REVISION DIRECTIONS

AUBURN SURFACE WATER MANAGEMENT MANUAL
EFFECTIVE DATE 06/06/2014
Revision No. 1

Preface, Volume I, Volume III, & Volume V

New, reprinted pages included with this revision are listed by page number in the right-hand column below. The left-hand column lists obsolete material, which should be removed from the book. Follow the instruction columns in sequence: remove and insert pages as necessary.

When completed, insert these directions in a convenient place near the front of the Surface Water Management Manual. For future reference, the person making these changes may also date and initial this page.

Remove these pages	**Insert these pages**
Preface page 3-4	**Preface page 3-4**
Volume I, Table of Contents	**Volume I, Table of Contents**
Volume I, pages 25-32	**Volume I, pages 25-32**
Volume I, pages 47-48	**Volume I, pages 47-48**
Volume III, pages 307-310	**Volume III, pages 307-310**
Volume III, pages 351-354	**Volume III, pages 351-354**
Volume III, pages 357-364	**Volume III, pages 357-364**
Volume V, pages 701-706	**Volume V, pages 701-706**
Volume V, pages 715-716	**Volume V, pages 715-716**

Approved by City of Auburn, Public Works Committee April 21, 2014

How to Use this Manual

This manual is designed for a variety of users.

- Project proponents should start by reviewing the minimum requirements described in Volume I. Volume I also describes a Stormwater Site Plan and provides guidance on how to develop this plan.
- City staff will use this manual to review Stormwater Site Plans, check BMP designs and provide technical advice to project proponents. City staff will also use this manual as a reference when designing public works projects. All development and redevelopment projects within the City of Auburn shall meet the requirements of this manual unless specifically exempted by this manual or the City Engineer.
- The City Engineer shall have authority to modify requirements to protect the health, safety or welfare of the public on the basis of information regarding threatened water quality, erosion problems or potential habitat destruction, flooding, protection of uninterruptible services, or endangerment to property. The City Engineer shall also have the authority to modify requirements based upon increases in requirements imposed by state or federal agencies, where existing requirements are not applicable to the particular site, or other pertinent factors.
- Permits may refer to this manual or the BMPs contained in this manual. In those cases, affected permit-holders or applicants should use this manual for specific guidance on how to comply with those permit conditions.

Where requirements in this manual are also mandated by any other law, ordinance, resolution, rule or regulation, the more restrictive requirement shall apply.

Note: Drawing and detail figures included throughout these volumes are intended for illustrative purposes only. Where any discrepancy exists between figure elements and specific design criteria, the design criteria shall take precedence.

Development of Best Management Practices (BMPs) for Stormwater Management

The method by which this manual controls the adverse impacts of development and redevelopment is through the application of Best Management Practices.

Best Management Practices (BMPs)

Best Management Practices are defined as schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of Washington State. The types of BMPs are source control, treatment, and flow control. BMPs that involve construction of engineered structures are often referred to as facilities in this manual. For instance, the BMPs referenced in the menus of Chapter 2 in Volume 5 are called Treatment Facilities.

Source Control BMPs

Source control BMPs **prevent or reduce** pollution, or other adverse effects of stormwater, from occurring. In this manual, source control BMPs are classified as operational or structural. Examples of source control BMPs include methods as various as using mulches and covers on disturbed soil, putting roofs over outside storage areas, and berming areas to prevent stormwater run-on and pollutant runoff.

It is generally more cost-effective to use source controls to prevent pollutants from entering runoff than to treat runoff to remove pollutants.

Treatment BMPs

Treatment BMPs include facilities that **remove** pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, and soil adsorption. Treatment BMPs can accomplish significant levels of pollutant load reductions if properly designed and maintained.

Flow Control BMPs

Flow control BMPs typically control the rate, frequency, and flow duration of stormwater surface runoff. The need to provide flow control BMPs depends on whether a development site discharges to a stream system or wetland, either directly or indirectly. Stream channel erosion control can be accomplished by BMPs that detain runoff flows and also by those which physically stabilize eroding stream banks. Both types of measures may be necessary. Only the former is covered in this manual. The size of such a facility can be reduced by changing the extent to which a site is disturbed.

In regard to wetlands, it is necessary to not alter the natural hydroperiod. This means control of flows from a development such that the wetland is within certain elevations at different times of the year and short-term elevation changes are within the prescribed limits. If, however, the wetland was fed by local groundwater elevations during the dry season, the impervious surface additions and the bypassing practice may cause variations from the dry season elevations which might need mitigation.

The city has additional requirements that are related to surface water management, including wetlands, critical areas, and flood protection. Refer to the City of Auburn Code.

Volume I – Stormwater Site Planning
Table of Contents

NOTE: With respect to Water Quality, a "net" total of pollution generating impervious surface will not be considered when dealing with replaced impervious surfaces. Construction of new surfaces that do not generate pollution does not balance the environmental impacts of newly created pollution generating surfaces. All new or redeveloped pollution generating surfaces that meet the thresholds for new and redevelopment and create, add and/or replace 5,000 square feet pollution generating impervious surface shall provide water quality.

See Volume V for more detailed guidance on selection, design, and maintenance of treatment facilities.

3.4.7 Minimum Requirement #7: Flow Control

3.4.7.1 Applicability

Projects must provide flow control to reduce the impacts of stormwater runoff from impervious surfaces and land cover conversions. Portions of projects discharging to a wetland shall also be subject to Minimum Requirement #8.

The flow control requirement thresholds apply to projects that discharge directly or indirectly:

- **Through a conveyance system, into fresh water; or**
- **Through a conveyance system into a gulch; or**
- **To a City identified capacity problem existing downstream of the development; or**
- **To a manmade conveyance system (ditch, swale, etc.) which has not been adequately stabilized to prevent erosion; or**
- **To a conveyance system without capacity to convey the fully developed design event as defined in Volume III, Chapter 3.**

3.4.7.2 Thresholds

Projects that meet or exceed the following thresholds require construction of flow control facilities and/or land use management BMPs.

- **Project sites in which the total of effective impervious surfaces is 10,000 square feet or more in a threshold discharge area, or**
- **Projects that convert ¾ acres or more of native vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in natural or man-made conveyance system from the site, or**
- **Projects that, through a combination of effective impervious surfaces and converted pervious surfaces, cause a 0.1 cfs increase in the 100-year flow frequency from a threshold discharge area as estimated using the Western Washington Hydrology Model or other approved model. Comparison will be between existing and proposed site conditions.**

That portion of any development project in which the thresholds listed above are not exceeded in a threshold discharge area, shall apply Onsite Stormwater Management BMPs in accordance with Minimum Requirement #5. Refer to Figure I-3-1, Figure I-3-2 and Figure I-3-3 to aid in determining project requirements.

3.4.7.3 Standard Requirement

Using WWHM for design, stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. The pre-developed condition to be matched shall be a forested land cover. The pre-developed soil types shall be assumed as either outwash (Hydrologic Soil Group A/B) or till (Hydrologic Soil Group C/D) soils, depending on supporting geotechnical information. Saturated soil conditions shall only be considered when determining existing wetland hydrology.

This standard requirement is waived for sites that will reliably infiltrate all the runoff from impervious surfaces and converted pervious surfaces.

Any areas for which the minimum thresholds are not exceeded must still meet the following criteria:

- **The project must be drained by a conveyance system with capacity to convey the fully developed design event as defined in Volume III, Chapter 3. The conveyance system must consist entirely of manmade conveyance elements (e.g., pipes, ditches, outfall protection, etc.) and extend to the ordinary high water line of the receiving water; and**
- **Any erodible elements of the manmade conveyance system must be adequately stabilized to prevent erosion under future build-out conditions from areas that contribute flow to the system; and**
- **No City identified capacity problems may exist downstream of the development; and**
- **Surface water flows from the area must not be diverted from or increased to an existing wetland, stream, or near-shore habitat sufficient to cause a significant adverse impact.**

3.4.7.4 Infrastructure Protection Requirement

The infrastructure protection requirement is intended to mitigate stormwater impacts from projects that are not required to provide flow control, but discharge to a system with capacity limitations such as projects with the following characteristics:

- **Inadequate capacity in downstream conveyance.**

Applicant may resolve the downstream capacity problem or may provide on-site detention. Where detention is provided, stormwater discharges for the developed condition shall match the discharges under existing conditions.

3.4.7.5 Objective

To prevent increases in the stream channel erosion rates that are characteristic of natural conditions (i.e., prior to the European settlement). The standard intends to maintain the total amount of time that a receiving stream exceeds an erosion-causing threshold based upon historic rainfall and natural land cover conditions. That threshold is assumed to be 50% of the 2-year peak flow. Maintaining the naturally occurring erosion rates within streams is vital, though by itself insufficient, to protect fish habitat and production.

3.4.7.6 Modeling Requirements

To meet the Standard Requirement, the applicant shall use the most current software version of the Department of Ecology's Western Washington Hydrology Model (WWHM) model (see Volume III). Alternative models for sizing flow control and water quality facilities may be considered, provided they are Washington State Department of Ecology equivalent, and approved by the City of Auburn. Approval from the City shall be obtained prior to submittal of design documents.

To meet the Downstream Analysis requirements, piped conveyance systems shall be modeled using either continuous simulation or single event methods. Stream systems shall be modeled using only continuous simulation methods.

The designer shall provide a copy of the completed hydrology analysis worksheet (Appendix C) and a copy of the electronic project files.

NOTE: Hand-calculated hydrographs and flow routing will no longer be accepted because of the wide availability of various software programs.

3.4.8 Minimum Requirement #8: Wetlands Protection

Wetlands are regulated by the City of Auburn through this requirement and the Critical Areas Code, Auburn City Code 16.10. For more information about wetlands, wetland permits and development close to wetlands, please contact the Planning, Building & Community Department at (253) 931-3090.

3.4.8.1 Applicability

Stormwater discharges to wetlands are regulated under the City's Critical Areas Ordinance (ACC 16.10).

The requirements below are in addition to requirements given in ACC 16.10 and apply only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system. These requirements must be met <u>in addition</u> to meeting Minimum Requirement #6, Runoff Treatment. All pollution generating surfaces discharging to wetlands shall require water quality treatment prior to discharge to the wetlands. Streams may also be regulated under this requirement as part of the wetland permit.

3.4.8.2 Thresholds

When either of the thresholds identified in Minimum Requirement #6 – Runoff Treatment, or Minimum Requirement #7 – Flow Control are met or exceeded, this requirement shall also be applied.

3.4.8.3 Standard Requirement

Discharges to wetlands shall maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated uses. The hydrologic analysis shall use the existing land cover condition to determine the existing hydrologic conditions unless directed otherwise by a regulatory agency with jurisdiction. A wetland can be considered for hydrologic modification and/or stormwater treatment in accordance with Guidesheet 1B in Appendix E. Modeling shall be completed with a continuous simulation model. Model calibration and pre- and post-development monitoring of wetland levels, groundwater levels, and water quality may be required by the City.

3.4.8.4 Additional Requirements

The standard requirement does not excuse any discharge from the obligation to apply whatever technology is necessary to comply with state water quality standards, Chapter 173-201A WAC, or state groundwater standards, Chapter 173-200 WAC. Additional treatment requirements to meet those standards may be required by federal, state, or local governments.

Stormwater treatment and flow control facilities shall not be constructed within a natural vegetated buffer, except for:

- **Necessary conveyance systems as approved by the City; or**
- **As allowed in wetlands approved for hydrologic modification and/or treatment in accordance with Guidesheet 1B in Appendix E of this Volume.**

Flow splitting devices or drainage BMPs must be applied to route natural runoff volumes from the project site to any downstream stream or wetland.

Design of flow splitting devices or drainage BMPs will be based on continuous hydrologic modeling analysis. The design will assure that flows delivered to stream reaches will approximate, but in no case exceed, durations ranging from 50% of the 2-year to the 50-year peak flow.

Flow splitting devices or drainage BMPs that deliver flow to wetlands shall be designed using continuous hydrologic modeling to preserve pre-project wetland hydrologic conditions unless specifically waived or exempted by regulatory agencies with permitting jurisdiction;

An adopted and implemented basin plan, or a Total Maximum Daily Load (TMDL, also known as a Water Clean-up Plan) may be used to develop requirements for wetlands that are tailored to a specific basin.

3.4.8.5 Objective

To ensure that wetlands receive the same level of protection as any other waters of the state. Wetlands are extremely important natural resources which provide multiple stormwater benefits, including groundwater recharge, flood control, and stream channel erosion protection. They are easily impacted by development unless careful planning and management are conducted. Wetlands can be severely degraded by stormwater discharges from urban development due to pollutants in the runoff and also due to disruption of natural hydrologic functioning of the wetland system. Changes in water levels and the frequency and duration of inundations are of particular concern.

3.4.8.6 Supplemental Guidelines

Appendix E contains guidance for wetlands when interacting with stormwater. **The City of Auburn may require applicants to utilize portions or all of the guidance in analyzing and mitigating wetland impacts.**

3.4.9 Minimum Requirement #9: Operation and Maintenance

An operation and maintenance manual that is consistent with the provisions in Section 4.1 of this Volume shall be provided for all proposed stormwater facilities and BMPs at the time construction plans are submitted for review, and the party (or parties) responsible for maintenance and operation shall be identified.

For private facilities, a copy of the manual shall be retained onsite or within reasonable access to the site, and shall be transferred with the property to the new owner. For private systems serving multiple lots within residential developments or other developments, a separate covenant or other guarantee of proper maintenance that can be recorded on title shall be provided and recorded. For public facilities, a copy of the manual shall be retained in the appropriate department.

For all facilities (public and private), a log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection by the City.

3.4.9.1 Objective

To ensure that stormwater control facilities are adequately maintained and operated properly.

3.4.9.2 Supplemental Guidelines

Inadequate maintenance is a common cause of failure for stormwater control facilities. The description of each BMP in Volumes II, III, V, and VI includes a section on maintenance. Appendix D of Volume I includes a schedule of maintenance standards for drainage facilities.

3.4.10 Minimum Requirement #10: Off-Site Analysis and Mitigation

As required by the Minimum Requirements of this Chapter, development projects that discharge stormwater offsite shall submit as part of their Stormwater Site Plan and Report an off-site analysis that assesses the potential off-site impacts of stormwater discharge.

All projects shall perform a *qualitative* analysis downstream from the site.

The City may require a quantitative analysis for any project deemed to need additional downstream information.

3.4.10.1 Qualitative Analysis:

Project applicants shall submit a *qualitative* analysis of each upstream system entering a site (run-on) and each downstream system leaving a site (run-off). The qualitative analysis shall extend downstream for the entire flow path, from the project site to the receiving water, or up to one-quarter mile, whichever is less. The upstream analysis shall identify and describe points where water enters the site and the tributary area. A basin map defining the onsite and offsite basins tributary to the site shall be provided. The basin map shall be to a defined scale.

Upon review of this analysis, the City may require a qualitative analysis further downstream, mitigation measures deemed adequate 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 onsite drainage facilities. Details on how to perform this analysis are located in Volume I, Chapter 4 and Volume I, Appendix B.

3.4.10.2 Quantitative Analysis

The City may require a *quantitative* analysis for any project deemed to need additional downstream information. Details on how to perform this analysis are located in Volume III, Section 3.1.2.

3.4.10.3 Objective

To identify and evaluate offsite water quality, erosion, slope stability, and drainage impacts that may be caused or aggravated by a proposed project, and to determine measures for preventing impacts and for not aggravating existing impacts. Aggravated shall mean increasing the frequency of occurrence and/or severity of a problem. Some of the most common and potentially destructive impacts of land development are erosion of downgradient properties, localized flooding, and slope failures. These are caused by increased surface water volumes and changed runoff patterns. The City believes taking the precautions of offsite analysis could prevent substantial property damage and public safety risks. In addition the applicant will evaluate types and locations of surface run-on to the project site. These must be safely conveyed across the project site.

3.5 Exceptions

NOTE: Throughout this Section, **guidance to meet the requirements is written in BOLD.** Supplemental guidelines that serve as advice and other materials are not written in bold.

Deviations from the Minimum Requirements may be requested, in writing, in accordance with ACC 13.48.226 to allow a waiver of a requirement, a reduction or modification of a requirement, or to permit an alternative requirement. Public notice of application for a deviation, draft decision, and written findings will be published in accordance with ACC 13.48.226, with an opportunity for public comment. Deviations must meet the following criteria:

- **The minimum requirements would impose a severe and unexpected economic hardship; and**

- **The deviation will not increase risk to the public health and welfare, nor injurious to other properties in the vicinity and/or downstream, and to the quality of waters of the state; and**

- **The deviation is the least possible exception that could be granted to comply with the intent of the Minimum Requirements.**

In accordance with ACC 13.48.226, the City Engineer may grant a deviation following a documented finding that:

The deviation is likely to be equally protective of public health, safety and welfare, the environment, and public and private property, as the requirement from which an exception is sought.

OR

Substantial reasons exist under ACC 13.48.226 C., for approving the requested deviation and the deviation will not cause significant harm. The substantial reasons may include, but are not limited to:

- **The requirement to be imposed is not technically feasible; or**
- **An emergency situation necessitates approval of the deviation; or**
- **No reasonable use of the property is possible unless the deviation is approved; or**
- **The requirement would cause significant harm or a significant threat of harm to public health, safety and welfare, the environment, or to public and private property, or would cause extreme financial hardship which substantially outweighs its benefits.**

The decision to grant a deviation is within the sole discretion of the City, and the City Engineer shall only approve a deviation to the extent it is necessary. The City Engineer may impose new or additional requirements to offset or mitigate harm that may be caused by approving the deviation. The City Engineer may require the applicant to submit a licensed engineer's report or analysis along with a request, in writing, for a deviation. Deviations are intended to maintain necessary flexible working relationship between the City and applicants.

The approval of a deviation shall not be construed to be an approval of any violation of any of the other provisions of the City's Municipal Code, or of any other valid law of any governmental entity having jurisdiction.

Applications for a deviation from the Minimum Requirements of ACC13.48.225 must be in writing and include the following information:

- **The current (pre-project) use of the site, and**

- **How the application of the minimum requirement(s) restricts the proposed use of the site compared to the restrictions that existed prior to the adoption of the minimum requirements; and**

- **The possible remaining uses of the site if the deviation were not granted; and**

- **The uses of the site that would have been allowed prior to the adoption of the minimum requirements; and**

- **A comparison of the estimated amount and percentage of value loss as a result of the minimum requirements versus the estimated amount and percentage of value loss as a result of requirements that existed prior to adoption of the minimum requirements; and**

- **The feasibility for the owner to alter the project to apply the minimum requirements.**

- ☐ Groundwater wells on-site and within 100 feet of site
- ☐ Septic systems on-site and/or within 100 feet of the site

☐ Identify difficult site conditions.
☐ State whether the project is located in an aquifer recharge area or wellhead protection area as defined by the Washington State Health Department, the Environmental Protection Agency or by the City.
☐ Identify any Superfund areas in the vicinity, and state whether they are tributary to, or receive drainage from, the project site.
☐ Identify any specific requirements included in a basin plan for the area.
☐ Include references to relevant reports such as basin plans, flood studies, groundwater studies, wetland designations, sensitive area designations, environmental impact statements, environmental checklists, lake restoration plans, water quality reports, etc. Where such reports impose additional conditions on the Proponent, state these conditions, and describe any proposed mitigation measures.
☐ Grading Plan per requirements.
☐ A soil report to identify the following:

- ☐ Soil types
- ☐ Hydrologic soil group classification
- ☐ Groundwater elevation
- ☐ Presence of perched aquifers, acquitters and confined aquifers
- ☐ Location of test pits
- ☐ Infiltration rates determined per the requirements of Volume III (where applicable)
- ☐ Discussion of critical areas or geologic hazards where present

☐ Soil reports should be contained in an Appendix of the report or as a separate document.
☐ Describe the 100-year flood hazard zone.

Chapter 3 – Off-Site Analysis (Minimum Requirement #10)

The City requires a qualitative discussion of the off-site upstream and downstream system for all projects. The City may require a quantitative analysis for any project deemed to need additional downstream information. Detailed calculations shall be contained in an Appendix of the report. Volume I, Chapter 4 describes the Off-site Analysis. In addition, a list of elements to be included is provided as follows.

Qualitative Analysis

☐ Review all available plans, studies, maps pertaining to the off-site study area.
☐ Investigate the drainage system ¼ mile downstream from the project by site visit, including the following items:

- ☐ Problems reported or observed during the resource review
- ☐ Existing/potential constrictions or capacity deficiencies in the drainage system
- ☐ Existing/potential flooding problems
- ☐ Existing/potential overtopping, scouring, bank sloughing, or sedimentation
- ☐ Significant destruction of aquatic habitat (e.g., siltation, stream incision)
- ☐ Existing public and private easements through the project site and their corresponding widths
- ☐ Qualitative data on features such as land use, impervious surface, topography, soils, presence of streams, and wetlands

- ☐ Information on pipe sizes, channel characteristics and drainage structures
- ☐ Verification of tributary drainage areas
- ☐ Date and weather at the time of the inspection

☐ Describe the drainage system and its existing and predicted problems through observations, reports, and hydraulic modeling (as necessary) of the City-specified design storm event described in Chapter 3 of Volume III. Describe all existing or potential problems as listed above (e.g. pooling water or erosion). The following information shall 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 the 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

☐ Properly include off-site areas in drainage calculations.

Quantitative Analysis (see Volume III, Section 3.1.2)

☐ Clearly describe tail water assumptions.
☐ Summarize results in text.
☐ Include calculations in Appendix B of the report.
☐ Discuss potential fixes for capacity problems.
☐ Provide profiles where appropriate.

Chapter 4 – Permanent Stormwater Control Plan

Chapter 4 will contain the information used to select, size and locate permanent stormwater control BMPs for the project site.

Pre-Developed Site Hydrology

☐ Provide a list of assumptions and site parameters for the pre-developed condition.
☐ Identify all sub-basins within, or flowing through, the site. Use consistent labeling for all sub-basins throughout figures, calculations, and text.
☐ For each sub-basin, identify current land use, acreage, hydrologic soil group and land use to be modeled under pre-developed conditions. The format used in Example Table I-B-1 show below is recommended.
☐ Provide justification for land uses other than forest.
☐ The pre-developed soil types shall be assumed as either outwash (Hydrologic Soil Group A/B) or till (Hydrologic Soil Group C/D) soils, depending on supporting geotechnical information. Saturated soil conditions shall only be considered when determining existing wetland hydrology.
☐ Summarize output data from the pre-developed condition. Example Tables I-B-2a or I-B-2b are recommended formats.
☐ Include completed Hydraulic Analysis worksheet (see Appendix C in this volume) and hydrologic calculations in Appendix D of the report.
☐ For WWHM models, provide model files electronically.

Volume III

Volume III: Surface Water Quantity Control and Conveyance

Purpose of this Volume

The purpose of this volume is to outline methods for calculating and designing methods to control the quantity of surface water runoff at developed sites. Quantity controls and on-site management for roof downspouts are described. Design criteria and methods of analysis for flow control BMPs are presented. Conveyance system requirements and design methods are also presented

Content and Organization of this Volume

Volume III of this manual contains three chapters and two appendices.

- Chapter 1 reviews methods of hydrologic analysis.
- Chapter 2 describes flow control design.
- Chapter 3 describes the requirements for analysis and design of surface water conveyance systems.
- Appendix A provides the Auburn Design Storm precipitation values.
- Appendix B describes the procedure for a Pilot Infiltration Test.

Chapter 1 Hydrologic Analysis

The purpose of this chapter is to define the minimum computational standards required, and outline how these computational standards may be applied.

1.1 Minimum Computational Standards

The minimum computational standards depend on the type of information required and the size of the drainage area to be analyzed, as follows:

- The most current software version of the Department of Ecology's Western Washington Hydrology Model (WWHM) model shall be used. Alternative models for sizing flow control and water quality facilities may be considered, provided they are Washington State Department of Ecology equivalent, and approved by the City of Auburn. Approval from the City shall be obtained prior to submittal of design documents.
- Model calibration shall be required for basins greater than 320 acres.

Exception: The Santa Barbara Urban Hydrograph method (SBUH) may be used to determine a water quality design storm volume for wetpond treatment facilities only.

Table III-1-1 summarizes the circumstances under which different design methodologies apply.

Table III-1-1. BMP Designs in Western Washington

Method		Treatment	Flow Control
Standard	Continuous Runoff Model (WWHM or approved equivalent)	Method applies to all BMPs.	Method applies throughout Auburn where flow control is required.
Alternative	SBUH	Wetpool water quality treatment facilities only.	Acceptable for City storm drainage system capacity problems.

1.2 Western Washington Hydrology Model

For most flow control design purposes, a continuous runoff model, such as the Western Washington Hydrology Model (WWHM), must be used. Information on the WWHM is provided in the Stormwater Management Manual for Western Washington (Washington State Department of Ecology, 2005). The software can be downloaded at the following website:

http://www.ecy.wa.gov/programs/wq/stormwater/wwhmtraining/index.html

More WWHM information is available at http://www.clearcreeksolutions.com

Note: Pre-developed conditions shall be modeled as a forested land cover with either outwash (Hydrologic Soil Group A/ B) or till (Hydrologic Soil Group C/D) soils. Saturated soil conditions shall only be considered when determining existing wetland hydrology.

1.3 Single-Event Hydrograph Method

Hydrograph analysis with a single event hydrograph method utilizes the standard plot of runoff flow versus time for a given design storm, allowing the key characteristics of runoff such as peak, volume, and phasing to be considered in the design of drainage facilities. Single event methods are only acceptable for sizing wetpool treatment facilities or for determining pipe capacity.

All storm event hydrograph methods require input of parameters that describe physical drainage basin characteristics. These parameters provide the basis from which the runoff hydrograph is developed.

1.3.1 Design Storm

The total depth of rainfall for storms of 24-hour duration and 2, 5, 10, 25, 50, and 100-year recurrence intervals are published by the National Oceanic and Atmospheric Administration (NOAA). The information is presented in the form of "isopluvial" maps for each state. Isopluvial maps are maps where the contours represent total inches of rainfall for a specific duration. Isopluvial maps for the 2, 5, 10, 25, 50, and 100-year recurrence interval and 24-hour duration storm events can be found in the NOAA Atlas 2, "Precipitation - Frequency Atlas of the Western United States, Volume IX-Washington." Based on these isopluvials, the following design storms shall be used for the City of Auburn:

6-month, 24-hour design storm:	1.44 inches
2-year, 24-hour design storm:	2.0 inches
10-year, 24-hour design storm:	3.0 inches
100-year, 24-hour design storm:	4.0 inches

1.3.2 Curve Number

Surface soils are classified by the National Resource Conservation Service into four hydrologic soil groups based on the soil's runoff potential: A, B, C, and D. Group A soils generally have the lowest runoff potential while Group D soils have the highest. In Auburn the valley floor is mostly Group D soils, which typically have very low infiltration rates and high runoff potential. The West Hill, Lea Hill, and Lakeland Hills areas are predominately Group C soils, which have low infiltration rates and moderate to high runoff potential. The southeast area, Bowman Creek area, and valley area located between Highway 18 and the White River contain some Group A soils, which are characterized by high infiltration rates and low runoff potential. Soils within the City limits shall be assumed to fall in the Hydrologic Soils Groups as shown in figure 4-4 of the City of Auburn Comprehensive Drainage Plan unless grain size distribution and/or permeability testing indicate otherwise. Refer to Section 2.2.7.4 for details on appropriate soil testing methods.

Table III-1-2 shows the curve numbers (CNs), by land use description, for the four hydrologic soil groups. These numbers are for a 24-hour duration storm and the typical antecedent soil moisture condition preceding 24-hour storms.

The following are important criteria/considerations for selection of CN values.

Many factors may affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lesser infiltration rate and greater runoff potential than would be indicated by strict application of the CN value to developed site conditions.

CN values can be area weighted when they apply to pervious areas of similar CNs (within 20 CN points). However, high CN areas should not be combined with low CN areas. In this case, separate estimates of S (potential maximum natural detention) and Qd (runoff depth) should be generated and summed to obtain the cumulative runoff volume unless the low CN areas are less than 15 percent of the sub-basin.

Separate CN values must be selected for the pervious and impervious areas of an urban basin or sub-basin. For residential districts, the percent impervious area given in Table III-1-2 must be used to compute the respective pervious and impervious areas. For proposed commercial areas, plats, etc., the percent impervious area must be computed from the site plan. For all other land uses, the percent impervious area must be estimated from best available aerial topography and/or field reconnaissance. The pervious area CN value must be a weighted average of all the pervious area CNs within the sub-basin. The impervious area CN value shall be 98.

1.4 Closed Depression Analysis

The analysis of closed depressions requires careful assessment of the existing hydrologic performance in order to evaluate the impacts of a proposed project. A calibrated continuous simulation hydrologic model must be used for closed depression analysis and design of mitigation facilities. The applicable requirements of this manual (see Minimum Requirement #7 and #8) and the City's Critical Areas Ordinance and Rules should be thoroughly reviewed prior to proceeding with the analysis.

Closed depressions generally facilitate infiltration of runoff. If a closed depression is classified as a wetland, then Minimum Requirement #8 for wetlands applies. If there is an outflow from the wetland to a surface water (such as a creek), then the flow from the wetland must also meet Minimum Requirement #7 for flow control. If a closed depression is not classified as a wetland, the ponding area at the bottom of the closed depression should be modeled as an infiltration pond.

Guidance for modeling closed depressions and model calibration shall be provided by the Department of Public Works.

Overlapping and Covering - Following the stone aggregate placement, the geotextile must be folded over the stone aggregate to form a 12 inch minimum longitudinal overlap. When overlaps are required between rolls, the upstream roll should overlap a minimum of 2 feet over the downstream roll in order to provide a shingled effect.

Voids behind Geotextile - Voids between the geotextile and excavation sides must be avoided. Removing boulders or other obstacles from the trench walls is one source of such voids. Natural soils should be placed in these voids at the most convenient time during construction to ensure geotextile conformity to the excavation sides. Soil piping, geotextile clogging, and possible surface subsidence will be avoided by this remedial process.

Unstable Excavation Sites - Vertically excavated walls may be difficult to maintain in areas where the soil moisture is high or where soft or cohesionless soils predominate. Trapezoidal, rather than rectangular, cross-sections may be needed.

2.2.16.4 Maintenance Criteria

Sediment buildup in the top foot of stone aggregate or the surface inlet should be monitored on the same schedule as the observation well.

2.3 Detention Facilities

This section presents the methods, criteria, and details for design and analysis of detention facilities. These facilities provide for the temporary storage of increased surface water runoff resulting from development pursuant to the performance standards set forth in Minimum Requirement #7 for flow control (Volume I). Storm detention systems shall be designed such that the storm drainage from public systems does not discharge into areas of private ownership or private maintenance responsibility.

There are three primary types of detention facilities described in this section: detention ponds, tanks, and vaults.

2.3.1 Detention Ponds

The design criteria in this section are for detention ponds. However, many of the criteria also apply to infiltration ponds (Volume III, Section 2.2 and Volume V), and water quality wetponds and combined detention/wetponds (Volume V). All detention ponds shall be appropriately and aesthetically located, designed and planted. Pre-approval of the design concept, including landscaping is required by the City for all proposed public ponds.

2.3.1.1 Dam Safety for Detention BMPs

Stormwater detention facilities that can impound 10 acre-feet (435,600 cubic feet; 3.26 million gallons) or more above normal, surrounding grade with the water level at the embankment crest are subject to Ecology's dam safety requirements, even if water storage is intermittent and infrequent (WAC 173-175-020). The principal safety concern is for the downstream population at risk if the dam should breach and allow an uncontrolled release of the pond contents. Peak flows from dam failures are typically much larger than the 100-year flows which these ponds are typically designed to accommodate. The Applicant shall contact Ecology's Dam Safety Engineers at Ecology Headquarters if any of these conditions are met.

2.3.1.2 Design Criteria

Standard details for detention ponds are provided in Figure III-2-7 through Figure III-2-10 and Table III-2-10. Control structure discussion and details are provided in Section 2.3.4.

General

- Ponds must be designed as flow-through systems (however, parking lot storage may utilize a back-up system; see Section 2.3.5). Developed flows must enter through a conveyance system separate from the control structure and outflow conveyance system. Maximizing distance between the inlet and outlet is encouraged to promote sedimentation.
- Pond bottoms shall be level and be located a minimum of 0.5 feet below the inlet and outlet to provide sediment storage.
- Design criteria for outflow control structures are specified in Section 2.3.4.
- A geotechnical analysis and report must be prepared for slopes 20% or greater, or if located within 200 feet of the top of a slope 20% or greater or landslide hazard area. The scope of the geotechnical report shall include the assessment of impoundment seepage on the stability of the natural slope where the facility will be located within the setback limits set forth in this section.
- Detention ponds should be designed using rounded shapes and variations in slopes to provide a more natural and aesthetically pleasing facility.
- The total maximum depth of the detention pond from the bottom to the emergency overflow water surface elevation shall be fifteen feet (15').

Side Slopes

- Interior side slopes above any wetpond surfaces, if present, shall not be steeper than 3H:1V unless an analysis is provided by a geotechnical engineer, demonstrating that steeper slopes will be stable. The analysis shall include, at a minimum, an assessment of the existing soil types, soil properties, groundwater conditions, potential for seepage, and stability of proposed slopes. The geotechnical analysis should also provide recommendations to ensure stability both during construction and in perpetuity.
- Exterior side slopes must not be steeper than 2H:1V unless analyzed for stability by a geotechnical engineer.
- A 10 foot level bench is required around the perimeter of the top of ponds to separate the pond facility from adjacent slopes.
- For maintenance and aesthetic reasons, pond designs should minimize structural elements such as retaining walls. For ponds where retaining walls are required, they should be limited to a maximum of three sides.
- Pond walls may be vertical retaining walls, provided:
    - They are constructed of minimum 3,000 psi structural reinforced concrete.
    - A fence is provided along the top of the wall.

- At least 25% of the pond perimeter shall be a vegetated soil slope not steeper than 3H:1V.
- Access for maintenance per this section shall be provided.
- The design is stamped by a licensed civil engineer with structural expertise.

Other retaining walls such as rockeries, concrete, masonry unit walls, and keystone type walls may be used if designed by a geotechnical engineer or civil engineer with structural expertise. If the entire pond perimeter is to be retaining walls, ladders shall be provided on the walls for safety reasons.

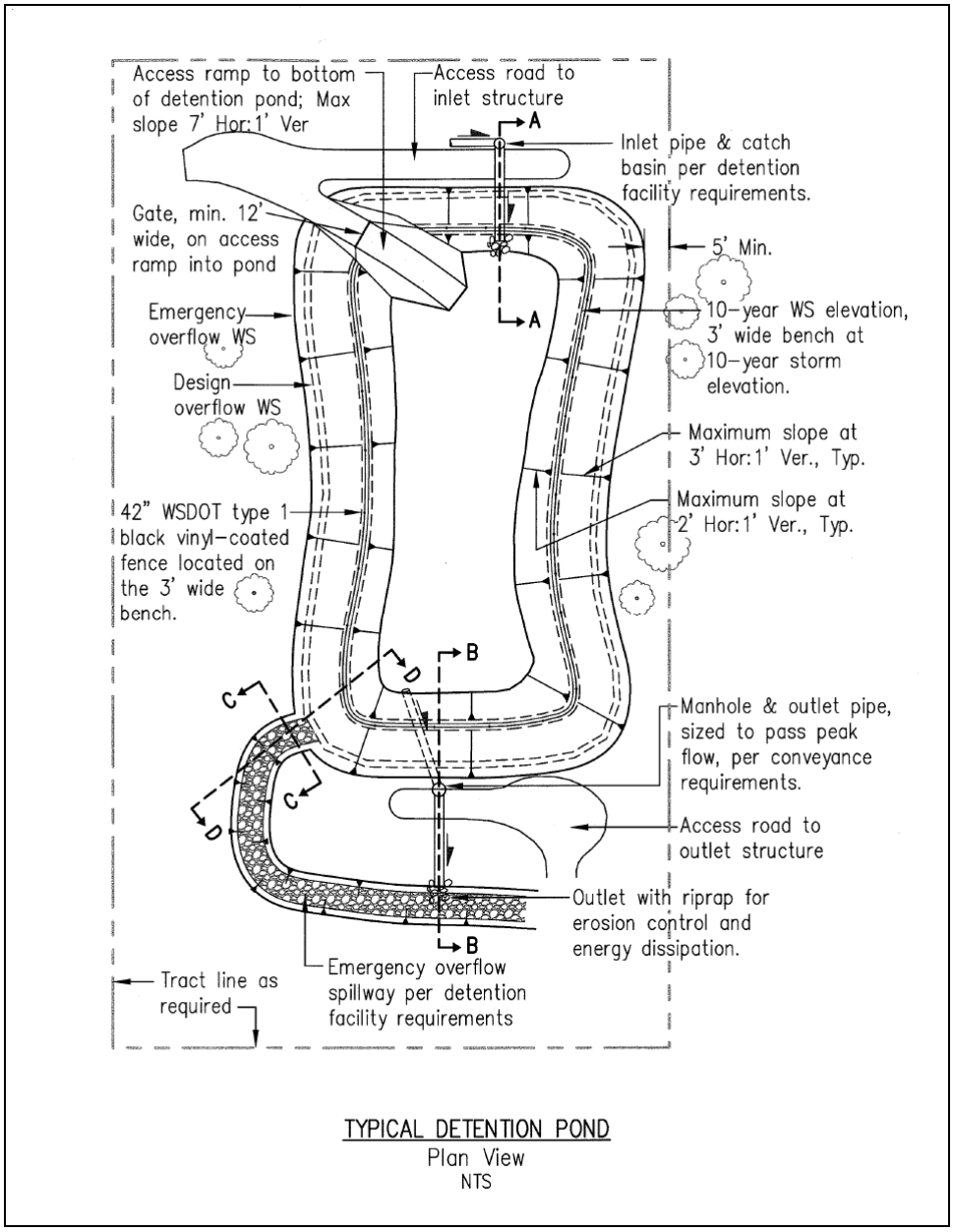

Figure III-2-7. Typical Detention Pond

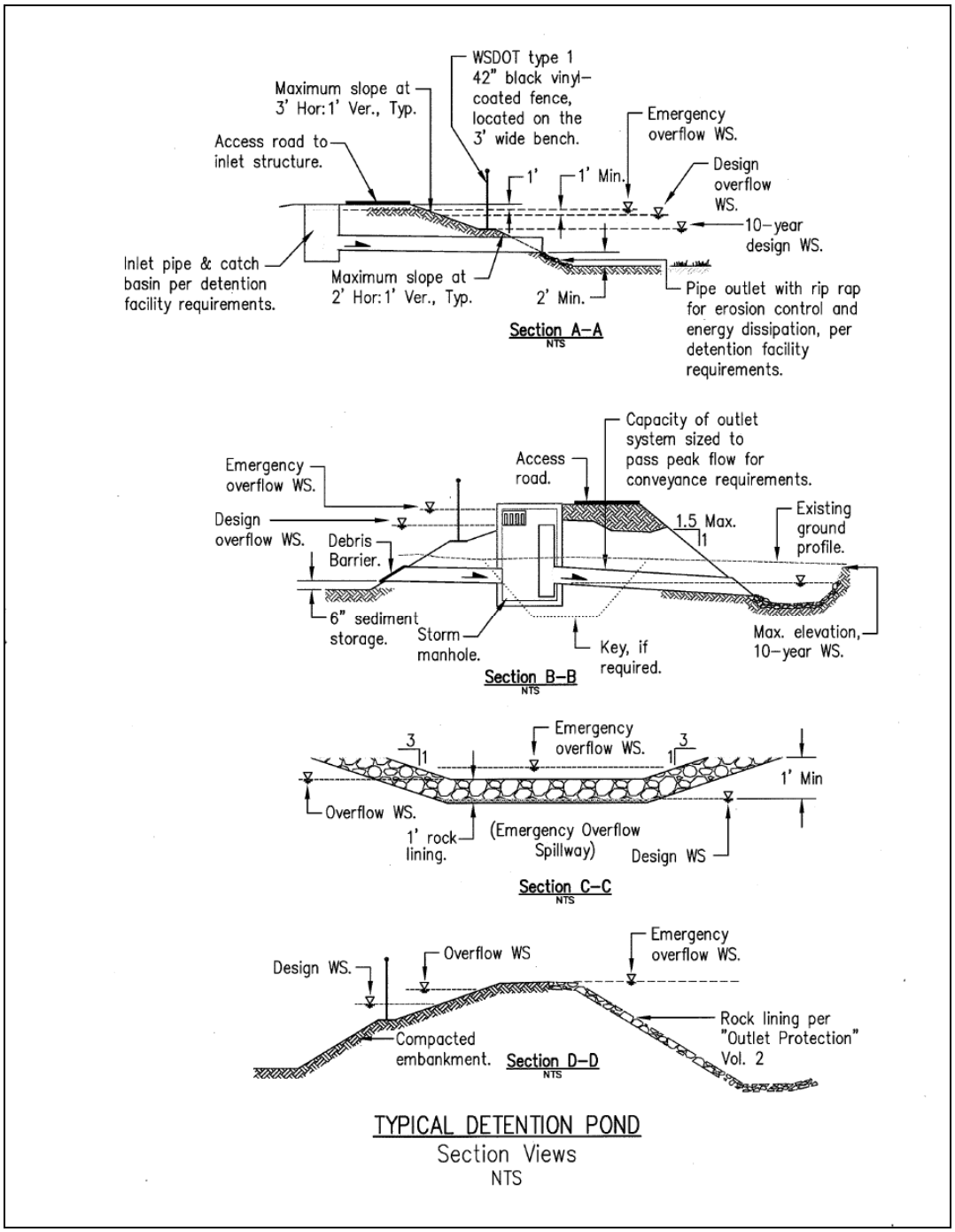

Figure III-2-8. Typical Detention Pond Sections

Emergency Overflow Spillway

- In addition to the above overflow provisions, ponds shall have an emergency overflow spillway. For impoundments of 10 acre-feet or greater, the emergency overflow spillway must meet the state's dam safety requirements (see above). For impoundments less than 10 acre-feet, ponds must have an emergency overflow spillway that is sized to pass the 100-year developed peak flow. Emergency overflow spillways shall control the location of pond overtopping such that flow is directed into the downstream conveyance system or public right of way.
- As an option for ponds with berms less than 2 feet in height and located at grades less than 5 percent, emergency overflow may be provided by an emergency overflow structure, such as a Type II manhole fitted with a birdcage as shown in Figure III-2-9. The emergency overflow structure must be designed to pass the 100-year developed peak flow, with a minimum of 6 inches of freeboard, directly to the downstream conveyance system or another acceptable discharge point.
- The emergency overflow spillway shall be armored with riprap in conformance with the "Outlet Protection" BMP in Volume II (BMP C209). The spillway must be armored full width, beginning at a point midway across the berm embankment and extending downstream to where emergency overflows re-enter the conveyance system (See Figure III-2-8).
- Emergency overflow spillway designs must be analyzed as broad-crested trapezoidal weirs as described in Methods of Analysis at the end of this section. Either one of the weir sections shown in Figure III-2-8 may be used.

Access

The following access shall be provided.

- Maintenance access road(s) shall be provided to the control structure and other drainage structures associated with the pond (e.g., inlet or bypass structures).
- An access ramp is required for pond cleaning and maintenance. The ramp must extend to the pond bottom with a maximum slope of 7H:1V (see access road criteria below).
- The internal berm of a wetpond or combined detention and wetpond may be used for access if it is designed to support a loaded 80,000 pound truck considering the berm is normally submerged and saturated.
- For combined detention and wetpond facilities, a 5 foot level bench area is required around the perimeter a minimum of 1 foot, but no more than 3 feet, above the wetpond surface elevation.
- Where a portion of the pond is constructed within a fill slope, an access road shall be provided adjacent to the detention pond along the entire length of the fill.
- Access roads/ramps must meet the following requirements:
    - Access roads may be constructed with an asphalt or gravel surface, or modular grid pavement.

  - Maximum grade shall be 7H:1V percent.
  - Outside turning radius shall be a minimum of 50 feet.
  - Fence gates shall be located only on straight sections of road.
  - Access roads shall be 15 feet in width.
  - A driveway meeting City design standards must be provided where access roads connect to paved public roadways.
- If a fence is required, access shall be limited by a double-posted gate. If a fence is not required, access shall be limited by two fixed bollards on each side of the access road and two removable bollards equally located between the fixed bollards.
- Additional easements or modification to proposed lot boundaries may be required to provide adequate access to detention facilities. Right-of-way may be needed for detention pond maintenance. Any tract not abutting public right-of-way shall have a 15-foot wide extension of the tract to an acceptable access location.

Fencing

- A fence is required when a pond interior side slope is steeper than 3H:1V, or when the wetpond depth is greater than 24 inches. Fencing is required for all vertical walls. Fencing is required if more than 10 percent of slopes are steeper 3H:1V.

  Also note that detention ponds on school sites shall comply with safety standards developed by the Department of Health (DOH) and the Superintendent for Public Instruction (SPI). These standards include what is called a 'non-climbable fence.'

- Fences shall be 42 inches in height (see WSDOT Standard Plan L-2, Type 1 chain link fence).
- Access gates shall be 16 feet in width consisting of two swinging sections 8 feet in width.
- Vertical metal balusters or 9 gauge galvanized steel fabric with bonded black vinyl coating shall be used as fence material with the following aesthetic features:
  - All posts, cross bars, and gates shall be painted or coated black.
  - Fence posts and rails shall conform to WSDOT Standard Plan L-2 for Types 1, 3, or 4 chain link fence.
- For metal baluster fences, Uniform Building Code standards apply.
- Wood fences may be used in residential areas where the fence will be maintained by homeowners associations or adjacent lot owners.
- Wood fences shall have pressure treated posts (ground contact rated) either set in 24-inch deep concrete footings or attached to footings by galvanized brackets. Rails and fence boards may be cedar, pressure-treated fir, or hemlock.

Signage

Detention ponds, infiltration ponds, wetponds, and combined ponds in residential subdivisions shall have a sign placed for maximum visibility from adjacent streets, sidewalks, and paths. An example and specifications for a permanent surface water control pond are provided in Figure III-2-10 and Table III-2-10.

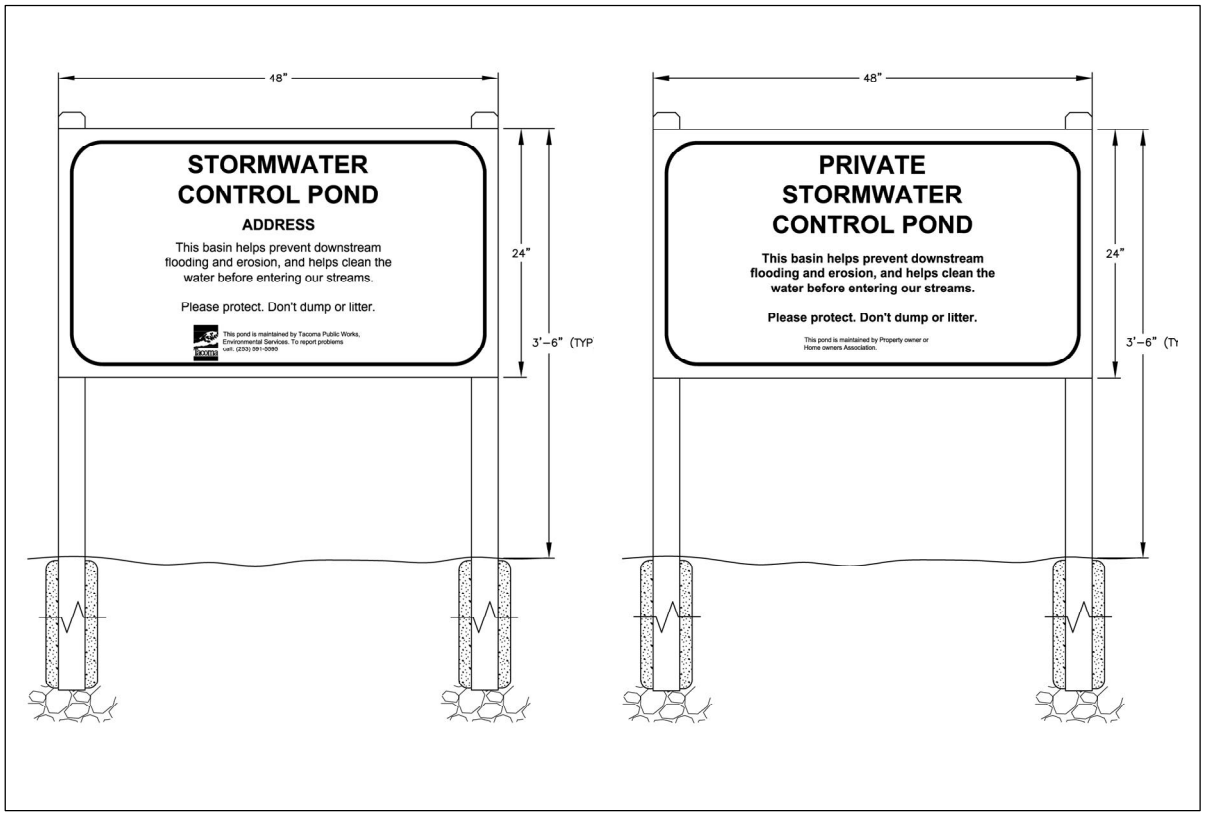

Figure III-2-10. Examples of Permanent Surface Water Control Pond Sign

Table III-2-10. Permanent Surface Water Control Pond Sign Specifications

Size	48 inches by 24 inches
Material	0.125 gauge aluminum
Face	Non-reflective vinyl or 3 coats outdoor enamel (sprayed)
Lettering	Silk-screen enamel where possible, or vinyl letters
Colors	Per City specifications where required
Type Face	Helvetica condensed. Title: 3 inch; Sub-Title: 1-1/2 inch; Text: 1 inch;
Border	Outer 1/8-inch border distance from edge: 1/4 inch All text shall be at least 1-3/4 inches from border.
Installation	Secure to chain link fence if available. Otherwise install on two posts as described below. Top of sign no higher than 42 inches from ground surface.

Posts	Pressure-treated 4" x 4"; beveled tops 1-1/2 inches higher than the top of the sign; mounted atop gravel bed, installed in 30-inch concrete-filled post holes (8-inch minimum diameter)
Placement	Face sign in direction of primary visual or physical access. Do not block any access road. Do not place within 6 feet of structural facilities (e.g. manholes, spillways, pipe inlets).
Special Notes	This facility is lined to protect groundwater (if a liner restricting infiltration of stormwater is used).

Setbacks

The City requires specific setbacks for sites with steep slopes, landslide areas, open water features, springs, wells, and septic tank drain fields. Adequate room for maintenance access and equipment shall also be considered. Project proponents should consult the Auburn City Codes to determine all applicable setback requirements. Where a conflict occurs between setbacks, the most stringent of the setback requirements applies.

Setbacks shall be as follows:

- Stormwater ponds shall be set back at least 100 feet from drinking water wells, septic tanks or drainfields, and springs used for public drinking water supplies.
- Infiltration facilities upgradient of drinking water supplies and within 1, 5, and 10-year time of travel zones must comply with Health Dept. requirements (Washington Wellhead Protection Program, DOH Publication # 331-018). Additional setbacks for infiltration facilities may be required per DOH publication #333-117, On-Site Sewage Systems Chapter 246-272A WAC.
- The 100-year water surface elevation shall be at least 10 feet from any structure or property line. If necessary, setbacks shall be increased from the minimum 10 feet in order to maintain a 1H:1V side slope for future excavation and maintenance. Vertical pond walls may necessitate an increase in setbacks.
- All pond systems shall be setback from sensitive areas, steep slopes, landslide hazard areas, and erosion hazard areas as governed by the Auburn City Code. Facilities near landslide hazard areas must be evaluated by a geotechnical engineer or qualified geologist. The discharge point shall not be placed on or above slopes 20% (5H:1V) or greater, or above erosion hazard areas without evaluation by a geotechnical engineer or qualified geologist and City approval.
- For sites with septic systems, ponds shall be downgradient of the drainfield unless the site topography clearly prohibits subsurface flows from intersecting the drainfield.

Seeps and Springs

Intermittent seeps along cut slopes are typically fed by a shallow groundwater source (interflow) flowing along a relatively impermeable soil stratum. These flows are storm driven. However, more continuous seeps and springs, which extend through longer dry periods, are likely from a deeper groundwater source. When continuous flows are intercepted and directed through flow control facilities, adjustments to the facility design shall be made to account for the additional base flow. Flow monitoring of intercepted flow may be required for design purposes.

Planting Requirements

Exposed earth on the pond bottom and interior side slopes shall be sodded or seeded with an appropriate seed mixture. All remaining areas of the tract shall be planted with grass or be landscaped and mulched with a 4-inch cover of hog fuel or shredded wood mulch. Shredded wood mulch is made from shredded tree trimmings, usually from trees cleared on site. The mulch should be free of garbage and weeds and should not contain excessive resin, tannin, or other material detrimental to plant growth. Multiple plantings and mulching may be required until vegetation has established itself. A bond may be required to guarantee vegetation stabilization for detention facilities.

Landscaping

Public and private storm drainage facilities should enhance natural appearances, protect significant cultural and natural resources, and be appropriate to the use of the site and the surrounding area. Landscaping shall be designed to screen the storm drainage facilities and create a natural-appearing setting while not adversely impacting the function and maintenance of the storm drainage facilities. A Landscape Plan with the Stormwater Site Plan is required for City review and approval.

Landscaping is required for all stormwater tract areas (see below for areas not to be landscaped). Landscaped stormwater tracts may, in some instances, provide a recreational space. In other instances, “naturalistic” stormwater facilities may be placed in open space tracts.

The following criteria shall be incorporated when designing landscaping for storm drainage facilities.

- Identify the type of landscaping and screening appropriate to the site taking into account zoning and proposed use. Landscaping and screening requirements are described in Auburn City Code (ACC) Title 18. The purpose of each type is to reflect the level of landscaping and screening density needed to maintain compatibility with the character of the neighborhood.
- An effort should be made to retain all significant trees on site, evergreens six inches (6”) or greater in diameter, or any deciduous tree four inches (4”) in diameter or greater as defined in ACC Title 18. Diameter measurements are taken at four feet (4’) above grade elevation. Authorization by the City is required for removal of any significant trees.
- Identify the soil type and hydrological regime or each portion of the storm drainage facility to determine appropriate site criteria for plant selection.
- Select tree and shrub species from the Plant Selection Guide contained herein. Plant choices must reflect the functional and aesthetic needs of the site. Fall planting is recommended for optimal acclimation and survivability. An irrigation system will be required for public ponds to insure plant establishment. Irrigation systems may also be needed for private ponds if plantings are done in the spring/summer or in times of limited precipitation, unless other watering provisions are established.
- Plant choices are not restricted to those listed in the Plant Selection Guide, but plant selection must be based on ease of maintenance, appropriateness to the use of the site (commercial, residential, or industrial), and survivability. Plant selection should correspond with street tree requirements and neighborhood character as appropriate. Selections are to be approved by the City during the review process. NOTE: Plants

identified in the Guide are predominately native and reflect the soil conditions and water regimes of the area.

- Develop a Landscape Plan to scale identifying the location and species of existing trees and the location and schedule of species, quantity and size of all proposed tree, shrubs, and ground covers. Drawings should be scaled at 1"=10' or 1"=20' to optimally relay information on the plant location and placement. Construction specifications should indicate appropriate soil amendments where necessary and planting specifications as recommended by the American Standards for Nursery Stock and the American National Standards Institute (ANSI).
- Excluding access points, a minimum of ten feet (10') width of Type-III landscaping in accordance with Auburn City Code 18.50 shall be provided around the exterior length of the pond. This width may be reduced to five feet (5') if the interior side slopes of the pond are landscaped.
- No tree and shrub planting is allowed with pipeline easements, traveled surfaces, or over underground utilities.
- No trees or shrubs shall be planted within 10 feet of inlet or outlet pipes or manmade drainage structures such as spillways or flow spreaders. Species with roots that seek water, such as willow or poplar, shall be avoided within 50 feet of pipes or manmade structures.
- Planting shall be restricted on berms that impound water either permanently or temporarily during storms. This restriction does not apply to cut slopes that form pond banks, only to berms.
    - Trees or shrubs may not be planted on portions of water-impounding berms taller than four feet high. Only grasses may be planted on berms taller than four feet.

      Grasses allow unobstructed visibility of berm slopes for detecting potential dam safety problems, such as animal burrows, slumping, or fractures in the berm.

    - Trees planted on portions of water-impounding berms less than 4 feet high must be small, not higher than 20 feet mature height, and must have a fibrous root system. Table III-2-11 gives some examples of trees with these characteristics developed for the Central Puget Sound.

  NOTE: The internal berm in a wetpond is not subject to this planting restriction since the failure of an internal berm would be unlikely to create a safety problem.

- All landscape material, including grass, shall be planted in topsoil. Native underlying soils may be made suitable for planting if amended with 4 inches of compost tilled into the subgrade. Compost used should meet specifications for Grade A compost quality. See http://www.ecy.wa.gov/programs/swfa/compost/
- For a naturalistic effect as well as ease of maintenance, trees of shrubs shall be planted in clumps to form "*landscape islands*" rather than planting evenly spaced.
- The landscaped islands shall be a minimum of six feet apart, and if set back from fences or other barriers, the setback distance should also be a minimum of 6 feet.

Where tree foliage extends low to the ground, the 6 feet setback should be counted from the outer drip line of the trees (estimated at maturity).

- This setback allows a 6-foot wide mower to pass around and between clumps.
- Evergreen trees and trees which produce relatively little leaf-fall (such as Oregon ash, mimosa, or locust) are preferred in areas draining to the pond.
- Trees should be set back so that branches do not extend over the pond (to prevent deposition of leaves into the pond).
- Drought tolerant species are recommended.

The following lists contain the suggested trees, plants and grasses to be used in landscaping storm drainage facilities. The trees and plants listed are native to the region and should be chosen over non-native species. The lists shown are not all-inclusive, additional trees and plants may be acceptable upon approval of the City.

Table III-2-11. Plant Selection Guide

Tree Selection Guide for Storm Drainage Detention/Retention Facilities				
Suggested Trees		Tolerates Wet to Saturated Soils	Recommend Moderately Wet to Dry Soils	Recommend Dry Soils
Botanical Name	**Common Name**			
Acer circinatum	Vine Maple			♦
Alnus rubra	Red Alder			♦
Betula papyrifera	Paper Birch	♦		
Corylus cornuta	Hazelnut			♦
Crataegus douglasii	Black Hawthorn			♦
Fraxinus latifolia	Oregon Ash	♦		
Picea sitchensis	Sitka Spruce	♦		
Pinus contorta	Shore Pine			♦
Pinus monticula	Western White Pine			♦
Populus tremuloides	Quaking Aspen	♦		
Prunus virginiana	Choke Cherry			♦
Pseudotsuga menziesii	Douglas Fir			♦
Salix lasiandra	Pacific Willow	♦		
Salix scouleriana	Scouler Willow		♦	
Salix sitchensis	Sitka Willow	♦		
Thuja pljcata	Western Red Cedar		♦	
Tsuga heterophylla	Western Hemlock			♦

Shrub Selection Guide for Storm Drainage Detention/Retention Facilities				
Suggested Shrubs		Tolerates Wet to Saturated Soils	Recommend Moderately Wet to Dry Soils	Recommend Dry Soils
Botanical Name	**Common Name**			
Amelanchier alnifolia	Serviceberry			♦
Cornus sericea	Red Osier Dogwood	♦		
Gaultheria shallon	Salal			♦
Holidiscus discolor	Ocean Spray			♦
Lonicera involucrata	Black Twinberry	♦		
Mahonia aquifolium	Tall Oregon Grape			♦
Mahonia repens	Low Oregon Grape			♦
Oemleria cerasiformis	Indian Plum			♦
Physocarpus capitatus	Pacific Ninebark	♦		
Ribes sanguineum	Red Flowering Currant			♦
Rosa nutkana	Nootka Rose		♦	
Rosa rugosa	Rugosa Rose	♦		
Rubus spectabilis	Salmonberry		♦	
Rubus spectabilis	Thimbleberry		♦	
Sambucus racemosa	Red Elderberry			♦
Symphoricarpos albus	Snowberry			♦
Vaccinium ovatum	Evergreen Huckleberry			♦
Vaccinium parviflorum	Red Huckleberry			♦

Perennial Groundcover Selection Guide for Storm Drainage Detention/Retention Facilities				
Suggested Perennial Groundcover		Tolerates Wet to Saturated Soils	Recommend Moderately Wet to Dry Soils	Recommend Dry Soils
Botanical Name	**Common Name**			
Athyrium filix-femina	Lady Fern		♦	
Dicentra formosa	Bleeding Heart			♦
Polystichum munitum	Sword Fern			♦

8.2.1.4 Wetpool Geometry

- Divide the wetpool into two cells separated by a baffle or berm. The first cell shall contain between 25 to 35 percent of the total wetpool volume. The baffle or berm volume shall not count as part of the total wetpool volume.
- Provide sediment storage in the first cell. The sediment storage shall have a minimum depth of 1-foot. Install a fixed sediment depth monitor in the first cell to gauge sediment accumulation unless an alternative gauging method is proposed.
- The minimum depth of the first cell shall be 4 feet, exclusive of sediment storage requirements. The depth of the first cell may be greater than the depth of the second cell.
- The maximum depth of each cell shall not exceed 8 feet (exclusive of sediment storage in the first cell). Plant pool depths of 3 feet or shallower (second cell) with emergent wetland vegetation (see planting requirements).
- Place inlets and outlets to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet shall be at least 3:1. The ***flowpath length*** is defined as the distance from the inlet to the outlet, as measured at mid-depth. The ***width*** at mid-depth can be found as follows: width = (average top width + average bottom width)/2.
- Wetponds with wetpool volumes less than or equal to 4,000 cubic feet may be single celled (i.e., no baffle or berm is required). However, it is especially important in this case that the flow path length be maximized. The ratio of flow path length to width shall be at least 4:1 in single celled wetponds, but should preferably be 5:1.
- All inlets shall enter the first cell. For multiple inlets, the length-to-width ratio shall be based on the average flowpath length for all inlets.
- Line the first cell in accordance with the liner requirements contained in Section 3.4.

8.2.1.5 Berms, Baffles, and Slopes

- A berm or baffle shall extend across the full width of the wetpool, and tie into the wetpond side slopes. If the berm embankments are greater than 4 feet in height, the berm must be constructed by excavating a key with dimensions equal to 50 percent of the embankment cross-sectional height and width. This requirement may be waived if recommended by a geotechnical engineer for specific site conditions. The geotechnical analysis shall address situations in which one of the two cells is empty while the other remains full of water.
- The top of the berm may extend to the WQ design water surface or be 1-foot below the WQ design water surface. If at the WQ design water surface, berm side slopes shall be 3H:1V. Berm side slopes may be steeper (up to 2H:1V) if the berm is submerged 1-foot.
- If good vegetation cover is not established on the berm, erosion control measures shall be used to prevent erosion of the berm back-slope when the pond is initially filled.

- The interior berm or baffle may be a retaining wall provided that the design is prepared and stamped by a licensed civil engineer. If a baffle or retaining wall is used, it shall be submerged one foot below the design water surface to discourage access by pedestrians.
- Criteria for wetpond side slopes are included in Section 3.3.

8.2.1.6 Embankments

Embankments that impound water must comply with the Washington State Dam Safety Regulations (Chapter 173-175 WAC). If the impoundment has a storage capacity (including both water and sediment storage volumes) greater than 10 acre-feet (435,600 cubic feet or 3.26 million gallons) above natural ground level, then dam safety design and review are required by the Department of Ecology. Contact Ecology for information about this regulation.

8.2.1.7 Inlet and Outlet

See Figure V-8-25 and Figure V-8-26 for details on the following requirements:

- Submerge the inlet to the wetpond with the inlet pipe invert a minimum of two feet from the pond bottom (not including sediment storage). The top of the inlet pipe shall be submerged at least 1-foot, if possible.
- Provide an outlet structure. Either a Type 2 catch basin with a grated opening ("jail house window") or a manhole with a cone grate ("birdcage") may be used (see Volume III, Figure III-2-9 for an illustration).
- The pond outlet pipe (as opposed to the manhole or type 2 catch basin outlet pipe) shall be back-sloped or have a down-turned elbow, and extend 1 foot below the WQ design water surface.
- Size the pond outlet pipe, at a minimum, to pass the on-line WQ design flow. The highest invert of the outlet pipe sets the WQ design water surface elevation.
- The overflow criteria for single-purpose (treatment only, not combined with flow control) wetponds are as follows:
    - The requirement for primary overflow is satisfied by either the grated inlet to the outlet structure or by a birdcage above the pond outlet structure.
    - The bottom of the grate opening in the outlet structure shall be set at or above the height needed to pass the WQ design flow through the pond outlet pipe. The grate invert elevation sets the overflow water surface elevation.
    - The grated opening and downstream conveyance shall be sized to pass the 100-year design flow. The capacity of the outlet system shall be sized to pass the peak flow for the conveyance requirements.
- Provide an emergency spillway and design it according to the requirements for detention ponds (see Volume III, Section 2.3.1).
- The City may require a bypass/shutoff valve to enable the pond to be taken offline for maintenance purposes.

- A gravity drain for maintenance is recommended if grade allows.
    - The drain invert shall be at least 6 inches below the top elevation of the dividing berm or baffle. Deeper drains are encouraged where feasible, but must be no deeper than 18 inches above the pond bottom.
    - The drain shall be at least 8 inches (minimum) diameter and shall be controlled by a valve. Use of a shear gate is allowed only at the inlet end of a pipe located within an approved structure.
    - Provide operational access to the valve to the finished ground surface.
    - The valve location shall be accessible and well marked with 1-foot of paving placed around the box. It must also be protected from damage and unauthorized operation.
    - A valve box is allowed to a maximum depth of 5 feet without an access manhole. If over 5 feet deep, an access manhole or vault is required.
- All metal parts shall be corrosion-resistant. Do not use galvanized materials.

8.2.1.8 Access and Setbacks

- All facilities shall be a minimum of 20 feet from any structure, property line, and any vegetative buffer required by the local government, and 100 feet from any septic tank/drainfield.
- All facilities shall be a minimum of 50 feet from any slope greater than 20 percent. A geotechnical report must address the potential impact of a wetpond on a slope steeper than 20% or if closer than 50 feet.
- Provide access and maintenance roads and designed them according to the requirements for detention ponds. Access and maintenance roads shall extend to both the wetpond inlet and outlet structures. An access ramp (7H minimum:1V) shall be provided to the bottom of the first cell unless all portions of the cell can be reached and sediment loaded from the top of the pond.
- The internal berm of a wetpond or combined detention and wetpond may be used for access if it is designed to support a loaded 80,000 pound truck considering the berm is normally submerged and saturated.

8.2.1.9 Planting Requirements

Planting requirements for detention ponds also apply to wetponds.

- Large wetponds intended for phosphorus control shall not be planted within the cells, as the plants will release phosphorus in the winter when they die off.
- If the second cell of a basic wetpond is 3 feet deep or shallower, the bottom area shall be planted with emergent wetland vegetation. See Table V-8-15 for recommended emergent wetland plant species for wetponds. The recommendations in Table V-8-15 are for all of western Washington. Local knowledge should be used to tailor this information to Auburn as appropriate.

- Cattails (Typha latifolia) shall not be used because they tend to crowd out other species and will typically establish themselves anyway.
- If the wetpond discharges to a phosphorus-sensitive lake or wetland, shrubs that form a dense cover should be planted on slopes above the WQ design water surface on at least three sides. Native vegetation species shall be used in all cases.

8.2.1.10 Recommended Design Features

The following features should be incorporated into the wetpond design where site conditions allow:

- The method of construction of soil/landscape systems can cause natural selection of specific plant species. Consult a soil restoration or wetland soil scientist for site-specific recommendations. The soil formulation will impact the plant species that will flourish or suffer on the site, and the formulation should be such that it encourages desired species and discourages undesired species.
- For private wetpond facilities, it is recommended that some form of recirculation be provided, such as an aerator, to prevent stagnation and low dissolved oxygen conditions. Recirculation is required for all public wetpond facilities.
- A flow length-to-width ratio greater than the 3:1 minimum is desirable. If the ratio is 4:1 or greater, then the dividing berm is not required, and the pond may consist of one cell rather than two. A one-cell pond must provide at least 6-inches of sediment storage depth.
- A tear-drop shape, with the inlet at the narrow end, rather than a rectangular pond is preferred since it minimizes dead zones caused by corners.
- A small amount of base flow is desirable to maintain circulation and reduce the potential for low oxygen conditions during late summer.
- Evergreen or columnar deciduous trees along the west and south sides of ponds are recommended to reduce thermal heating, except that no trees or shrubs may be planted on berms meeting the criteria of dams regulated for safety. In addition to shade, trees and shrubs also discourage waterfowl use and the attendant phosphorus enrichment problems they cause. Trees should be set back so that the branches will not extend over the pond.
- The number of inlets to the facility should be limited; ideally there should be only one inlet. The flowpath length should be maximized from inlet to outlet for all inlets to the facility.
- The access and maintenance road could be extended along the full length of the wetpond and could double as play courts or picnic areas. Placing finely ground bark or other natural material over the road surface would render it more pedestrian friendly.

- The following design features should be incorporated to enhance aesthetics where possible:
  - Provide pedestrian access to shallow pool areas enhanced with emergent wetland vegetation. This allows the pond to be more accessible without incurring safety risks.
  - Provide side slopes that are sufficiently gentle (3H:1V or flatter).
  - Create flat areas overlooking or adjoining the pond for picnic tables or seating that can be used by residents. Walking or jogging trails around the pond are easily integrated into site design.
  - Include fountains or integrated waterfall features for privately maintained facilities.
  - Provide visual enhancement with clusters of trees and shrubs. On most pond sites, it is important to amend the soil before planting since ponds are typically placed well below the native soil horizon in very poor soils. Make sure dam safety restrictions against planting do not apply.
  - Orient the pond length along the direction of prevailing summer winds (typically west or southwest) to enhance wind mixing.

Table V-8-15. Emergent Wetland Species Recommended for Wetponds

Species	Common Name	Notes	Maximum Depth
INUNDATION TO 1-FOOT			
Agrostis exarata[1]	Spike bent grass	Prairie to coast	2 feet
Carex stipata	Sawbeak sedge	Wet ground	
Eleocharis palustris	Spike rush	Margins of ponds, wet meadows	2 feet
Glyceria occidentalis	Western mannagrass	Marshes, pond margins	2 feet
Juncus tenuis	Slender rush	Wet soils, wetland margins	
Oenanthe sarmentosa	Water parsley	Shallow water along stream and pond margins; needs saturated soils all summer	
Scirpus atrocinctus (formerly S. cyperinus)	Woolgrass	Tolerates shallow water; tall clumps	
Scirpus microcarpus	Small-fruited bulrush	Wet ground to 18 inches depth	18 inches
Sagittaria latifolia	Arrowhead		
Inundation 1 to 2 feet			
Agrostis exarata[1]	Spike bent grass	Prairie to coast	
Alisma plantago-aquatica	Water plantain		
Eleocharis palustris	Spike rush	Margins of ponds, wet meadows	
Glyceria occidentalis	Western mannagrass	Marshes, pond margins	
Juncus effuses	Soft rush	Wet meadows, pastures, wetland margins	
Scirpus microcarpus	Small-fruited bulrush	Wet ground to 18 inches depth	18 inches
Sparganium emmersum	Bur reed	Shallow standing water, saturated soils	
Inundation 1 to 3 feet			
Carex obnupta	Slough sedge	Wet ground or standing water	1.5 to 3 feet
Beckmania syzigachne[1]	Western sloughgrass	Wet prairie to pond margins	
Scirpus acutus[2]	Hardstem bulrush	Single tall stems, not clumping	3 feet
Scirpus validus[2]	Softstem bulrush		
Inundation GREATER THAN 3 feet			
Nuphar polysepalum	Spatterdock	Deep water	3 to 7.5 feet
Nymphaea odorata[1]	White waterlily	Shallow to deep ponds	6 feet

[1] Non-native species. Beckmania syzigachne is native to Oregon. Native species are preferred.

[2] Scirpus tubers must be planted shallower for establishment, and protected from foraging waterfowl until established. Emerging aerial stems should project above water surface to allow oxygen transport to the roots.

Primary sources: *Municipality of Metropolitan Seattle, Water Pollution Control Aspects of Aquatic Plants*, 1990. *Hortus Northwest, Wetland Plants for Western Oregon*, Issue 2, 1991. Hitchcock and Cronquist, *Flora of the Pacific Northwest*, 1973.

8.2.3.5 Wetland Geometry

1. Stormwater wetlands shall consist of two cells, a presettling cell and a wetland cell.
2. The presettling cell shall contain approximately 33 percent of the wetpool volume calculated in Step 1 above.
3. The depth of the presettling cell shall be between 4 feet (minimum) and 8 feet (maximum), excluding sediment storage.
4. Provide one-foot of sediment storage in the presettling cell.
5. The wetland cell shall have an average water depth of about 1.5 feet (plus or minus 3 inches).
6. Shape the "berm" separating the two cells such that its downstream side gradually slopes to form the second shallow wetland cell (see the section view in Figure V-8-32). Alternatively, the second cell may be graded naturalistically from the top of the dividing berm (see Step 8 below).
7. The top of the berm shall be either at the WQ design water surface or submerged 1 foot below the WQ design water surface. Correspondingly, the side slopes of the berm must meet the following criteria:
    a. If the top of berm is at the WQ design water surface, the berm side slopes shall be no steeper than 3H:1V.
    b. If the top of berm is submerged 1-foot, the upstream side slope may be up to 2H:1V.
8. Grade the bottom of the wetland cell in one of two ways:
    a. Shallow evenly graded slope from the upstream to the downstream edge of the wetland cell (see Figure V-8-32).
    b. A "naturalistic" alternative, with the specified range of depths intermixed throughout the second cell (see Figure V-8-33). A distribution of depths shall be provided in the wetland cell depending on whether the dividing berm is at the water surface or submerged (see Table V-8-16).

    The maximum depth shall be 2.5 feet in either configuration.

8.2.3.6 Lining Requirements

In infiltrative soils, line both cells of the stormwater wetland. To determine whether a low-permeability liner or a treatment liner is required, determine whether the following conditions will be met. If soil permeability will allow sufficient water retention, lining may be waived.

1. The second cell must retain water for at least 10 months of the year.
2. The first cell must retain at least three feet of water year-round.

3. Use a complete precipitation record when establishing these conditions. Take into account evapo-transpiration losses as well as infiltration losses. Many wetland plants can adapt to periods of summer drought, so a limited drought period is allowed in the second cell. This may allow a treatment liner rather than a low permeability liner to be used for the second cell. The first cell must retain water year-round in order for the presettling function to be effective.

4. If a low permeability liner is used, place a minimum of 18 inches of native soil amended with good topsoil or compost (one part compost mixed with 3 parts native soil) over the liner. For geomembrane liners, a soil depth of 3 feet is recommended to prevent damage to the liner during planting. Hydric soils are not required.

The criteria for liners given in Chapter 3 must be observed.

8.2.3.7 Inlet and Outlet

Same as for wetponds (see BMP T1010).

8.2.3.8 Access and Setbacks

- Location of the stormwater wetland relative to site constraints (e.g., buildings, property lines, etc.) shall be the same as for detention ponds (see Volume III). See Chapter 3 for typical setback requirements for WQ facilities.
- Provide access and maintenance roads and design them according to the requirements for detention ponds (see Volume III). Extend access and maintenance roads shall to both the wetland inlet and outlet structures. Provide an access ramp (7H minimum:1V) to the bottom of the first cell unless all portions of the cell can be reached and sediment loaded from the top of the wetland side slopes.
- The internal berm of a stormwater treatment wetland may be used for access if it is designed to support a loaded 80,000 pound truck considering the berm is normally submerged and saturated.