SECTION 4
STORMWATER
DESIGN AND CONSTRUCTION REQUIREMENTS

4-1 INTRODUCTION

The City of Battle Ground's Engineering Division oversees new development, enforces water quality codes and ordinances in order to provide water quality treatment and control of stormwater run-off, and works to protect water bodies within the City limits. Staff provides technical management, comprehensive planning, and sound engineering to safely move flood waters and drainage in a manner which improves water quality, provides fish passage and habitat, promotes recreation opportunities, and enhances community aesthetics.

These goals are met through planning and prioritizing capital improvements, developing regional water quality and quantity control facilities, working with the development community to meet requirements, and making use of best management practices and the best available technologies.

Proper design of catch basins, pipes, curbs and other conveyance stormwater infrastructure as well as water quality and quantity control structures can help reduce maintenance costs and protect the environment. Additionally, erosion control, in and adjacent to construction sites, has a great impact on the water quality of stormwater runoff.

Storm sewer systems and onsite drainage systems are designed to handle stormwater from various sources including street, roof and footing drainage. Storm drains in the City are separate from the sanitary sewer system.

This section provides requirements and details on stormwater conveyance and stormwater facilities in the City of Battle Ground service area. All requirements and specifications are subject to revision. Standard details follow the text section.

These general requirements in conjunction with the standard details and the municipal code have been developed to provide the engineer with the minimum criteria for developing standalone plans for the construction of required improvements and are not intended to be all inclusive. The following criteria outlined in this document will assist the engineer in the design of drainage infrastructure per the requirements of the City of Battle Ground's Engineering Division.

4-2 STORM SEWER SYSTEMS

4-2.01 *Public and Private Systems and Facilities*

Stormwater systems and facilities which collect, convey, treat, and/or infiltrate runoff from public rights-of-way only will be publicly owned and maintained, unless it is demonstrated to the satisfaction of the City Engineer that the stormwater facility can be adequately maintained by private parties. Private stormwater facilities shall be owned and maintained by private parties. Additionally, facilities that mix both public and private runoff shall be owned and maintained by private parties.

4-2.02 *Location*

Typical location of storm drain lines in the public right-of-way is 3 feet north or east of center line. Locations that differ from standard shall be approved by the City Engineer.

4-2.03 *Easements*

Public storm sewer facilities that are not in the public right-of-way must be in an easement or a tract dedicated to the City of Battle Ground. The tract is intended to allow access for maintenance by City staff, and to prevent any structure or tree from interfering with the facility or hindering access to it. The easement dedication shall be of a standard form provided by the Engineering Division. The applicant shall record the document upon approval by staff. Easements shall cover conveyance systems. Tracts shall cover stormwater facilities. All questions regarding easements can be directed to the Engineering Division.

Public stormwater facilities requiring easements across or on private property include, but are not limited to, storm drain pipes, culverts, ditches, manholes, and catch basins.

Public easements shall be a minimum of 20 feet in width for pipes up to 36-inches in diameter. Diameters greater than 36 inches will require an easement width of 20 feet plus the pipe diameter. Pipes shall be located with their centerline no closer than one-quarter the easement width from an adjacent property line with a minimum distance of 5 feet. Stormwater easements shall be provided to the city for access and maintenance of all streams and channels within a development site. No buildings, structures, trees, or large shrubs are permitted within easements. Fences crossing easements must cross the easement perpendicularly and shall provide gates that extend across the entire width of the easement for access by maintenance vehicles.

Private stormwater facilities must have access and inspection easements dedicated to the City of Battle Ground surrounding the facility per Battle Ground Municipal Code (BGMC) 18.250. Access and inspection easements must be a minimum width of 20 feet and extend to a public right-of-way. The easement is intended to allow access for inspection and verification of maintenance frequency and practices. Prior to final acceptance of a project the developer is required to provide a legal description of the easement and sign a “covenant running with the land.”

4-2.04 *Capacity*

The flow capacity of a storm sewer main is calculated from Manning’s formula for open channel flow. A minimum roughness coefficient of n=0.013 for storm sewer design is required for capacity calculations.

$Q = (1.49/n)AR^{2/3}S^{1/2}$

Where: Q = discharge in cubic feet per second, CFS
n = coefficient of roughness, 0.013 (min.)
A = cross-sectional area of flow in square feet
R = hydraulic radius of flow in feet
S = the slope of the hydraulic gradient in feet per foot

Table 1: Storm Sewer Pipe Capacity and Minimum Slopes (n=0.013)

Inside Pipe Diameter (in)	Minimum Pipe Slope		Design Capacity (cfs)	As-built Velocity (fps)
	Design	As-Built		
8	0.00390	0.00340	0.757	2.024
10	0.00300	0.00250	1.203	2.014
12	0.00250	0.00200	1.786	2.034
15	0.00200	0.00150	2.897	2.044
18	0.00170	0.00120	4.343	2.065
24	0.00110	0.00080	7.523	2.042
30	0.00088	0.00058	12.200	2.018
36	0.00065	0.00045	17.051	2.007
42	0.00050	0.00037	22.558	2.017
48	0.00045	0.00031	30.553	2.018

4-2.05 *Pipe Slope*

Engineers shall design systems using the minimum design slopes in most cases. The minimum as-built slopes are based on slopes required to produce a mean velocity, when flowing full, of at least 2 feet per second (fps), based upon Manning's "n", the coefficient of roughness, valued at 0.013.

The differences between design slopes and as-built slopes represent an allowable tolerance of 0.0005, on pipe diameters of 18 inches or less. Mains installed at a flatter slope than the as-built minimum shall be re-laid by the contractor at their expense.

Laterals from inlets and catch basins shall have a minimum slope of 0.02.

4-2.06 *Pipe Materials*

Specifications for all materials and construction shall be in conformance with the most current version of WSDOT's *Standard Specifications for Road, Bridge & Municipal Construction*. The following table lists approved pipe materials and their specifications for storm sewers.

Table 2: Approved Pipe Materials and Specifications

Approved Material	Specifications
Corrugated Polyethylene (CPE)	AASHTO M252 or M294 Type S
Ductile Iron Pipe (DIP); Class 52	ANSI A21.51 or AWWA C151
Reinforced Concrete Pipe (RCP)	ASTM C 76, Class III, IV, or V
Steel Reinforced HDPE	ASTM F2562 & D2321

4-2.07 ***Pipe Diameter***

Mainline storm sewers shall be a minimum of 12 inches inside diameter. Downstream pipe diameters shall not be reduced except when approved by the City Engineer. Transitions in pipe sizes and material are only allowed at structures.

Lateral storm sewers shall be 8 or 10 inches inside diameter. Larger pipe diameter may be used with large capacity catch basins and when approved by the City Engineer.

4-2.08 ***Installation***

Installation of storm sewer pipe and culverts shall conform to Sections 7-08 of WSDOT's Standard Specifications. Prior to paving, 2 sets of as-builts shall be submitted to the City Engineering Division for review and approval and ponds shall have at least 75% of vegetation coverage established.

Water settling of backfill material is prohibited.

The Contractor will provide a television report, DVD and tabular as-built of all public storm mains and laterals prior to paving. This TV information will be submitted to the City Inspector for review. Approval and acceptance of the TV inspection will be based upon manufacturing and installation defects, as well as debris in the lines. Acceptable limits of pipe belly deflection shall be no more than 1/2" in 8- inch pipe, 3/4" in 10-inch pipe, and 1" in pipes 12-inches or greater. Variations in excess of these tolerances must be repaired at the contractor's expense to the satisfaction of the city.

4-2.09 ***Depth and Cover***

Storm sewer main lines laid in areas subject to wheel loads shall have a minimum cover of 3 feet measured from top of pipe to finished grade or be otherwise protected from damage by traffic. Cover may be reduced, as approved by the City Engineer, if necessary. Any pipe with less than 2 feet of cover must be ductile iron pipe. No pipe can be shallower than the rock and asphalt section of the road that the pipe is being constructed in.

In addition, if the storm sewer main is in a roadway, right of way or other paved area, the ductile iron pipe must be deep enough so that any installed, or future, laterals will have a minimum clearance between the top of the lateral and the bottom of the roadway section of at least 6 inches.

4-2.10 ***Separation***

Storm sewers will be designed to provide 6 inches minimum vertical and 5 feet minimum horizontal clearance (outside diameter) between storm drain pipes and other utility pipes and conduits.

The length of storm pipe shall be centered at the point of crossing sanitary sewer lines so that the joints will be equidistant. The storm pipe shall be the longest standard length available from the manufacturer.

4-3 MANHOLES

4-3.01 *Manhole Location*

Manholes are required at the following locations:

- At every change in slope or alignment
- At every point of change in size or pipe material
- At each intersection or junction
- At intervals of 400 feet
- At the end of main, unless other structure is approved by the City

Permanent vehicular access shall be provided to manholes located in easements.

Pipes will have a 0.2 foot minimum and a 0.4 foot maximum drop through manholes. Where grade considerations are considered critical, the design engineer may request a waiver. In such cases, the drop may be reduced to 0.1 foot for straight through manholes.

4-3.02 *Construction*

Manholes located in easements outside of public right of way shall have locking frame and covers. This requirement may be waived for manholes located in paved easements.

4-3.03 *Design Considerations*

The minimum required inside diameter for a manhole is 48 inches.

Table 3: Manhole Dimension Table

Manhole Diameter (in)	Wall Thickness (in)	Base Thickness (in)	Maximum Knockout Size (in)	Minimum Distance Between Knockouts (in)
48	4	6	36	8
54	4.5	8	42	8
60	5	8	48	8
72	6	8	60	12
84	8	12	72	12
96	8	12	84	12

4-4 CATCH BASINS, CURB INLETS, and COMBINATION CURB INLETS

Curb inlets are the City standard and shall be used wherever possible. Catch basins and combination curb inlets may only be used where approved. All references to catch basins means a catch basin with a curb inlet top unless otherwise approved.

4-4.01 *Location*

Catch basins are required at the following locations:

- At any low point in the roadway
- Where any roadway transitions from a crown section to a shed section (when approved) to prevent gutter flow from flowing across the roadway
- Such that a maximum of 400 linear feet of paved street is collected by a single catch basin

Catch basins shall not be placed in areas of expected pedestrian traffic. The engineer shall design the roadway low points to avoid placing a catch basin in crosswalks, adjacent to curb ramps, or in the gutter of a driveway. Care should be taken on the part of the engineer to assure that the catch basin will not be in conflict with any existing or proposed utilities.

Combination curb inlets are required on slopes greater than 8% or when necessary for capacity.

4-4.02 *Laterals*

Catch basin laterals shall be connected to a manhole or other accessible structure. There can be no more than two catch basins connected (daisy chained) together. Laterals shall not be connected to the storm main by tee or wye, unless specifically approved by the City Engineer. All connections to catch basins will be water tight.

Laterals will be constructed to enter the structure perpendicular to the wall. The lateral will enter only at the location of knockout with no laterals allowed to enter the base at the corners. If needed, a 45° bend (max.) may be used within 5 feet of structure.

4-4.03 *Catch Basin Traps*

An Outlet Trap shall be installed on each outlet pipe from any catch basin. See Standard Detail ST-5.01.

4-5 WATER QUALITY & QUANTITY CONTROL

Refer to BGMC 18.250 and the Stormwater Management Manual for Western Washington.

4-6 OTHER DESIGN/CONSTRUCTION CONSIDERATIONS

4-6.01 *Railroad Crossings*

The developer shall obtain and make full payment for any permits required from the railroad prior to city approval for constructing storm sewer under any railroad tracks. All requirements of the permit shall be met prior to acceptance of any construction. Requirements usually include boring under the tracks with a steel casing for installation of the storm sewer.

4-6.02 *Low Impact Development*

Projects required to meet Low Impact Development requirements shall use an accepted infiltration test method to determine the infiltration rate. Accepted test methods include:

- USDA Soil Textural Classification (on sites with soils unconsolidated by glacial advance)
- Large Scale Pilot Infiltration Test (PIT)
- Small Scale Pilot Infiltration Test (PIT)
- Double Ring Infiltrometer Test
- Single-Ring Falling Head Infiltration Test
- Auger Borehole (if appropriate for site)
- Other test methods as recommended by the geotechnical engineer

4-7 CIVIL PLAN SUBMITTALS

4-7.01 *Civil Plan Approval*

Stormwater civil plans shall meet the requirements of BGMC 18.250, the Stormwater Management Manual for Western Washington, the latest edition of WSDOT Standard Specifications, the attached approved standard details, and the general requirements stated herein.

4-7.02 *Contents of engineering plans*

The engineering plans shall contain the information listed below. All maps shall contain a scale and north arrow. Ensuring the accuracy of all the information is the applicant's responsibility.

A. Site Location Map. A site location map (minimum USGS 1:24000 Quadrangle Topographic Map), shall be required. The site location map may be placed on a cover sheet if the stormwater plan is part of a larger set of plans.

B. The engineering plans shall show the character of the existing site and proposed features, including but not limited to:

   1. Existing and proposed property boundaries, easements and rights-of-way;

   2. Existing contours of the project site and adjacent properties with a one-foot maximum contour interval, unless the director determines a lesser interval is sufficient to show drainage patterns;

3. Existing on-site water wells, known agricultural drain tiles, areas of potential slope instability, structures, utilities, and septic tanks and drainfields;

4. Location of the one-hundred-year floodplain and floodways and shoreline management area limits on the site;

5. Proposed impervious surfaces outside of single-family residential lots;

6. Existing water resource features on and adjacent to the site including streams, wetlands, springs, sinks and stormwater facilities;

7. Drainage flow routes and existing discharge points to and from the site;

8. Location and size and design of proposed stormwater facilities, including typical cross-sections of proposed facilities, storage volumes of detention facilities, water level elevations for all design storms, elevations and dimensions of all structures, and, for vegetated facilities, planting plan including plant species, spacing and total number of plants required;

9. Wetland delineation if wetlands exist on the site;

10. A conceptual grading plan verifying the constructability of a stormwater facility; and

11. Additional site or vicinity information required by the director, if needed, to determine the feasibility of the proposed stormwater plan. (Ord. 09-16 (part), 2010; Ord. 96-802 § 37, 1996)

4-7.03 *Hydrology Report*

A Hydrology Report shall be submitted with each stormwater plan.

4-7.04 Contents of the hydrology report.

The hydrology report shall contain the following information:

A. Certificate of completeness and feasibility that reads as follows:

This Technical Information Report includes all information required by the City of Battle Ground Municipal Code Chapter 18.250—Stormwater Control and Drainage, for (Name of Project). The facilities, as designed, are feasible to construct and maintain and conform to the City Code requirements.

B. Table of Contents.

1. List section headings and their respective page numbers;

2. List of tables with page numbers;

3. List of figures with page numbers;

4. List of attachments, numbered; and

5. List of references.

C. Vicinity Maps. All vicinity maps shall clearly show the site of the development activity or drainage project.

1. Site Location Map. Minimum USGS 1:24000 Quadrangle Topographic Map showing (and labeling where appropriate):

a. Surrounding roadways;

b. Contributing drainage areas and acreage; and

c. Natural and manmade drainage features adjacent to site including existing and proposed (if known) stormwater facilities;

2. Soils Map.

a. The soils map shall show soils within the contributing area draining to the site and the site itself. Copies of Clark County soil survey maps may be used; however, if the maps do not appear to accurately represent the soils for a site, the applicant is responsible for verifying the actual soil types existing on a site.

b. Where unstable or complex soil conditions exist which may significantly impact the design of stormwater facilities, the director may require a preliminary soils report to be completed that addresses stormwater design considerations arising from soil conditions. The preliminary soils report shall be prepared by a registered professional engineer proficient in geotechnical investigation and engineering, or a soil scientist. The preliminary soils report shall include a soils map, developed using the criteria set in the USDA, SCS National Soils Handbook and USDA, SCS Title 430 Soil Survey Manual at a minimum scale of one to five thousand;

3. Site basin map, showing:

a. Pre- and post-development conditions and contributing areas of pollution generating and non-pollution generating pervious and impervious areas;

b. Existing and proposed contours (one-foot maximum contour interval); and

c. Directions and lengths of overland, pipe and channel flow;

4. Other Maps. The following additional vicinity maps shall be required in the situations noted below:

a. Conveyance System. If a direct surface water discharge of stormwater is proposed from the site, a map showing the conveyance system downstream to a point where the stormwater enters a stream, wetland, or other natural water body shall be required.

b. Wellhead Protection. If the site lies within the ten-year zone of contribution of a public water supply well, maps showing all the zones of contribution that overlap the site are required.

c. Floodplains. If a floodplain mapped by Federal Emergency Management Agency exists on or adjacent to the site, a map showing the floodplain is required.

d. Shoreline Management Area. If the site contains or is adjacent to a stream or lake regulated under the State Shorelines Management Act, a map showing the boundary of the shoreline management area in relation to the site is required.

D. Project Overview.

1. Describe the requirements that apply to the project. Include flow charts from the city of Battle Ground and/or the Stormwater Management Manual for Western Washington showing assumptions used to find project requirements;

2. Describe drainage to and from adjacent properties;

3. Describe any known flooding or drainage issues;

4. Describe proposed site construction, applicable minimum requirements, and proposed methods of mitigating stormwater runoff quantity and quality impacts;

5. Include a table showing amount of land-disturbing activity, existing and proposed impervious surface area, amount of new and replaced impervious surface in each threshold discharge area, amount of lawn and landscaping in each threshold discharge area, and amount of pollution generating pervious and impervious surfaces; and

6. Discuss water table elevations, and data on seasonal water table fluctuations with minimum and maximum water table elevations in areas of high groundwater.

E. Quantity Control Analysis and Design.

1. Hydrologic Analysis, Existing and Developed Conditions.

a. Tabulate acreage; imperviousness; curve number; length and grade of overland, pipe and channel flow, off-site flows; and other hydrologic parameters used in completing analyses;

b. Complete detailed hydrologic analysis for existing and developed site conditions in accordance with the requirements of BGMC 18.250.200 and the Stormwater Management Manual for Western Washington. Compute existing and developed peak flows and volumes

for the design storms for all site basins. Refer to labeled points shown on the site location map and development plan;

c. Include and reference all hydrologic and hydraulic computations in the technical appendix;

d. Include all maps, exhibits, graphics and references used to determine existing and developed site hydrology;

e. Include a compact disk with the input file used to model the project.

2. Quantity Control System Design.

a. Compute inflow, outflow and peak flows and storage volumes using an approved continuous runoff model. Reference conveyance and stormwater control facilities to labeled points shown on the development plan;

b. Tabulate existing and proposed peak flows and storage volumes; and

c. Show all hydrologic and hydraulic computations, equations, ratings curves, stage/storage/discharge tables, and graphs necessary to show methodology and results.

3. Quantity Control System Plan.

a. Provide illustrative sketch of quantity control facility and its appurtenances;

b. Show basic measurements necessary to confirm storage volumes;

c. Show all orifice, weir and flow restrictor dimensions and elevations;

d. Tabulate peak flow rates, storage volumes and ponding elevations for all design storms.

F. Water Quality Design.

1. Identify best management practices used in design and their sources;

2. Identify and discuss initial conditions including groundwater elevations, beginning storage elevations, and other data or assumptions used to determine initial conditions in order to complete analyses;

3. Identify and discuss assumptions used in completing analysis;

4. Complete detailed analysis and design of all proposed water quality system elements in accordance with BGMC 18.250.130 through 18.250.190;

5. Include and reference all computations, equations, charts, nomographs, detail drawings and other tabular or graphic aids used to design water quality system elements;

6. Summarize results of water quality design and describe how the proposed design meets the requirements of BGMC 18.250.

G. Conveyance Systems Analysis and Design.

1. Identify criteria used in completing analyses and their sources;

2. Complete detailed hydraulic analysis of all proposed collection and conveyance systems. Compute and tabulate design flows and velocities and conveyance element capacities for all conveyance elements within the development;

3. Include and reference all hydraulic computations, equations, pipe flow tables, flow profile computations, charts, and nomographs;

4. Downstream Analysis. The analysis shall be extended downstream to points where the impact is insignificant.

5. Inlet Analysis. Include an inlet analysis for all inlets. Roadway drainage shall not exceed the capacity of the inlet or produce a flow depth of greater than 0.12 feet at the edge of the travel lane for the ten-year storm.

6. Off-site Analysis. Projects that discharge stormwater off-site shall submit an off-site 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 in accordance with the Stormwater Management Manual for Western Washington, Volume I, Section 2.6.2.

H. Soils Evaluation.

1. Identify on-site soil types and their erosive potential and discuss their suitability for implementation of proposed best management practices (BMPs) and quantity control facilities;

2. Identify seasonal high water table elevations in cases where this will impact the stormwater facilities;

3. Identify and discuss soil parameters, testing, and design methods used in hydrologic and hydraulic design of proposed facilities; and

4. Where infiltration BMPs are proposed, complete soil tests to determine the infiltration rates. In some cases the director may require additional geotechnical investigation, in accordance with the requirements of Chapter 3.3 of Volume III of the Stormwater Management Manual for Western Washington.

I. Special Reports and Studies. Where specific site characteristics including, but not limited to steep slopes, wetlands, and sites located in wellhead protection areas pose difficult drainage and water quality design problems, the director may require additional information or the preparation of

special reports and studies which further address the specific site characteristics, the potential for impacts associated with the development, and the measures which would be implemented to mitigate impacts. Special reports shall be prepared by professional persons with expertise in the particular area of analysis, who shall date, sign, stamp and otherwise certify the report. Subjects of special reports may include, but not be limited to, the following:

1. Geotechnical/pedological;
2. Wetlands;
3. Floodplains and floodways;
4. Groundwater;
5. Structural design; and
6. Fluvial geomorphology (erosion and deposition).

All special reports and studies shall be included as an attachment to the hydrology report.

J. Other Permits. Construction of roads, stormwater facilities, and infiltration facilities may require additional water-related permits from other agencies. These additional permits may contain requirements which impact design of the stormwater system. This subsection of the hydrology report shall list the titles of all other required permits, the agencies requiring the permits, and identify the permit requirements, if known, that affect the stormwater plan. Approved permits that are critical to the feasibility of the stormwater facility design shall be included in this section. Examples of other permits are as follows:

1. Developer/local agency agreement: Washington State Department of Transportation;
2. Short-term water quality modification approval: Washington State Department of Ecology;
3. Hydraulic project approval: Washington State Departments of Fisheries and Wildlife;
4. Dam safety permit: Washington State Department of Ecology;
5. Section 10, 103 and 404 permits: U.S. Army Corps of Engineers;
6. Surface mining reclamation permits: Washington State Department of Natural Resources;
7. Underground injection control registration: Washington State Department of Ecology.

K. Maintenance and Operations Manual.

1. The standards set forth in the city of Battle Ground stormwater facility maintenance manual shall be used for all standard BMPs. If the city manual is to be used it may be adopted by reference in the hydrology report.

2. For any stormwater control or treatment facility which constitutes an experimental system under BGMC 18.250.180, or for any facility that does not have maintenance standards set forth in the city of Battle Ground stormwater facility maintenance manual, the project engineer shall prepare a maintenance and operations manual. The manual shall provide an outline of required maintenance tasks with recommended frequencies at which each task should be performed. (Ord. 09-16 (part), 2010; Ord. 96-802 § 38, 1996)

4-7.05 ***Stormwater plan***

A. Purpose. The stormwater plan provides engineering design and construction drawings for the stormwater aspects of a proposed development activity or drainage project.

1. A stormwater plan is required for all projects required to comply with Minimum Requirement No. 1.

B. Contents. The stormwater plan shall consist of two parts, engineering plans as described in Section 4-7.02 and a hydrology report as described in Section 4-7.04. Both the engineering plans and hydrology report shall be signed and stamped by the project engineer.

1. Preliminary Stormwater Plan. The preliminary engineering plans shall contain all information required by Section 4-7.02. The preliminary hydrology report shall contain the information required by Section 4-7.04 (B), (C) and (D) and preliminary calculations to show feasibility for Sections (E), (F) and (G). Information used to create the preliminary stormwater plan may be approximate, but must represent the most current data available at the time of preparation.

2. Final Stormwater Plan. The final engineering plans shall contain all of the information required by Section 4-7.02. The final hydrology report shall contain all information required by Section 4-7.04.

C. Modification of Content Requirements. The director may waive, in writing, some of the content requirements of the stormwater plan if:

1. The development activity or drainage project is included in an approved final stormwater plan which meets the requirements of this chapter and the applicant demonstrates to the satisfaction of the director that the applicable provisions of the previously approved final stormwater plan will be met;

2. The director determines, upon receipt of a letter of request from the applicant, that less information is required to accomplish the purposes of this chapter; or

3. A basin plan exists that makes some of the information irrelevant.

D. Review and Approval.

1. All final stormwater plans require approval by the director. Approval is only for conformance with city standards and does not relieve the engineer of record of responsibility for the design.

2. Approval of final stormwater plans does not relieve the applicant from the obligation to comply with this chapter and does not prevent the city from recovering for defective work or violation of this chapter.

E. Timing. The preliminary stormwater plan is required at the time of development application, if applicable. The final stormwater plan must be approved by the director prior to beginning utility construction related to a development activity or drainage project. (Ord. 09-16 (part), 2010; Ord. 96-802 § 6, 1996)

4-7.06 ***Design methodology for water quality treatment facilities***

A. Treatment BMPs shall be sized to capture, hold and treat the water quality design storm. Treatment BMPs shall be sized based on the following:

1. Water Quality Design Storm Volume. The volume of runoff predicted from a 24-hour storm with a 6-month return frequency (a.k.a., 6-month, 24-hour storm). Alternatively, when using an approved continuous runoff model, the water quality design storm volume shall be equal to the simulated daily volume that represents the upper limit of the range of daily volumes that accounts for 91% of the entire runoff volume over a multi-decade period of record.

2. Water Quality Design Storm Flow Rate.

a. For projects that are required to comply with Minimum Requirement No. 6: the flow rate at or below which ninety-one percent of the runoff volume, as estimated by a continuous runoff model, will be treated. Design criteria for treatment facilities are assigned to achieve the applicable performance goal at the water quality design flow rate (e.g., eighty percent total suspended solids removal).

b. Downstream of detention facilities the water quality design flow rate must be the full two-year release rate from the detention facility. Alternative methods may be used if they identify volumes and flow rates that are at least equivalent.

4-7.07 ***Design methodology for quantity control facilities***

A. Projects required to meet Minimum Requirement No. 7 shall use a continuous runoff model for hydrologic and hydraulic analysis and facility sizing in accordance with Volume III of the Stormwater Management Manual for Western Washington and the city of Battle Ground NPDES permit.

B. All facilities shall provide emergency overflow routes for storm events that exceed the design capacity of the facility.

C. Infiltration facilities shall be designed to infiltrate the one-hundred-year design storm. Facilities that infiltrate less than the one-hundred-year design storm shall meet the requirements of this section.

D. Soil groups used for analysis shall be as defined in the most current version of “Hydrologic Soil Groups for Soils in Clark County,” published by the SCS. Alternatively, hydrological soil groups from

the United States Department of Agriculture (USDA) "Web Soil Survey" can be used, or soil groups can be developed by a registered soil scientist.

E. Closed depression analysis shall be performed as required in Chapter 2.4 of Volume III of the Stormwater Management Manual for Western Washington for projects required to meet Minimum Requirement No. 7, as prepared by the Washington State Department of Ecology. The requirements of subsection C of this section will be waived for projects in closed depressions. (Ord. 09-16 (part), 2010; Ord. 96-802 § 16, 1996)

4-7.08 ***Conveyance systems***

A. Open channel conveyance systems incorporating water quality treatment, habitat improvement, and emergency overland flood relief routes shall be utilized to the maximum extent practicable.

B. Stormwater conveyance elements to transport water within and from a project site shall be sized to carry flows from the design storm from the contributing drainage area based upon the projected full buildout of that contributing drainage area, and be fully compatible with existing downstream conveyance elements and flow conditions.

C. Projects shall utilize the Santa Barbara Unit Hydrograph (SBUH) method for conveyance sizing. A Soil Conservation Society (SCS) Type 1A rainfall distribution resolved to a maximum of ten-minute time intervals shall be used. Isopluvial maps used for analysis shall be "Isopluvial Maps for Design Storms in Clark County," as published in National Oceanic and Atmospheric Administration (NOAA) Atlas 2, "Precipitation—Frequency Atlas for the Western United States," Volume IX, Washington. Isopluvial maps are available from the city of Battle Ground engineering division. Curve numbers used for analysis shall be as specified in "USDA SCS TR-55," June 1986, published by the SCS

D. For stormwater conveyance design the design storms shall be as follows:

    1. Ten-year storm: contributing drainage areas less than forty acres;

    2. Twenty-five-year storm: contributing drainage areas of forty acres or more;

    3. One-hundred-year storm: culverts with contributing drainage areas greater than two hundred acres, culverts in areas of special flood hazard as described in Federal Emergency Management Agency "FIRM" maps and reports for Clark County, culverts where upsizing in order to meet design requirements for the one-hundred-year storm is required.

E. Development sites shall be planned to be able to pass the one-hundred-year storm through the site.

F. Closed conveyance system elements shall be designed to operate in an open flow, not pressure flow regime, for the design storm.

G. A backwater analysis shall be performed under any of the following conditions:

    1. Pipes with slopes less than 0.5 percent;

2. Pipes with subcritical flow velocities over 6.5 feet per second;

3. Stormwater main lines forming an angle of forty-five degrees or more at junctions;

4. Pipes with inverts less than three feet deep.

H. When backwater analysis is required, the hydraulic grade line shall be calculated for the required design storm as well as the twenty-five- and one-hundred-year storm events. For the twenty-five-year event there shall be a minimum of one foot of freeboard between the water surface and the top of any manhole or catch basin. For the one-hundred-year event the stormwater flows must meet the requirements of subsections J, K, and L of this section.

I. Backwater analysis shall be performed as described in Section 6.6 of the WSDOT Hydraulics Manual, 2017, as prepared by the Washington State Department of Transportation.

J. Runoff from the one-hundred-year storm may leave pipes and channels but shall not rise to elevations more than two feet below that of the lowest finished floor of buildings.

K. For roadway flooding conditions during the one-hundred-year storm, one travel lane in either direction shall remain open to emergency vehicles at all times. A travel lane will be considered to be open to emergency vehicles if the maximum depth of flow in the travel lane does not exceed 0.5 feet.

L. For parking lot flooding conditions during the one-hundred-year storm, the maximum depth of ponding shall not exceed 1.5 feet. Storage volumes resulting from ponding in street and parking lot areas may be used to meet the storage requirements for the maximum design storm.

M. Design of conveyance systems shall be in accordance with the city of Battle Ground stormwater construction requirements. (Ord. 09-16 (part), 2010; Ord. 96-802 § 18, 1996)

4-7.09 *Side slopes of stormwater facilities*

A. For maintenance and safety reasons, side slopes of stormwater facilities normally shall be no steeper than three to one.

B. Side slopes steeper than three to one may be allowed by the director where all the following conditions are met:

1. Side slopes do not need to be mowed; and

2. Adequate long-term erosion control is provided.

C. Use of retaining walls greater than four feet high in stormwater facilities requires approval of the director. The height of the wall shall be measured from the bottom of the footing to the top of the wall. (Ord. 09-16 (part), 2010; Ord. 96-802 § 25, 1996)

4-7.10 Record drawings.

Record drawings will be provided consistent with the standards maintained by the city engineer.

A. Preliminary record drawings are required to be submitted and accepted prior to paving over newly constructed public infrastructure. Authorization to pave must be received prior to paving.

    1. The preliminary record drawings submittal shall include two sets of full size drawings plotted on paper.

B. Accepted, final record drawings shall be submitted prior to engineering acceptance.

    1. The final record drawing submittal shall include the following: One set of full size drawings plotted on Mylar, one set of full size drawings plotted on paper, two sets of drawings plotted on eleven-inch by seventeen-inch paper, and one compact disc version of the record drawings in AutoCAD and TIF format.

C. Information provided on record drawings shall include, but not be limited to, the following:

    1. Invert elevations;

    2. Pipe slope;

    3. Rim elevations;

    4. Pipe diameters;

    5. Top of berm elevations;

    6. Bottom of pond elevations;

    7. Elevations of orifices or weirs in flow control structures; and

    8. Emergency spillway elevations.

D. The record drawings submittal shall be stamped, signed and dated by a licensed professional civil engineer, registered in the state of Washington. (Ord. 09-16 (part), 2010; Ord. 96-802 § 7, 1996)

4-8 RESOURCES

City of Battle Ground, “Battle Ground Municipal Code Title 18: Environmental Protection,” available from Battle Ground’s website: http://www.cityofbg.org. Washington State Department of Ecology, Stormwater Management Manual for Western Washington, 2012 Edition as amended in December, 2014, Washington State Department of Transportation, Standard Specifications for Road, Bridge, and Municipal Construction, M41-10, latest version adopted by the City of Battle Ground.

4-9 STORMWATER STANDARD DETAILS

4-9.01 *Drainage Standard Details Description and Number*

STORMWATER STANDARD DETAILS	
Number	**Detail**
ST-1.00	Stormwater General Notes & Testing
ST-2.00	Manhole
ST-2.01A	Flow Control Manhole (Tee Type)
ST-2.01B	Flow Control Manhole (Tee Type) Notes
ST-2.02A	Flow Control Manhole (Notch Type)
ST-2.02B	Flow Control Manhole (Notch Type) Notes
ST-2.03	Top Slab for Manhole
ST-2.04	Manhole Frames and Covers
ST-2.05	Manhole Step
ST-2.06	Cleanout
ST-3.00A	Catch Basin (Type 1)
ST-3.00B	Catch Basin (Type 1) Notes
ST-3.01	Catch Basin (Type 40)
ST-3.02	Catch Basin (Type G2)
ST-3.03	Catch Basin (Steel)
ST-3.04A	Catch Basin (Nyloplast or Equal)
ST-3.04B	Catch Basin (Nyloplast or Equal) Notes
ST-3.05	Catch Basin (Rolled Curb)
ST-3.06	Spill Control (SC) Separator
ST-4.00A	Drain Basin (Nyloplast or Equal)
ST-4.00B	Drain Basin (Nyloplast or Equal) Notes
ST-4.01	Ditch Inlet (Type 1L)
ST-5.00	Gutter Pan
ST-5.01	Outlet Trap
ST-5.02	Storm Grates
ST-6.00A	Bioswale Section
ST-6.00B	Bioswale Section Notes
ST-6.01A	Bioswale Section With Underdrain
ST-6.01B	Bioswale Section With Underdrain Notes
ST-6.02	Bioswale Sedimentation Trap
ST-6.03	Flow Spreader
ST-6.04	Rip Rap
ST-6.05	Beveled End Section
ST-6.06	Trash Screen
ST-7.00	Pipe Bedding (Flexible Pipe)
ST-7.01	Pipe Bedding (Rigid Pipe)

ST-7.02	Trench Backfill
ST-7.03	Pipe Anchor
ST-8.00	Chain Link Fence & Gate
ST-9.00	Typical Detention Pond Plan
ST-9.01	Typical Detention Pond Profile
ST-9.02	Birdcage Overflow Structure
ST-9.03	Typical Combined Wetpond-Detention Pond Plan
ST-9.04	Combined Detention-Wetpond Profile
ST-9.05	Detention and Wetpool Alternate Configurations
ST-9.06	Wetpond Emergent Wetland Plant Species
ST-10.00	Compost Amended Vegetated Filter Strip
ST-10.01	Concentrated Flow Dispersion - Diagonal Berms
ST-10.02	Concentrated Flow Dispersion - Slotted Drains
ST-10.03	Sheet Flow Dispersion Trench
ST-10.04	Sheet Flow Dispersion
ST-10.05	Permeable Pavement Section
ST-10.06	Permeable Paver Section
ST-10.07	Permeable Pavement Interceptor Infiltration Trench
ST-10.08	Permeable Pavement Check Dam
ST-11.00	Planting Bed Cross-Section
ST-11.01	Bioretention Outlet Structure
ST-11.02	Bioretention Planting Zones
ST-11.03	Bioretention Soil Mix
ST-11.04	Bioretention Cell Section With Curb
ST-11.05	Bioretention Planter
ST-11.06	Typical Bioretention
ST-11.07	Bioretention With Underdrain
ST-11.08	Bioretention With Liner (Not LID)
ST-12.00	Typical Downspout Infiltration Trench
ST-12.01	Alternate Downspout Infiltration Trench System for Coarse Sand and Gravel
ST-12.02	Typical Downspout Infiltration Drywell
ST-12.03	Typical Downspout Dispersion Trench
ST-12.04	Standard Dispersion Trench with Notched Grade Board
ST-12.05	Downspout Splashblock Dispersion
ST-12.06	Perforated Stub-out Connection
ST-12.07	Vegetated Roof Section
ST-13.00	Rain Garden Flow Chart
ST-13.01	Simple Infiltration Rain Garden
ST-13.02	Infiltration Rain Garden
ST-13.03	Infiltration Rain Garden With Planting Soil (1)
ST-13.04	Infiltration Rain Garden With Planting Soil (2)

ST-13.05	Lined Filtration Rain Garden (1)
ST-13.06	Lined Filtration Rain Garden (2)
ST-13.07	Lined Filtration Rain Garden (3)
ST-13.08	Filtration Rain Garden Without Impermeable Liner (1)
ST-13.09	Filtration Rain Garden Without Impermeable Liner (2)
ST-13.10	Filtration Rain Garden Without Impermeable Liner (3)
ST-13.11	Infiltration Rain Garden With Planting Soil
ST-13.12	Infiltration Rain Garden With Planting Soil Notes
ST-13.13	Rain Garden Planting Zones