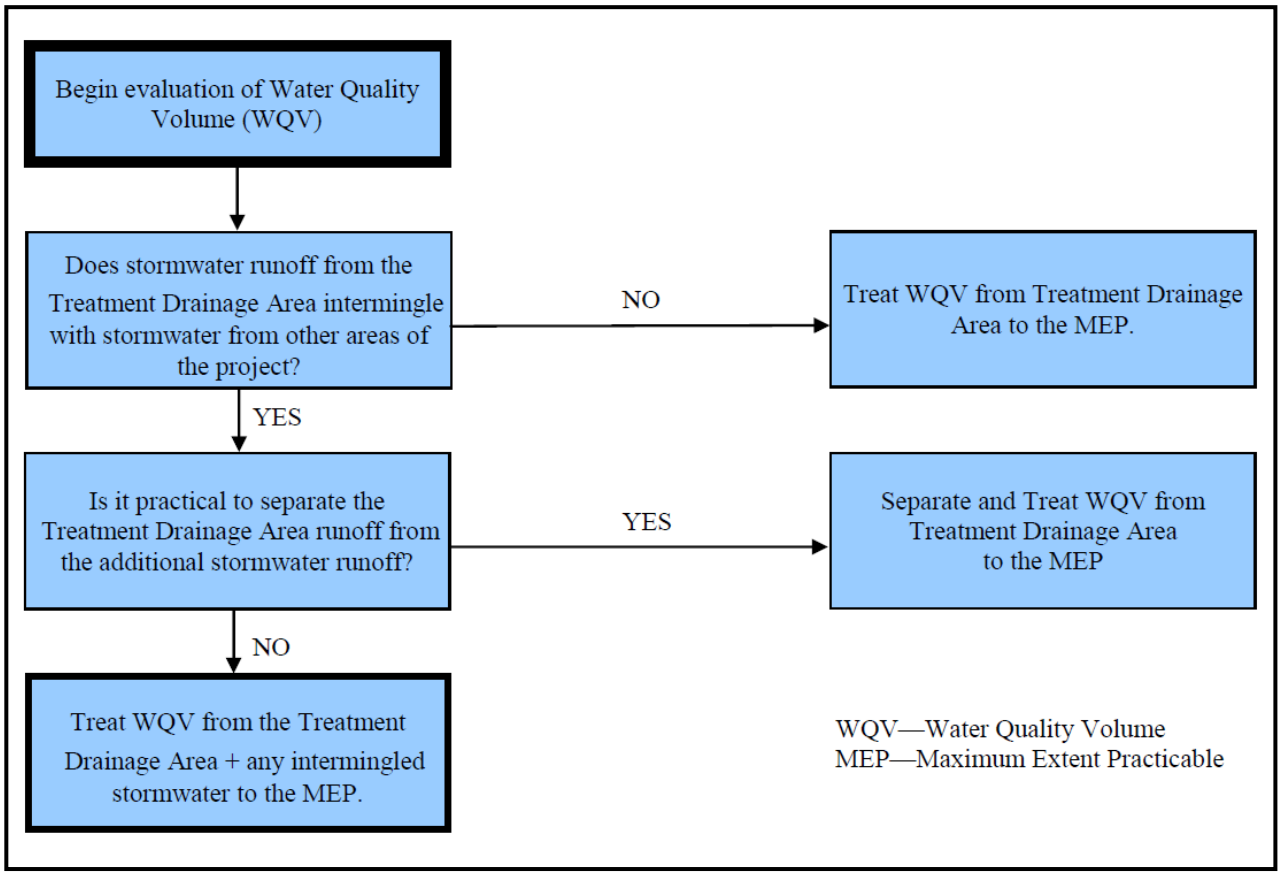

Exhibit 3.5 Stormwater Run-On Flow Chart

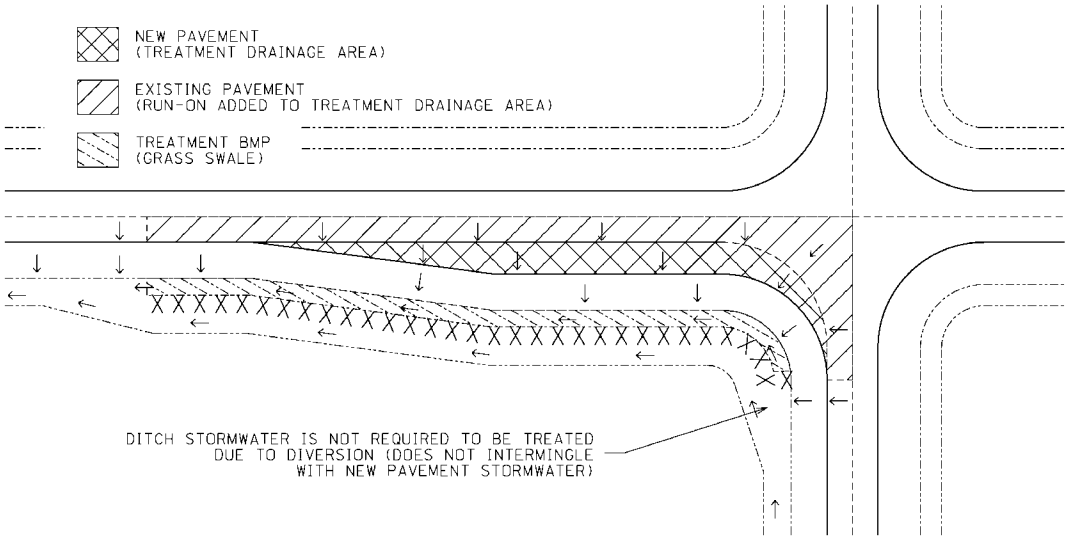

Exhibit 3.6 Example of Stormwater Run-On

It is desirable to avoid having to treat excessive run-on from impervious areas, particularly off-site run-on. Roadway designers should strive to treat stormwater prior to it intermingling with run-on from impervious areas on and off the project site. This may be accomplished by establishing a treatment point prior to the intermingling, or by physical separation of the flows as necessary to allow treatment prior to comingling. Roadway designers will maintain the existing drainage discharge point pattern when considering separation of flows for stormwater treatment purposes.

If it is not feasible to treat run-on prior to intermingling (e.g. when adding an outside lane to existing roadway), stormwater treatment facilities will be sized to account for all stormwater run-off from impervious areas. Providing treatment to the maximum extent practicable, as indicated in EXHIBIT 3.5, means providing treatment for at least 80% of the Water Quality Volume. If this threshold cannot be achieved other treatment options, such as on-site mitigation (See Section 7.A.4.a of this chapter) shall be pursued.

Treatment of run-on from existing impervious areas within **NDOT** right-of-way will be considered as excess treatment and may be claimed as a treatment credit. This credit may be used to offset requirements for new impervious pavement for which treatment cannot be accomplished. Roadway designers will consider treating prior to intermingling before taking a treatment credit approach. Documentation will occur on Form B.

If it is not feasible to treat run-on from existing impervious areas within **NDOT** right-of-way, or when inseparable stormwater run-on is received from impervious areas off of State right-of-way, roadway designers will consult and coordinate with **PDD RDC** and/or the local municipality for other on- or off-site mitigation options.

If stormwater run-on to the project from *pervious* areas occurs, it will not increase the TDA.

Protection and maintenance of stormwater treatment facilities (STFs) will be included in agreements with the local community, who will be responsible for protecting existing STFs from untreated run-on as future community development occurs.

7. STF SELECTION AND PRELIMINARY DESIGN

The third step in the STF design process is to evaluate each Priority Stormwater Discharge Point identified in Section 5 of this chapter, select an appropriate STF or series of STFs, and complete a preliminary STF design. **NDOT** has identified several general considerations and established a STF Selection Chart to assist the roadway designer with this process.

The roadway designer should review the general considerations and select a STF for each of the priority stormwater discharge point locations. The roadway designer will record this selection on Form B.

7.A General Considerations

7.A.1 Online and Offline Treatment

STFs can be designed as either online or offline. An online STF is one where all stormwater runoff generated by the project is conveyed through the STF. An offline STF is one where only a selected amount of stormwater runoff, frequently the WQV, is diverted through the STF and all additional runoff bypasses the STF. See EXHIBIT 3.7 for a graphical representation.

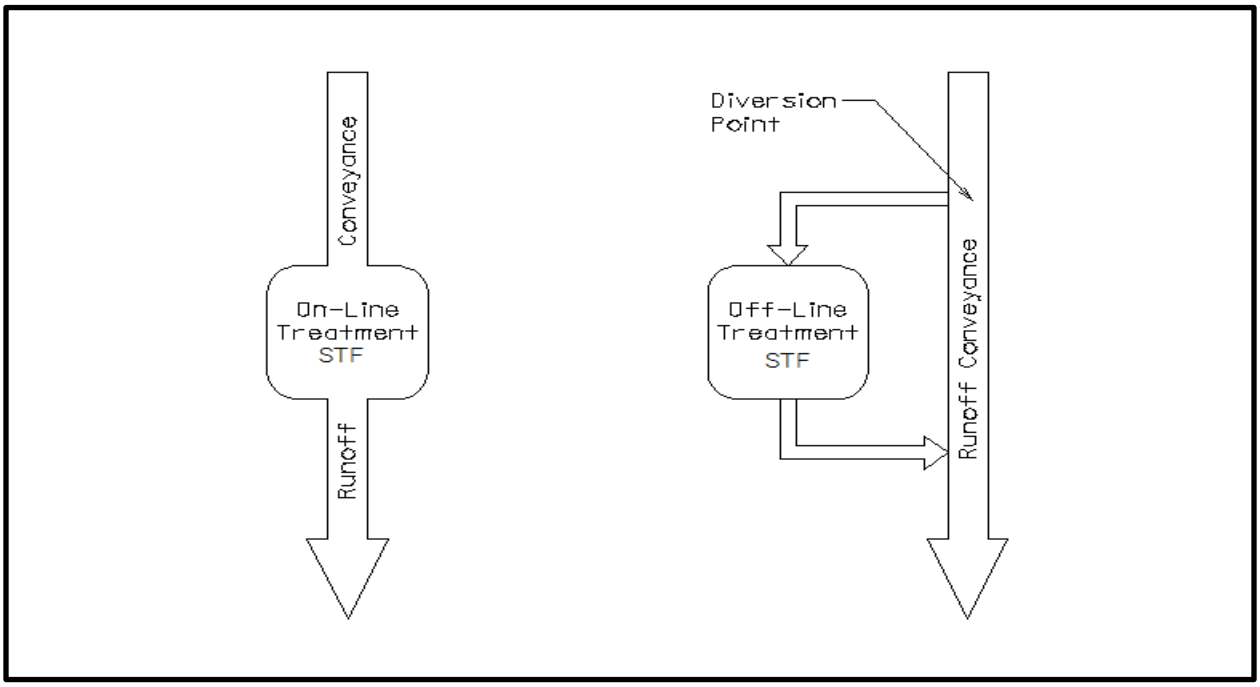

Exhibit 3.7 Schematic of Online and Offline STFs

An online STF is located within the stormwater runoff conveyance pathway. Flows up to the WQV are captured and treated by the STF while the larger storm events are passed through the STF without treatment. The online STF needs to be able to convey anticipated stormwater flows without adversely impacting the STF, the adjacent highway, highway right-of-way, or adjacent property. Inlet and outlet structures need to be designed to both control the water quality volume and convey the highway design storm.

An offline STF is located outside and separate from the normal stormwater runoff conveyance pathway. Flows up to the WQV are diverted into the STF from the normal stormwater runoff conveyance pathway, where they are captured and treated. Large flow events are generally allowed to bypass or are actively diverted around the STF. In some cases an offline STF may be designed to collect flows above the WQV for secondary reasons, but are not required to treat those larger flows. An offline STF is only designed to handle the stormwater flows diverted to it and can be located adjacent to or a distance away from the stormwater runoff conveyance pathway.

Appendix P of this manual includes recommendations on whether a STF should be designed as either offline or online.

7.A.2 Safety and Aesthetics

Safety is a consideration when designing STFs. To operate effectively some STFs need to impound water for a period of time. This may introduce the potential for ponding on or near roadways. **NDOT's** preference is that STFs be located outside the clear zone (See Chapter Six: The Typical Roadway Cross-Section, Section 9, of the *RDM*, Ref. 3.3).

The following guidelines apply to the location and application of STFs:

- STFs should be designed so the roadway surface is not subjected to ponded water
- Embankments such as dikes placed within the lateral obstacle clear distance should be constructed with 1:6 or flatter slopes
- Fencing may be needed around impoundments located within urbanized areas

Aesthetics may also be a factor when selecting and designing STFs since many of them require the establishment of vegetation to function properly. Efforts should be made to blend the STF into the surrounding landscape.

7.A.3 Coordination with Adjacent MS4

Coordination with **Federal**, **State**, and **Local** (**City** and **County**) **Governmental Agencies** is often necessary due to legal implications or special local drainage ordinances. Communication with adjacent MS4 permit holders and other **Municipalities** (**Cities** and **Counties**) may be required whenever a proposed project results in stormwater discharges from the **NDOT's** stormwater drainage systems to stormwater drainage systems owned and operated by the local **MS4 Community** or **Municipality**, and vice versa.

Coordination with the adjacent **MS4 Community** may take on the form of an agreement between **NDOT** and the **MS4 Community**. When it is necessary to complete an agreement, the *DPO* (Ref. 3.1) and **NDOT's** Operating Instruction 45-5 – "Agreements" must be followed. Language will be included in the municipal agreement assigning protection, operation, and maintenance of the constructed STFs to the local **MS4 Community**.

7.A.4 Off-Site Stormwater Mitigation

In some cases it may not be practicable to provide stormwater treatment within the project limits due to various constraints such as site limitations (available right-of-way), costs, or other obstacles. If on-site mitigation is not feasible, off-site mitigation may be an option at other locations within the local watershed or MS4.

When all on-site mitigation options have been exhausted and documented, the roadway designer should contact **PDD RDC** to determine if off-site mitigation is feasible.

7.A.4.a On-Site Stormwater Mitigation

Run-off from other existing impervious areas within project limits that do not require treatment may be considered for treatment in the following conditions:

1. When a project is not in a TMDL or other area with defined water quality requirements, and
2. When it is not feasible to treat new impervious areas and/or run-on from any impervious areas *within the* TDA.

This is considered as on-site mitigation. Documentation should take place on Form B describing the Priority Discharge Point, the TDA being mitigated, and the location where on-site mitigation (treatment) will occur.

If a project is not in a TMDL or other area with defined water quality requirements, and it is not practical to treat new impervious areas and any run-on within the project limits, then off-site mitigation may occur. If the project is in a TMDL or other area with defined water quality requirements, stormwater run-off must be treated at the location and mitigation is not an option.

On-site and off-site mitigation will require concurrence from **PDD RDC** and **Bridge Hydraulics**, verifying that treatment is not practical within the TDA and/or within the project limits. If off-site mitigation is justified, **PDD RDC** will note the area requiring treatment and account for that treatment in a separate stormwater treatment facility within the community's **NDOT** MS4 boundary. Documentation will occur on Form B.

7.A.5 Maintenance Responsibilities

The responsibility for maintenance of the STF s on a project varies over time and by location.

- **During Construction** – The contractor will be responsible for maintaining the completed STFs
- **During Vegetation Establishment Period** – After the contractor is released from the project, **NDOT** will be responsible for maintaining the completed STFs until the stormwater permit obligations are complete
- **Post Vegetation Establishment Period** - The maintenance responsibilities for non-freeway highway appurtenances located within corporate limits reside with the **Municipalities**, according to Nebraska State Statutes, Sections 39-1339, 39-1372 and 39-2105 (http://law.justia.com/codes/nebraska/2009/Chapter39/Chapter39.html):
    - **Interstates and Freeways** – **NDOT** will continue to be responsible for maintaining the STFs
    - **Non-Freeways within Corporate Limits** – The **Municipality** is responsible for continued maintenance of the STFs
    - **Non-Freeways outside Corporate Limits** – **NDOT** will continue to be responsible for maintaining the STFs

The roadway designer should be aware of the agency ultimately responsible for maintaining the STFs. The adjacent **MS4 Community** may have limitations and/or concerns about maintenance requirements of particular STFs.

The detailing of maintenance responsibilities may require an agreement between **NDOT** and the **MS4 Community**. When it is necessary to complete an agreement, the *DPO* (Ref. 3.1) and **NDOT's** Operating Instruction 45-5 – "Agreements" must be followed.

7.A.6 Right-of-Way Considerations

Acquisition of property rights may be necessary to incorporate STFs in the roadside environment. This should be discussed during Roadway Design (Clarity Task 5350, see the *DPO*, Ref. 3.1) to provide adequate time to determine if additional ROW will be available.

7.A.6.a Retention of ROW for STFs

STFs should be identified on the ROW plans to protect them against sale as excess land. Since many of these STFs will detain/retain water and may develop wetland conditions, it is necessary to permanently label and maintain these STFs as Stormwater Treatment Facilities.

7.A.7 Compliance with Chapter One – Drainage Design

STFs designed under the guidance found in this chapter must also comply with the policies and procedures of Chapter One: Drainage Design, of this manual.

In this chapter STFs are designed to minimize the potential discharge of pollutants in highway stormwater runoff to waters of the state during the WQV Rainfall Event (0.75-inch 24-hr storm). The guidance found in Chapter One is used to define and direct the peak discharges of stormwater runoff during the highway Design Storms (2-year to 100-year storm events).

STFs must be designed to meet the requirements of both Chapter Three and Chapter One of this manual. The STF must be able to both collect/treat the WQV Rainfall Event and convey the peak discharges occurring during the highway Design Storm.

7.B STF Selection Process

7.B.1 Existing Conditions

The first step in the STF Selection Process is to determine the effectiveness of the existing site conditions in treating the WQV. The roadway designer should evaluate the conditions between the Treatment Drainage Area and the Priority Stormwater Discharge Point to determine if there are existing features at the site (e.g. vegetated swales or detention basins, etc.) that may be utilized for water quality treatment. These existing features may not have been originally designed to treat stormwater but as long as they meet the criteria or can be enhanced to meet the criteria outlined in this chapter, a roadway designer may take credit for the water quality treatment they are providing. Existing features evaluated and used as STFs are documented on Form B.

7.B.2 STF Selection Guidance

The second step in the STF Selection Process is to select and size the STF for the Treatment Drainage Area WQV. A flowchart illustrating the STF selection process is shown in EXHIBIT 3.8. The roadway designer can use this flowchart to select an appropriate STF at each priority discharge point location. It may be necessary to combine STFs (e.g., a Detention Basin may be preceded by a grassed swale) to attain the treatment goal. EXHIBIT 3.9 provides a tabulation of the available STFs and their suitability to various locations and conditions.

The selection of STFs is documented on Form B. The roadway designer utilizes the corresponding STF Design Guide given in Appendix P of this manual to complete preliminary design.

When the roadway designer has completed a preliminary STF design for the project, the roadway designer's **Unit Head** will review and sign off on Form B. The **Unit Head** will then forward a copy of the Form B to **PDD RDC** for review. Environmental Coordination Meeting 30 can be used to discuss the preliminary STF designs.

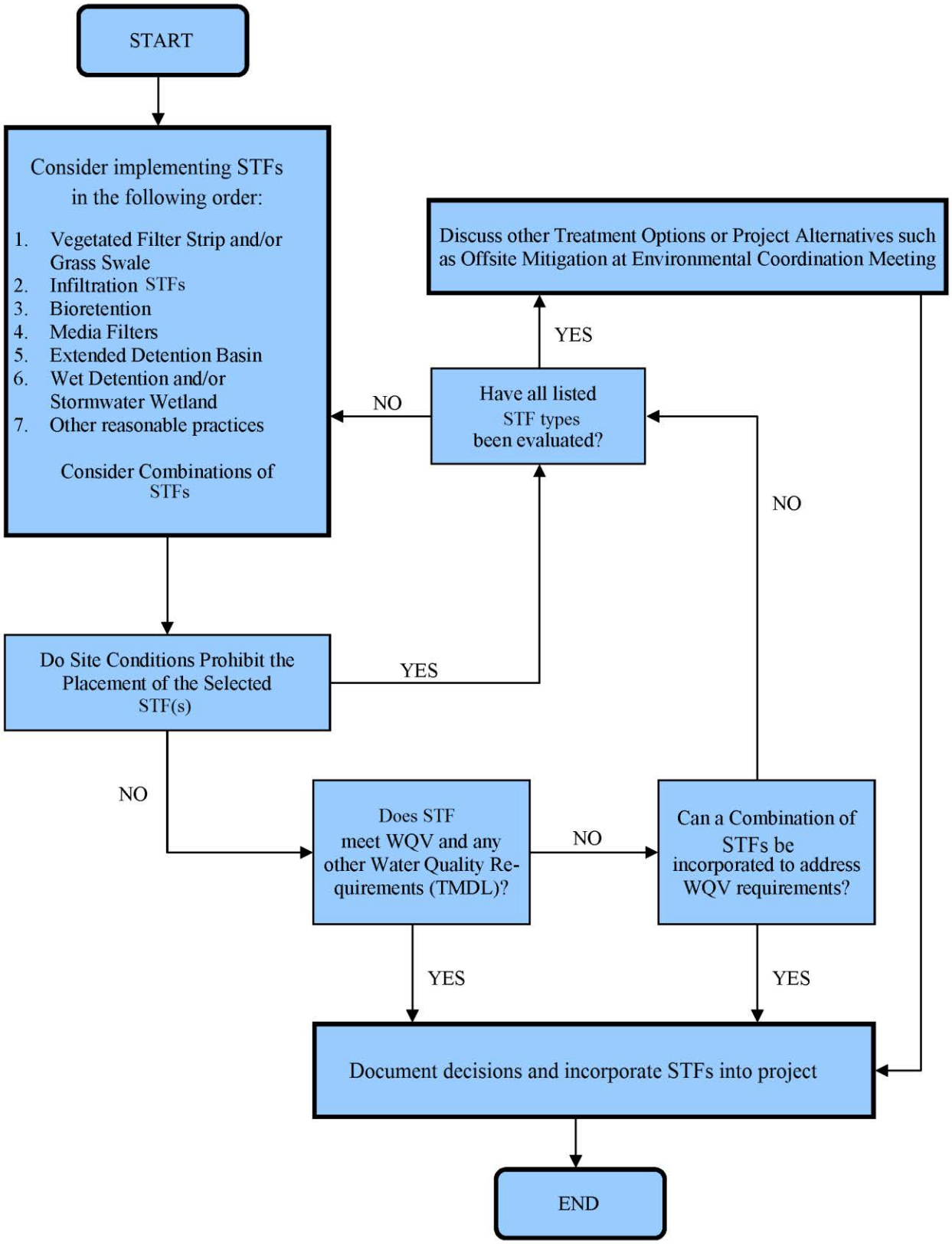

Exhibit 3.8 STF Selection Chart

NDOT STF Suitability Matrix										
STF	**Description**	**Treatment Type**	**Typical Drainage Area**	**Site Suitability**	**Soil Permeability**	**Groundwater Limitations**	**Best at Removing....**	**Construction Cost**	**Maintenance Cost**	**Comments**
Vegetated Filter Strips	Densely vegetated strip of land designed to treat sheet flow	Water Quality Treatment Rate	Based on Sheet Flow Loading	Rural and Urban Section	Any (with soil conditioning)	≥ 2 feet	Suspended Solids	Low	Low	Maximum slope generally 6H:1V - longer filter strip needed on steeper slopes
Grass Swale	Densely vegetated drainage way designed to convey runoff slowly to allow for treatment	Water Quality Treatment Rate	≤ 5 acres	Rural and Urban Section	Any (with soil conditioning)	≥ 2 feet	Suspended Solids, Heavy Metals, Hydrocarbons	Low	Low	Limited depth of flow and velocity for effective treatment
Infiltration Trench	Aggregate-filled trench designed to capture runoff in the void space and infiltrate it	Water Quality Volume	≤ 5 acres	Rural and Urban Section	0.5 - 12 in/hr	≥ 4 feet	Suspended Solids, Nutrients, Heavy Metals	Moderate-High	Moderate	Width of Trench ≥ Depth
Infiltration Basin	Shallow basin designed to capture runoff above ground and infiltrate it through natural soils	Water Quality Volume	10-20 acres	Rural and Urban Section	0.5 - 12 in/hr	≥ 4 feet	Suspended Solids, Nutrients, Heavy Metals, Hydrocarbons	Moderate	Moderate	Drainage area limited if constructed online
Bioretention Basin	Shallow basin designed to capture runoff above ground and infiltrate it through an amended soil zone with underdrain	Water Quality Volume	≤ 5 acres	Rural and Urban Section	0 - 12 in/hr	≥ 4 feet	Suspended Solids, Heavy Metals	Moderate	Moderate	Landscape plantings typical with this BMP
Media Filter	Structure that includes a sedimentation chamber and sand filtration chamber to treat runoff	Water Quality Volume	≤ 2 acres	Urban and Ultra-Urban	Any	n/a	Suspended Solids	High	High	Typically a cast-in-place structure - check hydraulic grade lines and possibly buoyancy issues
Extended Dry Detention	Dry basin designed to capture runoff with drawdown to the basin bottom over an extended period	Water Quality Volume	≤ 5 acres	Rural and Urban Section	0 - 12 in/hr	0	n/a (see comments)	Low	Low	Only moderate treatment efficiency in general
Wet Detention	Basin with permanent pool of water designed to capture runoff with drawdown to the normal pool elevation over an extended period	Water Quality Volume	10 acres + (typ)	Rural and Urban Section	Depends on Design	Depends on Design	Suspended Solids	Low	Low	Minimum drainage area needed to maintain permanent pool
Stormwater Wetland	Basin or drainage way with a pool of water of varying depths designed to support wetland vegetation and treat water flowing through the system	Water Quality Volume	10 acres + (typ)	Rural and Urban Section	Depends on Design	Depends on Design	Suspended Solids, Heavy Metals	Moderate	Moderate	Minimum drainage area needed to maintain wetland
Pervious Pavement	Various types of pavement with the ability to pass stormwater through the surface to an underlying aggregate bed - the aggregate bed is designed to capture runoff in the void space and release it slowly through an underdrain	Water Quality Volume	≤ 5 acres	Urban and Ultra-Urban	0 - 12 in/hr	≥ 4 feet	Suspended Solids, Heavy Metals, Hydrocarbons	High	High	Protect adjacent pavement
Proprietary Structural Treatment Controls	Various types of proprietary devices designed to treat stormwater runoff	Water Quality Treatment Rate (Typical)	≤ 2 acres	Urban and Ultra-Urban	Any	n/a	Varies	High	High	Approval of device needed - check hydraulic grade lines and possibly buoyancy issues

Exhibit 3.9 STF Suitability Matrix

7.B.2.a Order of STF(s)

The order of STFs listed in EXHIBIT 3.8 is a suggested ranking which shows the preference of **NDOT** for treating stormwater discharges. The suggested order moves from less intrusive methods, from both a visual and maintenance perspective, to methods that require more area, are more costly to build, and require more maintenance. Some of the least intrusive designs may provide the best means to obtain **NDOT's** water quality objectives. The roadway designer, in consultation with their **Unit Head**, may choose to implement any of the STFs without going through the listed order. See Section 7.B.2.d of this chapter for a discussion on Combining STFs.

7.B.2.b Site Conditions

Site-specific conditions can affect the operation, maintenance, construction costs, safety, and aesthetics of STFs. When designing a STF, the roadway designer must consider the recovery zones, setbacks, hydraulic head, and maintenance access roads and ramps.

Each STF has minimum design parameters that need to be met in order to treat the stormwater discharge effectively. For example, grass swales require ditch slopes of 4% or flatter, extended detention basins require both a specific amount of volume and a minimum width to length ratio, and infiltration basins require adequate space and a relatively high native soil infiltration rate. The site conditions where a STF will be located often determine whether or not the minimum design parameters are achievable for a particular STF.

When a desired STF cannot be placed due to a site limitation, the roadway designer should select a different STF and evaluate it for the site conditions. The roadway designer may choose to place multiple STFs that each treat a limited amount of the WQV (See Section 7.B.2.c of this chapter), but when added together treat the entire WQV. See Section 7.B.2.d of this chapter for additional discussion on combining STFs.

7.B.2.c Design STF for WQV

The STF Design Guides (See Appendix P of this manual) provides the specifics for designing each of the approved STFs. The roadway designer uses these guides and the calculated WQV goal as discussed in Section 6 of this chapter to establish the design for the selected STF.

Contact the **Bridge Division 408 & Roadway Design Hydraulics Unit Engineer** and **PDD RDC** for assistance with designing STFs for water quality requirements other than the ½ inch WQV goal (e.g. TMDL requirements).

When site conditions allow the placement of a STF but do not allow for it to treat the entire WQV goal the roadway designer, in consultation with their **Unit Head**, may either choose to evaluate another STF or add multiple STFs in series to attain the WQV goal (See Section 7.B.2.d of this chapter).

7.B.2.d Combining STFs

When the calculated WQV or other water quality goal exceeds the capacity of a single STF, the roadway designer may be able to combine several of the same or multiple STFs in sequence to achieve the desired WQV or goal.

Where STFs are used in combination, the roadway designer shall first determine the parameters of each of the STFs that can be placed and then, using the STF Design Guides (See Appendix P of this manual), calculate the amount of WQV each STF can treat. The sum of the WQV from each STF in the sequence should total 100% of the Treatment Drainage Area WQV goal.

7.B.2.e Other Treatment Options or Project Alternative

There may be occasions when the site conditions are such that the WQV goal cannot be met utilizing the process provided and the STFs approved by **NDOT**. The roadway designer should bring this issue to the next Environmental Coordination Meeting, where additional options can be discussed. The roadway designer is also encouraged to consult with **PDD RDC** and the **Bridge Division 408 & Roadway Design Hydraulics Unit** for assistance.

7.C STF Summary

The following is a brief description of all approved STFs (See EXHIBIT 3.9). Detailed design guides for each STF are available in Appendix P of this manual.

7.C.1 Vegetated Filter Strips

Vegetated Filter Strips are zones of vegetation through which stormwater runoff is directed. Vegetated filter strips intercept and convey sheet runoff from an impervious area (e.g. highway) and treat the runoff by filtration through vegetation, sediment deposition, and the infiltration and adsorption by soil. They are effective if the velocity of sheet flow is slow, providing an opportunity for sediments and other pollutants to settle and be filtered. Vegetated filter strips can be used to enhance the water quality of stormwater runoff on small sites or as pre-treatment for another structural stormwater STF. Maintaining sheet flow and preventing concentrated flows are important components in the design of vegetated filter strips.

Examples:

- Roadside vegetated foreslope
- Flattened backslope receiving runoff from an adjacent parking area or development

Design Notes:

- Requires dense vegetative growth
- Appropriate for small drainages (<1 acres)
- Water must enter as sheet flow across the entire filter strip (Level Spreader)
- Minimum slope length of approximately 20 ft.
- Slope range between 2% and 17%
- Commonly used as a pretreatment for other STFs
- Low maintenance and low cost STF

7.C.2 Grass Swales

Grass swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. A grass swale is designed to meet nominal treatment of runoff for the WQV and can be an important component in a combined STF system. Grass swales are very similar to roadside ditches with mild slopes and dense vegetation and are therefore well suited for treating runoff from roads, highways, and impervious surfaces. When properly incorporated into a stormwater treatment design grass swales help to reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.

Examples:

- Roadside ditch

Design Notes:

- Ditch Slopes 0.5% to 6%
- Side slopes no greater than 1:3
- Good addition to a combined STF system
- Relatively low maintenance STF

7.C.3 Infiltration Trench

The infiltration trench is an excavated trench, 3 to 8 ft. deep, backfilled with rock or stone aggregate and lined with filter fabric. This installation temporarily stores small water quality volumes, allowing it infiltrate into the soil over a prescribed period. The WQV passes through a combination of pretreatment measures (vegetated filter strip, vegetated swale, sediment forebay, etc.) and into the infiltration trench, creating an underground reservoir for the runoff. The runoff gradually infiltrates through the bottom and sides of the trench, eventually reaching the underground water table.

Examples of Installations:

- A series of trenches cut across the roadside ditch or median at defined intervals
- At the outlet of a flume or small storm sewer system (one to three inlets)
- Along the edge of a parking area or development

Design Notes:

- Recommended in soils with a minimum infiltration rate of ½ in/hr.
- Underdrains can be incorporated in soils with low permeability
- Depth to water table must be considered
- Maintenance is variable
- Most effective for smaller drainages (<5 acres)

7.C.4 Infiltration Basin

An infiltration basin is an excavated impoundment with no primary outlet that captures and temporarily stores larger water quality volumes until it can infiltrate into the soil over a prescribed period. The basin has a flat bottom, with an optional underdrain system to allow draining in the event of standing water. A secondary outlet may be provided to pass higher volumes of flow.

Examples:

- Basin at the end of larger storm sewer system or extended length of ditch
- Widened and flattened section of ditch with amended soils
- Capture runoff from edge of facilities (rest areas, maintenance yards, etc.)

Design Notes:

- Pre-treatment is recommended to avoid premature clogging of the system
- Typically, it serves drainage areas from 5-10 acres (20 acres if offline)
- Recommended in soils with a minimum infiltration rate of ½ in/hr.
- A secondary or emergency outlet should be incorporated
- Depth to water table must be considered
- Regular maintenance is required

7.C.5 Bioretention

The bioretention STF is a shallow stormwater basin or landscaped area that utilizes engineered soils and vegetation to capture and treat runoff. Stormwater runoff is temporarily ponded within the basin and seeps through the engineered soils. The biomass in the system retains nutrients and other pollutants and the stormwater is filtered through the surface vegetation, mulch layer, and pervious soil layer. The filtered stormwater is then either allowed to infiltrate the surrounding soils or, more commonly, is discharged through an aggregate base layer and perforated pipe sub-drain.

Examples:

- Curb cut into rain garden
- A series of offline plantings adjacent to the roadside ditch
- Sections of or the entire length of a median
- At the outlet of a flume or small storm sewer system (one to three inlets)
- Along the edge of a parking area or development

Design Notes:

- Pre-treatment is optional but recommended
- Depth to water table must be considered
- Incorporate an underdrain system
- Regular maintenance is required

7.C.6 Media Filter

A media filter is a structural stormwater STF system that temporarily stores stormwater runoff and passes it through a filter bed of sand or other filtering media. The system usually consists of two chambers; the first is the sediment forebay or sedimentation chamber, which collects and allows heavier sediment to settle and the second is the filtration chamber, which filters the runoff through a bed of sand or other filtering media. An underdrain is used to return the filtered runoff to the conveyance system or other receiving waters.

Examples:

- An underground vault associated with a storm sewer system in ultra-urban location
- An open-air vault or basin located at the end of a culvert/storm sewer system
- A ditch check with a sand filled drain

Design Notes:

- Pre-treatment is recommended
- The permeability of the filtering media controls the design
- Regular maintenance is required
- Typically, it serves drainage areas up to 2 acres (5 acres, if offline)

7.C.7 Extended Dry Detention

An extended dry detention facility is designed to temporarily store the WQV and slowly release it to receiving waters. This allows the suspended solids in the stormwater sufficient time to settle out of suspension. Stormwater flows are collected in the shallow basin and constricted by an outlet structure to produce low flow rates calculated to delay the drawdown of the basin to a 24-to-48-hour period (72 hours maximum). Extended detention basins are typically end-of-system STFs designed to limit the impact of a site's stormwater discharge on downstream property and receiving waters.

Examples:

- Basin at the end of larger storm sewer system or extended length of ditch
- At the outlet of a flume or small storm sewer system
- Along the edge of a parking area or development

Design Notes:

- A pre-treatment forebay may improve performance and lower maintenance frequency
- Outlet control structures determine the extent of detention/retention and treatment
- Appropriately sized basin and outlet design are critical to the effectiveness of these systems
- Typically, it serves larger drainage areas (>5 acres)
- Regular maintenance is required

7.C.8 Wet Detention Pond

A wet detention pond is designed to intercept stormwater runoff, temporarily impound that runoff, and then release it at a reduced rate to the receiving stream or stormwater system. Wet detention ponds use a permanent pool of water to aid in achieving water quality control. The pool may cover the entire pond bottom or may be located in only a portion of the pond. A wet detention pond can be used to reduce the post-development discharge to that of the pre-development rate under the 2-year, 10-year and 100-year event storms and can provide relatively good water quality improvement along with rate control. Stormwater runoff entering the pond intermixes with the standing pool, reducing the sediment concentration and diluting the dissolved constituents. The effectiveness of the Wet Detention Pond is dependent on the size of the standing pond relative to the water quality volume.

Examples:

- Pond at the end of larger storm sewer system
- At the ends of ditches with larger drainage areas
- Pond located at the end of midsize culverts
- Located on small flowing drainages

Design Notes:

- Design outlet control structures for both WQV and larger detention and determine the extent of detention/retention and treatment
- Basin size and outlet design are critical to the effectiveness of these systems
- Extended wet detention ponds typically detain water for 24-48 hours to provide settling of particulates
- Requires larger drainage areas (10 acres minimum)
- A pre-treatment forebay may improve the performance and lower the maintenance frequency

7.C.9 Stormwater Wetland

A stormwater wetland is a constructed wetland planted with emergent vegetation to treat stormwater. Stormwater wetlands can also function in reducing the peak discharge of storm events by providing temporary water storage above the normal pool elevation. Stormwater treatment is achieved by the settling of particulates and biological uptake by the wetland vegetation. Stormwater wetlands are among the most effective STFs for pollutant removal while providing aesthetic and wildlife benefits with relatively low maintenance costs.

Examples:

- Basin at the end of larger storm sewer system
- At the ends of ditches with larger drainage areas
- Pond located at the end of midsize culverts
- Located on low flow drainages

Design Notes:

- A relatively large contributing drainage area is required to maintain an adequate water source (10 acres minimum)
- A forebay should be incorporated to decrease velocity and reduce sediment loading
- The wetland should be designed with varied depths to support a diverse range of vegetation
- There generally are high maintenance requirements during the first few years while vegetation is establishing

7.C.10 Pervious Pavement

A pervious pavement system allows the infiltration of stormwater runoff through a pavement surface into an aggregate base. The aggregate base provides temporary storage of captured rainfall, which then infiltrates into underlying soils or is collected by an underdrain. A pervious pavement system also provides the structural and functional features needed for the roadway, parking lot, or sidewalk. The paving surface, subgrade, and installation requirements of porous pavements are more complex than those for conventional asphalt or concrete surfaces.

Examples:

- Potential applications in low volume traffic areas such as rest areas, maintenance yards, weigh stations, etc.
- Other uses include emergency stopping areas, traffic islands, sidewalks, road shoulders, vehicle cross-overs on divided highways, and low-traffic roads

Design Notes:

- Generally not suited for areas with high traffic volumes or loads
- Requires an underdrain system
- Regular maintenance is necessary to reduce the potential for clogging

7.C.11 Proprietary Structural Treatment Control

Proprietary Structural Treatment Controls are commercially available, often prefabricated, units designed and sized for stormwater treatment by the manufacturer based on criteria provided. These systems treat stormwater in various ways; some devices use settling and surface oil separation mechanisms while others use filtration or vortex motion separating mechanisms. Structural treatments may be placed online or offline depending on the manufactures' specifications.

Examples:

- Catch basin insert
- Oil/grit separators built into the inlet structure
- Hydrodynamic separator

Design Notes:

- Used as pre-treatment in storm sewer systems
- Particularly suitable for ultra-urban environment
- Size dependent upon the amount of stormwater requiring treatment
- High maintenance STF

7.C.12 Other Reasonable Practices

Stormwater management is an evolving field and STFs will need to be updated as technologies advance and research provides additional information. The roadway designer shall coordinate **PDD RDC** before incorporating a treatment device not described in this chapter.

8. COMPLETING STF DESIGN

Prior to PCM 35 (Clarity Task 5331) (See the *DPO*, Ref. 3.1), the roadway designer will complete the STF design. This will include finalizing the STF size, designing the discharge structure, and applying build notes, etc. The roadway designer will also address landscaping, construction, maintenance, and a number of miscellaneous items related to the STFs.

At the end of Phase 3: Design (Activity 5300) the roadway designer reviews and revises Form B. The **Unit Head** will then sign off on the completed form and forwards a copy to **PDD RDC**. **PDD RDC** will review the form along with final plans for the STF(s) during the erosion control plan review. The final stormwater treatment plans will be presented and discussed during Environmental Coordination Meeting 40.

For additional information see *Finalize Stormwater Treatment Within MS4 Communities* in the *DPO* (Ref. 3.1).

8.A Landscaping

The final landscape plan will be completed by **PDD RDC** and provided to the roadway designer for inclusion with project plans. The landscape plan will include the planting scheme necessary to provide both functional and aesthetic value to the stormwater STFs.

8.B Construction Phasing

STFs are intended to be operational when a project is completely stabilized. This eliminates the potential for early failure due to sedimentation during the vegetation establishment period of the site. The following three options are available to a roadway designer for phasing construction of STFs:

1. The STF is constructed as the project is built and is isolated from stormwater flows until the Treatment Drainage Area is completely stabilized.
2. The STF is partially constructed with the project and utilized as a temporary sediment control measure until the Treatment Drainage Area is completely stabilized.
3. The STF is constructed after the Treatment Drainage Area is completely stabilized.

The roadway designer documents on Form B which option(s) is appropriate for each selected STF. Phasing will also need to be documented on the construction plans or by special provision. Phasing decisions are made in consultation with the **District**.

8.C Maintenance Schedule

Maintenance schedules for each STF are provided in Appendix P of this manual. If a roadway designer has a maintenance requirement that differs from those provided, he/she needs to document them on Form B. **PDD RDC** will utilize that information and the schedules in Appendix P to complete Stormwater Treatment within MS4 Communities/Form C – Maintenance. **PDD RDC** will forward Form C to the **Operations Division**.

8.D Plan Labeling of STF

The roadway designer must coordinate the labeling of the STFs on the design plans (See Section 7.A.6.a of this chapter). Label STFs on both design plans and ROW plans as a Stormwater Treatment Facility, followed by the specific STF title. STF titles are given in in Appendix P of this manual. For example, a sand filter used as a STF will be labeled as Stormwater Treatment Facility – Sand Filter.

8.E Miscellaneous

8.E.1 Fencing

The majority of STFs will be located along highways within urbanized areas; the roadway designer may choose to include fencing around the STF to limit access by the general public. This may be of particular importance on STFs which pond water more than a foot deep. The **Unit Head** will review the use of fencing and request approval from the **District**.

8.E.2 Signage

In addition to stormwater treatment, the MS4 permit requires **NDOT** to implement a stormwater education program. The use of STFs may provide **NDOT** with an outreach opportunity to showcase environmental commitments. This could be accomplished by placing a sign adjacent to a STF that explains how the measure functions to provide water quality benefits. **PDD RDC** will coordinate with the roadway designer and the **Traffic Engineering Division** to determine if sign(s) are feasible and what information should be included.

9. REFERENCES

3.1 Nebraska Department of Transportation, Design Process Outline (*DPO*), Current Edition. (https://dot.nebraska.gov/business-center/design-consultant/)

3.2 Nebraska Department of Transportation, Roadway Design Manual (*RDM*), Current Edition (https://dot.nebraska.gov/business-center/design-consultant/rd-manuals/)

3.3 United States Environmental Protection Agency, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, Washington, D.C., November 2005 (National Management Measures to Control Nonpoint Source Pollution from Urban Areas, November 2005, EPA-841-B-05-004)