Chapter 3 - Preparation of Stormwater Site Plans

3.1 Introduction

The Stormwater Site Plan is the comprehensive report containing all of the technical information and analysis necessary for regulatory agencies to evaluate a proposed new development or redevelopment project for compliance with stormwater requirements. Contents of the Stormwater Site Plan will vary with the type and size of the project, individual site characteristics, and special requirements of the local jurisdiction.

The scope of the Stormwater Site Plan also varies depending on the applicability of Core Elements (see Chapter 2).

This chapter describes the contents of a Stormwater Site Plan and provides a general procedure for how to prepare the plan. The specific BMPs and design methods and standards to be used are contained in Chapters 4 to 8.

The goal of this chapter is to provide a framework for uniformity in plan preparation. Such uniformity will promote predictability throughout the region and help secure prompt governmental review and approval. Properly drafted engineering plans and supporting documents will also facilitate the operation and maintenance of the proposed system long after its review and approval.

State law requires that engineering work be performed by or under the direction of a professional engineer licensed to practice in Washington State. Plans involving construction of treatment facilities or flow control facilities (detention ponds or infiltration basins), structural source control BMPs, or drainage conveyance systems generally involve engineering principles and shall be prepared by or under the direction of a licensed engineer. Construction Stormwater Pollution Prevention Plans (SWPPPs) that involve engineering calculations must also be prepared by or under the direction of a licensed engineer.

3.2 Stormwater Site Plans: Step-By-Step

3.2.1 The Steps to Developing a Stormwater Site Plan

Four basic steps should be followed during the preparation of a stormwater site plan.

Step 1 – Collect and Analyze Information on Existing Conditions

Step 2 – Determine Applicable Core Elements

Step 3 – Prepare a Permanent Stormwater Control Plan

Step 4 – Prepare a Construction Stormwater Pollution Prevention Plan

Steps 1 and 2 are qualtitative in nature, while Steps 3 and 4 synthesize the information gathered in Steps 1 and 2 into practical designs. Additional

information on data collection and investigation can be found in Design and Construction of Urban Stormwater Management Systems, ASCE, 1992. The level of detail needed for each step depends upon the project size, as explained in the individual steps. A narrative description of each of these steps follows.

Step 1 – Collect and Analyze Information on Existing Conditions

Collect and review information on the existing site conditions including: topography, drainage patterns, soils, ground cover, presence of critical areas, adjacent areas, existing development, existing stormwater facilities, and adjacent on- and off-site utilities. Analyze data to determine site limitations including:

- Areas with high potential for erosion and sediment deposition (based on soil properties, slope, etc.);
- Locations of sensitive and critical areas (e.g., vegetative buffers, wetlands, steep slopes, floodplains, geologic hazard areas, streams, etc.);
- Observation of potential runoff contribution from off-site basins;
- Adjacent properties and(or) projects that have a history of stormwater problems, noting whether the cause of the problem(s) has been determined; and
- Adjacent properties and(or) projects where geotechnical investigations have identified shallow bedrock, high groundwater, seasonally perched groundwater, or clay lenses in the substrata.

Delineate these areas on the site map required as part of Step 3, Prepare a Permanent Stormwater Control Plan. Prepare an Existing Conditions Summary that will be submitted as part of the Site Plan. Part of the information collected in this step should be used to help prepare the Construction Stormwater Pollution Prevention Plan.

Downstream Analysis and Mitigation Procedure (for projects with surface, offsite, or potential problem discharges)

Development projects that propose to discharge stormwater offsite are required to submit a downstream analysis report that assesses the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project and that proposes appropriate mitigation of those impacts. An initial qualitative analysis should extend downstream for the entire flow path from the project site to the receiving water, or up to one mile or to a point where the impact to receiving waters are minimal or nonexistent, as determined by the local jurisdiction. If a receiving water is within one-quarter mile, the analysis should extend within the receiving water to one-quarter mile from the project site. The analysis should extend one-quarter mile beyond any improvements proposed as mitigation. The analysis should extend upstream to a point where

backwater effects created by the project cease. Upon review of the qualitative analysis, the local jurisdiction may require that a quantitative analysis be performed. A full description of a typical downstream analysis procedure, along with a sample checklist to aid in the preparation and review of a downstream analysis, are included in Appendix 3A.

Step 2 – Determine and Read the Applicable Core Elements

The NPDES Phase II permit or local jurisdiction establishes project size thresholds for the application of Core Elements (in Chapter 2), to new development and redevelopment projects. The designer of the Stormwater Site Plan should meet with local officials to agree on the applicable Core Elements, prior to proceeding to Step 3.

Step 3 – Prepare a Permanent Stormwater Control Plan

Select stormwater control BMPs and facilities that will serve the project site in its developed condition. The designer may want to consider the use of landscaping and/or low impact development techniques for stormwater quantity and quality control. The local jurisdiction may have landscaping or low impact development policies and they should be incorporated where required. Several references are available on the topic of low impact development:

www.lowimpactdevelopment.org/

www.epa.gov/owow/nps/lid/lid.pdf

www2.ncsu.edu/ncsu/CIL/WRRI/news/so00lowimpactmanuals.html

A preliminary design of the BMPs and facilities is necessary to determine how they will fit within and serve the entire preliminary development layout. After a preliminary design is developed, the designer may want to reconsider the site layout to reduce the need for construction of facilities, or the size of the facilities by reducing the amount of impervious surfaces created and increasing the areas to be left undisturbed. After the designer is satisfied with the BMP and facilities selections, the information must be presented within a Permanent Stormwater Control Plan. The Permanent Stormwater Control Plan typically consists of a Drainage Report and a set of Construction Plans.

Drainage Report

The Drainage Report is to be inclusive, clear, legible, and reproducible, with a complete set of drainage computations and stamped by a Professional Engineer. The computations are to be presented in a rational format with information included so as to allow a reviewer to be able to reproduce the same results. The computations should provide sufficient information for an unbiased third party to be able to review the report and determine that all applicable standards have been met. All assumptions and computer input and output data, and variables listed in the computer printouts, should be clearly identified. Computer printouts should clearly

show which subbasin(s) they are applicable to, and the design storm event identified thereon if multiple-storm events are addressed in the design. Copies of design charts, nomographs, or other design aids used in the analysis should be included in the calculations.

All relevant geotechnical information related to the project and all site specific soil logs and subsurface testing information should be included in the Drainage Report or provided in a separate report prepared and stamped by the geotechnical engineer or Licensed Engineering Hydrogeologist.

The Drainage Report should also include a basin map. Under most conditions both a pre-developed basin map and post-developed basin map should be provided, unless deemed unnecessary by the local jurisdiction. See Appendix 3B for a checklist of items to be included on the basin map.

The Drainage Report is to identify existing drainage facilities which are clearly inadequate or need repair, such as collapsed culverts or culverts with a substantial amount of debris. The condition and capacity of existing drainage facilities located onsite, which are proposed to be utilized by the development, should be evaluated and disclosed in the drainage report.

Calculations for detention and infiltration ponds may include the following: inflow and outflow hydrographs, level-pool routing calculations, a listing of the maximum water surface elevation, a pond volume rating table (e.g., stage vs. storage), and discharge rating table (e.g., stage vs. discharge). Each hydrograph and level-pool routing calculation sheet is to have clearly marked: the design storm event, the applicable subbasin(s), and the pond identification name, which corresponds with the basin map and plans.

The drainage submittal should incorporate all calculations for the determination of the required size of the systems. Typical calculations include:

- Hydrology computations
- Inlet capacities
- Detention/Retention storage capacities
- Culvert and pipe system capacities and outlet velocities
- Ditch capacities and velocities
- Map with the project plotted thereon

A copy of applicable floodplain maps, or studies within the project area should be included in the Drainage Report.

Construction Plans

Construction plans should be prepared for all open and closed stormwater collection systems. The plans should call out sufficient hydraulic and physical data for construction of the system and future evaluation of the

design. A checklist describing many of the items typically shown on construction plans is included in Appendix 3C.

Step 4 – Prepare a Construction Stormwater Pollution Prevention Plan

The Construction SWPPP must contain sufficient information to satisfy the local jurisdiction that the potential pollution problems have been adequately addressed for the proposed project. An adequate Construction SWPPP includes a narrative and drawings. The narrative is a written statement that explains the pollution prevention decisions made for a particular project. The narrative contains concise information concerning existing site conditions, construction schedules, and other pertinent items that are not contained on the drawings. The drawings and notes describe where and when the various BMPs should be installed, the performance the BMPs are expected to achieve, and actions to be taken if the performance goals are not achieved.

The 12 Elements listed below must be considered in the development of the Construction SWPPP unless site conditions render the element unnecessary and the exemption from that element is clearly justified in the narrative of the Construction SWPPP. These elements are described in detail in Chapter 7. They cover the general water quality protection strategies of limiting site impacts, preventing erosion and sedimentation, and managing activities and sources.

The 12 Elements are:

- Mark Clearing Limits
- Establish Construction Access
- Control Flow Rates
- Install Sediment Controls
- Stabilize Soils
- Protect Slopes
- Protect Drain Inlets
- Stabilize Channels And Outlets
- Control Pollutants
- Control De-Watering
- Maintain BMPs
- Manage the Project

A complete description of each Element and the BMPs applicable to particular Elements are given in Chapter 7.

On construction sites that discharge to surface water, the primary consideration in the preparation of the Construction SWPPP is compliance with the state Water Quality Standards. The step-by-step procedure outlined in Chapter 7 is recommended for the development of these Construction SWPPPs. A checklist is contained in Chapter 7 that may be helpful in preparing and reviewing the Construction SWPPP.

On construction sites that infiltrate all stormwater runoff, the primary consideration in the preparation of the Construction SWPPP is the protection of the infiltration facilities from fine sediments during the construction phase and protection of ground water from other pollutants. Several of the other elements are very important at these sites as well, such as marking the clearing limits, establishing the construction access, and managing the project.

Under current federal regulations, if a project disturbs greater than one acre and discharges to surface water, the local jurisdiction may require review and approval of the SWPPP prior to construction.

3.2.2 Plans Required After Stormwater Site Plan Approval

This section includes the specifications and contents required of those plans submitted after the local government agency with jurisdiction has approved the original Stormwater Site Plan.

Stormwater Site Plan Changes

If the designer wishes to make changes or revisions to the originally approved stormwater site plan, the proposed revisions should be submitted to the local jurisdiction with review authority prior to construction. The submittals should include the following:

1. Brief narrative description of the change and the purpose/reason for the change.
2. Substitute pages of the originally approved Stormwater Site Plan that include the proposed changes.
3. Revised drawings showing structural changes.
4. Other supporting information that explains and supports the reason for the change.

Final Corrected Plan Submittal

If the project included construction of conveyance systems, treatment facilities, flow control facilities, or structural source control BMPs, the applicant should submit a final corrected plan (Record Drawings) to the local government agency with jurisdiction when the project is completed. These should be engineering drawings that accurately represent the project as constructed. These corrected drawings must be legibly drafted revisions that are stamped, signed, and dated by a licensed engineer registered in the state of Washington.

Appendix 3A – Downstream Analysis

Objective: To identify and evaluate potential offsite water quality, erosion, slope stability, and drainage impacts that could result from the proposed project, and to determine measures to mitigate potential impacts or mitigate aggravating existing problems. Aggravated means increasing the frequency of occurrence and/or severity of an already existing problem.

Guidelines: Some of the common negative impacts of land development can be erosion of downgradient properties, localized flooding, and slope failures. These are caused by increased volumes of surface water, increased volumes of stormwater injected into the subsurface, and(or) changed runoff patterns. Taking the precautions of offsite analysis can reduce future property damage and public safety risks.

The existing or potential impacts to be evaluated and mitigated should include:

- Conveyance system capacity problems;
- Localized flooding;
- Upland erosion impacts, including landslide hazards;
- Stream channel erosion at the outfall location;
- Violations of surface water quality standards as identified in a Basin Plan or a TMDL (Water Cleanup Plan); or violations of groundwater standards in a wellhead protection area, or any other known violation that exists;
- Aggravated existing problems.

Projects are required to initially submit, with the permit application, a qualitative analysis of each downstream system leaving the site. The analysis should accomplish four tasks:

Task 1 – Define and map the study area.

A submission of a site map showing site property lines; a topographic map (at a minimum a USGS 1:24000 Quadrangle Topographic map) showing site boundaries, study area boundaries, downstream flowpath, and potential/existing problems.

Task 2 – Review all available information on the study area.

This should include all available basin plans, groundwater management area plans, drainage studies, floodplain/floodway FEMA maps, wetlands inventory maps, Critical Areas maps, stream habitat reports, etc. Contact the local jurisdiction for assistance in locating these and other relevant or historical data.

Task 3 – Field inspect the study area.

The design engineer or engineering geologist must physically inspect the existing on- and offsite drainage systems of the study area for existing or potential problems and drainage features. An initial inspection and investigation should include:

- Investigate problems reported or observed during the resource review;
- Locate existing/potential constrictions or capacity deficiencies in the drainage system;
- Identify existing/potential flooding problems;
- Identify existing/potential overtopping, scouring, bank sloughing, or sedimentation;
- Identify significant destruction of aquatic habitat (e.g., siltation, stream incision);
- Collect qualitative data on features such as land use, impervious surface, topography, soils, presence of streams, wetlands;
- Collect information on pipe sizes, channel characteristics, drainage structures;
- Verify tributary drainage areas identified in Task 1;
- In some cases it may be required or appropriate to contact the local jurisdiction with drainage review authority, neighboring property owners, and residents about drainage problems;
- Note date and weather at time of inspection;

Task 4 – Describe the drainage system, and its existing and predicted problems.

For each drainage system component (e.g., pipe, culvert, bridges, outfalls, ponds, vaults) the following should be covered in the analysis: location, physical description, problems, and field observations. All existing or potential problems (e.g., ponding water, erosion) identified in Tasks 2 and 3 above should be described. The descriptions should be used to determine whether adequate mitigation can be identified, or whether more detailed quantitative analysis is necessary. The following information should be provided for each existing or potential problem:

- Magnitude of or damage caused by the problem;
- General frequency and duration;
- Return frequency of storm or flow when the problem occurs (may require quantitative analysis);
- Water elevation when the problem occurs;
- Names and concerns of parties involved;
- Current mitigation of the problem;
- Possible cause of the problem;
- Whether the project is likely to aggravate the problem or create a new one.

Upon review of this analysis, the local government may require mitigation measures to address the problems, or a quantitative analysis, depending upon the presence of existing or predicted flooding, erosion, or water quality problems, and on the proposed design of the on-site drainage facilities. The analysis should repeat Tasks 3 and 4 above, using quantitative field data including profiles and cross-sections.

The quantitative analysis should provide information on the severity and frequency of an existing problem or the likelihood of creating a new problem. It should evaluate proposed mitigation intended to avoid aggravation of the existing problem and to avoid creation of a new problem.

Appendix 3B – Basin Maps

PROJECT: _____

LOCATION: _____

DESIGNER: _____ **COMPANY:** _____

DATE: _____

The following items should be included on pre-developed and post-developed basin maps:

☐ Site boundary

☐ Basin limits, both on-site and off-site areas which contribute or receive stormwater runoff onto or from the project, field verified by the engineer.

☐ Drainage sub-basins. All sub-basins should be clearly labeled and correlated with the calculations.

☐ Topographic contours, which should extend beyond the project or drainage basin boundaries to the extent necessary to confirm basin limits used in the calculations; or, in the absence of topographic mapping being available, the Engineer may field verify the basin limits, including contributing off-site areas, and should describe how the basin limits were determined.

☐ Significant drainage features, natural or man-made, such as creeks, seasonal drainage channels, culverts, closed depressions, manholes.

☐ Time of concentration routes, clearly labeled and correlated with the calculations.

☐ Footprint of proposed drainage features, such as ponds, vegetated or other infiltration facilities, pipe routes, ditches.

☐ Indications of floodplain limits, as defined by FEMA or other studies.

☐ North arrow and scale bar.

☐ Wetlands

☐ Existing easements

Appendix 3C – Stormwater Construction Plans

PROJECT: _____

LOCATION: _____

DESIGNER: _____ **COMPANY:** _____

DATE: _____

The following items should be included on stormwater construction plans, as applicable:

- ☐ A plan profile of all key drainage systems including: streets, roads, and drainage facilities
- ☐ Elevation Datum
- ☐ North Arrow
- ☐ Right-of-Way details
- ☐ Outfall details
- ☐ Ditch details
- ☐ Invert elevations, slopes, and lengths of ditches
- ☐ Cross sections of all open ditches
- ☐ Elevations of all inlet grates
- ☐ Size, types, invert elevations, and lengths of all culverts and pipe systems
- ☐ Invert elevations of the existing or other proposed drainage system to which the drainage plan proposes to connect
- ☐ Stationing of all inlets, culverts and pipe systems angle points
- ☐ Invert elevations of pipes at all structures such as catch basins or manholes
- ☐ Construction details for inlets, drywells, detention facilities, etc. (notes referring to standard plans may suffice where applicable)
- ☐ Drainage easements shown, with key dimensions for depicting location, width, and length.
- ☐ The location of existing underground and above-ground utilities
- ☐ Lot grading elevations where appropriate
- ☐ Grading plan for drainage ponds. The grading plan should include existing contours, proposed contours, and catch points. A typical cross section of the pond should be provided in the plans, showing bottom of pond elevation, maximum water surface elevation for the design storm(s), inlet and outlet elevations, berm elevation and slopes, and keyway location and dimensions.

- ☐ Drainage ponds, pipe inlets and outlets, ditches, and drainage structures, which are serving public roads or are in single-family residential neighborhoods, should be horizontally defined with respect to property corners, street stationing, or a coordinate system.
- ☐ Drainage ditches should have their longitudinal grades defined with either a profile or elevation grades at intervals of 50 feet. Ditch centerlines and flow directions should be also be illustrated.
- ☐ Summary of short and long-term operation and maintenance requirements