City of Auburn Supplemental Manual to 2019 Stormwater Management Manual for Western Washington

Volume I – What Requirements Apply to My Site?

Volume II – Construction Stormwater Pollution Prevention

Volume III – Choosing, Modeling, and Documenting Your BMPs

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City of Auburn Departments of Public Works and Community Development

Effective Date: 2/9/2023

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Volume I

What Requirements Apply to My Site?

City of Auburn Supplemental Manual

I-1 – Introduction to Stormwater Management in Western Washington

I-1.1 About This Manual

The COA Supplemental Manual to the 2019 Department of Ecology's (Ecology) Stormwater Management Manual for Western Washington (SWMMWW) provides additional requirements and guidance for applying the Minimum Requirements for stormwater management to all new development and redevelopment projects. These two documents together are referred to as the COA Surface Water Management Manual (SWMM), as defined in Chapter 12.04.010 of the ACC. The SWMM is the manual of the specific requirements related to storm drainage management in the COA.

Each volume of the COA Supplemental Manual is organized to correspond to the same volume in the SWMMWW.

Each topic is identified with the volume number followed by the chapter and section (e.g., III-3.2 refers to Volume 3, Chapter 3, Section 2 of the SWMMWW or COA Supplemental Manual). Best Management Practices (BMP) are grouped by activity in Volumes 2, 4, and 5 (e.g., IV-2 refers to Volume 4, Section 2 which addresses Cleaning or Washing Source Control BMPs).

The Ecology SWMMWW is available online at the link below:

2019 SWMMWW

General additions and/or changes to the SWMMWW contained in this Volume include:

- **I-2.15: Other Requirements** contains Auburn's regulatory authority to require stormwater management systems to prevent pollution of State waters.
- **I-3: Minimum Requirements for New Development and Redevelopment** contains clarifications, additional information regarding exceptions/exemptions to the Minimum Requirements, and additions to the Minimum Requirements:
    - **I-3.1** provides additional requirements for multiple properties that share private storm drainage facilities.
    - **I-3.2** provides additional definitions and clarifications for projects exempt from all or part of the Minimum Requirements.
    - **I-3.3** provides guidelines about when additional requirements to the Minimum Requirements are required.
    - **I-3.4.1 – I-3.4.9** provide additional COA requirements and guidance for meeting Minimum Requirements #1 through #9.
    - **I-3.4.10** includes the additional Minimum Requirement #10 – Off-Site Analysis and Mitigation, applicable to projects meeting the thresholds for Minimum Requirements #1 through #5 and #1 through #9.
    - **I-3.5** clarifies the existing COA policies that are related to the Additional Protective Measures (Optional) contained in that Section of the SWMMWW.

    - **I-3.6** contains information on Exceptions/Variances to the Minimum Requirements within the COA.
- **Appendix I-F: Glossary and Notations -** contains additional definitions of terms used throughout the SWMMWW and the COA Supplemental Manual.
- **Additional Appendices** contained in the COA Supplemental Manual include:
    - **Supplemental Appendix I-G: City of Auburn Areas with Special Development Requirements** identifies geographic areas within the COA and the requirements specific to those areas.
    - **Supplemental Appendix I-H: On – Site Stormwater Management BMP List Option Infeasibility Criteria** provides infeasibility criteria for use in evaluating BMPs to meet Minimum Requirement #5: On-Site Stormwater Management using the List Option.
    - **Supplemental Appendix I-I: Stormwater Site Plan Report Submittal Requirements Checklist is** presented to assist with meeting the COA submittal requirements for Stormwater Site Plan Reports.
    - **Supplemental Appendix I-J: Stormwater Facility Access Requirements** provides COA access and easement requirements for stormwater facility design.

I-2 – Relationship of This Manual to Permits, Requirements, and Programs

I-2.15 Other Requirements

The two main general stormwater permits relevant to the use of this Volume are:

- **The Phase II Municipal Stormwater General Permit** requires the COA to adopt ordinances and other enforceable mechanisms that implement stormwater controls for new development and redevelopment, including stormwater management of construction sites. The City is responsible for the enforcement of the ordinances and other enforceable mechanisms required by this permit.
- **The Construction Stormwater General Permit,** the requirements of which are outlined in I-2.7.

Project proponents are required to obtain all applicable COA permits for construction activities. Contact the Permit Center at 253-931-3020 or online at development@auburnwa.gov for more information on required permits.

City of Auburn Codes and Ordinances

The following summarizes ACC that applies to surface water and pollution control. The complete code may be found online at: https://auburn.municipal.codes/

- **Chapter 8.08 ACC** Solid Waste
- **Chapter 12.20 ACC** Driveways

- **Title 13 ACC** Water, Sewer and Public Utilities
- **Chapter 13.48 ACC** Storm Drainage Utility
- **Section 13.48.330 ACC** Off-site Improvements
- **Title 14 ACC** Project Review
- **Chapter 15.74 ACC** Land Clearing, Filling and Grading
- **Title 16 ACC** Environment
- **Chapter 16.08 ACC** Shoreline Regulation
- **Chapter 16.10 ACC** Critical Areas
- **Title 17 ACC** Subdivision
- **Title 18 ACC** Zoning

I-3 – Minimum Requirements for New Development and Redevelopment

These requirements are codified in Chapter 13.48 of the ACC. New development and redevelopment projects may also be subject to other City code requirements, depending on the nature and location of the project. These code requirements may include, but are not limited to:

- **Chapter 12.20 ACC –** Driveways
- **Title 14 ACC –** Project Review, Land Adjustments and Divisions
- **Chapter 15.74 ACC –** Land Clearing, Filling, and Grading
- **Chapter 16.08 ACC –** Shoreline Management, Administrative, and Permitting Procedures
- **Chapter 16.10 ACC –** Critical Areas
- **Title 17 ACC –** Land Adjustments and Divisions

I-3.1 Introduction to the Minimum Requirements

Private stormwater facilities shared by multiple properties require private cross drainage easement(s) and maintenance agreement(s) or other binding instruments, such as plat conditions. Copies of said easements, agreements or other binding instruments must be provided to the City prior to civil plan approval.

I-3.2 Exemptions

Pavement Maintenance

When replacing or expanding public sidewalk in the City owned right of way, Minimum Requirements #1 through #5 apply to the replaced sidewalk. The expanded public sidewalk is subject to Minimum Requirements #1 through #10.

Underground Utility Projects

Underground utility projects include, but are not limited to, installation of underground detention or storm conveyance systems that are required due to other ground disturbing activities.

Additional Exemptions to the Minimum Requirements for the City of Auburn:

Oil and Gas Field Activities or Operations

Per Appendix I of the Ecology Western Washington Phase II Municipal Stormwater Permit, construction of drilling sites, waste management pits, and access roads, as well as construction of transportation and treatment infrastructure such as pipelines, natural gas treatment plants, natural gas pipeline compressor stations, and crude oil pumping stations are exempt from meeting the Minimum Requirements. Operators are encouraged to implement and maintain BMPs to minimize erosion and control sediment during and after construction activities to help ensure protection of surface water quality during storm events.

Minor Clearing and Grading

The following minor clearing and grading activities are exempt from all the Minimum Requirements, except for Minimum Requirement #2 – Construction Stormwater Pollution Prevention, unless located within a critical or sensitive area governed by the City's Critical Areas Ordinance, found in Chapter 16.10 of the ACC. Information on Critical Areas is available through Community Development Services in the Community Development Department at (253) 931-3090.

- Activities qualifying for a Minor Grading Permit, where the 2,000 SF threshold for new or replaced hard surfaces is exceeded due to underground utility work;
- Excavation for wells and exploratory excavations under the direction of soil engineers or engineering geologists licensed in Washington State; fill made with the material from these excavation activities remains subject to the Minimum Requirements and the City's Land Clearing, Filling and Grading requirements per Chapter 15.74 of the ACC;
- Removal of hazardous trees;
- Removal of trees or other vegetation that cause sight distance obstructions at intersections;
- Minor clearing and grading associated with cemetery graves;
- Land clearing associated with routine maintenance by public utility agencies, as long as appropriate vegetation management practices are followed as described in the Best Management Practices of the Regional Road Maintenance Endangered Species Act Program Guidelines located at http://www.wsdot.wa.gov/maintenance/roadside/esa.htm

Emergencies

Emergency projects which, if not performed immediately, would substantially endanger life or property, are exempt, only to the extent necessary to meet the emergency. Emergency activities may include, but are not limited to: sandbagging, diking, ditching, filling, or similar work during or after periods of extreme weather; and road reconstruction to restore damage from a flood, earthquake, landslide, volcanic activity, or other natural disaster. Permits authorizing the emergency work may be required after completion of the emergency project.

I-3.3 Applicability of the Minimum Requirements

All New Development projects and all redevelopment projects in the COA that meet the thresholds for Minimum Requirements #1 through #5 or #1 through #9 are also required to meet Minimum Requirement #10 – Off-Site Analysis and Mitigation. See I-3.4.10 of this COA Supplemental Manual for information regarding Minimum Requirement #10.

I-3.4 Minimum Requirements (MRs)

I-3.4.1 MR1: Preparation of Stormwater Site Plans

To assist with meeting the submittal requirements of the Stormwater Site Plan (SSP) report, a SSP report outline and checklist is provided in Appendix I-I.

I-3.4.2 MR2: Construction Stormwater Pollution Prevention (SWPPP)

A complete Construction Stormwater Pollution Prevention Plan (SWPPP) is required for projects that:

- Grade/Fill greater than 500 cubic yards of material, or
- Disturb critical areas or buffers.

Projects that are required to submit a complete Construction SWPPP must use the most current version of Ecology's Construction SWPPP Template, available at:

http://www.ecy.wa.gov/programs/wq/stormwater/construction/

A Construction SWPPP Short Form is discussed in Appendix II-B. A fillable version of the Construction SWPPP Short Form is also available on the City's website under "Civil" permit applications at the following link:

https://www.auburnwa.gov/forms

For more information on SWPPP submittal requirements refer to Chapter II-2.

I-3.4.3 MR3: Source Control of Pollution

Source Control BMPs are used to control long-term pollutant sources from many practices in commercial, industrial, and residential settings. Volume IV contains long-term Source Control BMPs for these practices. The BMP resources available in Volume IV shall be used to develop a comprehensive SSP report by including these BMPs in the Permanent Stormwater Control Plan section of that report (see Chapter III-3). Including and implementing the Source Control BMPs found in Volume IV is a required component of the SSP report that will be submitted to the City for review and approval. It is also required to include these Source Control BMPs in the

Operations and Maintenance Manual that is prepared in compliance with Minimum Requirement #9 – Operation and Maintenance and included in the SSP report.

Additional Source Control BMPs are found in Volume II. These BMPs are specific to source control of pollution during the construction process. Source Control BMPs for construction shall be included as part of the Construction SWPPP that is prepared in compliance with Minimum Requirement #2 – Construction Stormwater Pollution Prevention. Refer to Volume II for complete information on construction Source Control BMPs and the Construction SWPPP.

I-3.4.4 MR4: Preservation of Natural Drainage Systems and Outfalls

No Additional Guidelines or Requirements.

I-3.4.5 MR5: On-Site Stormwater Management

Flow Control Exception

Flow Control Exception in accordance with Section I-3.4.7, as it relates to Minimum Requirement #5, requires approval from the City Engineer per the Exceptions procedure of ACC 13.48 Projects that have received approval from the City Engineer for a Flow Control Exemption may meet Minimum Requirement #5 as described in Section I-3.4.5.

All land within the COA is located within the Urban Growth Area (UGA); therefore, the second and third requirements in Table I-3.1 of the SWMMWW do not apply.

Figure I-3.3A Flow Chart for Determining LID MR #5 Requirements in the City of Auburn below, based on Figure I-3.3, provides guidance in considering the options available for complying with Minimum Requirement #5.

Project proponents that must satisfy Minimum Requirement #5 can choose to employ the On-Site Stormwater Management BMPs from Lists #1 or #2, as required by the project size, or meet the Low Impact Development (LID) Performance Standard.

Applying the List Option

When choosing the List option, each On-Site Stormwater Management BMP must be considered for each surface in the order they are given for the appropriate List. A BMP must be determined to be infeasible prior to continuing to the next BMP for that surface on the List. Per Minimum Requirement #1 and Chapter III-3 (Stormwater Site Plans), any BMPs from the list that have been determined to be infeasible for the project must include documentation of the infeasibility within the SSP report. Where appropriate, the infeasibility documentation should include citations of site conditions identified in a geotechnical report. Refer to Appendix I-H for more information on List Option LID BMP infeasibility.

Once an On-Site Stormwater Management BMP from List #1 or #2 is considered feasible, this BMP is applied to the project. On-Site Stormwater Management BMPs must be applied in

accordance with the specified design criteria. No further consideration of BMPs on the List is required for that surface, and the remaining BMPs for that surface on the List that are below the applied BMP do not require documentation of infeasibility. The BMPs for each surface type must be evaluated for feasibility. If all BMPs from the List have been found to be infeasible, Minimum Requirement #5 has been met and no further action is required. Projects that have satisfied Minimum Requirement #5 through the List option are not required to meet the LID Performance Standard, even if all LID BMPs have been determined to be infeasible.

Applying the LID Performance Standard Option

Project proponents must demonstrate compliance with the LID Performance Standard using any facility or combination of facilities that are approved by the City. Facilities are not limited to the On-Site Stormwater Management BMPs from the List Option. Rain Gardens cannot be used when selecting this option. Compliance with the LID Performance Standard must be shown using the most current version of the Western Washington Hydraulic Model (WWHM). Model results must be included in the appropriate section of the SSP report and submitted to the City. Refer to Chapter III-2 for more information on hydrologic modeling requirements.

Projects that must apply only Minimum Requirements #1 through #5 and #10 <u>are not</u> required to implement BMP T5.13 Post – Construction Soil Quality and Depth when the LID Performance Standard option is applied. Projects that must apply Minimum Requirements #1 through #9 and #10 <u>are</u> required to implement BMP T5.13, if feasible, when the LID Performance Standard option is applied.

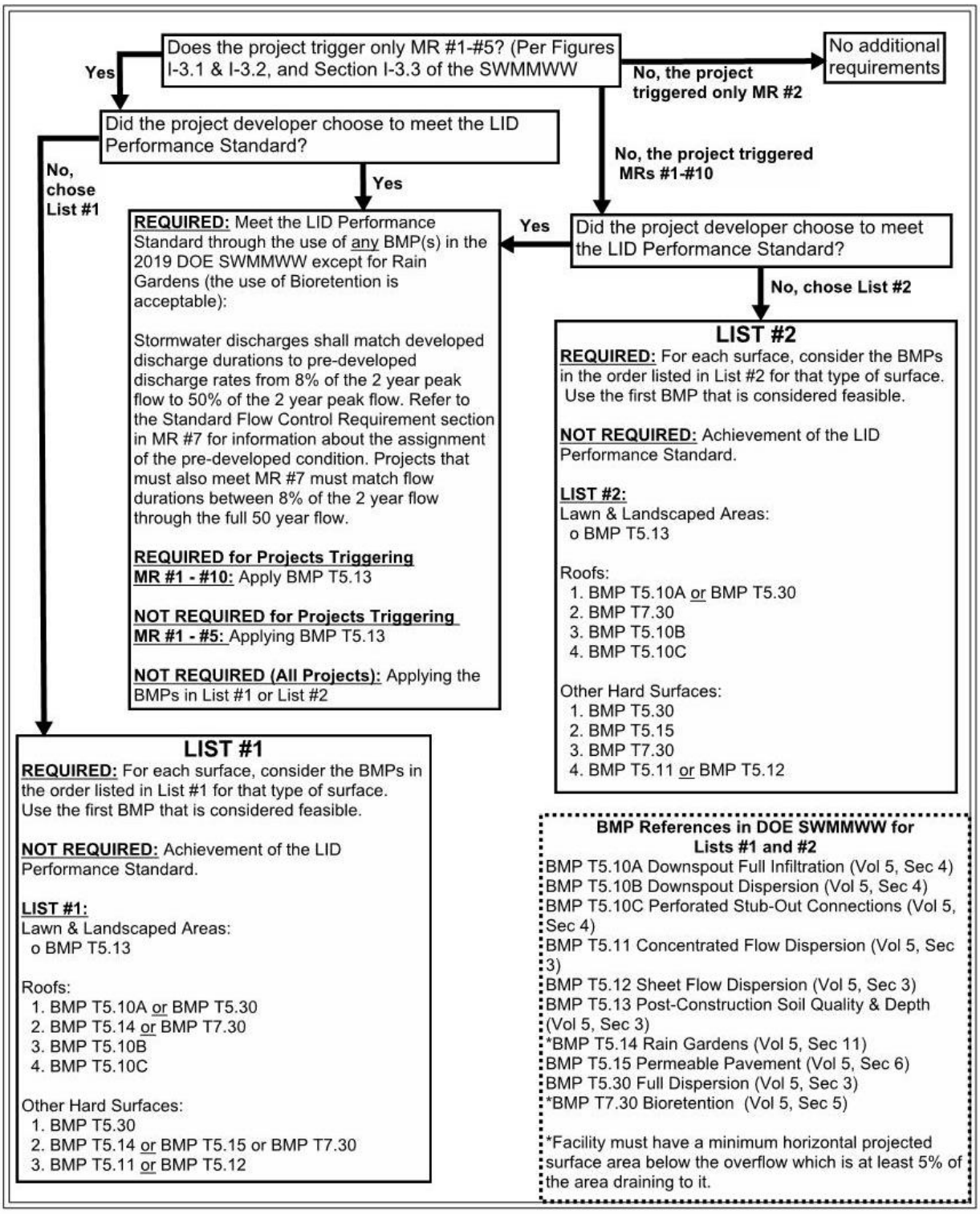


Figure I-3.3A Flow Chart for Determining LID MR #5 Requirements in the City of Auburn

I-3.4.6 MR6: Runoff Treatment

Infiltration of any amount of runoff from a Pollution Generating Surface within Groundwater Protection Zones 1 and 2 requires the approval of the City Engineer, and at a minimum requires that the site not be classified as a “high-use site” per the Glossary and runoff from the Pollution Generating Surface must undergo Enhanced Treatment, prior to entering an infiltration facility, per III-1.2.

I-3.4.7 MR7: Flow Control

Infrastructure Protection Requirement

The infrastructure protection requirement is intended to mitigate stormwater impacts from projects that are not required to provide flow control, but that discharge to a system with downstream capacity limitations.

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 pre-existing conditions.

Flow Control Exemption

Flow Control Exemption requires approval from the City Engineer per the Exceptions procedure of ACC 13.48.

Please Note: The Green River identified in Appendix I-A is identified as WRIA 26 in Cowlitz County, Washington. This river is not the Green River located in the COA, and flow control exemption does not apply to projects that discharge directly to the Green River within the COA.

Per Figure I-3.4, the COA does not contain any areas that are recognized by the Department of Ecology as a basin with 40% or more of total impervious area as of 1985. Pre-existing site conditions shall be modeled using Forested conditions unless reasonable, historic evidence exists showing that the area should be modeled as Prairie.

I-3.4.8 MR8: Wetlands Protection

Stormwater discharges to wetlands are regulated under the City’s Critical Areas Ordinance. See Chapter 16.10 of the ACC.

These requirements are in addition to the requirements given in Chapter 16.10 of the ACC and apply only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system. These requirements must be met in addition 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.

For more information about wetlands, wetland permits and development close to wetlands, please contact the Community Development Department at (253) 931-3090.

I-3.4.9 MR9: Operation and Maintenance

The Operations and Maintenance Manual is a component of the SSP report, but it should be prepared as a stand-alone document. The Operations and Maintenance Manual for privately maintained facilities shall be retained on-site and transferred with the ownership of the property with the Stormwater Easement and Maintenance Agreement per Section 13.48.435 of the ACC. The Operations and Maintenance Manual for public facilities shall be provided to the City and retained within the appropriate department. Guidance for developing the Operations and Maintenance Manual is available in multiple locations. Important sections include:

- **Appendix V-A** contains maintenance standards for drainage facilities
- **Volumes II, IV, and V** contain sections on maintenance in the description of each BMP
- **Volume IV** contains source control BMPs that can be included in the operations and maintenance manual where applicable
- **III-3.2** contains an overview of operations and maintenance manual requirements
- **Appendix I-I** SSP Checklist provides key components on completing the Operations and Maintenance Manual for submittal

I-3.4.10 MR10: Off-Site Analysis and Mitigation

Minimum Requirement #10 is required for all projects meeting the project thresholds and criteria for Minimum Requirements #1 through #5 and #1 through #9, unless the project discharges directly into a flow-control exempt water, as defined in SWMMWW Appendix I-A.

Projects with offsite discharge are required to make a connection to the closest available component of the municipal storm system, or otherwise designated component of the municipal storm system. If multiple connections to a component of the municipal storm system are possible, the following priority list should be used: 1) catch basin, 2) stormwater management pond, 3) ditch, 4) natural feature. If it can be demonstrated that a connection to the developed storm system is infeasible for the project location, an outfall to existing stormwater courses is permissible, provided that all other minimum requirements have been met, and an appropriate outfall structure, as identified in Appendix III-D.5, is implemented.

Development projects that discharge stormwater off-site, to the municipal storm system or otherwise, shall submit as part of their SSP 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. A quantitative analysis may be required where there are known downstream flow

constraints or there are known or suspected drainage issues downstream from the proposed development.

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 on-site and off-site 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 on-site drainage facilities. Details on how to perform this analysis and submittal requirements are located in Appendix I-I.3.

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 Appendix III-D.

Objective

To identify and evaluate off-site 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. Aggravating 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. Off-site 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.

I-3.5 Additional Protective Measures (APM) (Optional)

I-3.5.2 APM1: Financial Liability

The following information regarding Financial Liability and bonding shall supersede the APM1 in I-3.5.2:

Per ACC, performance and maintenance bonding is required for constructing public stormwater facilities within the COA.

I-3.5.3 APM2: Off Site Analysis Report

The off-site analysis and mitigation requirements described in I-3.4.10 in this COA Supplemental Manual shall supersede the APM 2 in I-3.5.3. Minimum Requirement #10 – Off Site Analysis and Mitigation is required in the COA for projects that meet the thresholds for Minimum Requirements #1 through #5 and #1 through #9.

I-3.6 Adjustments and Exceptions/Variances to the MRs

Exceptions from the Minimum Requirements

Deviations from the Minimum Requirements may be requested in writing, in accordance with Chapter 13.48 of the ACC.

Exceptions from COA Engineering Design Standards

Deviations from any COA Engineering Design Standards requires approval by the City Engineer through the General Deviation request process outlined in Chapter 1 of the COA Engineering Design Standards.

Appendix I-F Glossary and Notations

The following terms and acronyms are provided as reference for use in addition to those available in the SWMMWW.

AC
Asphalt Concrete – pavement consisting of a composite mixture of aggregate and asphalt.

ACC
Auburn City Code – the codification of ordinances for the COA, Washington.

ADT
Average Daily Traffic means the volume of traffic passing a point or segment of a highway, in both directions, during a period of time, divided by the number of days in the period and factored to represent an estimate of traffic volume for an average day of the year.

COA
City of Auburn, Washington.

City of Auburn Engineering Design Standards
The Engineering Design Standards and details developed and adopted by the City of Auburn, Washington Public Works Department.

Groundwater Protection Zone
Land areas designated by the COA, Washington beneath which groundwater occurs that is a current or potential future source of drinking water for the City.

SSP

Stormwater Site Plan – a comprehensive report containing all of the technical information and analysis necessary for the COA to evaluate a proposed new development or redevelopment for compliance with the stormwater requirements.

Appendix I-G City of Auburn Areas with Special Development Requirements

This Appendix identifies geographic areas within the COA and the requirements specific to those areas. These requirements shall be in addition to the Minimum Requirements found in Chapter 3 of this Volume unless the text specifically indicates that the area-specific requirement supersedes or replaces a Minimum Requirement.

Groundwater Protection Areas 1 and 2

In 2005, the COA adopted the Critical Areas Ordinance, Chapter 16.10 of the ACC, which formally designates Groundwater Protection Areas (Zones) within the COA. Groundwater Protection Zones 1 and 2 represent the land area, See Figure I-H-1 below, which the principal aquifer used by the City for water supply is, overlain by highly permeable sand and gravel deposits. These geologic conditions provide a direct pathway for contaminants that may be released to the soil to reach the aquifer.

Private infiltration systems used in Groundwater Protection Zones 1 and 2 that receive stormwater from any Pollution Generating Surface including streets, parking areas, or galvanized roofs are prohibited, unless approved by the City Engineer or designee per the General Deviation requirements in Chapter 1 of the COA Engineering Design Standards. To receive approval, a Pollution Generating Surface must not be classified as a “high-use site” per the Glossary and runoff from the Pollution Generating Surface must undergo Enhanced Treatment, prior to discharge into the infiltration facility per Volume V. In such case, a private disposal system may be approved.

Impaired Water Bodies

Section 305(b) of the Clean Water Act (CWA) requires the Department of Ecology to prepare a report every two years on the status of the overall condition of the state’s waters. Section 303(d) of the CWA requires Ecology to prepare a list every two years containing water bodies not expected to meet state surface water quality standards after implementation of technology-based controls. The State is then required to complete a TMDL for all water on that list. The existing list and other related information are available on Ecology’s water quality website:

http://www.ecy.wa.gov/programs/wq/links/wq_assessments.html

If a project site discharges to one of these listed water bodies, additional treatment or flow control requirements may apply.

Floodplains

Floodplains are not regulated. However, stormwater facilities proposed within floodplains will be reviewed on a case-by-case basis to determine if the facilities are acceptable. Additional analysis and requirements may be needed for stormwater facilities located within floodplains. Refer to ACC 15.68 for additional guidance.

Airport Operations

Open water in stormwater facilities may attract birds and other wildlife, which can pose a hazard for aircraft.

The following requirements apply to any parcel located within Airport Zones 1, 2, and 5 for the COA Municipal Airport, as defined in Chapter 18.38 of the ACC. See www.auburnwa.gov/maps for Zoning Map and for Airport Overlay Map. Any stormwater facilities that are situated within the boundaries of these zones must use underground vaults, underground detention/infiltration facilities, or LID facilities that drain completely within 48 hours. Open stormwater ponds are not allowed.

Appendix I-H On – Site Stormwater Management BMP List Option Infeasibility Criteria

This Appendix summarizes infeasibility criteria provided in the SWMMWW for evaluating BMPs when applying the List Option to meet Minimum Requirement #5 – On-Site Stormwater Management. Projects that chose to meet the LID Performance Standard may use any BMP or facility in the SWMMWW to achieve that standard, except Rain Gardens. Projects that chose the List #1 or #2 option to comply with Minimum Requirement #5 must select On-Site Stormwater Management BMPs from the applicable list and consider them in the order given. If a BMP is found to be infeasible based on the criteria for that BMP, consider the next BMP on the applicable list. Refer to Section I-3.4.5 to determine which On-Site Stormwater Management BMPs require evaluation for a project. Evaluation is based on project type, discharge location, and other criteria.

Prior to evaluating On-Site Stormwater Management BMPs, review the site design considerations in III-3 to conserve natural areas, retain native vegetation, reduce impervious surfaces, and integrate stormwater controls into the existing site layout to the extent feasible. Also consider the design criteria for individual BMPs as given in the SWMMWW and amended in this COA Supplemental Manual.

The Infeasibility Criteria summarized below apply to BMPs when selecting the List Option, if the area proposed for the BMP is the only available area for the BMP, after all reasonable efforts to regrade the site and allow for alternative placement of the BMP have been made.

When using the On-Site Stormwater Management List Option, an On-Site BMP is considered infeasible if any one infeasibility criteria for that BMP is met. Citation of infeasibility when using the List Option is a component of the SSP report. Refer to III-3 and Appendix I-H for more information on the SSP report and documenting infeasibility criteria.

Through historical data and existing topography, the COA has defined specific areas where On – Site Stormwater Management BMPs that require infiltration are restricted or limited, illustrated in Figure I-H-1 Map of Infiltration Restriction Areas below. Projects located in Groundwater Protection Zones 1 and 2 require Enhanced Treatment and approval from the City Engineer to use infiltrative BMPs for managing stormwater from pollution generating surfaces. Other areas are identified as infeasible for infiltrative List Option On-Site Stormwater Management BMPs based on slope proximity, typical groundwater elevations, proximity to critical areas, and other site-specific criteria. Contact the Public Works Department at (253)-931-3010 for more information and assistance in identifying areas where List Option On-Site Stormwater Management Infiltration BMPs are restricted.

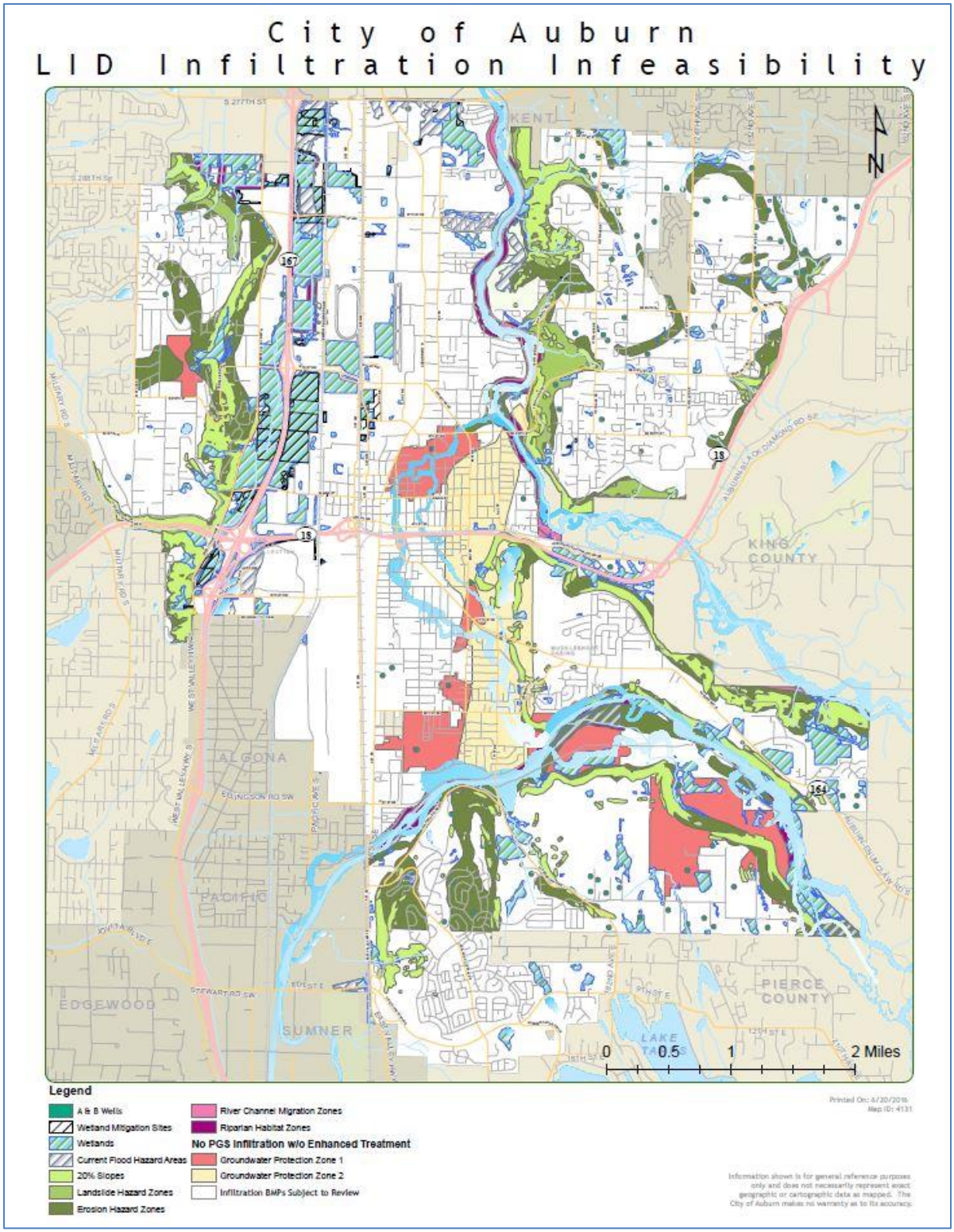


Figure I-H-1 Map of Infiltration Restriction Areas

On-Site Stormwater Management BMP Infeasibility Summary

BMP T5.13 Post-Construction Soil Quality and Depth

- When the site is located on till soil slopes steeper than 50%.

All Dispersion BMPs (includes T5.30, T5.10B, T5.11, T5.12)

- In areas where BMP installation creates a reasonable risk of erosion, slope failure, or flooding, as determined by a licensed engineer, geologist, or hydrogeologist registered in the State of Washington.
- On project sites where the dispersion flow path area is within 10 feet of a proposed or existing septic system or drainfield.
- On project sites where the dispersion flow path area is within a Critical Area Buffer. For more information on identifying Critical Area Buffers within the COA, contact the Community Development Department at (253) 931-3090.
- On project sites where the dispersion flow path area is on a slope greater than 20%.
- The flow path does not meet minimum horizontal setback requirements to property lines, structures, and other flow paths.

All Infiltration BMPs (includes T5.10A, T7.30, T5.14, T5.15, T5.10C)

- A licensed engineer, geologist, or hydrogeologist registered in the State of Washington has determined that the area available for installing the infiltration BMP:
    - Would threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage facilities, pre-existing structures, or pre-existing road or parking lot surfaces or subgrades.
    - Would threaten flood control structures such as levees.
    - Is within a steep slope area or a landslide prone area or setback.
    - Would create a risk of erosion, slope failure, or flooding.
- The area available for installing the infiltration BMP does not meet the minimum horizontal and/or vertical setback requirements.
- Infiltration is restricted due to known contaminated soil or groundwater.
- Infiltration is restricted due to Seasonal High Groundwater limitations as determined through analysis by a licensed engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington (see individual BMPs for Seasonal High Groundwater depth requirements).

T5.30 Full Dispersion

- Where any of the Infeasibility Criteria listed for All Dispersion BMPs above apply.
- Where the site has less than a 65 to 10 ratio of native vegetation area to impervious area.

- The minimum native vegetation flow path is less than 100 feet.
- The flow path is steeper than 15% for any 20 ft. reach of flow path.
- A copy of the conservation easement agreement that would be required by the City in connection with this BMP can be provided upon request.

T5.10A Downspout Full Infiltration

- Where any of the Infeasibility Criteria listed for All Infiltration BMPs above apply.
- The Seasonal High Groundwater elevation has been determined by a licensed professional engineer, geologist, hydrogeologist, or engineering geologist registered in the State of Washington, and:
    - There is less than 3 feet of permeable soil from the proposed final grade to the Seasonal High Groundwater elevation.
    - There is less than 1 foot of clearance from the expected bottom elevation of the infiltration trench or dry well to the Seasonal High Groundwater elevation.
- The area available for installation of dry wells and infiltration trenches is on or discharges to a slope greater than 25%.

T7.30 Bioretention and T5.14 Rain Gardens

- Where any of the Infeasibility Criteria listed for All Infiltration BMPs above apply.
- Where the City Engineer has determined that the only area available for installing the bioretention or rain garden facility does not allow for a safe overflow pathway to the municipal separate stormwater system or private stormwater system.
- Where there is a lack of usable space for bioretention or rain garden facilities at re-development sites, or where there is insufficient space within the existing public right-of-way on public road projects.
- Where bioretention or rain garden facilities are not compatible with surrounding drainage system as determined by the City Engineer (e.g., project drains to an existing stormwater collection system whose elevation or location precludes connection to a properly functioning bioretention facility).
- Where the site cannot be reasonably designed to locate bioretention or rain garden facilities on slopes less than 8%.
- Within 50 feet from the top of slopes that are greater than 20% and over 10 feet of vertical relief.
- Within 100 ft of a closed or active landfill.
- Within 100 ft of a drinking water well, aquifer, or a spring used for drinking water supply.
- Within 10 ft of any known underground storage tank and connecting underground pipes, when tank and pipe system capacity is 1100 gallons or less.
- Within 100 ft of any known underground storage tank and connecting underground pipes, when tank and pipe system capacity is 1100 gallons or greater.

- Where the minimum vertical separation of 1 foot to the seasonal high water table, bedrock, or other impervious layer would not be achieved below bioretention or rain garden facilities that would serve a drainage area that is: 1) less than 5,000 sq. ft. of pollution- generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface; and 3) less than ¾ acres of pervious surface.
- Where the minimum vertical separation of 3 feet to the seasonal high water table, bedrock or other impervious layer would not be achieved below bioretention facilities that: 1) would serve a drainage area that meets or exceeds: a) 5,000 sq. ft. of pollution generating impervious surface, or b) 10,000 sq. ft. of impervious surface, or c) 3/4 acres of pervious surfaces; and 2) cannot reasonably be broken down into amounts smaller than indicated in (1).
- Where field testing indicates soils have a measured native soil saturated hydraulic conductivity less than 0.3 in/hr. Minimum requirements for field testing are found in the Small-Scale Pilot Infiltration Test (PIT Test) section in Appendix III-F.
- Within geographic areas that the COA has determined that bioretention or rain gardens are designated as infeasible due to year-round, seasonal or periodic high groundwater conditions, or due to inadequate infiltration rates. Contact the Public Works Department at (253) 931-3010 for more information and assistance in identifying areas where bioretention and raingardens are designated as infeasible. Refer to Figure I-H-1 Map of Infiltration Restriction Areas for an indication of where infiltration and LID may be feasible.
- The minimum bottom width of the infiltrating bioretention facility cannot be met due to, but not limited to: encroachment within the critical root zone of an existing tree(s) or minimum setback to structures, utilities, or property lines.

T5.15 Permeable Pavement

- Where any of the Infeasibility Criteria listed for All Infiltration BMPs above apply.
- Roads that receive more than very low traffic volumes and more than very low truck traffic. Roads with a projected average daily traffic volume of 400 vehicles or less are very low volume roads; very low truck traffic roads are not subject to through truck traffic but may receive up to weekly use by utility trucks, buses, etc.
- Where infiltrating and ponded water below new permeable pavement area would compromise adjacent impervious pavements.
- Down slope of steep, erosion prone areas that are likely to deliver sediment.
- Where fill soils area used that can become unstable when saturated.
- Excessively steep slopes (>15%) where water within aggregate base layer or at sub-grade surface cannot be controlled by detention structures and may cause erosion and structural failure, or where surface runoff velocities may preclude adequate infiltration at the pavement surface.
- Where permeable pavements cannot provide sufficient strength to support heavy loads at industrial facilities.
- Within 50 ft from the top of slopes that are greater than 20%.

- Within 100 ft of an area known to have deep soil contamination.
- Within 10 ft of any known underground storage tank and connecting underground pipes, regardless of tank size.
- Within 100 ft of a closed or active landfill.
- Within 100 ft of a drinking water well, aquifer, or a spring used for drinking water supply.
- The pavement is over a structure, such as, but not limited to: parking garages and over culverts and bridges.
- In areas likely to have long-term excessive sediment deposition after construction.
- Where site cannot be designed to have porous AC at less than a 5 % slope, pervious concrete at less than a 10% slope, or permeable pavers at less than 10% slope. Use of permeable pavers is limited to walkways, private parking lots, and private driveways.
- Where seasonal high ground water or an underlying impermeable/low permeability layer would create saturated conditions within one foot of the bottom of the lowest gravel base course.
- Where underlying soils are unsuitable for supporting traffic loads when saturated. Soils with a California Bearing Ratio of less than 5% are considered unsuitable for residential access roads.
- Where field testing indicates soils have a measured native soil saturated hydraulic conductivity less than 0.3 in/hr. Minimum requirements for field testing are found in the Small-Scale Pilot Infiltration Test (PIT Test) section in Section V-5.4. May be built with an underdrain if flow control benefits to meet Minimum Requirement #7 are desired, but this will not meet Minimum Requirement #5.
- Where replacing existing impervious surfaces unless the existing surface is a non-pollution generating surface over an outwash soil with a saturated hydraulic conductivity of 4 in/hr or more.
- Where the risk of concentrated pollutant spills is more likely (gas stations, truck stops, industrial chemical storage sites, etc.).
- Where routine, heavy applications of sand occur in frequent snow zones.
- Within geographic areas that the COA has determined that permeable pavements are designated as infeasible due to year-round, seasonal or periodic high groundwater conditions, or due to inadequate infiltration rates.
- Where the site is considered “high use” due to one of the following criteria being met:
    - The site is a commercial or industrial site subject to an expected ADT count equal to or greater than 100 vehicles per 1,000 SF of gross building area.
    - The site is a commercial or industrial site subject to petroleum storage and transfer more than 1,500 gal/yr, not including routinely delivered heating oil.
    - The site is a commercial or industrial site subject to parking, storage, or maintenance of 25 or more vehicles that are over 10 tons gross weight.

- The site is a road intersection with a measured ADT count of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements.

T5.10B Downspout Dispersion Systems

- Where any of the Infeasibility Criteria listed for All Dispersion BMPs above apply.
- The vegetated flow path is less than 25 feet between the trench outlet and any property line, structure, stream, wetland, or impervious surface.
- The vegetated flow path is less than 50 feet between the trench outlet and any slope steeper than 15%.
- There is insufficient space to accommodate the dispersion trench or trenches required for the surface area draining to it. The minimum trench length is 10 feet per 700 SF of surface area.
- The dispersion area is flat and would result in ground saturation.

T5.11 Concentrated Flow Dispersion

- Where any of the Infeasibility Criteria listed for All Dispersion BMPs above apply.
- There are no concentrated flows to disperse.
- The vegetated flow path is less than 50 feet between the trench outlet and any property line, structure, stream, wetland, or impervious surface.
- The surface area draining to each concentrated flow area is greater than 700 SF.
- The vegetated flow path is less than 50 feet between the trench outlet and any slope steeper than 15%.

T5.12 Sheet Flow Dispersion

- Where any of the Infeasibility Criteria listed for All Dispersion BMPs above apply.
- The area to be dispersed has a slope greater than 15%.
- The minimum vegetated flow path for sheet flow dispersion cannot be met. Note: A 10-foot flow is required to disperse runoff from a contributing flow length of up to 20 feet. An additional 10 feet of flow path is required for each additional 20 feet of contributing flow path or fraction thereof.

T5.10C Perforated Stub-Out Connections

- The location for the perforated pipe portion of the system is under impervious or heavily compacted surfaces.
- The minimum perforated stub-out length of 10 feet per 5,000 SF of contributing roof area cannot be met.
- Where the site cannot be reasonably designed to locate a catch basin between the perforated stub-out and point of connection to the public storm drainage system.

Appendix I-I Stormwater Site Plan (SSP) Report Submittal Requirements Checklist

The Submittal Requirements Checklist is intended to aid the design engineer in preparing a SSP report. All items included in the following checklist must be addressed as part of any SSP report. The City requires the design engineer follow the order and structure of the checklist to facilitate review, which in turn will expedite permit issuance.

Title Page and Formatting

- ☐ Provide a title page with applicant, permit number, engineer, and property owner information including name, address, telephone number and email address for all parties.
- ☐ Provide date of document preparation on the title page.
- ☐ Include a Table of Contents.
- ☐ Include List of Figures.
- ☐ Number all pages, figures, maps and attachments.

Chapter 1 – Project Overview

The project overview is intended to be a summary of detailed information describing the project. Information that is provided in detail in following chapters should be summarized here.

- ☐ Identify type of COA permit requested and permit number
- ☐ Identify all permits and approvals required by other regulatory agencies.
- ☐ Identify the project location, including address and parcel number(s).
- ☐ Provide a brief narrative description of the project, including a summary of site constraints.

Chapter 2 – Existing Condition Summary

The Existing Condition Summary is intended to provide a complete understanding of the project site and must be based on thorough site research and investigation. Analyze this data to determine site constraints, including but not limited to:

- *Areas with high potential for erosion and sediment deposition based on soil properties, slope, etc.; and*
- *Locations of sensitive and critical areas; and*
- *Areas of existing Native Vegetation; and*
- *Points where existing surface water enters and exits the project site.*

Delineate these areas on the vicinity map and/or site map and provide a narrative summary outlining key details. Include all reports and studies used to develop this summary in Attachment D of the SSP report.

- ☐ Describe, discuss and identify the following for the project site:
  - ☐ Topography.
  - ☐ Land use and ground cover.

- ☐ Natural and man-made drainage patterns.
- ☐ Points of entry and exit for existing drainage to and from the site.
- ☐ Any known historical drainage problems such as flooding, erosion, etc. Contact the COA Storm Utility at 253-931-3010 for more information on historical drainage problems.
- ☐ Existing on-site and adjacent utilities, including stormwater facilities, water, and sewer.
- ☐ Areas with high potential for erosion and sediment deposition.
- ☐ Locations of sensitive and critical areas (e.g., vegetative buffers, wetlands, steep slopes, floodplains, geologic hazard areas, streams, creeks, ponds, ravines, springs).
- ☐ Existing fuel tanks.
- ☐ Groundwater wells on-site and within 100 feet of site.
- ☐ Septic systems on-site and/or within 100 feet of the site.

☐ 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. For information on the City's wellhead protection areas (Groundwater Protection Zones 1-4), contact the COA Water Utility at 253-931-3010.

☐ 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, or water quality reports. Where such reports impose additional conditions on the Proponent, state these conditions, and describe any proposed mitigation measures.

☐ A summary of a geotechnical report prepared and stamped by a geotechnical engineer licensed in Washington State.

☐ Describe the 100-year flood hazard zone, if applicable.

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. If a quantitative analysis is required, detailed calculations shall be contained in Attachment C of the SSP report. This COA Supplemental Manual I-3.4.10 describes the Off-site Analysis. In addition, a list of elements to be included is provided below.

Qualitative Analysis

☐ Investigate the drainage system ¼ mile downstream from the project by site visit and plan review, and discuss the following items:

- ☐ Problems reported or observed during the plan review and site visit.
- ☐ 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 downstream of 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 site visit.

- ☐ Describe the drainage system and its existing and predicted problems through observations and reports.
- ☐ A map of each basin showing the drainage system and all existing and predicted problems.
- ☐ Site visit photographs illustrating the existing system and conditions.
- ☐ Complete the following table for each basin/subbasin:

Off Site Analysis Drainage System Table

Basin:		Subbasin Name:		Subbasin Number:		Date:	

Symbol	Drainage Component Type, Size, and Name	Description	Slope	Distance from Site Discharge	Existing Problems	Potential Problems	Observations
See Map	Type: sheet flow, swale, channel, pipe, pond, flow control/water quality BMP Size: diameter, surface area	Drainage basin, vegetation, cover, depth, type of sensitive area, volume	%	¼ mile = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion		Tributary area, likelihood of problem, overflow pathways, potential impacts

Quantitative Analysis (see Appendix III-D)

- ☐ Clearly describe tail water assumptions.
- ☐ Summarize the hydraulic modeling of the City-specified design storm event (Appendix III-E) as described in Chapter III-2 of this COA Supplemental Manual.
- ☐ Include downstream system capacity calculations in Attachment E of the SSP report.
- ☐ Discuss potential fixes for capacity problems.
- ☐ Include off-site areas in drainage calculations.
- ☐ Provide storm system pipe 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 in its developed condition.

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

Refer to Volume V for on-site stormwater management BMP selection and feasibility analysis related to Minimum Requirement #5 – On-Site Stormwater Management.

Refer to Volume V for treatment facility selection related to Minimum Requirement #6 – Runoff Treatment.

Refer to Volume III for flow control facility design related to Minimum Requirement #7 – Flow Control.

The City requires that model files to be provided electronically. Hydrologic modeling must conform to the COA requirements presented in III-2 of this COA Supplemental Manual.

The Permanent Stormwater Control Plan shall contain the following sections:

Pre-Developed Site Hydrology

This section describes the pre-development characteristics of the site. This includes the acreage, soil types, and land covers used to determine the pre-development flow characteristics.

When developing the hydrologic model in Western Washing Hydrology Model (WWHM), the pre-developed condition shall be a forested land cover. This applies unless reasonable, historic information is provided that indicates the site was prairie prior to settlement.

- ☐ Provide justification for land uses other than forest with C soils.
- ☐ Summarize Pre-Developed Site Hydrology model input. Include complete WWHM reports in Attachment C.

Developed Site Hydrology

Project Summary

- ☐ Provide a list of assumptions and site parameters for the developed condition.
- ☐ Describe Low Impact Development (LID) principles used in developing the site, and steps taken to preserve native vegetation, minimize impervious areas, and reduce stormwater runoff.
- ☐ Identify all developed sub-basins within, or flowing through, the site. Use consistent labeling for all sub-basins throughout figures, calculations, and text.
- ☐ Summarize WWHM input/output data from the developed condition.
- ☐ Include the WWHM report "Formatted Report With Charts" in Attachment C. Include the WWHM reports "LID Duration Standard" and "Wetland Fluctuation" in Attachment C, where applicable.
- ☐ State conclusions from decision and flow charts (Figure I-3.1, Figure I-3.2 from Volume I of the SWMMWW, and Figure I-3.3A from Volume I of this COA Supplemental Manual). Include the flow charts in Chapter 5 of the SSP report.

On-Site Stormwater Management System – Minimum Requirement #5

- ☐ Include total area of Native Vegetation retained.
- ☐ Indicate if using the LID Performance Standard or List Option to comply with Minimum Requirement #5 – On-Site Stormwater Management.
- ☐ If using the LID Performance Standard to meet Minimum Requirement #5, summarize model results showing that the Performance Standard has been met. Provide complete WWHM reports in Attachment C.
- ☐ If using the LID List Option, describe the On-Site Stormwater Management BMPs that are infeasible and provide documentation of the infeasibility criteria that apply. Summarize associated geotechnical reports and other documentation of feasibility/infeasibility. Refer to Appendix I-H.
- ☐ Include a summary of proposed public or private ownership and maintenance responsibilities of On-Site Stormwater Management BMPs and any areas serving a stormwater function.
- ☐ Provided areas of disturbed soils to be amended per BMP T5.13 Post-Construction Soil Quality and Depth.

Water Quality System – Minimum Requirement #6 (where required)

- ☐ Identify the sizing method used.
- ☐ Where appropriate summarize model results related to Minimum Requirement #6 – Runoff Treatment. Provide complete WWHM reports in Attachment C.
- ☐ Calculations for the water quality design storm and facility sizing calculations must be included in Attachment C of the SSP report.
- ☐ Identify treatment methods used, including size, type, and characteristics of treatment facility and appurtenances.
- ☐ Identify proposed distributed bioretention facilities and/or infiltration below pollution-generating hard surfaces used to meet water quality requirements.

- ☐ Proposed proprietary treatment devices that have not received GULD approval through Ecology's TAPE process must be accompanied with documentation showing how the device meets the runoff treatment requirements of Minimum Requirement #6.

Flow Control System – Minimum Requirement #7 (where required)

- ☐ Identify sizing system used.
- ☐ Describe proposed flow control system and appurtenances, including size, type, and characteristics of storage facility and control structure.
- ☐ Identify proposed distributed bioretention facilities, storage below permeable pavement, and any other on-site stormwater management facilities used to meet flow control requirements.
- ☐ Summarize model results showing that Minimum Requirement #7 – Flow Control has been met. Provide complete WWHM reports in Attachment C of the SSP report.

Conventional Conveyance System Analysis and Design

- ☐ Identify pipe sizes, types, and slopes.
- ☐ Describe capacities, design flows, and velocities for each reach.
- ☐ Include conveyance calculations in Attachment C of the SSP report.

Chapter 5 – Discussion of Minimum Requirements

Chapter 5 is intended as a checklist for the applicant and reviewer to verify that the applicable Minimum Requirements have been met and documented in the SSP report.

- ☐ Include applicable flowcharts for determining Minimum Requirements (Figure I-3.1, Figure I-3.2 from the SWMMWW, and Figure I-3.3A from this COA Supplemental Manual) with decision paths clearly marked.
- ☐ List the Minimum Requirements that apply to the project.
- ☐ Briefly discuss how the project satisfies each Minimum Requirement.
- ☐ Indicate where in the SSP report documentation can be found that shows how the Minimum Requirements are satisfied.

SSP Report Attachments

Attachments A and B are components of the SSP report that are also intended as stand-alone documents for the project during and after construction. This section also contains all background data, calculations, reports, and other documents that support the information summarized in the SSP report. Additional Attachments should be labeled clearly and included in the SSP report Table of Contents.

- ☐ **SSP Attachment A** – Operations and Maintenance Manual, when required to satisfy Minimum Requirement #9. **Note:** The Operations and Maintenance Manual shall be written as a stand-alone document for the project owner when the project is complete.
  - ☐ A narrative description of the on-site storm system.

- ☐ An 11 x 17-inch map of the site, with the locations of the **treatment/detention/infiltration/on-site stormwater management/source control/etc**. facilities prominently noted. This is needed to enable the Operations and Maintenance Manual to be a stand-alone document.
- ☐ The person or organization responsible for maintenance of the on-site storm system, including the phone number and current responsible party.
- ☐ Where the Operations and Maintenance Manual is to be kept. Note that it must be made available to the City for inspection.
- ☐ A description of each stormwater facility, including what it does and how it works. Include any manufacturer's documentation.
- ☐ A description of all maintenance tasks and the frequency of each task for each stormwater facility. Include all applicable Maintenance Standards for Drainage Facilities per Appendix V-A, and any manufacturer's recommendations.
- ☐ A list and description of all source control BMPs per Volume IV that are applied to the site.
- ☐ A sample maintenance activity log indicating emergency and routine actions to be taken.

☐ **SSP Attachment B** – Construction Stormwater Pollution Prevention Plan (SWPPP)

- ☐ SWPPP Long Form – Use the most current version of the Department of Ecology's SWPPP Template (See I-3.4.2).
- ☐ SWPPP Short Form – See Vol II, Appendix II-B.

☐ **SSP Attachment C** – Hydraulic /Hydrologic Analysis and Modeling Results.

- ☐ WWHM "Formatted Report With Charts" report shall be included.
- ☐ WWHM "LID Duration Standard" report shall be included when applicable.
- ☐ WWHM "Wetland Fluctuation" report shall be included when applicable.
- ☐ Include all other water quality, oil/water separator, GULD approval, conveyance, and hydraulic/ hydrologic calculations and information related to the project.
- ☐ Basin Maps used for all hydraulic/hydrologic analysis, modeling results, and Off-Site Analyses (See Chapter 3 above).

☐ **SSP Attachment D** – Other Special Reports – See Engineering Design Standards Chapter 4 for report preparation requirements.

- ☐ Geotechnical Soils Report.
- ☐ Critical Area Report.
- ☐ Other reports related to historical site conditions, proposed project impacts, Low Impact Development feasibility analysis, and stormwater management.

Required Drawings

Include the following project drawings:

- ☐ Vicinity Map.
- ☐ Existing Conditions Summary Site Map.
- ☐ Site Map and Grading Plan.
- ☐ Basin Map.
- ☐ Site Plan showing all stormwater facilities, including on-site stormwater management facilities, treatment facilities, flow control facilities, conveyance systems, and mitigated impervious surfaces.
- ☐ Erosion Control Plan.

- ☐ Detail Sheets.
- ☐ An 8.5”x11” exhibit with minimum 0.1” height text showing the site plan, storm system and labels for major storm system elements (detention facility, control structure, water quality treatment facility, etc.). This exhibit is required for Stormwater Easement and Maintenance Agreements.

Appendix I-J Stormwater Facility Access Requirements

All publicly owned, manmade stormwater facilities and conveyances and all natural channels on the project site used for conveyance of altered flows due to development (including swales, ditches, stream channels, lake shores, wetlands, potholes, estuaries, gullies, ravines, etc.) shall be located within easements as required by the City.

Maintenance Access Easements

A minimum 15-foot-wide maintenance access easement shall be provided to drainage facilities from a public street or right-of-way.

Maintenance access must be provided for all manholes, catch basins, vaults, detention ponds, or underground drainage facilities operated by the City. Maintenance access shall be through a public easement . Driving access to all parts of detention ponds for maintenance of structures and for mowing shall be provided, including locking vehicle gates if access is restricted by fencing . Such access shall not be blocked by vegetation, fencing or standing water . Access to the site shall be limited by a double-posted gate with a minimum width of 15 feet, or other approved equal.

Access roads shall be constructed in accordance with COA Engineering Design Standards, Chapter 6.

Public Stormwater Facility Easements

A stormwater easement is required for the placement, operation and maintenance of facilities upon private property.

Public stormwater easements shall meet the requirements of COA Engineering Design Standards, Chapter 6.

Detention Ponds

The following access shall be provided for public detention ponds:

- 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). See access road criteria above.
- An access ramp meeting the gravel access road standards 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 above.
- The internal berm of a wetpond, or combined detention and wetpond, may NOT be used for access.

- 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. See access road criteria above.
- Additional easements or modification to proposed lot boundaries, fencing, and/or gates 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 easement or extension of the tract to an acceptable access location.

Volume II

Construction Stormwater Pollution Prevention

City of Auburn Supplemental Manual

Executive Summary of Volume II

General additions and/or changes to the SWMMWW contained in this Volume include:

- **II-2: Construction Stormwater Pollution Prevention Plans (Construction SWPPPs)**
  - **II-2.2** provides the thresholds for projects requiring a Construction SWPPP for the COA.
  - **II-2.4** provides the Construction SWPPP submittal requirements for the COA.
- **II-3: Construction Stormwater BMPs**
  - **BMP C163:** Demolition of Buildings (Additional)
  - **BMP C164:** Building, Repair, Remodeling and Construction (Additional)
  - **BMP C233, C235, C250** (Amended)
- **Supplemental Appendix II-B: Construction Stormwater Pollution Prevention Plan Short Form** provides a short form Construction SWPPP for use on projects that meet the criteria described in that appendix.

II-2 –Construction Stormwater Pollution Prevention Plans (Construction SWPPPs)

II-2.2 When is a Construction SWPPP Required?

All sites are required to comply with Elements #1 through #13 of the SWPPP. The Construction SWPPP must include an explanation for any elements that are not used.

Unless located in a critical area, a SWPPP is not required for projects that:

- Grade/fill less than 500 cubic yards of material.

II-2.4 Preparing Construction SWPPPs

The Construction SWPPP Short Form may be used for projects that meet the thresholds found in Appendix II-B.

Projects that are required to submit a complete Construction SWPPP must use the most current version of the Department of Ecology's Construction SWPPP Template (See I-3.4.2).
The Construction SWPPP shall be prepared as a separate stand-alone document. Keep the Construction SWPPP on the construction site or within reasonable access to the site for construction and inspection personnel. As site work progresses, the plan must be modified to reflect changing site conditions, subject to the rules for plan modification by the City.

II-3 – Construction Stormwater BMPs

Changes to BMPs in the SWMMWW and additional BMPs required in the City are contained in this section.

BMP C163: Demolition of Buildings (Additional)

Description of Pollutant Sources

This applies to removal of existing buildings by controlled explosions, wrecking balls, or manual methods, and subsequent clearing of the rubble. The loose debris can contaminate stormwater. Pollutants of concern include toxic organic compounds, heavy metals, asbestos, and suspended solids.

Pollutant Control Approach

Regularly clean up debris that can contaminate stormwater. Protect the storm drainage system from dirty runoff and loose particles. Sweep paved surfaces daily. Vacuum sweeping is preferred.

The following BMPs are required of all businesses and public agencies engaged in building demolition:

- Identify, obtain required City permits, and properly abandon all utility connections such as sanitary sewer, water, gas, fuel lines and tanks.
- If directed to keep water out of the storm system during demolition activity, storm drain covers or a similarly effective containment device must be placed on all nearby drains to prevent dirty runoff and loose particles from entering the storm drainage system. If storm drains are not present, dikes, berms, or other methods must be used to protect overland discharge paths from runoff.
- Utilize storm drain inlet protection **BMP C220: Inlet Protection** in Volume II.
- Street gutters, sidewalks, driveways, and other paved surfaces in the immediate area of the demolition must be swept at the end of each work day to collect and properly dispose of loose debris and garbage.
- Use dust control methods **BMP C140: Dust Control** in Volume II and/or **BMP S407: BMPs for Dust Control at Disturbed Land Areas and Unpaved Roads and Parking Lots** in Volume IV.

The following BMPs are not required, but can provide additional pollution protection:

- If possible, a wall should be constructed to prevent stray building materials and dust from escaping the area during demolition.
- Schedule demolition to take place at a dry time of the year.

BMP C164: Building, Repair, Remodeling and Construction (Additional)

Description of Pollutant Sources

This activity refers to activities associated with construction of buildings and other structures, remodeling of existing buildings and houses, and general exterior building repair work. Washing of buildings is covered under **S431: BMPs for Washing and Steam Cleaning Vehicles/Equipment/Building Structures** in Volume IV. Painting of buildings is covered under

S420: BMPs for Painting, Finishing, and Coating of Vehicles, Boats, Buildings, and Equipment in Volume IV.

Pollutants of concern include toxic organics, suspended solids, heavy metals, asbestos, pH, oils, and greases.

Pollutant Control Approach

Employees must be educated about the need to control site activities. Control leaks, spills, and loose material. Utilize good housekeeping practices.

The following BMPs are required of all businesses engaged in building repair, remodeling, and construction:

- Employees must be educated about the need to control site activities to prevent stormwater pollution, and also must be trained in spill cleanup procedures.
- Spill cleanup materials, appropriate to the chemicals being used on site, must be available at the work site at all times.
- The work site must be cleaned up at the end of each work day, with materials such as solvents put away indoors or covered and secured so that vandals will not have access to them.
- The area must be swept daily to collect loose litter, paint chips, grit, and dirt.
- Absolutely no substance can be dumped on pavement, the ground, or in or toward storm drains, regardless of its content, unless it is only uncontaminated water.
- Bermed ground or drop cloths must be used underneath scraping and sandblasting work. Ground cloths, buckets, or tubs must also be used anywhere that work materials are laid down.
- **BMP C154: Concrete Washout Area** in Volume II shall be applied when performing interior or exterior concrete work.
- Tools covered with non-water-based finishes or other materials must be cleaned in a manner that enables collection of used solvents for recycling or proper disposal. See **BMP S445: BMPs for Discharging Process Wastewater to a Sanitary Sewer, Holding Tank, or Water Treatment System** in Volume IV for disposal options.
- Inlet protection as described in **BMP C220: Inlet Protection** in Volume II must be used if dust, grit, wash water, or other pollutants may escape the work area. This is particularly necessary on rainy days. Provide inlet protection over the storm drain at the beginning of the work day. Do not perform outdoor work during wet weather if contaminants could be washed off-site by rainfall.

The following BMPs are not required, but can provide additional pollution protection:

- Recycle materials whenever possible.
- Activities such as tool cleaning should occur over a ground cloth or within a containment device such as a tub.

II-3.3 Construction Runoff BMPs

BMP C233: Silt Fence (Amended)

All silt fence applications shall conform to the COA Standard Detail E-02.

BMP C235: Wattles (Amended)

The City requires removal of non-biodegradable wattles and wattle netting at project completion.

BMP C250: Construction Stormwater Chemical Treatment (Amended)

Conditions of Use

Formal written approval from the Department of Ecology and the COA is required for the use of chemical treatment regardless of size. When approved, include the chemical treatment system in the Construction SWPPP. Discharges to the wastewater system must also comply with King County wastewater discharge requirements and permits. Refer to the King County Wastewater Services webpage for more information.

Appendix II-B Construction Stormwater Pollution Prevention Plan Short Form

Projects falling within the thresholds listed below may use this short form instead of preparing a professionally-designed Construction SWPPP. If your project meets the following thresholds and includes or may impact a critical area, the SWPPP short form may be used.

The Construction SWPPP Short Form may be used for projects meeting one of the following thresholds:

- Add or replace between 2,000 and 5,000 square feet of hard surface, or
- Clear or disturb between 7,000 square feet and 1 acre of land, or
- Grade/Fill less than 500 cubic yards of material.

If project quantities exceed any of these thresholds, prepare a formal Construction SWPPP as described in Chapter 3 of this Volume.

The SWPPP Short Form may also be used, with approval by the City Engineer or designee, for projects that:

- Add or replace between 5000 square feet and 10,000 square feet of hard surface, or,
- Disturb critical areas or buffers.

The Construction SWPPP Short form is available as a separate download at:

https://www.auburnwa.gov/Forms

Volume III

Choosing, Modeling, and Documenting Your BMPs

City of Auburn Supplemental Manual

Executive Summary of Volume III

General additions and/or changes to the SWMMWW contained in this Volume include:

- **III-2: Modeling Your BMPs** contains several sections to assist with meeting the hydrologic analysis requirements for project submittal to the City, including:
    - **III-2.2 Continuous Simulation Models** provides specific hydrologic modeling requirements for project submittal.
    - **III-2.3 Single Event Hydrograph Method** contains the Water Quality Design Storm for Single Event Hydrograph Method modeling to be used for the design of piped conveyance systems within the City.
    - **II-2.5 Closed Depression Analysis** contains important information on Closed Depression Analysis in the City.
- **III-3: Stormwater Site Plans (SSPs)**
    - **III-3.2 Preparing a Stormwater Site Plan** describes the submittal requirements for SSPs submitted to the City.
- **Appendix III-D** contains detailed information on hydraulic analysis and the design of traditional storm conveyance systems.

III-2 – Modeling Your BMPs

III-2.2 Continuous Simulation Models

Western Washington Hydrology Model

For flow control, treatment, and on-site stormwater management design submittal to the City, the most current version of the Western Washington Hydrology Model (WWHM) shall be used. Information on the WWHM is provided in the SWMMWW. 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

Hydrologic modeling submittal requirements are outlined the Stormwater Site Plan (SSP) report checklist found in Appendix I-I.

The City does not accept MGS Flood or KCRTS (King County Runoff Time Series) modeling results for flow control, treatment, or on-site stormwater management design submittal.

Synthetic turf field/grass shall be modeled as grass over underlying soil type (till or outwash) without underlying perforated drain pipes, and as impervious surface with underlying perforated drain pipes.

III-2.3 Single Event Hydrograph Method

Single event hydrologic modeling shall be used for the design of conveyance systems only. See Appendix III-D for more information on the design and modeling of conveyance systems.

Water Quality Design Storm

For sizing wetpool treatment facilities, the following design storm shall be used for the City:

6-month, 24-hour design storm: 1.44 inches

III-2.5 Closed Depression Analysis

The requirements of Chapter 16.10 of the ACC apply to closed depression analyses.

III-3 - Stormwater Site Plans

III-3.2 Preparing a Stormwater Site Plan

The SSP is the comprehensive report containing all the technical information and analysis needed for review. All SSP reports must conform to the format outlined in the SSP Submittal Requirements Checklist found in Appendix I-I. The SSP report outline is provided in a checklist format to assist project proponents in meeting the submittal requirements of the City. All items in the checklist must be addressed in the SSP report.

III-3.3 Changes to a Previously Approved Stormwater Site Plan

In lieu of the process in the SWMMWW, changes or revisions to the originally-approved SSP shall use one or more of the following requirements in the submittal for City review:

1. Submit revised pages of the SSP with a footnote indicating the revision date.
2. Submit a dated memorandum or letter explaining the proposed changes to the SSP.

Appendix III-D Conveyance System Design and Hydraulic Analysis

This Appendix presents acceptable methods for the analysis and design of storm and surface water conveyance systems. Conveyance systems can be separated into the following categories:

- Pipe systems
- Culverts
- Open Channels (ditches, swales)
- Outfalls

Pipe systems, culverts, and open channels are addressed in Section III-D.4. Outfalls are addressed in Section III-D.5.

The purpose of a conveyance system is to drain surface water, up to a specific design flow, from properties so as to provide protection to property and the environment. This Appendix contains detailed design criteria, methods of analysis, and standard details for all components of a conveyance system. A complete basic understanding of hydrology and hydraulics and the principles on which the methodology of hydrologic analysis is based is essential for the proper and accurate application of methods used in designing conveyance systems.

- Refer to Appendix I-J for access easement requirements for storm conveyance systems.
- Where storm drainage is directed against a curb, the curb shall be either a concrete curb and gutter or concrete vertical curb. An extruded curb or asphalt wedge section in any form will not be allowed for directing drainage.

III-D.1 Conveyance System Analysis Requirements

The project engineer shall provide calculations demonstrating the adequacy of all the project's existing and proposed surface water conveyance system components. The project engineer shall provide calculations regarding all off-site flows as required by Volume I. All relevant work/calculations shall be submitted for City review in the SSP report as part of a permit submittal. Small and/or isolated storm system (detention and water quality treatment) designs shall address how they will be incorporated into larger drainage systems likely to be built in the future. For example, site specific frontage and half street improvement designs shall also use a corridor analysis approach to ensure that they can be incorporated into larger future storm systems.

D.1.1 On-site Analysis

All proposed on-site surface water conveyance systems shall be sized to meet the required design event per Section D.2 of this Appendix.

D.1.2 Offsite Analysis (1/4 mile Downstream Analysis)

Refer to Minimum Requirement #10 – Offsite Analysis and Mitigation in Volume I for more information on downstream analysis. All projects required to meet Minimum Requirements #1 through #5 or #1 through #9 shall complete a qualitative downstream analysis. A quantitative analysis shall be required as described in Appendix I-I.3.

The engineer must field survey all existing storm drainage systems downstream from the project for a minimum of ¼ mile from the point of connection to the existing public drainage system, unless a City-identified trunkline is encountered. The goal of the inspection and analysis is to evaluate whether the capacity of the drainage system(s) is adequate to handle the existing flows, flows generated by the proposed project, and any overflow. Adequacy will be evaluated based on conveyance capacity, flooding problems, erosion damage or potential, amount of freeboard in channels and pipes, and storage potential within the system. All existing and proposed off-site surface stormwater conveyance systems shall be sized to convey flows from the required design storm event per Section D.2.

The offsite analysis may be stopped shorter than the required ¼-mile downstream if the analysis reaches a City-identified trunk line. Storm drainage pipes greater than or equal to 36 inches in diameter are generally considered trunk lines. However, where minimal grades (less than 0.5%) necessitated the use of a larger pipe to maintain flows, the City may not consider a pipe greater than or equal to 36 inches as a trunk line. Contact the COA Storm Utility at 253-931-3010 for final determination of whether a storm drainage pipe is a trunk line.

If a capacity problem or stream bank erosion problem is encountered, the flow durations from the project will be restricted per Minimum Requirement #7 – Flow Control. The design shall meet the requirements of III-3. For projects that do not meet the thresholds of Minimum Requirement #7 and are therefore not required to provide flow control by the Department of Ecology, the project proponent may be allowed to correct the downstream problem instead of providing on-site flow control.

III-D.2 Design Event

The design events for all existing and new conveyance systems are as follows:

- All private pipe systems less than 24 inches in diameter shall be designed to convey at minimum the 10-year, 24-hour peak flow rate without surcharging (the water depth in the pipe must not exceed 90% of the pipe diameter).

- All private pipe systems greater than or equal to 24-inches in diameter and all public pipe systems shall be designed to convey the 25-year, 24-hour peak flow rate without surcharging (the water depth in the pipe must not exceed 90% of the pipe diameter).
- Culverts shall convey the 25-year, 24-hour peak flow rate without submerging the culvert inlet (i.e., HW/D $\leq$ 1).
- Constructed and natural channels shall contain the 100-year, 24-hour storm event.

D.2.1 Additional Design Criteria

- For the 100-year event, overtopping of the pipe conveyance system may occur. However, the additional flow shall not extend beyond half the lane width of the outside lane of the traveled way and shall not exceed 4 inches in depth at its deepest point.
- All conveyance systems shall be designed for fully developed conditions. The fully developed conditions for the project site shall be derived from the percentages of proposed and existing impervious area. For off-site tributary areas, typical percentages of impervious area for fully developed conditions are provided in Table III-D.2-1 Percentage Impervious For Fully Developed Conditions Offsite Tributary Areas below.
- Conveyance systems shall be modeled as if no on-site detention is provided upstream.

Land Use Description	Percentage Impervious
Commercial/Industrial	85%
Residential	65%

Table III-D.2-1 Percentage Impervious For Fully Developed Conditions Offsite Tributary Areas

III-D.3 Methods of Analysis

Proponent site surveys shall be used as the basis for determining the capacity of existing systems. For preliminary analyses only, the proponent may use City drainage maps and record drawings. For naturally occurring drainage systems, drainage ditches, or undeveloped drainage courses, the engineer must consider the hydraulic capacity of the existing drainage course and environmental considerations such as erosion, siltation, and increased water velocities or water depths.

Describe capacities, design flows, and velocities in each reach. Describe required materials or specifications for the design (e.g., rock-lined for channels when velocity is exceeded; high density polyethylene pipe needed for steep slope). Comprehensive maps showing the flow route and basins for both the on-site and off-site surface water (for the minimum 1/4 mile downstream distance) must be included in the storm drainage calculations.

If hydrologic modeling is required, the Project Engineer shall state methods, assumptions, model parameters, data sources, and all other relevant information to the analysis. If model parameters are used that are outside the standards of practice, or if parameters are different than those standards, justify the parameters. Copies of all calculations for capacity of channels, culverts, drains, gutters and other conveyance systems shall be included with the SSP report. If used, include all standardized graphs and tables and indicate how they were used. Show headwater and tailwater analysis for culverts when necessary. Provide details on references and sources of information used. Single event modeling shall be used for designing conveyance systems; WWHM is not accepted.

For a full description of the information required for preparing a SSP report consult III-3 and the Stormwater Site Plan Submittal Requirements Checklist found in Appendix I-I.

D.3.1 Rational Method

This method shall only be used for preliminary pipe sizing and capacity analysis.

The Rational Method is a simple, conservative method for analyzing and sizing conveyance elements serving small drainage sub-basins, subject to the following specific limitations:

- Only for use in predicting peak flow rates for sizing conveyance elements (not for use in sizing flow control or treatment facilities).
- Drainage sub-basin area, *A*, cannot exceed 10 acres for a single peak flow calculation
- The time of concentration, T_c, must be computed using the method described below and cannot exceed 100 minutes. A minimum T_c of 6.3 minutes shall be used.
- Unlike other methods of computing times of concentration, the 6.3 minutes is not an initial collection time to be added to the total computed time of concentration.

D.3.1.1 Rational Method Equation

The following is the traditional Rational Method equation:

$$Q_R = CI_RA \qquad \text{(equation 1)}$$

Where Q_R = peak flow (cfs) for a storm of return frequency R

C = estimated runoff coefficient (ratio of rainfall that becomes runoff)

I_R = peak rainfall intensity (inches/hour) for a storm of return frequency R

A = drainage sub-basin area (acres)

When the composite runoff coefficient, C_c (see equation 2) of a drainage basin exceeds 0.60, the T_c and peak flow rate from the impervious area should be computed separately. The computed peak rate of flow for the impervious surface alone may exceed that for the entire

drainage basin using the value at T_c for the total drainage basin. The higher of the two peak flow rates shall then be used to size the conveyance element.

"C" Values

The allowable runoff coefficients to be used in this method are shown by type of land cover in Table III-D.3-1 Runoff Coefficients for the Rational Method below. These values were selected following a review of the values previously accepted by the City for use in the Rational Method and as described in several engineering handbooks. The value for single family residential areas were computed as composite values (as illustrated in the following equation) based on the estimated percentage of coverage by roads, roofs, yards, and unimproved areas for each density. For drainage basins containing several land cover types, the following formula may be used to compute a composite runoff coefficient, C_c:

$$C_c = (C_1A_1+C_2A_2+\ldots+C_nA_n)/A_t \qquad \text{(equation 2)}$$

Where A_t = total area (acres)

$A_{1,2...n}$ = areas of land cover types (acres)

$C_{1,2...n}$ = runoff coefficients for each area land cover type

GENERAL LAND COVERS			
LAND COVER	**C**	**LAND COVER**	**C**
Dense forest	0.10	Playgrounds	0.30
Light forest	0.15	Gravel areas	0.80
Pasture	0.20	Pavement and roofs	0.90
Lawns	0.25	Open water (pond, lakes, wetlands)	1.00
SINGLE FAMILY RESIDENTIAL AREAS* ***[Density is in dwelling units per gross acreage (DU/GA)]***			
LAND COVER DENSITY	**C**	**LAND COVER DENSITY**	**C**
0.20 DU/GA (1 unit per 5 ac.)	0.17	3.00 DU/GA	0.42
0.40 DU/GA (1 unit per 2.5 ac.)	0.20	3.50 DU/GA	0.45

0.80 DU/GA (1 unit per 1.25 ac.)	0.27	4.00 DU/GA	0.48
1.00 DU/GA	0.30	4.50 DU/GA	0.51
1.50 DU/GA	0.33	5.00 DU/GA	0.54
2.00 DU/GA	0.36	5.50 DU/GA	0.57
2.50 DU/GA	0.39	6.00 DU/GA	0.60

*Based on average 2,500 square feet per lot of impervious coverage.
For combinations of land covers listed above, an area-weighted "C_c x A_t" sum should be computed based on the equation C_c x A_t = (C_1 x A_1)+(C_2 x A_2)…(C_n x A_n), where A_t = (A_1+A_2…A_n), the total drainage basin area

Table III-D.3-1 Runoff Coefficients for the Rational Method

"I_R" Peak Rainfall Intensity

The peak rainfall intensity, I_R, for the specified design storm of return frequency *R* is determined using a unit peak rainfall intensity factor, i_R, in the following equation:

$$I_R = (P_R)(i_R) \qquad \text{(equation 3)}$$

Where P_R = the total precipitation at the project site for the 24-hour duration storm event for the given return frequency. Refer to Table III-D.3-2 Design Storm Frequency Coefficients for the Rational Method below for P_R values.

i_R = the unit peak rainfall intensity factor

The unit peak rainfall intensity factor, i_R, is determined by the following equation:

$$i_R = (a_R)(T_c)^{(-bR)} \qquad \text{(equation 4)}$$

Where T_c = time of concentration (minutes), calculated using the method described below and subject to equation limitations (6.3 < Tc < 100)

a_R, b_R = coefficients from Table III-D.3-2 used to adjust the equation for the design storm return frequency R

Table III-D.3-3 Rainfall Intensities for the City of Auburn below includes values of rainfall intensity as a function of time of concentration, calculated using the coefficients from Table III-D.3-2.

Design Storm Frequency	***P_R (inches)***	***a_R***	***b_R***

2 years	2.0	1.58	0.58
5 years	2.5	2.33	0.63
10 years	3.0	2.44	0.64
25 years	3.5	2.66	0.65
50 years	3.5	2.75	0.65
100 years	4.0	2.61	0.63

Table III-D.3-2 Design Storm Frequency Coefficients for the Rational Method

	Rainfall Intensity (I_R) (inches per hour)					
	Design storm recurrence interval (probability)					
Time of Concentration (min)	**2-year (50%)**	**5-year (20%)**	**10-year (10%)**	**25-year (4%)**	**50-year (2%)**	**100-year (1%)**
6.3	1.09	1.83	2.25	2.81	2.91	3.27
7	1.02	1.71	2.11	2.63	2.72	3.06
8	0.95	1.57	1.93	2.41	2.49	2.82
9	0.88	1.46	1.79	2.23	2.31	2.62
10	0.83	1.37	1.68	2.08	2.15	2.45
11	0.79	1.29	1.58	1.96	2.03	2.30
12	0.75	1.22	1.49	1.85	1.91	2.18
13	0.71	1.16	1.42	1.76	1.82	2.07
14	0.68	1.10	1.35	1.67	1.73	1.98
15	0.66	1.06	1.29	1.60	1.66	1.90
16	0.63	1.02	1.24	1.54	1.59	1.82

17	0.61	0.98	1.19	1.48	1.53	1.75
18	0.59	0.94	1.15	1.42	1.47	1.69
19	0.57	0.91	1.11	1.37	1.42	1.63
20	0.56	0.88	1.08	1.33	1.37	1.58
25	0.49	0.77	0.93	1.15	1.19	1.37
30	0.44	0.68	0.83	1.02	1.06	1.22
35	0.40	0.62	0.75	0.92	0.95	1.11
40	0.37	0.57	0.69	0.85	0.88	1.02
45	0.35	0.53	0.64	0.78	0.81	0.95
50	0.33	0.50	0.60	0.73	0.76	0.89
55	0.31	0.47	0.56	0.69	0.71	0.84
60	0.29	0.44	0.53	0.65	0.67	0.79
70	0.27	0.40	0.48	0.59	0.61	0.72
80	0.25	0.37	0.44	0.54	0.56	0.66
90	0.23	0.34	0.41	0.50	0.52	0.61
100	0.22	0.32	0.38	0.47	0.48	0.57

Table III-D.3-3 Rainfall Intensities for the City of Auburn

"T_c" Time of Concentration

The time of concentration is defined as the time it takes runoff to travel overland (from the onset of precipitation) from the most hydraulically distant location in the drainage basin to the point of discharge.

Due to the mathematical limits of the equation coefficients, values of T_c less than 6.3 minutes or greater than 100 minutes cannot be used. Therefore, real values of T_c less than 6.3 minutes must be assumed to be equal to 6.3 minutes, and values greater than 100 minutes must be assumed to be equal to 100 minutes.

T_c is computed by summation of the travel times T_t of overland flow across separate flow path segments. The equation for time of concentration is:

$T_c = T_1 + T_2 + \ldots + T_n$ (equation 5)

Where $T_{1,2...n}$ = travel time for consecutive flow path segments with different categories or flow path slope

Travel time for each segment, *t*, is computed using the following equation:

$T_t = L/60V$ (equation 6)

where T_t = travel time (minutes)

T_t through an open water body (such as a pond) shall be assumed to be zero with this method.

T_t = Travel time for each segment (ft)

L = the distance of flow across a given segment (feet)

V = average velocity (ft/s) across the land cover = $k_R\sqrt{s_o}$

Where k_R = time of concentration velocity factor; see Table III-D.3-4 "n" and "k" Values for Hydrographs.

s_0 = slope of flow path (feet/feet)

"n_s" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel)	
Manning values for sheet flow only, from Overton and Meadows 1976[1]	**n_s**
Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil)	0.011
Fallow fields or loose soil surface (no residue)	0.05
Cultivated soil with residue cover ≤20%	0.06
Cultivated soil with residue cover >20%	0.17
Short prairie grass and lawns	0.15
Dense grasses	0.24

Bermuda grass	0.41
Range (natural)	0.13
Woods or forest with light underbrush	0.40
Woods or forest with dense underbrush	0.80
"k" Values Used in Travel Time/Time of Concentration Calculations[2]	
Sheet Flow	**k_R**
Forest with heavy ground litter and meadow	2.5
Fallow or minimum tillage cultivation	4.7
Short grass pasture and lawns	7.0
Nearly bare ground	10.1
Grasses waterway	15.0
Paved area (sheet flow) and shallow gutter flow	20.0
Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1)	**k_s**
1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n= 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (n = 0.030)	11
6. Nearly bare ground (n = 0.025)	13
7. Paved and gravel areas (n = 0.012)	27
Channel Flow (intermittent) (At the beginning of visible channels R = 0.2)	**k_c**
1. Forested swale with heavy ground litter (n = 0.10)	5
2. Forested drainage course/ravine with defined channel bed (n = 0.050)	10

3. Rock-lined waterway (n = 0.035)	15
4. Grassed waterway (n = 0.030)	17
5. Earth-lined waterway (n = 0.025)	20
6. CMP pipe, uniform flow (n = 0.024)	21
7. Concrete pipe, uniform flow (0.012)	42
8. Other waterways and pipe	0.508/n
Channel Flow (Continuous stream, R = 0.4)	**k_c**
9. Meandering stream with some pools (n = 0.040)	20
10. Rock-lined stream (n = 0.035)	23
11. Grass-lined stream (n = 0.030)	27
12. Other streams, man-made channels and pipe	0.807/n

[1] See TR-55, 1986
[2] 210-VI-TR-55, Second Ed., June 1986

Table III-D.3-4 "n" and "k" Values for Hydrographs

III-D.4 Pipes, Culverts and Open Channels

This section presents the methods, criteria and details for analysis and design of pipe systems, culverts, and open channel conveyance systems.

Storm drainage conveyance for public street requirements are as follows:

- Maximum surface run without considering curve super elevation (gutter flow) between catch basins on paved roadway surfaces shall be as follows:

Pavement Slope, %	Maximum Flow Length, ft
0.5 – 1	200
1 to 6	300
6 to 10	200

- Refer to Chapter 8 - Sewer and Storm Drainage Facilities and Chapter 9 - Facilities in the Right of Way of the COA Engineering Design Standards for more requirements related to drainage conveyance located in public street right-of-way.

D.4.1 Pipe Systems

Pipe systems are networks of storm drain pipes, catch basins, manholes, inlets, and outfalls, designed and constructed to convey surface water. The hydraulic analysis of flow in storm drainage pipes typically is limited to gravity flow; however, in analyzing existing systems it may be necessary to address pressurized conditions. A properly designed pipe system will maximize hydraulic efficiency by utilizing proper material, slope, and pipe size.

D.4.1.1 Design Flows

Design flows for sizing or assessing the capacity of pipe systems shall be determined using the hydrologic analysis methods described in this appendix. Approved single event models described in III-2 may also be used to determine design flows for pipe systems. The design event is described above in Section D.2, Appendix D. Pipe systems shall be designed to convey the design event without surcharging (water depth in pipe shall not exceed 90% of the pipe diameter).

D.4.1.2 Conveyance Capacity

Two methods of hydraulic analysis using Manning's Equation are required by the City for the analysis of pipe systems. First, the **Uniform Flow Analysis** method is used for preliminary design and analysis of pipe systems. Second, the **Backwater Analysis** method is used to analyze both proposed and existing pipe systems to verify adequate capacity. See Section D.2, Appendix D for the required design events for pipe systems.

Uniform Flow Analysis

This method is typically used for preliminary sizing of new pipe systems to convey the design flow as calculated from the required design.

Assumptions:

- Flow is uniform in each pipe (i.e., depth and velocity remain constant throughout the pipe for a given flow).
- Friction head loss in the pipe barrel alone controls capacity. Other head losses (e.g., entrance, exit, junction, etc.) and any backwater effects or inlet control conditions are not specifically addressed.
- All pipes shall be modeled as if no on-site detention is provided up-stream.

- All pipes shall be designed for fully developed conditions. The fully developed conditions shall be derived from the percentages of impervious area provided in Table III-D.4-1 Percentage Impervious for Modeling Fully Developed Conditions below.

Land Use Description[1]	% Impervious
Commercial/Industrial	85
Residential	65

[1] For the land use descriptions, roads are included in the percentage impervious.

Table III-D.4-1 Percentage Impervious for Modeling Fully Developed Conditions

Each pipe within the system shall be sized and sloped such that its barrel capacity at normal full flow is equal to or greater than the design flow calculated from the appropriate design storm as identified in Section D.2. The nomographs in Figure III-D.4-1 Pipe Sizing Nomograph below can be used for approximate sizing of the pipes or Manning's Equation can be solved for pipe size directly:

$$V = \frac{1.49}{n} R^{2/3} S^{1/2} \qquad \text{(equation 7)}$$

or use the continuity equation, $Q = A \bullet V$, such that

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \qquad \text{(equation 8)}$$

Where Q = discharge (cfs)

V = velocity (fps)

A = area (sf)

n = Manning's roughness coefficient; see Table III-D.4-2 Manning's "n" Values for Pipes

R = hydraulic radius = area/wetted perimeter

S = slope of the energy grade line (ft/ft)

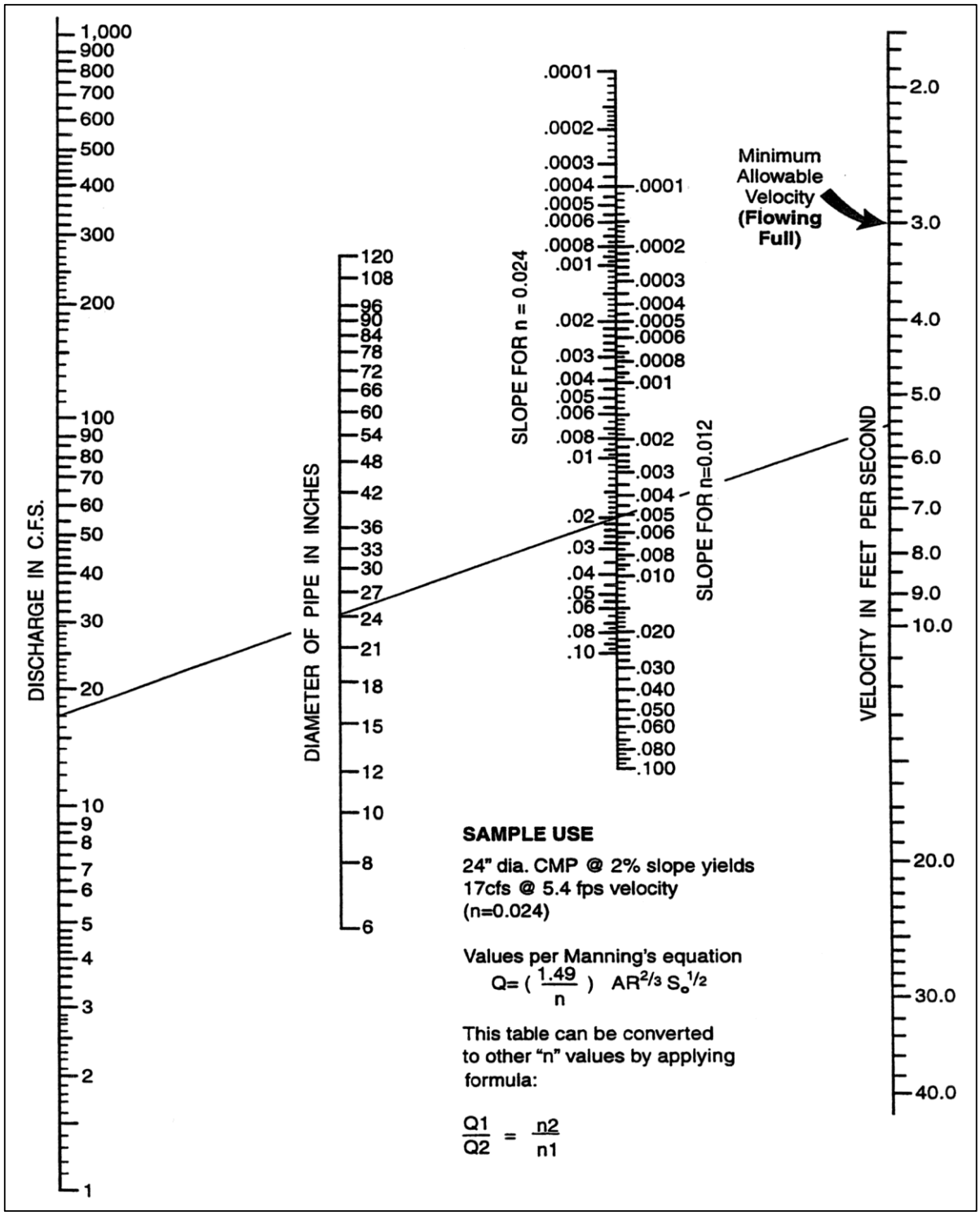


Figure III-D.4-1 Pipe Sizing Nomograph

Type of Pipe Material		Analysis Method	
		Backwater Flow	**Manning's Equation Flow**
A.	Polypropylene CPEP-smooth interior pipe	0.012	0.014
B.	Solid Wall PVC pipe	0.011	0.013
C.	Ductile iron pipe cement lined	0.012	0.014
D.	High density polyethylene pipe (butt fused only)	0.009	0.009

Table III-D.4-2 Manning's "n" Values for Pipes

Table III-D.4-2 Manning's "n" Values for Pipes above provides the recommended Manning's "n" values for preliminary design for pipe systems. The "n" values for this method are 15% higher in order to account for entrance, exit, junction, and bend head losses.

For pipes flowing partially full, the actual velocity may be estimated from the hydraulic properties shown below in Figure III-D.4-2 Circular Channel Ratios by calculating Q_{full} and V_{full} and using the ratio of Q_{design}/Q_{full} to find V and d (depth of flow).

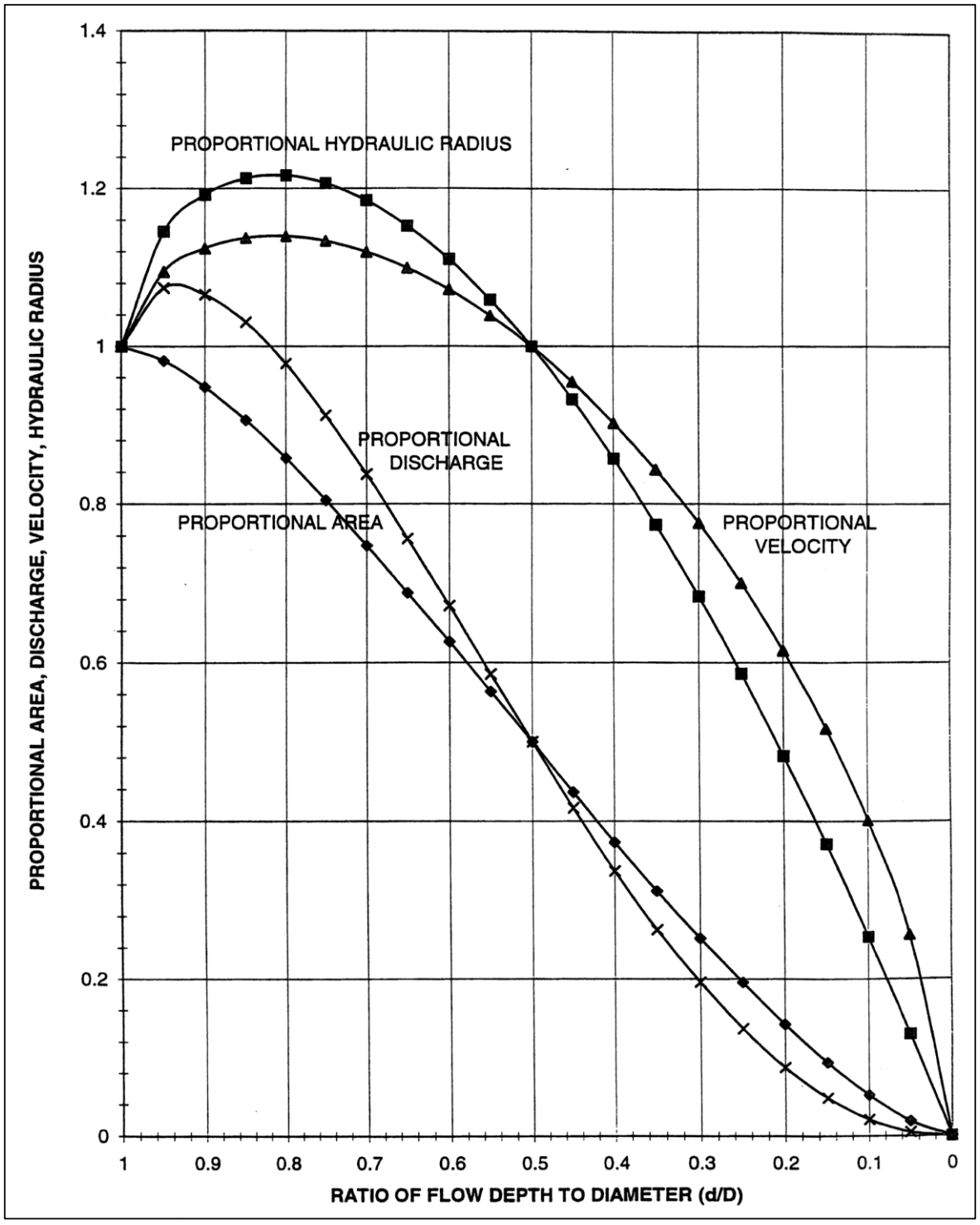


Figure III-D.4-2 Circular Channel Ratios

D.4.1.3 Backwater Analysis

A backwater analysis shall be required when the design depth of flow is greater than 90% of the pipe inside diameter or as directed by the City. The backwater analysis method described in this section is used to analyze the capacity of both proposed and existing pipe systems to convey the required design flow (i.e., either the 10-year or 25-year peak flow as required in Section D.2). The backwater analysis shall verify that the pipe system meets the following conditions:

- For the 25-year event, there shall be a minimum of 0.5 feet of freeboard between the water surface and the top of any manhole or catch basin.
- For the 100-year event, overtopping of the pipe conveyance system may occur, however, the additional flow shall not extend beyond half the lane width of the outside lane of the traveled way and shall not exceed 4 inches in depth at its deepest point. Refer to the Washington State Department of Transportation (WSDOT) Hydraulics Manual for pavement drainage calculations. Off-channel storage on private property is allowed with recording of the proper easements. When this occurs, the additional flow over the ground surface is analyzed using the methods for open channels described in Sections D.2 and D.4.3 and added to the flow capacity of the pipe system.

This method is used to compute a simple backwater profile (hydraulic grade line) through a proposed or existing pipe system for the purposes of verifying adequate capacity. It incorporates a re-arranged form of Manning's equation expressed in terms of friction slope (slope of the energy grade line in ft/ft). The friction slope is used to determine the head loss in each pipe segment due to barrel friction, which can then be combined with other head losses to obtain water surface elevation at all structures along the pipe system.

The backwater analysis begins at the downstream end of the pipe system and is computed back through each pipe segment and structure upstream. The friction, entrance, and exit head losses computed for each pipe segment are added to that segment's tailwater elevation (the water surface elevation at the pipes' outlet) to obtain its outlet control headwater elevation. This elevation is then compared with the inlet control headwater elevation, computed assuming the pipe's inlet alone is controlling capacity using the methods for inlet control presented in Section D.4.2. The condition that creates the highest headwater elevation determines the pipe's capacity. The approach velocity head is then subtracted from controlling headwater elevation, and the junction and bend head losses are added to compute the total headwater elevation, which is then used as the tailwater elevation for the upstream pipe segment.

The Backwater Calculation Sheet in Figure III-D.4-3 Backwater Calculation Sheet can be used to compile the head losses and headwater elevations for each pipe segment. The numbered columns on this sheet are described in Table III-D.4-3 Backwater Calculation Sheet Notes. An example calculation is performed in Figure III-D.4-6 Backwater Pipe Calculation Example. This method should not be used to compute stage/discharge curves for level pool routing purposes.

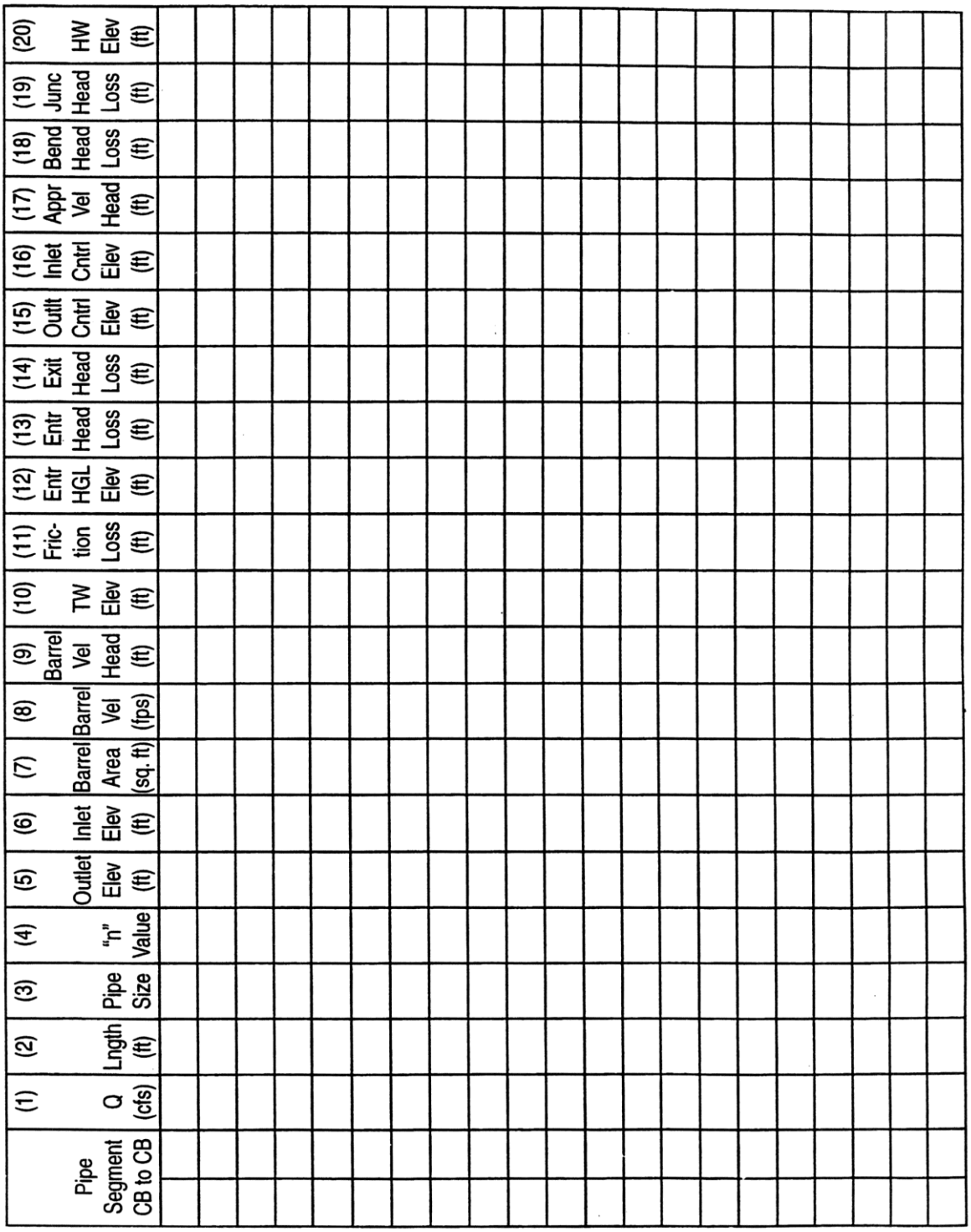


Figure III-D.4-3 Backwater Calculation Sheet

Column	Description
(1)	Design flow to be conveyed by pipe segment.
(2)	Length of pipe segment.
(3)	Pipe size: indicate pipe diameter or span % rise.
(4)	Manning's *"n"* value.
(5)	Outlet Elevation of pipe segment.
(6)	Inlet Elevation of pipe segment.
(7)	Barrel Area: this is the full cross-sectional area of the pipe.
(8)	Barrel Velocity: this is the full velocity in the pipe as determined by: $V = Q/A$ or Col. (8) = Col. (1)/Col. (7)
(9)	Barrel Velocity Head = $V^3/2g$ or $(\text{Col. (8)})^2/2g$; Where g = 32.2 ft./sec.^{2} (acceleration due to gravity)
(10)	Tailwater (*TW*) Elevation: this is the water surface elevation at the outlet of the pipe segment. If the pipe's outlet is not submerged by the TW and the TW depth is less than $D+d_c)/2$, set TW equal to $D+d_c)/2$ to keep the analysis simple and still obtain reasonable results (D=pipe barrel height and d_c=critical depth, both in feet. See Figure III-D.4-4 Critical Depth of Flow for Circular Culverts for determination of d_c.
(11)	Friction Loss = $S_f \times L$ (or S_f X Col (2)); Where S_f is the friction slope or head loss per linear foot of pipe as determined by Manning's equation expressed in the form: $S_f = (nV)^2/2.22R^{1.33}$
(12)	Hydraulic Grade Line (HGL) Elevation just inside the entrance of the pipe barrel; this is determined by adding the friction loss to the TW elevation: Col. (12) = Col. (11) + (Col. (10) If this elevation falls below the pipe's inlet crown, it no longer represents the true HGL when computed in this manner. The true HGL will fall somewhere between the pipe's crown and either normal flow depth or critical flow depth, whichever is greater. To keep the analysis simple and still obtain reasonable results (i.e., erring on the conservative side), set the HGL elevation equal to the crown elevation.
(13)	Entrance Head Loss = $K_e/2g$ (or K_e x Col (9))

	Where K_e = Entrance Loss Coefficient from Table III-D.4-7 Entrance Loss Coefficients This is the head lost due to flow contractions at the pipe entrance.
(14)	Exit Head Loss = 1.0 x $V^2/2g$ or 1.0 x Col. (9); This is the velocity head lost or transferred downstream.
(15)	Outdoor Control Elevation = Col. (12) + Col. (13) + Col. (14) This is the maximum headwater elevation assuming the pipe's barrel and inlet/outlet characteristics are controlling capacity. It does not include structure losses or approach velocity considerations.
(16)	Inlet Control Elevation (see Section D.4.2.5 for computation of inlet control on culverts); this is the maximum headwater elevation assuming the pipe's inlet is controlling capacity. It does not include structure losses or approach velocity considerations.
(17)	Approach Velocity Head: This is the amount of head/energy being supplied by the discharge from an upstream pipe or channel section, which serves to reduce the headwater elevation. If the discharge is from a pipe, the approach velocity head is equal to the barrel velocity head computed for the upstream pipe. If the upstream pipe outlet is significantly higher in elevation (as in a drop manhole) or lower in elevation such that its discharge energy would be dissipated, an approach velocity head of zero should be assumed.
(18)	Bend Head Loss = K_b x $V^2/2g$ (or K_b x Col. (17)); Where K_b = Bend Loss Coefficient (from Figure III-D.4-11 Head for Culverts (Pipe W/"N"=0.024) Flowing Full with Outlet Control). This is due to loss of head/energy required to change direction of flow in an access structure.
(19)	Junction Head Loss: This is the loss in head/energy which results from the turbulence created when two or more streams are merged into one within the access structure. Figure III-D.4-5 Junction Head Loss in Structures can be used to determine this loss, or it can be computed using the following equations derived from Figure III-D.4-5: Junction Head Loss = K_j x $V^2/2g$ (or K_j x Col. (17) where K_j is the Junction Loss Coefficient determined by: $K_j = (Q^3/Q^1)/(1.18 + 0.63(Q^3/Q^1))$
(20)	Headwater (HW) Elevation: This is determined by combining the energy heads in Columns 17, 18, and 19 with the highest control elevation in either Column 15 or 16, as follows: Col. (20) = Col. (15 or 16) – Col. (17) + Col. (18) + Col. (19)

Table III-D.4-3 Backwater Calculation Sheet Notes

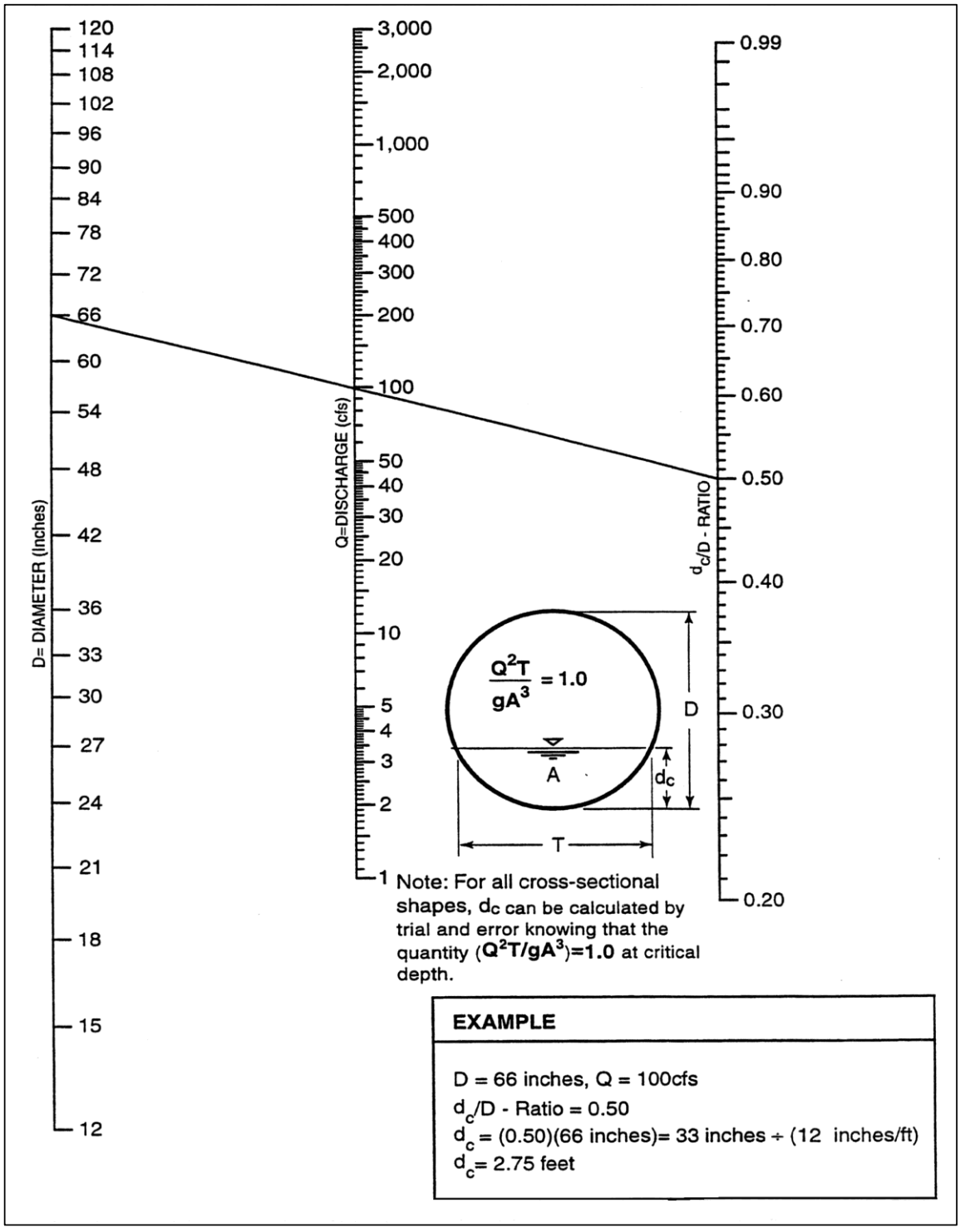


Figure III-D.4-4 Critical Depth of Flow for Circular Culverts

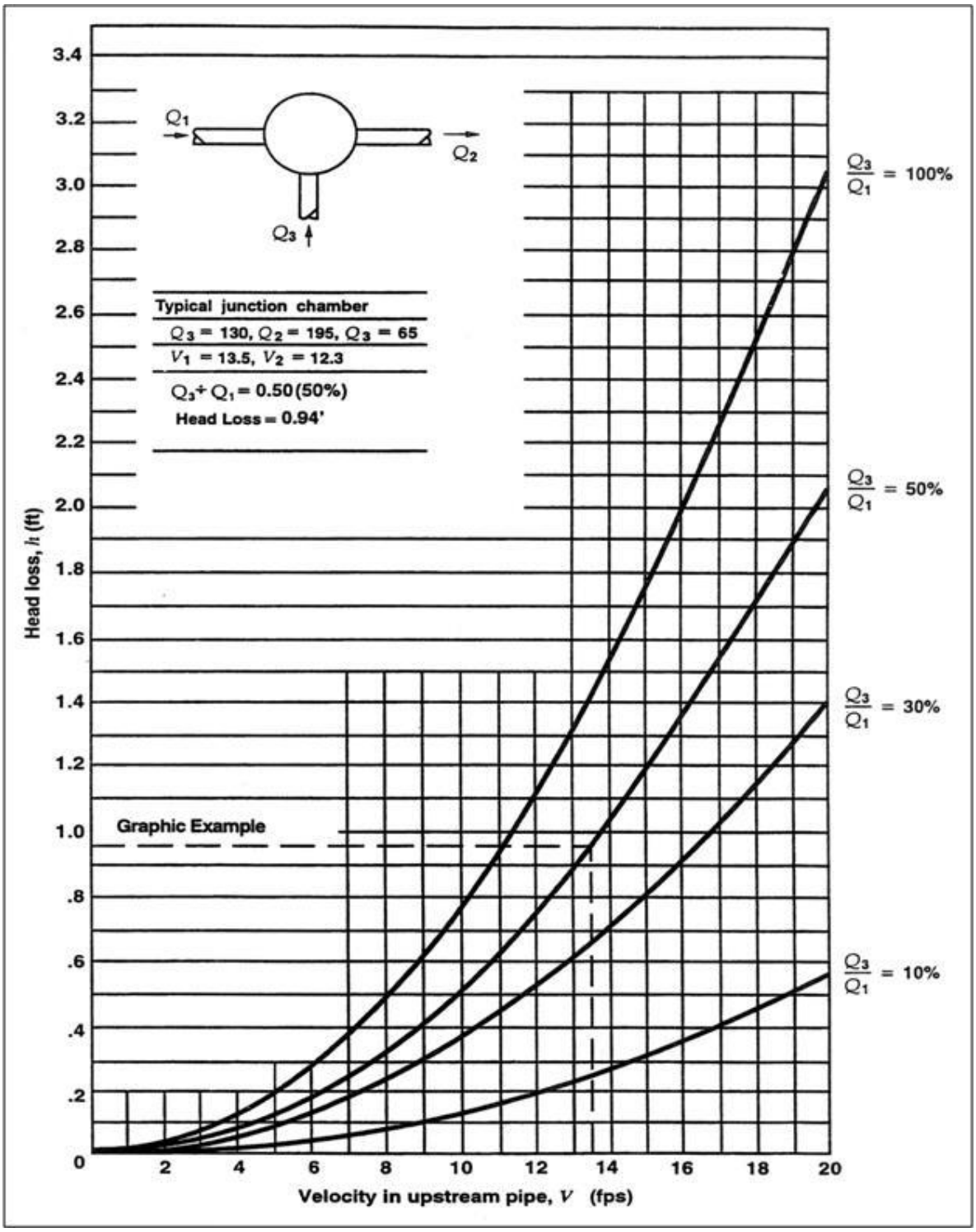
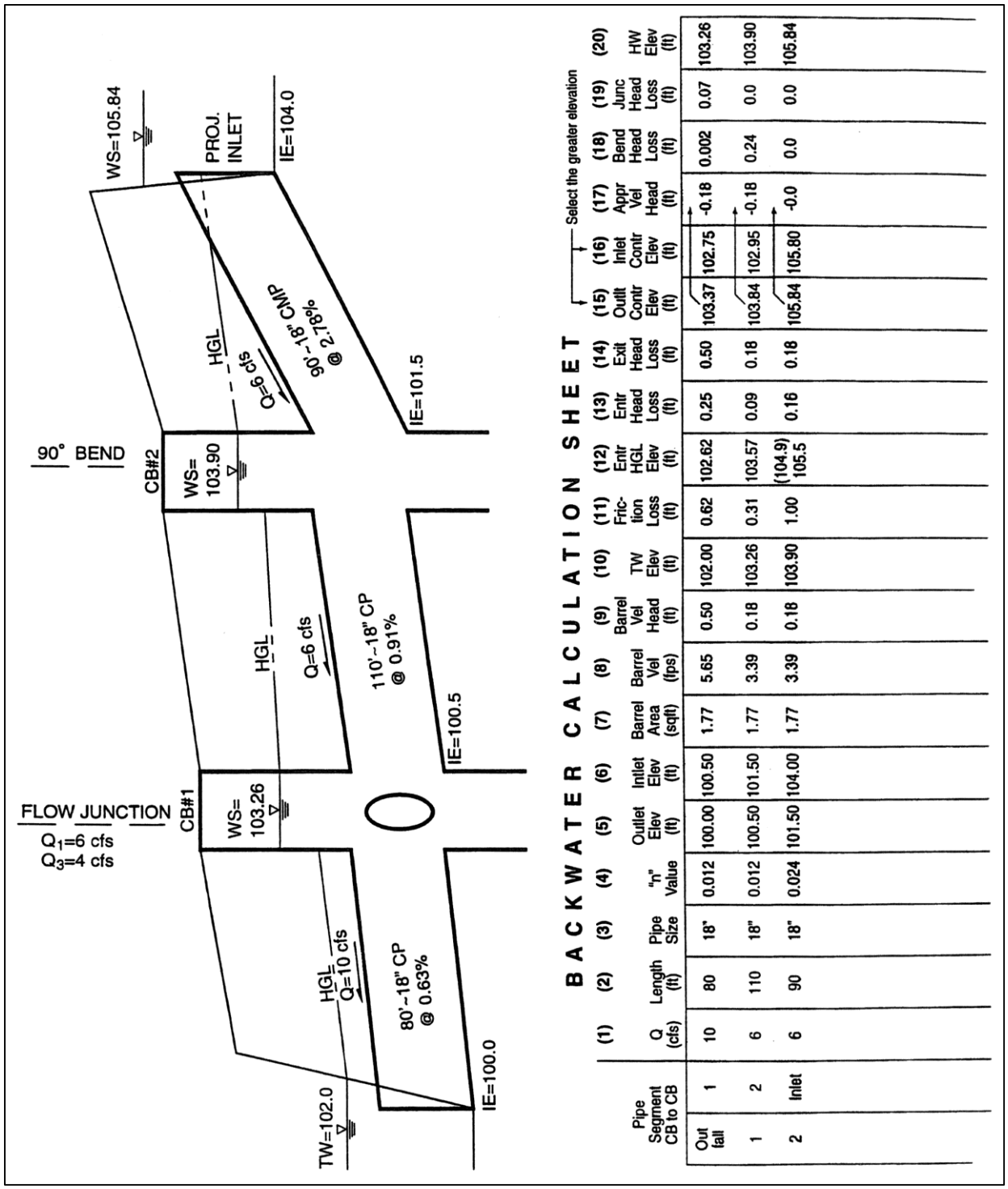


Figure III-D.4-5 Junction Head Loss in Structures



BACKWATER CALCULATION SHEET

Select the greater elevation

Pipe Segment CB to CB		(1) Q (cfs)	(2) Length (ft)	(3) Pipe Size	(4) "n" Value	(5) Outlet Elev (ft)	(6) Inllet Elev (ft)	(7) Barrel Area (sqft)	(8) Barrel Vel (fps)	(9) Barrel Vel Head (ft)	(10) TW Elev (ft)	(11) Fric-tion Loss (ft)	(12) Entr HGL Elev (ft)	(13) Entr Head Loss (ft)	(14) Exit Head Loss (ft)	(15) Outlt Contr Elev (ft)	(16) Inlet Contr Elev (ft)	(17) Appr Vel Head (ft)	(18) Bend Head Loss (ft)	(19) Junc Head Loss (ft)	(20) HW Elev (ft)
Out fall	1	10	80	18"	0.012	100.00	100.50	1.77	5.65	0.50	102.00	0.62	102.62	0.25	0.50	103.37	102.75	-0.18	0.002	0.07	103.26
1	2	6	110	18"	0.012	100.50	101.50	1.77	3.39	0.18	103.26	0.31	103.57	0.09	0.18	103.84	102.95	-0.18	0.24	0.0	103.90
2	Inlet	6	90	18"	0.024	101.50	104.00	1.77	3.39	0.18	103.90	1.00	(104.9) 105.5	0.16	0.18	105.84	105.80	-0.0	0.0	0.0	105.84

Figure III-D.4-6 Backwater Pipe Calculation Example

D.4.1.4 Inlet Grate Capacity

The *Washington State Department of Transportation (WSDOT) Hydraulics Manual* can be used in determining the capacity of inlet grates when capacity is of concern. When verifying capacity, assume:

- Grate areas on slopes are 80 percent free of debris, and “vaned” grates are 95 percent free.
- Grate areas in sags or low spots are 50 percent free of debris, and “vaned” grates, 75 percent free.

D.4.1.5 Pipe Materials

See COA Engineering Construction Standards, Division 8, for pipe specifications.

D.4.1.6 Pipe Sizes

- The following pipe sizes shall be used for pipe systems to be maintained by the City: 12-inch, 15-inch, 18-inch, 21-inch, 24-inch, 30-inch, 36-inch and 42-inch.
- Pipes smaller than 12-inch may only be used for privately maintained systems, or as approved in writing by the City.
- Catch basin leads shall be a minimum of 12-inch.
- Single-family home site roof, foundation and driveway drains may use pipe as small as 4 inches.
- Non-single family roof, foundation and small driveway drains may use pipe as small as 6 inches. Pipes under 10-inch may require capacity analysis if requested by the City.
- For pipes larger than 30-inch increasing increments of 6-inch intervals shall be used (36-inch, 42-inch, 48-inch, etc.).

D.4.1.7 Changes in Pipe Sizes

- Pipe direction changes or size increases or decreases are only allowed at manholes and catch basins.
- Where a minimal fall is necessary between inlet and outlet pipes in a structure, pipes must be aligned vertically by one of the following in order of preference:
    - Match pipe crowns
    - Match 80% diameters of pipes
    - Match pipe inverts or use City approved drop inlet connection

D.4.1.8 Pipe Alignment and Depth

- Pipes must be laid true to line and grade with no curves, bends, or deflections in any direction.

    - ***Exception:*** *Vertical deflections in HDPE and ductile iron pipe with flanged restrained mechanical joint bends (not greater than 30%) on steep slopes are allowed provided the pipe adequately drains, with a minimum velocity of 2 feet per second (fps).*
- A break in grade or alignment or changes in pipe material shall occur only at catch basins or manholes.
- For the standard main alignment refer to the COA Engineering Design and Construction Standards.
- The standard depth for new mains measures 6 feet from the center of the pipe to the main street surface.
- The project engineer shall consult with the City for the potential of a future extension of the storm system. In this case, the City may require modifications to the depth or alignment.
- Connections to the main shall be at 90°. Slight variations may be allowed.
- Pipes shall be allowed to cross under retaining walls as specifically approved in writing by the City when no other reasonable alternatives exist.

D.4.1.9 Pipe Slopes and Velocities

- The slope of the pipe shall be set so that a minimum velocity of 2 feet per second can be maintained at full flow.
- A minimum slope for all pipes shall be 0.5% (under certain circumstances, a minimum slope of 0.3% may be allowed with prior approval in writing from the City).
- Maximum slopes, velocities, and anchor spacings are shown in Table III-D.4-4 Maximum Pipe Slopes, Velocities, and Anchor Requirements below. If velocities exceed 15 feet per second for the conveyance system design event described in Section D.2, provide anchors and/or restrained joints at bends and junctions.

D.4.1.10 Pipes on Steep Slopes

- Slopes 20% or greater shall require all drainage to be piped from the top to the bottom in High Density Polyethylene (HDPE) pipe (butt-fused) or ductile iron pipe welded or mechanically restrained. Additional anchoring design is required for these pipes.
- Above-ground installation is required on slopes greater than 40% to minimize disturbance to steep slopes, unless otherwise approved in writing by the City.
- HDPE pipe systems longer than 100 feet must be anchored at the upstream end if the slope exceeds 20% or as required by the City.
- Above ground installations of HDPE shall address the high thermal expansion/contraction coefficient of the pipe material. An analysis shall be completed to demonstrate that the system as designed will tolerate the thermal expansion of the pipe material.

Pipe Material	Pipe Slope Above Which Pipe Anchors Required and Minimum Anchor Spacing	Max. Slope Allowed	Max. Velocity @ Full Flow
Spiral Rib[1], PVC[1]	20% (1 anchor per 100 L.F. of pipe)	30%(3)	30 fps
Concrete[1]	10% (1 anchor per 50 L.F. of pipe)	20%(3)	30 fps
Ductile Iron[4]	40% (1 anchor per pipe section)	None	None
HDPE[2]	50% (1 anchor per 100 L.F. of pipe – cross slope installations may be allowed with additional anchoring and analysis)	None	None

[1]Not allowed in landslide hazard areas.
[2]Butt-fused pipe joints required. Above-ground installation is required on slopes greater than 40% to minimize disturbance to steep slopes.
[3]Maximum slope of 20% allowed for these pipe materials with no joints (one section) if structures are provided at each end and the pipes are property grouted or otherwise restrained to the structures.
[4]Restrained joints required on slopes greater than 25%. Above-ground installation is required on slopes greater than 40% to minimize disturbance to steep slopes.

Table III-D.4-4 Maximum Pipe Slopes, Velocities, and Anchor Requirements

D.4.1.11 Structures

For the purposes of this Manual, all catch basins and manholes shall meet WSDOT standards such as Type 1L, Type 1, and Type 2. Table III-D.4-5 Allowable Structures and Pipe Sizes below presents the structures and pipe sizes allowed by size of structure.

Catch Basin Type[1]	**Maximum Inside Pipe Diameter**	
	CMP)[(5)], Spiral Rib)[5], CPEP (single wall)[5], HDPP, Ductile Iron, PVC [2] (Inches)	**Concrete, CPEP (smooth interior), (Inches)**
Inlet [4]	12	12
Type 1 [3]	15	12
Type IL [3]	21	18
Type 2 - 48-inch dia.	30	24
Type 2 - 54-inch dia.	36	30
Type 2 – 60-inch dia.	42	36
Type 2 - 72-inch dia.	54	42
Type 2 - 96-inch dia.	72	60

[1]Catch basins (including manhole steps, ladder, and handholds) shall conform to the W.S.D.O.T. Standard Plans or an approved equal based upon submittal for approval.
[2]Maintain the minimum sidewall thickness per this Section.
[3]Maximum 5 vertical feet allowed between grate and invert elevation.
[4]Normally allowed only for use in privately maintained drainage systems and must discharge to a catch basin immediately downstream.
[5]Allowed for private system installations only.

Table III-D.4-5 Allowable Structures and Pipe Sizes

The following criteria shall be used when designing a conveyance system that utilizes catch basins or manholes:

- Catch basin (or manhole) diameter shall be determined by pipe diameter and orientation at the junction structure. A plan view of the junction structure, drawn to scale, will be required when more than four pipes enter the structure on the same plane, or if angles of approach and clearance between pipes is of concern. The plan view (and sections if

necessary) must ensure a minimum distance (of solid concrete wall) between pipe openings of 8 inches for 48-inch and 54-inch diameter catch basins and 12 inches for 72-inch and 96-inch diameter catch basins.

- Type 1 catch basins should be used when overall catch basin height does not exceed 8 feet or when the invert depth does not exceed 5 feet below rim.
- Type 1L catch basins should be used for the following situations:
    - When overall catch basin height does not exceed 8 feet or when invert depth does not exceed 5 feet below rim.
    - When any pipes tying into the structure exceed 21 inches connecting to the long side, or 18 inches connecting to the short side at or very near to right angles.
- Type 2 (48-inch minimum diameter) catch basins or manholes shall be used at the following locations or for the following situations:
    - When overall structure height exceeds 8 feet.
    - When all pipes tying into the structure exceed the limits set for Type 1 structures. Type 2 catch basins or manholes over 4 feet in height shall have standard ladders.
- The maximum slope of ground surface for a radius of 5 feet around a catch basin grate shall be 3:1. The preferred slope is 5:1 to facilitate maintenance access.
- Catch basin (or manhole) evaluation of structural integrity for H-20 loading will be required for multiple junction catch basins and other structures that exceed the recommendations of the manufacturers. The City may require further review for determining structural integrity.
- Catch basins leads shall be no longer than 50 feet.
- Catch basins shall not be installed in graveled areas or sediment generating areas.
- Catch basins shall be located:
    - At the low point of any sag vertical curve or grade break where the grade of roadway transitions from a negative to a positive grade.
    - Prior to any intersection such that a minimal amount of water flows across the intersection, through a curb ramp, or around a street return.
    - Prior to transitions from a typical crown to a full warp through a downhill grade.
- Catch basins shall not be placed in areas of expected pedestrian traffic. The engineer shall avoid placing a catch basin in crosswalks, adjacent to curb ramps, or in the gutter of a driveway. Care shall 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.
- Connections to structures and mains shall be at 90°. Slight variations may be allowed.
- The maximum surface run between structures shall not exceed 400 linear feet.
- Changes in pipe direction, or increases or decreases in size, shall only be allowed at structures.
- For pipe slope less than the required minimum, distance between structures shall be decreased to 200 linear feet.

- For Type 1 and 1L, catch basin to catch basin connections shall not be allowed.
- Bubble up systems shall not be allowed.

D.4.1.12 Pipe Clearances

Horizontal and Vertical

For horizontal and vertical separation of storm drainage pipes from other utilities, refer to the COA Engineering Design Standards, Chapter 6.

D.4.1.13 Pipe Cover

For pipe cover requirements for public storm drainage systems and for private systems within the rights of way or that connection to the public storm drainage system, refer to Chapter 8 of the COA Engineering Design Standards.

Pipe cover for private storm drainage pipes shall conform to the following:

- Suitable pipe cover over storm pipes shall be calculated for H-20 loading by the Project Engineer. Pipe cover is measured from the finished grade elevation down to the top of the outside surface of the pipe. Pipe manufacturer's recommendations are acceptable if verified by the Project Engineer.
- PVC (ASTM D3034 - SDR 35) minimum cover shall be three feet in areas subject to vehicular traffic; maximum cover shall be 30 feet or per the manufacturer's recommendations and as verified with calculations from the Project Engineer.
- Cover for ductile iron pipe may be reduced to a 1-foot minimum as long as it is not within the structural pavement of the roadway surfacing. Use of reinforced concrete pipe or AWWA C900 PVC pipe in this situation requires the engineer to provide verifying calculations to confirm the adequacy of the selected pipe's strength for the burial condition.
- Pipe cover in areas not subject to vehicular loads, such as landscape planters and yards, may be reduced to a 1-foot minimum.

Catch basin evaluation of structural integrity for H-20 loading will be required for multiple junction catch basins and other structures that exceed the recommendations of the manufacturers.*D.4.1.14 System Connections*

Connections to a pipe system shall be made only at catch basins or manholes.

Connections to structures and mains shall be at 90°. Slight variations may be allowed.

Minimum fall through manhole structures shall be 0.1 foot. Pipes of different diameters shall be aligned vertically in manholes by one of the following methods, listed in order of preference:

1. Match pipe crowns
2. Match 80% diameters of pipes.
3. Match pipe inverts or use City approved drop inlet connection.

Drop connections shall be considered on a case by case basis.

Private connections to the City storm system shall be at a drainage structure (i.e., catch basin or manhole) and only if sufficient capacity exists. Tee connections into the side of a pipe shall not be permitted.

Roof downspouts may be infiltrated or dispersed in accordance with the provisions of V-4. Infiltration and dispersion shall be evaluated first. If infiltration and dispersion are not feasible, roof drains may be discharged through the curb for residential projects per V-4 of this COA Supplemental Manual into the roadway gutter or connected into a drainage structure. Roof downspouts may **not** be connected directly into the side of a storm drainage pipe.

D.4.1.15 Debris Barriers

Access barriers are required on all pipes 12 inches and larger exiting a closed pipe system. Debris barriers (trash racks) are required on all pipes entering a pipe system. See Figure III-D.4-7 Debris Barriers for required debris barriers on pipe ends outside of roadways and for requirements on pipe ends (culverts) projecting from driveways or roadway side slopes.

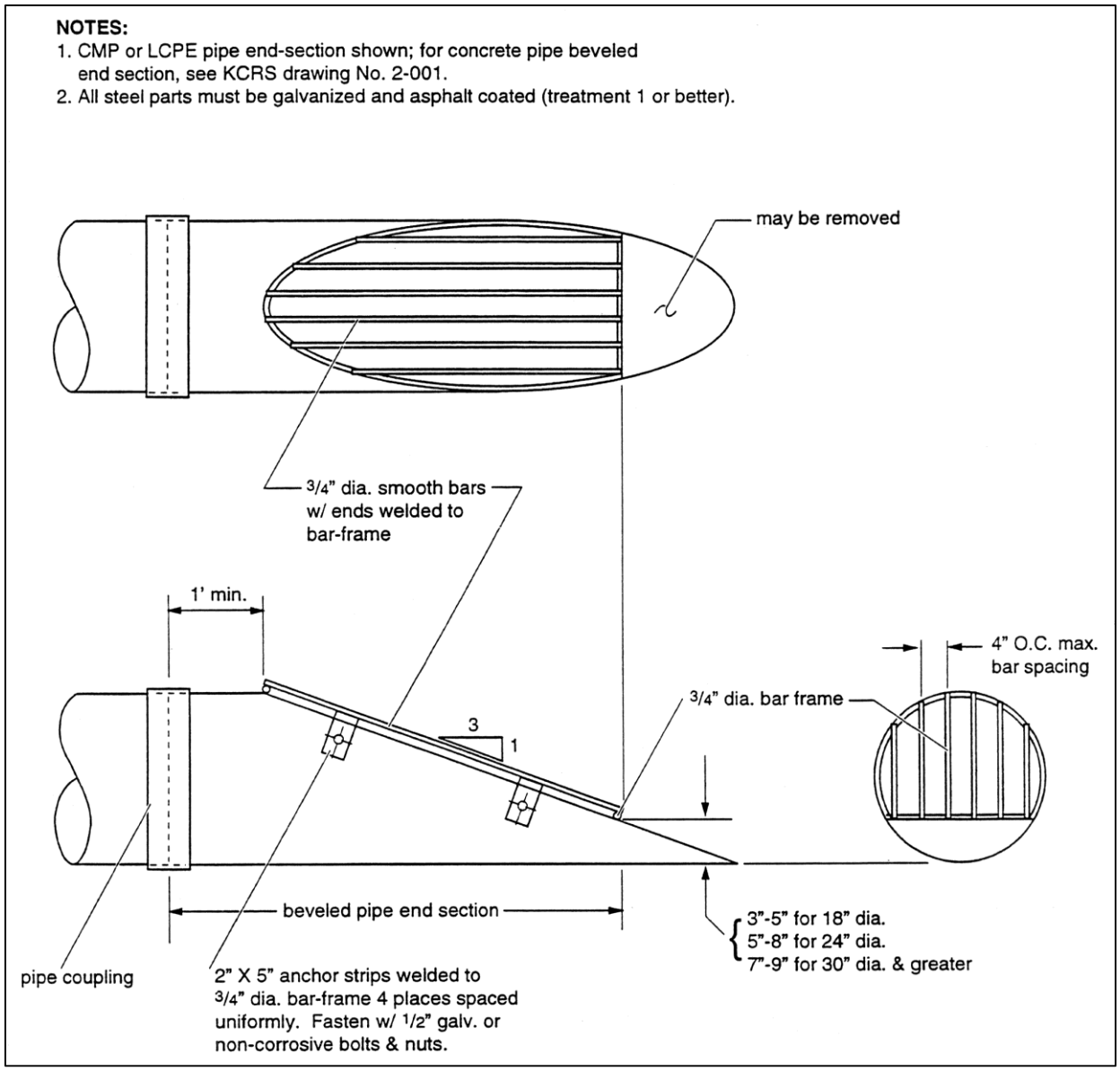


Figure III-D.4-7 Debris Barriers

D.4.2 Culverts

Culverts are relatively short segments of pipe of circular, elliptical, rectangular, or arch cross section and typically convey flow under road embankments or driveways. Culverts installed in streams and natural drainages shall meet the City's Critical Areas Code and *any fish passage requirements of the Washington State Department of Fish and Wildlife.*

D.4.2.1 Design Event

The design event for culverts is given in Section D.2.

D.4.2.2 Design Flows

Design flows for sizing or assessing the capacity of culverts shall be determined using the hydrologic analysis methods described in this appendix.

Other single event models as described in III-2 may be used to determine design flows. In addition, culverts shall not exceed the headwater requirements as established below:

D.4.2.3 Headwater

- For culverts 18-inch diameter or less, the maximum allowable headwater elevation for the 100-year, 24-hour design storm (measured from the inlet invert) shall not exceed 2 times the pipe diameter or arch-culvert-rise.
- For culverts larger than 18-inch diameter, the maximum allowable headwater elevation for the 100-year, 24-hour design storm (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter or arch-culvert-rise.
- The maximum headwater elevation at the 100-year, 24-hour design flow shall be below any road or parking lot subgrade.

D.4.2.4 Conveyance Capacity

Use the procedures presented in this section to analyze both inlet and outlet control conditions to determine which governs. Culvert capacity is then determined using graphical methods.

D.4.2.5 Inlet Control Analysis

Nomographs such as those provided in Figure III-D.4-8 Headwater Depth for Smooth Interior Pipe Culverts with Inlet Control and Figure III-D.4-9 Headwater Depth for Corrugated Pipe Culverts with Inlet Control below can be used to determine the inlet control headwater depth at design flow for various types of culverts and inlet configurations. These and other nomographs can be found in the FHWA publication *Hydraulic Design of Highway Culverts, HDS No. #5 (Report No. FHWA-NHI-01-020),* September 2001; or the WSDOT *Hydraulic Manual.*

Also available in the FHWA publication are the design equations used to develop the inlet control nomographs. These equations are presented below.

For **unsubmerged** inlet conditions (defined by $Q/AD^{0.5} \leq 3.5$);

Form 1*: $HW/D = H_c/D + K(Q/AD^{0.5})^M - 0.5S$** (equation 9)

Form 2*: $HW/D = K(Q/AD^{0.5})^M$ (equation 10)

For **submerged** inlet conditions (defined by $Q/AD^{0.5} \geq 4.0$);

$HW/D = c(Q/AD^{0.5})^2 + Y - 0.5S$** (equation 11)

Where HW = headwater depth above inlet invert (ft)

D = interior height of culvert barrel (ft)

H_c = specific head (ft) at critical depth ($d_c + V_c^2/2g$)

Q = flow (cfs)

A = full cross-sectional area of culvert barrel (sf)

S = culvert barrel slope (ft/ft)

K,M,c,Y = constants from Table III-D.4-6 Constants for Inlet Control Equations

The specified head H_c is determined by the following equation:

$H_c = d_c + V_c^2/2g$ (equation 12)

where d_c = critical depth (ft); see Figure III-D.4-4 Critical Depth of Flow for Circular Culverts

V_c = flow velocity at critical depth (fps)

g = acceleration due to gravity (32.2 ft/sec2)

*The appropriate equation form for various inlet types is specified in Table III-D.4-6 Constants for Inlet Control Equations

**For mitered inlets, use +0.7S instead of –0.5S.

NOTE: Between the unsubmerged and submerged conditions, there is a transition zone ($3.5 < Q/AD^{0.5} < 4.0$) for which there is only limited hydraulic study information. The transition zone is defined empirically by drawing a curve between and tangent to the curves defined by the unsubmerged and submerged equations. In most cases, the transition zone is short and the curve is easily constructed.

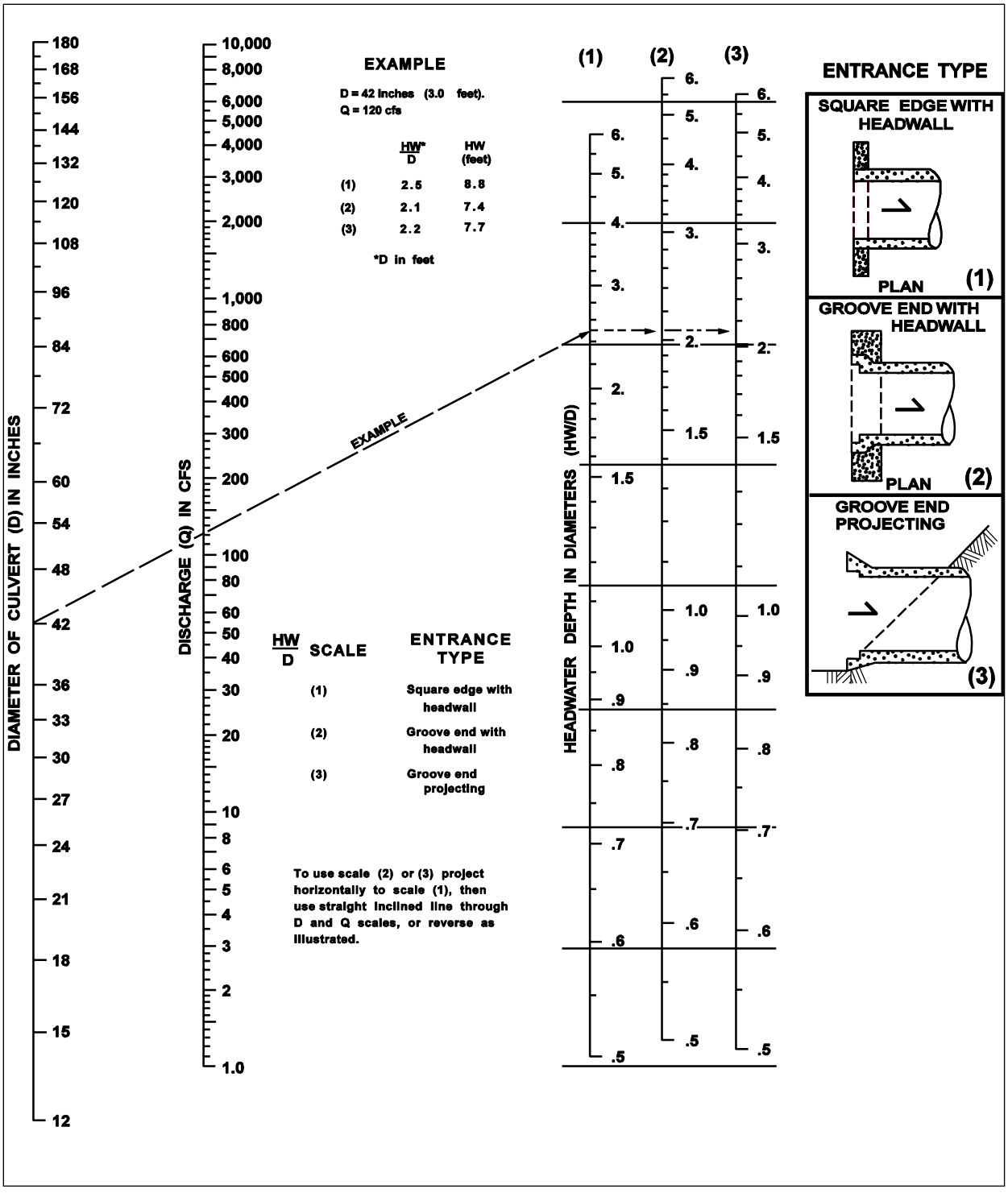


Figure III-D.4-8 Headwater Depth for Smooth Interior Pipe Culverts with Inlet Control

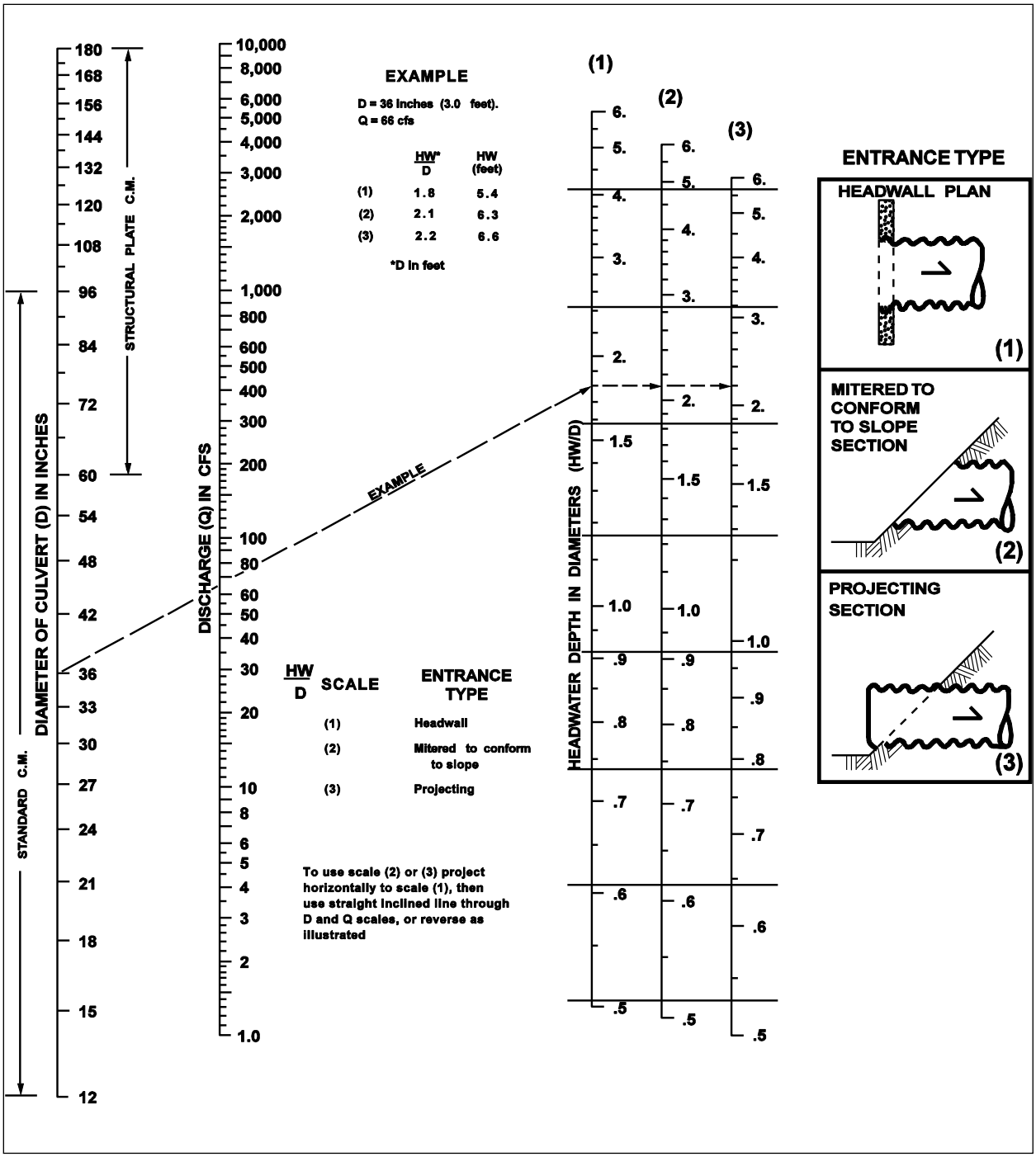


Figure III-D.4-9 Headwater Depth for Corrugated Pipe Culverts with Inlet Control

Shape and Material	Inlet Edge Description	Unsubmerged			Submerged	
		Equation Form	*K*	*M*	*c*	*Y*
Circular Concrete	Square edge with headwall	1	0.0098	2.0	0.0398	0.67
	Groove end with headwall		0.0078	2.0	0.0292	0.74
	Groove end projecting		0.0045	2.0	0.0317	0.69
Circular CMP	Headwall	1	0.0078	2.0	0.0379	0.69
	Mitered to slope		0.0210	1.33	0.0463	0.75
	Projecting		0.0340	1.50	0.0553	0.54
Rectangular Box	30° to 75° wingwall flares	1	0.026	1.0	0.0385	0.81
	90° and 15° wingwall flares		0.061	0.75	0.0400	0.80
	0° wingwall flares		0.061	0.75	0.0423	0.82
CM Boxes	90° headwall	1	0.0083	2.0	0.0379	0.69
	Thick wall projecting		0.0145	1.75	0.0419	0.64
	Thin wall projecting		0.0340	1.5	0.0496	0.57
Arch CMP	90° headwall	1	0.0083	2.0	0.0496	0.57
	Mitered to slope		0.0300	1.0	0.0463 0.0496	0.75
	Projecting		0.0340	1.5		0.53
Bottomless Arch CMP	90° headwall	1	0.0083	2.0	0.0379	0.69
	Mitered to slope		0.0300	2.0	0.0463	0.75
	Thin wall projecting		0.0340	1.5	0.0496	0.57

Table III-D.4-6 Constants for Inlet Control Equations

D.4.2.6 Outlet Control Analysis

Nomographs such as those provided in Figure III-D.4-10 Head for Culverts (Pipe W/"N"=0.012) Flowing Full with Outlet Control and Figure III-D.4-11 Head for Culverts (Pipe W/"N"=0.024) Flowing Full with Outlet Control can be used to determine the outlet control headwater depth at design flow for various types of culverts and inlets. Outlet control nomographs other than those provided can be found in *FHWA HDS No. 5* or the *WSDOT Hydraulic Manual.*

The outlet control headwater depth can also be determined using the simple Backwater Analysis method presented in Section D.4 for analyzing pipe system capacity. This procedure is summarized as follows for culverts:

$HW = H + TW - LS$ (equation 13)

where $H = H_f + H_e + H_{ex}$

H_f = friction loss (ft) = $(V^2n^2L)/(2.22R^{1.33})$

NOTE: If $(H_f+TW-LS) < D$, adjust H_f such that $(H_f+TW-LS) = D$. This will keep the analysis simple and still yield reasonable results (erring on the conservative side).

H_e = entrance head loss (ft) = $K_e(V^2/2g)$

H_{ex} = exit head loss (ft) = $V^{2/}2g$

TW = tailwater depth above invert of culvert outlet (ft)

NOTE: If $TW < (D+d_c)/2$, set $TW = (D+d_c)/2$. This will keep the analysis simple and still yield reasonable results.

L = length of culvert (ft)

S = slope of culvert barrel (ft/ft)

D = interior height of culvert barrel (ft)

V = barrel velocity (fps)

n = Manning's roughness coefficient from Table III-D.4-2 *Manning's* "n" Values for Pipes

R = hydraulic radius (ft)

K_e = entrance loss coefficient from Table III-D.4-7 Entrance Loss Coefficients

G = acceleration due to gravity (32.2 ft/sec^2)

d_c = critical depth (ft); see Figure III-D.4-4 Critical Depth of Flow for Circular Culverts

NOTE: The above procedure should not be used to develop stage/discharge curves for level pool routing purposes because its results are not precise for flow conditions where the hydraulic grade line falls significantly below the culvert crown (i.e., less than full flow conditions).

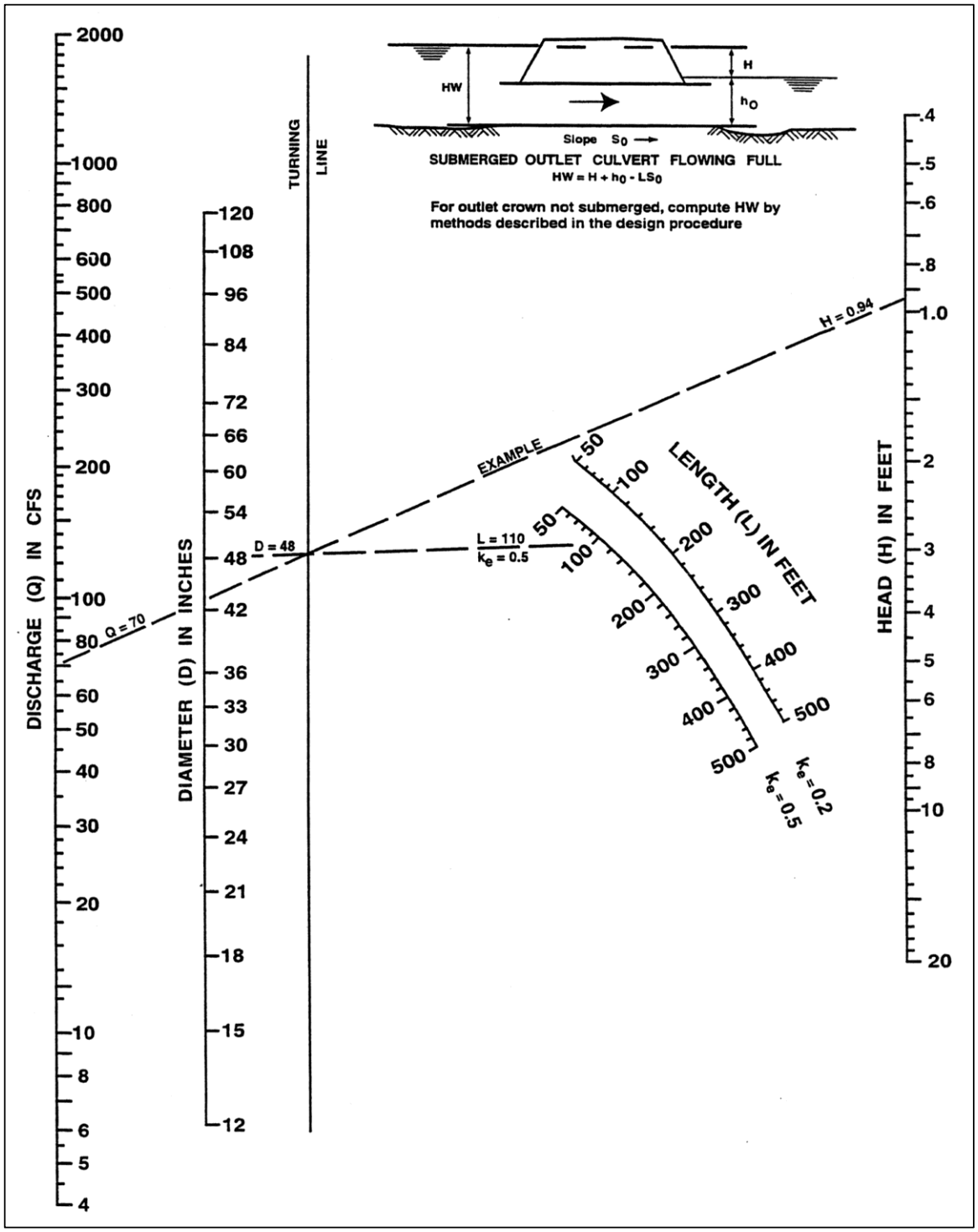


Figure III-D.4-10 Head for Culverts (Pipe W/"N"=0.012) Flowing Full with Outlet Control

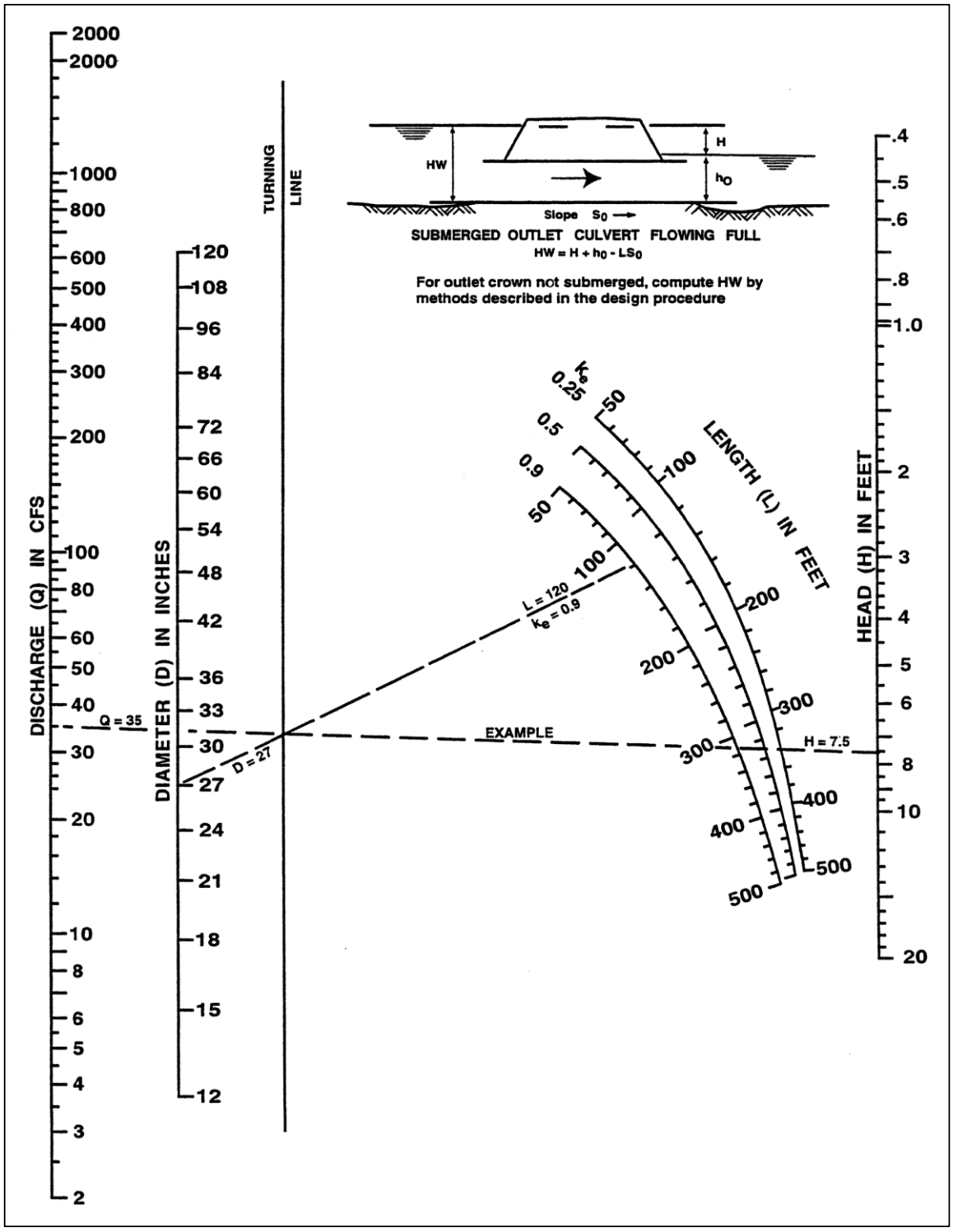


Figure III-D.4-11 Head for Culverts (Pipe W/"N"=0.024) Flowing Full with Outlet Control

Type of Structure and Design Entrance	**Coefficient, K_e**
Pipe, Concrete, PVC, Spiral Rib, DI, and LCPE	
Projecting from fill, socket (bell) end	0.2
Projecting from fill, square cut end	0.5
Headwall, headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
End section conforming to fill slope*	0.5
Beveled edges, 33.7^o or 45^o bevels	0.2
Side- or slope-tapered inlet	0.2
Pipe, Pipe-Arch, Corrugated Metal and Other Non-Concrete or D.I.	
Projecting from fill (no headwall)	0.9
Headwall, or headwall and wingwalls (square-edge)	0.5
Mitered to conform to fill slope (paved or unpaved slope)	0.7
End section conforming to fill slope*	0.5
Beveled edges, 33.7^o or 45^o bevels	0.2
Side- or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension	0.2
or beveled edges on 3 sides	
Wingwalls at 30^o to 75^o to barrel	

Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension or beveled top edge	0.2
Wingwall at 10º to 25º to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

Table III-D.4-7 Entrance Loss Coefficients

NOTE: "End section conforming to fill slope" are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections incorporating a closed taper in their design have a superior hydraulic performance.

D.4.2.7 Inlets and Outlets

All inlets and outlets in or near roadway embankments must be flush with and conforming to the slope of the embankments.

- For culverts 18-inch diameter and larger, the embankment around the culvert inlet shall be protected from erosion by rock lining or riprap as specified in Section D.5.1, except the length shall extend at least 5 feet upstream of the culvert, and the height shall be at or above the design headwater elevation.
- Inlet structures, such as concrete headwalls, may provide a more economical design by allowing the use of smaller entrance coefficients and, hence, smaller diameter culverts. When properly designed, they will also protect the embankment from erosion and eliminate the need for rock lining.
- In order to maintain the stability of roadway embankments, concrete headwalls, wingwalls, or tapered inlets and outlets may be required if right-of-way or easement constraints prohibit the culvert from extending to the toe of the embankment slopes. All inlet structures or headwalls installed in or near roadway embankments must be flush with and conforming to the slope of the embankment.
- Debris barriers (trash racks) are required on the inlets of all culverts that are over 60 feet in length and are 12 to 36 inches in diameter. This requirement also applies to the inlets of pipe systems. See Figure III-D.4-7 *Debris* Barriers for a debris barrier detail. Exceptions are culverts on Type 1 or 2 streams.

- For culverts 18-inch diameter and larger, the receiving channel of the outlet shall be protected from erosion by rock lining specified in Section D.5.1, except the height shall be one foot above maximum tailwater elevation or one foot above the crown as specified below in Section D.5., whichever is higher.

D.4.3 Open Channels

This section presents the methods, criteria, and details for hydraulic analysis and design of open channels.

D.4.3.1 Natural Channels

Natural channels are defined as those that have occurred naturally due to the flow of surface waters, or those that, although originally constructed by human activity, have taken on the appearance of a natural channel including a stable route and biological community. They may vary hydraulically along each channel reach and should be left in their natural condition, wherever feasible or required, in order to maintain natural hydrologic functions and wildlife habitat benefits from established vegetation.

D.4.3.2 Constructed Channels

Constructed channels are those constructed or maintained by human activity and include bank stabilization of natural channels. Constructed channels shall be either vegetation-lined, rock lined, or lined with appropriately bioengineered vegetation.

- **Vegetation-lined channels** are the most desirable of the constructed channels when properly designed and constructed. The vegetation stabilizes the slopes of the channel, controls erosion of the channel surface, and removes pollutants. The channel storage, low velocities, water quality benefits, and greenbelt multiple-use benefits create significant advantages over other constructed channels. The presence of vegetation in channels creates turbulence, which results in loss of energy and increased flow retardation; therefore, the design engineer must consider sediment deposition and scour, as well as flow capacity, when designing the channel.
- **Rock-lined channels** are necessary where a vegetative lining will not provide adequate protection from erosive velocities they may be constructed with riprap, gabions, or slope mattress linings. The rock lining increases the turbulence, resulting in a loss of energy and increased flow retardation. Rock lining also permits a higher design velocity and therefore a steeper design slope than in grass-lined channels. Rock linings are also used for erosion control at culvert and storm drain outlets, sharp channel bends, channel confluences, and locally steepened channel sections.
- **Bioengineered vegetation lining** is a desirable alternative to the conventional methods of rock armoring. *Soil bioengineering* is a highly specialized science that uses living

plants and plant parts to stabilize eroded or damaged land. Properly bioengineering systems are capable of providing a measure of immediate soil protection and mechanical reinforcement. As the plants grow, they produce vegetative protective cover and a root reinforcing matrix in the soil mantle. This root reinforcement serves several purposes:

- The developed anchor roots provide both shear and tensile strength to the soil, thereby providing protection from the frictional shear and tensile velocity components to the soil mantle during the time when flows are receding and pore pressure is high in the saturated bank.
- The root mat provides a living filter in the soil mantle that allows for the natural release of water after the high flows have receded.
- The combined root system exhibits active friction transfer along the length of the living roots. This consolidates soil particles in the bank and serves to protect the soil structure from collapsing and the stabilization measures from failing.

D.4.3.3 Design Flows

Design flows for sizing or assessing the capacity of open channels shall be determined using the hydrologic analysis methods described in this chapter. Single event models as described in III-2 of the SWMMWW may be used to determine design flows. In addition, open channel shall meet the following:

- **Open channels** shall be designed to provide required conveyance capacity while minimizing erosion and allowing for aesthetics, habitat preservation, and enhancement.
- **An access easement for maintenance** is required along all constructed channels located on private property. Required easement widths and building setback lines vary with channel top width.
- **The maximum distance** from the edge of the adjacent access to the farthest point shall be 18 feet.
- **Channel cross-section geometry** shall be trapezoidal, triangular, parabolic, or segmental as shown in Figure III-D.4-12 through Figure III-D.4-14. Side slopes shall be no steeper than 3:1 for vegetation-lined channels and 2:1 for rock-lined channels.
- **Vegetation-lined channels** shall have bottom slope gradients of 6% or less and a maximum velocity at design flow of 5 fps (see Table III-D.4-8 Channel Protection).
- **Rock-lined channels or bank stabilization of natural channels** shall be used when design flow velocities exceed 5 feet per second. Rock stabilization shall be in accordance with Table III-D.4-8 Channel Protection or stabilized with bioengineering methods as described above in “Constructed Channels.”

NO.	DIMENSIONS				HYDRAULICS			
	Side Slopes	B	H	W	A	WP	R	$R^{(2/3)}$
D-1	--	--	6.5"	5'-0"	1.84	5.16	0.356	0.502
D-1C	--	--	6"	25'-0"	6.25	25.50	0.245	0.392
D-2A	1.5:1	2'-0"	1'-0"	5'-0"	3.50	5.61	0.624	0.731
B	2:1	2'-0"	1'-0"	6'-0"	4.00	6.47	0.618	0.726
C	3:1	2'-0"	1'-0"	8'-0"	5.00	8.32	0.601	0.712
D-3A	1.5:1	3'-0"	1'-6"	7'-6"	7.88	8.41	0.937	0.957
B	2:1	3'-0"	1'-6"	9'-0"	9.00	9.71	0.927	0.951
C	3:1	3'-0"	1'-6"	12'-0"	11.25	12.49	0.901	0.933
D-4A	1.5:1	3'-0"	2'-0"	9'-0"	12.00	10.21	1.175	1.114
B	2:1	3'-0"	2'-0"	11'-0"	14.00	11.94	1.172	1.112
C	3:1	3'-0"	2'-0"	15'-0"	18.00	15.65	1.150	1.098
D-5A	1.5:1	4'-0"	3'-0"	13'-0"	25.50	13.82	1.846	1.505
B	2:1	4'-0"	3'-0"	16'-0"	30.00	16.42	1.827	1.495
C	3:1	4'-0"	3'-0"	22'-0"	39.00	21.97	1.775	1.466
D-6A	2:1	--	1'-0"	4'-0"	2.00	4.47	0.447	0.585
B	3:1	--	1'-0"	6'-0"	3.00	6.32	0.474	0.608
D-7A	2:1	--	2'-0"	8'-0"	8.00	8.94	0.894	0.928
B	3:1	--	2'-0"	12'-0"	12.00	12.65	0.949	0.965
D-8A	2:1	--	3'-0"	12'-0"	18.00	13.42	1.342	1.216
B	3:1	--	3'-0"	18'-0"	27.00	18.97	1.423	1.265

D-9	7:1	--	1'-0"	14'-0"	7.00	14.14	0.495	0.626
D-10	7:1	--	2'-0"	28'-0"	28.00	28.28	0.990	0.993
D-11	7:1	--	3'-0"	42'-0"	63.00	42.43	1.485	1.302

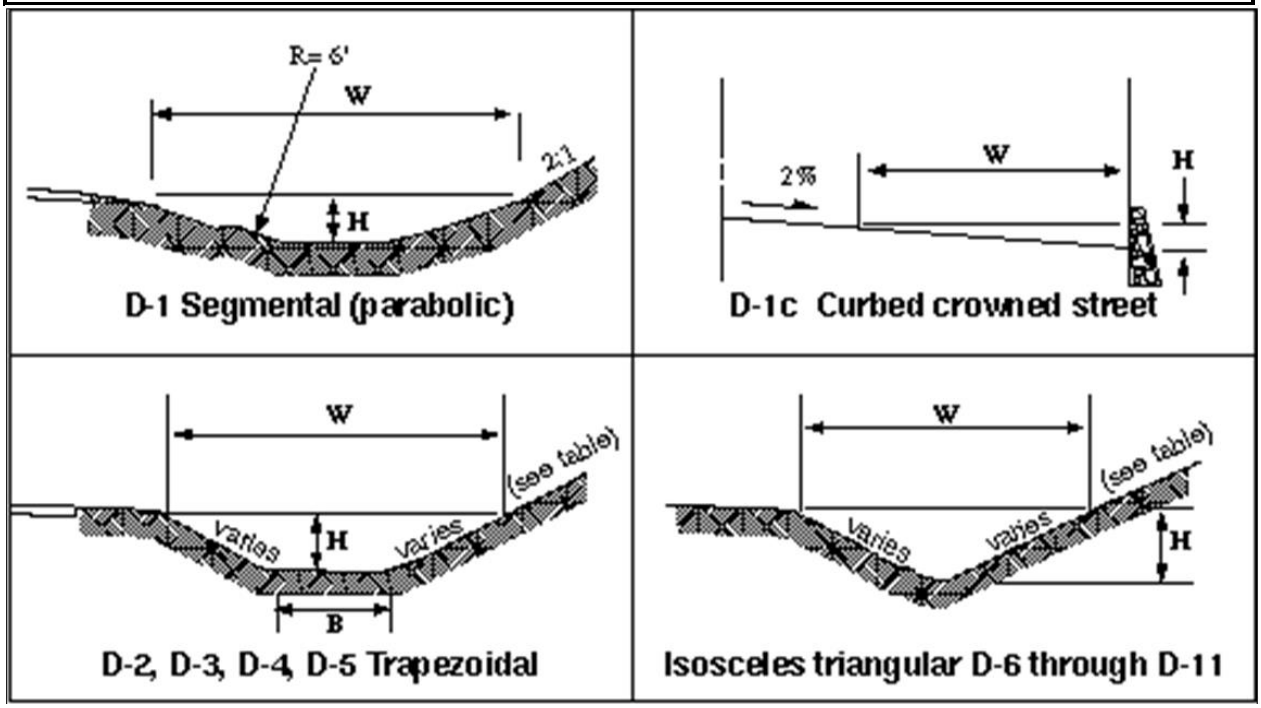


Figure III-D.4-12 Ditches – Common Section Properties

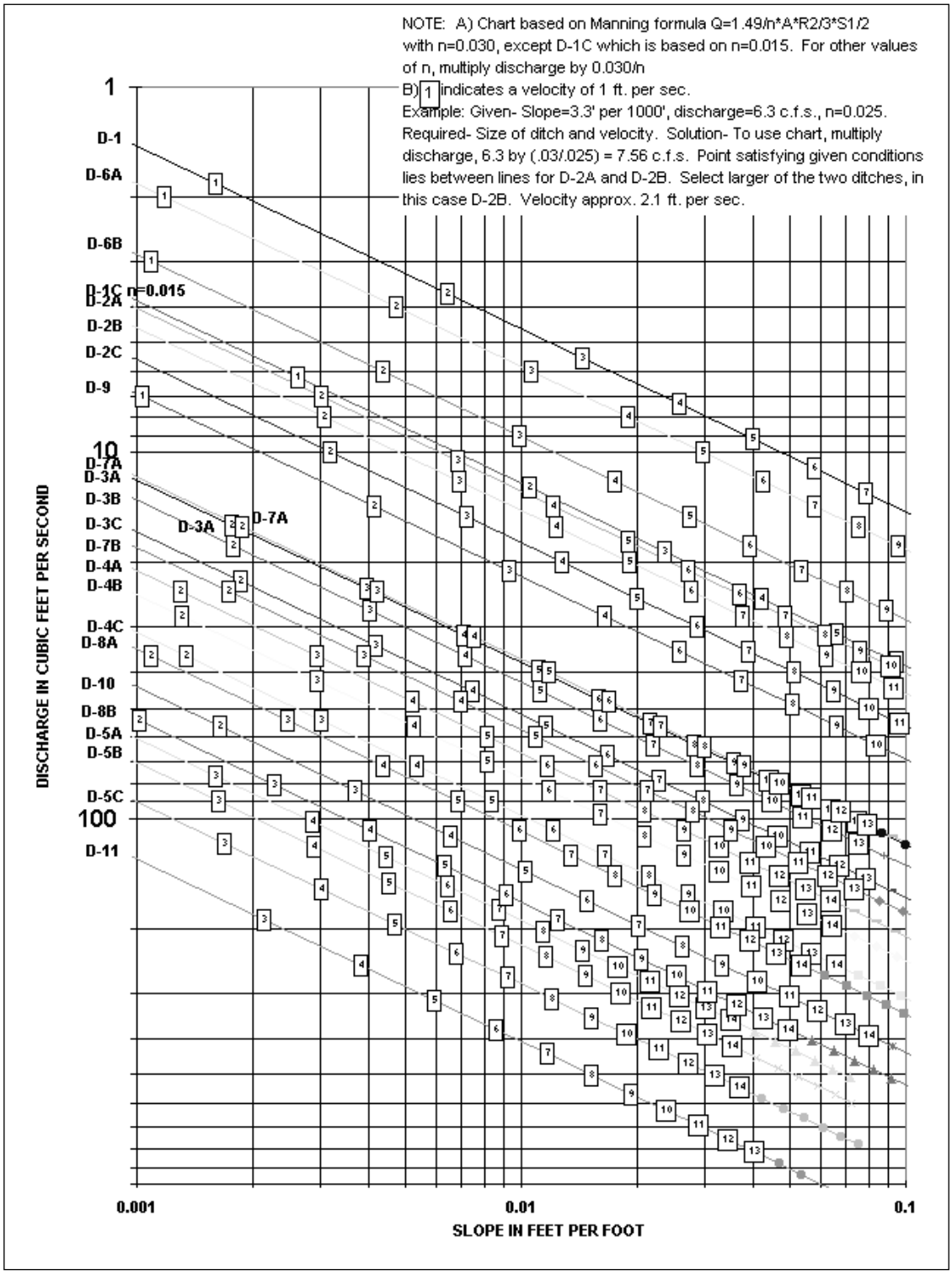
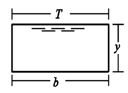
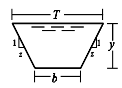
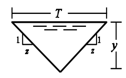
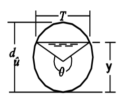
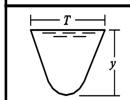
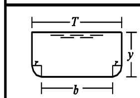
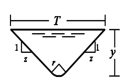


Figure III-D.4-13 Drainage Ditches – Slope/Discharge Chart

Section	Area A	Wetted perimeter P	Hydraulic radius R	Top width W	Hydraulic depth D	Section factor Z
 Rectangle	by	$b + 2y$	$\frac{by}{b+2y}$	b	y	$by^{1.5}$
 Trapezoid	$(b + zy)y$	$b + 2y\sqrt{1+z^2}$	$\frac{(b+zy)y}{b+2y\sqrt{1+z^2}}$	$b + 2zy$	$\frac{(b+zy)y}{b+2zy}$	$\frac{[(b+zy)y]^{1.5}}{\sqrt{b+2zy}}$
 Triangle	zy^2	$2y\sqrt{1+z^2}$	$\frac{zy}{2\sqrt{1+z^2}}$	$2zy$	$^1/_2 y$	$\frac{\sqrt{2}}{2} zy^{2.5}$
 Circle	$^1/_8(\theta - \sin\theta)d_o^2$	$^1/_2 \theta d_o$	$^1/_4\left(1 - \frac{\sin\theta}{\theta}\right)d_o$	$(\sin(^1/_2\theta)d_o)$ *or* $2\sqrt{y(d_o - y)}$	$^1/_8\left(\frac{\theta - \sin\theta}{\sin {^1/_2}\theta}\right)d_o$	$\frac{\sqrt{2}}{32}\frac{(\theta - \sin\theta)^{1.5}}{(\sin {^1/_2}\theta)^{0.5}} d_o^{2.5}$
 Parabola	$^2/_3 Ty$	$T + \frac{8y^2}{3T}$ *	$\frac{2T^2 y}{3T^2 + 8y^2}$ *	$\frac{3A}{2y}$	$^2/_3 y$	$^2/_9\sqrt{6}Ty^{1.5}$
 Round-cornered Rectangle ($y>r$)	$(\frac{\pi}{2} - 2)r^2 + (b + 2r)y$	$(\pi - 2)r + b + 2y$	$\frac{(\frac{\pi}{2} - 2)r^2 + (b+2r)y}{(\pi - 2)r + b + 2y}$	$b + 2r$	$\frac{(\frac{\pi}{2} - 2)r^2}{(b + 2r)} + y$	$\frac{[(\frac{\pi}{2} - 2)r^2 + (b+2r)y]^{.5}}{\sqrt{b+2y}}$
 Round-bottomed Triangle	$\frac{T^2}{4z} - \frac{r^2}{z}(1 - z\cot^{-1} z)$	$\frac{T}{z}\sqrt{1+z^2} - \frac{2r}{z}(1 - z\cot^{-1} z)$	$\frac{A}{P}$	$2[z(y - r) + r\sqrt{1+z^2}]$	$\frac{A}{T}$	$A\sqrt{\frac{A}{T}}$

*Satisfactory approximation for the interval $0 < x \le 1$, where $x=4y/T$. When $x>1$, use the exact expression $P = (^T/_2)\left[\sqrt{1+x^2} + {^1/_x}\ln\left(x + \sqrt{1+x^2}\right)\right]$

Figure III-D.4-14 Geometric Elements of Common Sections

Velocity at Design Flow (fps)		REQUIRED PROTECTION		
Greater than	**Less than or equal to**	**Type of Protection**	**Thickness**	**Minimum Height Above Design Water Surface**
0	5	Grass lining or bioengineered lining	N/A	0.5 foot
5	8	Rock lining[(1)] or bioengineered lining	1 foot	1 foot
8	12	Riprap[(2)]	2 feet	2 feet
12	20	Slope mattress gabion, etc.	Varies	2 feet

(1) Rock Lining shall be reasonable well graded as follows:
Maximum stone size: 12 inches
Median stone size: 8 inches
Minimum stone size: 2 inches

(2) Riprap shall be reasonably well graded as follows:
Maximum stone size: 24 inches
Median stone size: 16 inches
Minimum stone size: 4 inches

Note: *Riprap sizing is governed by side slopes on channel, assumed to be approximately 3:1.*

Table III-D.4-8 Channel Protection

D.4.3.4 Conveyance Capacity

There are 3 acceptable methods of analysis for sizing and analyzing the capacity of open channels:

- Manning's equation for preliminary sizing
- Direct Step backwater method
- Standard Step backwater method

D.4.3.5 Manning's Equation for Preliminary Sizing

Manning's equation is used for preliminary sizing of open channel reaches of uniform cross section and slope (i.e., prismatic channels) and uniform roughness. This method assumes the

flow depth (or normal depth) and flow velocity remain constant throughout the channel reach for a given flow.

The charts in Figure III-D.4-12 Ditches – Common Section Properties and Figure III-D.4-13 Drainage Ditches – Slope/Discharge Chart can be used to obtain graphic solutions of Manning's equation for common ditch sections. For conditions outside the range of these charts or for more precise results, Manning's equation can be solved directly from its classic forms shown in Equations 7 and 8 Section D.4.1.2.

Table III-D.4-9 *Values* of "n" for Channels below provides a reference for selecting the appropriate "*n*" values for open channels. A number of engineering reference books, such as *Open-Channel Hydraulics* by V.T. Chow, may also be used as guides to select "*n*" values. Figure III-D.4-14 Geometric Elements of Common Sections contains the geometric elements of common channel sections useful in determining area A, wetted perimeter WP, and hydraulic radius (R=A/WP).

If flow restrictions raise the water level above normal depth within a given channel reach, a *backwater condition* (or non-uniform flow) is said to exist. This condition can result from flow restrictions created by a downstream culvert, bridge, dam, pond, lake, etc., and even a downstream channel reach having a higher normal flow depth. If backwater conditions are found to exist for the design flow, a backwater profile must be computed to verify that the channel's capacity is still adequate as designed. The Direct Step or Standard Step backwater methods presented in this section can be used for this purpose.

Type of Channel and Description	Manning's "*n*"* (Normal)
I. Constructed Channels	
a. Earth, straight and uniform	
1. Clean, recently completed	0.018
2. Gravel, uniform section, clean	0.025
3. With short grass, few weeds	0.027
b. Earth, winding and sluggish	
1. No vegetation	0.025
2. Grass, some weeds	0.030
3. Dense weeds or aquatic plants in deep channels	0.035
4. Earth bottom and rubble sides	0.030 0.035
5. Stony bottom and weedy banks	
6. Cobble bottom and clean sides	0.040

Type of Channel and Description	Manning's "*n*"* (Normal)
II. Natural Streams	
II-1 Minor Streams (top width at flood stage <100 ft)	
a. Streams on plain	
1. Clean, straight, full stage no rifts or deep pools	0.030
2. Same as #1, but more stones and weeds	0.035
3. Clean, winding, some pools and shoals	0.040
4. Same as #3, but some weeds	0.040
5. Same as #4, but more stones	0.070
6. Sluggish reaches, weedy deep pools	0.100 0.050
7. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	

c. Rock lined		b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages	
1. Smooth and uniform	0.035	1. Bottom: gravel, cobbles, and few boulders	0.040
2. Jagged and irregular	0.040	2. Bottom: cobbles with large boulders	0.050
d. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.080	**II-2 Floodplains**	
2. Clean bottom, brush on sides	0.050	a. Pasture, no brush	
3. Same as #2, highest stage of flow	0.070	1. Short grass	0.030
4. Dense brush, high stage	0.100	2. High grass	0.035
		b. Cultivated areas	
		1. No crop	0.030
		2. Mature row crops	0.035
		3. Mature field crops	0.040
		c. Brush	
		1. Scattered brush, heavy weeds	0.050
		2. Light brush and trees	0.060
		3. Medium to dense brush	0.070
		4. Heavy, dense brush	0.100
		d. Trees	
		1. Dense willows, straight	0.150
		2. Cleared land with tree stumps, no sprouts	0.040
		3. Same as #2, but with heavy growth of sprouts	0.060
		4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.100
		5. Same as #4, but with flood stage reaching branches	0.120

***Note:** These "n" values are "normal" values for use in analysis of channels. For conservative design for channel capacity, the maximum values listed in other references should be considered. For channel bank stability, the minimum values should be considered.*

Table III-D.4-9 Values of "n" for Channels

D.4.3.6 Direct Step Backwater Method

The Direct Step Backwater Method can be used to compute backwater profiles on prismatic channel reaches (i.e., reaches having uniform cross section and slope) where a backwater condition or restriction to normal flow is known to exist. The method can be applied to a series of prismatic channel reaches in succession beginning at the downstream end of the channel and computing the profile upstream.

Calculating the coordinates of the water surface profile using the method is an iterative process achieved by choosing a range of flow depths, beginning at the downstream end, and proceeding incrementally up to the point of interest or to the point of normal flow depth. This is best accomplished by the use of a table (see Figure III_D.4-15 Direct Step Backwater Method Example) or computer programs.

y (1)	A (2)	R (3)	$R^{4/3}$ (4)	V (5)	$\alpha V^2/2g$ (6)	E (7)	ΔE (8)	S_f (9)	$\bar{S}_f$ (10)	$S_o - \bar{S}_f$ (11)	Δx (12)	x (13)
6.0	72.0	2.68	3.72	0.42	0.0031	6.0031	-	0.00002	-	-	-	-
5.5	60.5	2.46	3.31	0.50	0.0040	5.5040	0.4990	0.00003	0.000025	0.00698	71.50	71.5
5.0	50.0	2.24	2.92	0.60	0.0064	5.0064	0.4976	0.00005	0.000040	0.00696	71.49	142.99
4.5	40.5	2.01	2.54	0.74	0.0098	4.5098	0.4966	0.00009	0.000070	0.00693	71.64	214.63
4.0	32.0	1.79	2.17	0.94	0.0157	4.0157	0.4941	0.00016	0.000127	0.00687	71.89	286.52
3.5	24.5	1.57	1.82	1.22	0.0268	3.5268	0.4889	0.00033	0.000246	0.00675	72.38	358.90
3.0	18.0	1.34	1.48	1.67	0.0496	3.0496	0.4772	0.00076	0.000547	0.00645	73.95	432.85
2.5	12.5	1.12	1.16	2.40	0.1029	2.6029	0.4467	0.00201	0.001387	0.00561	79.58	512.43
2.0	8.0	0.89	0.86	3.75	0.2511	2.2511	0.3518	0.00663	0.004320	0.00268	131.27	643.70

The step computations are carried out as shown in the above table. The values in each column of the table are explained as follows:

Col. 1. Depth of flow (ft) assigned from 6 to 2 feet

Col. 2. Water area (ft^2) corresponding to depth y in Col. 1

Col. 3 Hydraulic radius (ft) corresponding to y in Col. 1

Col. 4. Four-thirds power of the hydraulic radius

Col. 5. Mean velocity (fps) obtained by dividing Q (30 cfs) by the water area in Col. 2

Col. 6. Velocity head (ft)

Col. 7. Specific energy (ft) obtained by adding the velocity head in Col. 6 to depth of flow in Col. 1

Col. 8. Change of specific energy (ft) equal to the difference between the E value in Col. 7 and that of the previous step.

Col. 9. Friction slope S_f, computed from V as given in Col. 5 and $R^{4/3}$ in Col. 4

Col.10. Average friction slope between the steps, equal to the arithmetic mean of the friction slope just computed in Col. 9 and that of the previous step

Col.11. Difference between the bottom slope, S_o, and the average friction slope, S_f

Col.12. Length of the reach (ft) between the consecutive steps;
Computed by $\Delta x = \Delta E/(S_o - S_f)$ or by dividing the value in Col. 8 by the value in Col. 11

Col.13. Distance from the beginning point to the section under consideration. This is equal to the cumulative sum of the values in Col. 12 computed for previous steps.

There are a number of commercial software programs for use on personal computers that use variations of the Standard Step backwater method for determining water surface profiles. The most common and widely accepted program is called HEC-2, published and supported by the United States Army Corps of Engineers Hydraulic Engineering Center. It is the model required by FEMA for use in performing flood hazard studies for preparing flood insurance maps. Other programs include WSP-2, published by the SCS, and WSPRO or E-431, published by USGS.

Figure III_D.4-15 Direct Step Backwater Method Example

Equating the total head at cross section 1 and 2, the following equation may be written:

$$S_0 \Delta x + y_1 + \alpha_1 \frac{V_1^2}{2g} = y_2 + \alpha_2 \frac{V_2^2}{2g} + S_f \Delta x \qquad \text{(equation 14)}$$

where, Δx = distance between cross sections (ft)

y_1, y_2 = depth of flow (ft) at cross sections 1 and 2

V_1, V_2 = velocity (fps) at cross sections 1 and 2

α_1, α_2 = energy coefficient at cross sections 1 and 2

S_0 = bottom slope (ft/ft)

S_f = friction slope = $(n_2 V_2)/2.21R^{1.33}$)

g = acceleration due to gravity, (32.2 ft/sec^2)

If the specific energy E at any one cross-section is defined as follows:

$$E = y + \alpha \frac{V^2}{2g} \qquad \text{(equation 15)}$$

Assuming $\alpha = \alpha_1 = \alpha_2$ where α is the energy coefficient which corrects for the non-uniform distribution of velocity over the channel cross section, equations 14 and 15 can be combined and rearranged to solve for Δx as follows:

$$\Delta x = \frac{(E_2 - E_1)}{(S_0 - S_f)} = \frac{\Delta E}{(S_0 - S_f)} \qquad \text{(equation 16)}$$

Typically values of the energy coefficient α are as follows:

- Channels, regular section 1.15
- Natural streams 1.3
- Shallow vegetated flood fringes (includes channel) 1.75

For a given flow, channel slope, Manning's "*n*," and energy coefficient α, together with a beginning water surface elevation y_2, the values of Δx may be calculated for arbitrarily chosen values of y_1. The coordinates defining the water surface profile are obtained from the cumulative sum of Δx and corresponding values of y.

The normal flow depth y_n should first be calculated from Manning's equation to establish the upper limit of the backwater effect.

D.4.3.7 Standard Step Backwater Method

The Standard Step Backwater Method is a variation of the Direct Step Backwater Method and can be used to compute backwater profiles on both prismatic and non-prismatic channels. In this method, stations are established along the channel where cross section data is known or has been determined through field survey. The computation is carried out in steps from station to station rather than throughout a given channel reach as is done in the Direct Step method. As a result, the analysis involves significantly more trial-and-error calculation in order to determine the flow depth at each station.

D.4.3.8 Computer Applications

There are several different computer programs capable of the iterative calculations involved for these analyses. The project engineer is responsible for providing information describing how the program was used, assumptions the program makes and descriptions of all variables, columns, rows, summary tables, and graphs. The most current version of any software program shall be used for analysis. Auburn may find specific programs not acceptable for use in design. Please check with COA Development Services at 253-931-3020, to confirm the applicability of a particular program prior to starting design.

D.4.3.9 Riprap Design[1]

Proper riprap design requires the determination of the median size of stone, the thickness of the riprap layer, the gradation of stone sizes, and the selection of angular stones, which will interlock when placed. Research by the U.S. Army Corps of Engineers has provided criteria for selecting the median stone weight, W_{50} (Figure III-D.4-16 Mean Channel Velocity vs Medium Stone Weight (W50) and Equivalent Stone Diameter). If the riprap is to be used in a highly turbulent zone (such as at a culvert outfall, downstream of a stilling basin, at sharp changes in channel geometry, etc.), the median stone W_{50} should be increased from 200% to 600% depending on the severity of the locally high turbulence. The thickness of the riprap layer should generally be twice the median stone diameter (D_{50}) or at least equivalent to the diameter of the

[1] From a paper prepared by M. Schaefer, Dam Safety Section, Washington State Department of Ecology.

maximum stone. The riprap should have a reasonably well-graded assortment of stone sizes within the following gradation:

$1.25 \leq D_{max}/D_{50} \leq 1.50$

$D_{15}/D_{50} = 0.50$

$D_{min}/D_{50} = 0.25$

Riprap Filter Design

Riprap should be underlain by a sand and gravel filter (or filter fabric) to keep the fine materials in the underlying channel bed from being washed through the voids in the riprap. Likewise, the filter material must be selected so that it is not washed through the voids in the riprap. Adequate filters can usually be provided by a reasonably well graded sand and gravel material where:

$D_{15} < 5d_{85}$

The variable d_{85} refers to the sieve opening through which 85% of the material being protected will pass, and D_{15} has the same interpretation for the filter material. A filter material with a D_{50} of 0.5 mm will protect any finer material including clay. Where very large riprap is used, it is sometimes necessary to use two filter layers between the material being protected and the riprap.

Example:

What embedded riprap design should be used to protect a streambank at a level culvert outfall where the outfall velocities in the vicinity of the downstream toe are expected to be about 8 fps.

From Figure III-D.4-16 Mean Channel Velocity vs Medium Stone Weight (W50) and Equivalent Stone Diameter, W_{50} = 6.5 lbs, but since the downstream area below the outfall will be subjected to severe turbulence, increase W_{50} by 400% so that:

W_{50} = 26 lbs, D_{50} = 8.0 inches

The gradation of the riprap is shown in Figure III-D.4-17 Riprap Gradation Curve, and the minimum thickness would be 1 foot (from Table III-D.4-8 Channel Protection); however, 16 inches to 24 inches of riprap thickness would provide some additional insurance that the riprap will function properly in this highly turbulent area.

Figure III-D.4-17 Riprap Gradation Curve shows that the gradation curve for ASTM C33, size number 57 coarse aggregate (used in concrete mixes), would meet the filter criteria. Applying the filter criteria to the coarse aggregate demonstrates that any underlying material whose gradation was coarser than that of concrete sand would be protected.

For additional information and procedures for specifying filters for riprap, refer to *the Army Corps of Engineers Manual EM 1110-2-1601 (1970), Hydraulic Design of Flood Control Channels*, Paragraph 14, “Riprap Protection.”

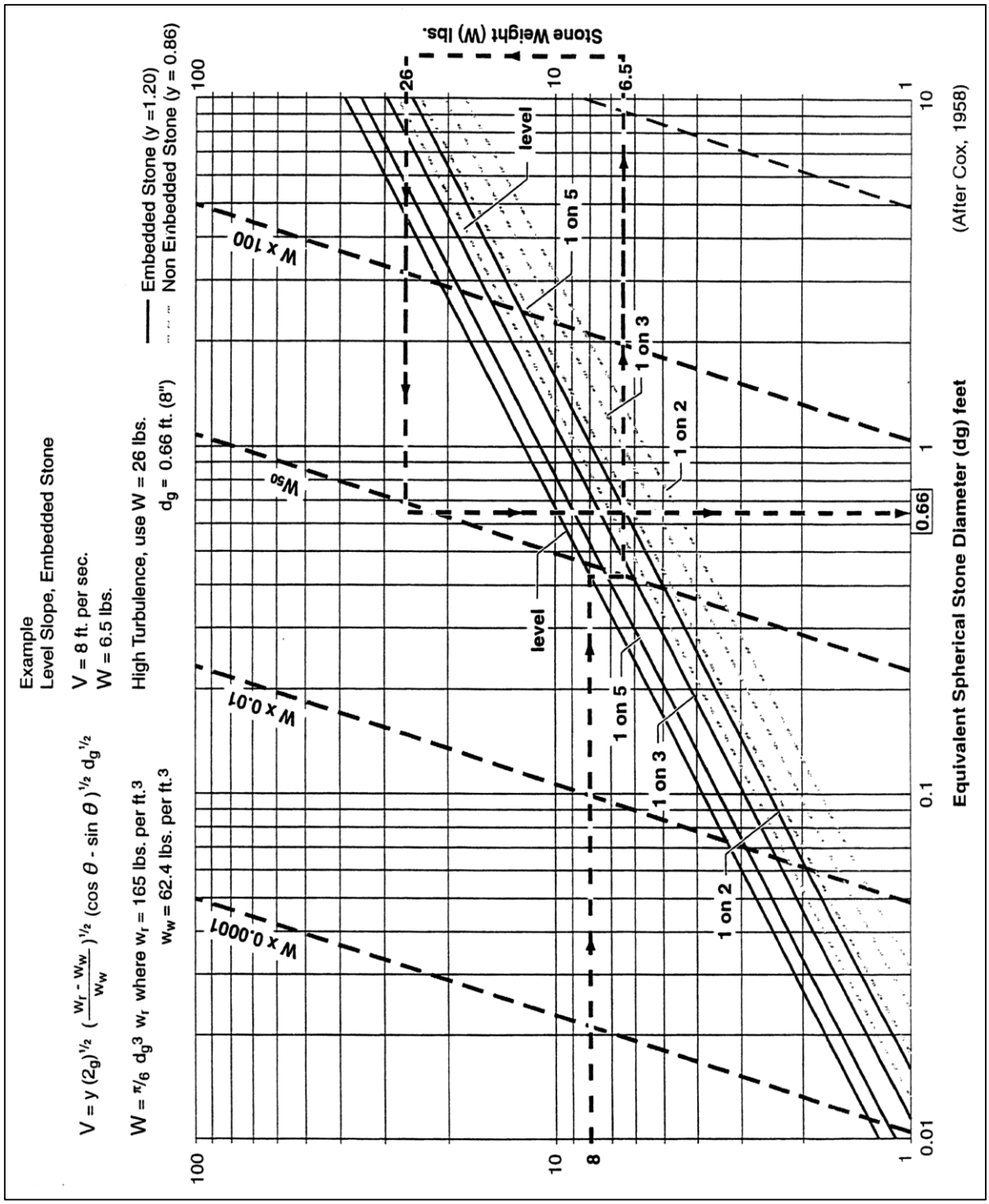


Figure III-D.4-16 Mean Channel Velocity vs Medium Stone Weight (W50) and Equivalent Stone Diameter

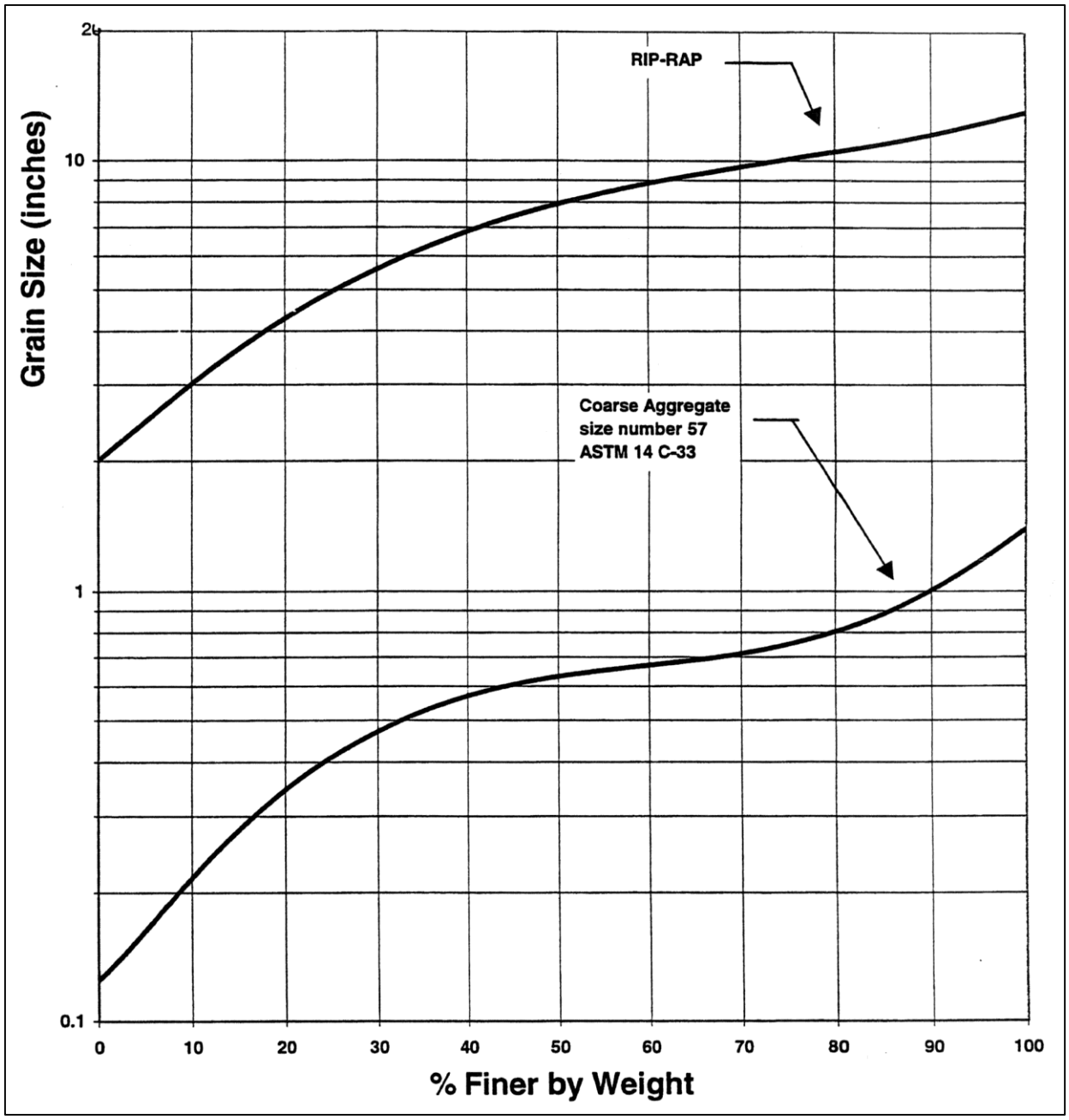


Figure III-D.4-17 Riprap Gradation Curve

III-D.5 Outfalls Systems

This section presents the methods, criteria and details for analysis and design of outfall systems. Outfall systems are required when discharging water to open culverts, ponds, or

naturally vegetated areas. The manner in which stormwater runoff and surface water are discharged from the project site must be demonstrated to not create a significant adverse impact to downhill properties or drainage facilities. Outfall systems include rock splash pads, flow dispersal trenches, gabions, or other engineered energy dissipaters. Outfalls designed as part of MR#5, MR#6, or MR#7 will be subject to the design considerations of the specified BMP in Vol V. All other outfalls will be designed per the criteria of this section.

D.5.1 Direct Outfall Design Criteria

Direct Outfalls are those where a single pipe discharges directly into an open channel, pond, or riverbank. Direct outfalls require energy dissipation, and the application and design of such should follow the guidance in SWWMM V-1.4.3.

D.5.2 Distributed Outfall Design Criteria

Distributed outfalls are those where stormwater is spread out and discharged in a distributed manner onto the ground surface. These include dispersal trenches, spray fields, and other engineered water distribution methods.

- Distributed outfalls are subject to the following conditions:
    - Distributed outfalls shall not be used unless the outfall is necessary where no conveyance system exists;
    - The 100-year peak discharge rate of a distributed outfall must be less than or equal to 0.5 cfs and be at or below the analyzed discharge rate of the undeveloped condition per an approved continuous simulation model.
- A distributed outfall with a discharge below the undeveloped condition but greater than 0.5 cfs may be allowed providing that adequate design details and calculations to demonstrate that discharge will be sheet flow are submitted and approved by the City.
- A vegetated flow path of at least 10 feet in length must be maintained between the distributed outfall and any property line, structure, stream, wetland, or impervious surface. A vegetated flow path of at least 50 feet in length must be maintained between the outlet of the trench and any steep slope. For dispersion trenches discharging more than 0.5 cfs, additional vegetated flow path may be required.
- All pipes, structures, or appurtenances of the distributed outfall 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.
- Distributed outfalls shall be setback from sensitive areas, slopes 20% or greater, landslide hazard areas, and erosion hazard areas as governed by the ACC or as outlined in this manual, whichever is more restrictive.

- For sites with multiple distributed outfalls, a minimum separation of 10 feet is required between any point of the respective flow paths. The City may require a larger separation based upon site conditions such as slope, soil type and total contributing area.
- Runoff discharged towards landslide hazard areas must be evaluated by a geotechnical engineer or a licensed geologist, hydrogeologist, or engineering 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.

Please refer to the ACC for additional requirements. Chapter 16.10 Critical Areas of the ACC may contain additional requirements depending upon the project proposal. A Hydraulic Project Approval (Chapter 77.55 RCW) and an Army Corps of Engineers permit may be required for any work within the ordinary high water mark.

Other provisions of that RCW or the Hydraulics Code - Chapter 220-110 WAC may also apply.

III-D.6 Pump Systems

Pump systems are only allowed if applied for through the City's deviation process (see Chapter 1 of the Engineering Design Standards). Feasibility of all other methods of gravity conveyance, infiltration, dispersion, and other on-site stormwater management strategies shall first be investigated and demonstrated to be infeasible in the following order of preference:

1. Infiltration of surface water on site.
2. Dispersion of surface water on site.
3. Gravity connection to the City storm drainage system.

D.6.1 Design Criteria

If approved by the City's deviation process, the pump system must convey, at a minimum, the peak design flow for the 25-year 24-hour rainfall event. Pump capacity plus system storage or overflow, must convey or store the 100-year, 24-hour storm event.

D.6.2 Pump Requirements

If approved through the City's deviation process, proposed pump systems must meet the following minimum requirements:

- Pump failure can not result in flooding of a building or emergency access, nor will it overflow to a location other than the natural discharge point for the project site.

- The pump system must have a dual pump (alternating) equipped with emergency back-up power OR a single pump may be provided without back-up power if the design provides the 100-year 24-hour storage volume.
- Pumps, wiring, and control systems shall be intrinsically safe per IBC requirements.
- All pump systems must be equipped with an external pump failure and high water alarm system.
- The pump system will serve only one lot or business owner.
- The pump system must be privately owned and maintained.
- The pump system shall not be used to circumvent any other City drainage requirements. Construction and operation of the pump system shall not violate any City requirements.

Pumped stormwater systems will require the following additional items:

- Operations and Maintenance Manual describing the system itself and all required maintenance and operating instructions, including procedures to follow in the event of a power outage. All the requirements of Section Appendix V-A shall be included in the O&M manual.
- Notice to Title on the property outlining that a private stormwater system is constructed on the site and that the maintenance of that system is the responsibility of the property owner. Wording of the Notice to Title shall be approved by the City prior to placing the Notice.
- Operations and Maintenance Agreement signed by the property owner and the City. After signature by the City, the agreement shall be recorded with the appropriate County and listed in the Notice of Title with the recording number.

All fees associated with preparing and recording documents and placing the Notice to Title shall be the responsibility of the applicant.

D.6.4 Sump Pumps

The above pump requirements do not apply to internal sump pumps. However, internal sump pumps do require a permit prior to connection to the City storm drainage system.

- Sump pumps shall be sized to properly remove water from basements and crawl spaces.
- Sump pumps shall NOT be connected to the sanitary sewer system.
- Consult the pump manufacturer or an engineer for appropriate sizing of a sump pump.

III-D.7 Easements and Access

Refer to Appendix I-J for storm facility access criteria.

Appendix III-E City of Auburn Design Storm

Return Frequency 24-Hour Storm Event (Years)	Precipitation (Inches)
0.5	1.44
2	2.0
5	2.5
10	3.0
25	3.5
50	3.5
100	4.0

Table III-E-1 Design Storm Precipitation Values

The depth of a 7-day, 100-year storm can be determined in one of three ways:

- Use 12 inches for the lowland areas between sea level and 650 MSL.
- Use the U.S. Department of Commerce Technical Paper No. 49, “Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States.”
- Use the U.S. Department of Commerce NOAA Atlas 2, “Precipitation Frequency Atlas of the Western United States,” Volume IX – Washington, 24-hour, 100-year isopluvials and add 6.0 inches to the appropriate isopluvial for the project area.

Appendix III-F Procedure for Conducting a Pilot Infiltration Test

The Pilot Infiltration Test (PIT) consists of a relatively large-scale infiltration test to better approximate infiltration rates for design of stormwater infiltration facilities. The PIT reduces some of the scale errors associated with relatively small-scale double ring infiltrometer or "stove-pipe" infiltration tests. It is not a standard test but rather a practical field procedure recommended by Ecology's Technical Advisory Committee.

Infiltration Test

- Excavate the test pit to the depth of the bottom of the proposed infiltration facility. Lay back the slopes sufficiently to avoid caving and erosion during the test.
- The horizontal surface area of the bottom of the test pit should be approximately 100 square feet. For small drainages and where water availability is a problem, smaller areas may be considered as determined by the site professional.
- Accurately document the size and geometry of the test pit.
- Install a vertical measuring rod (minimum 5-ft. long) marked in half-inch increments in the center of the pit bottom.
- Use a rigid 6-inch diameter pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates.
- Add water to the pit at a rate that will maintain a water level between 3 and 4 feet above the bottom of the pit. A rotometer can be used to measure the flow rate into the pit.

A water level of 3 to 4 feet provides for easier measurement and flow stabilization control. However, the depth should not exceed the proposed maximum depth of water expected in the completed facility.

Every 15 – 30 min, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point (between 3 and 4 feet) on the measuring rod.

Add water to the pit until one hour after the flow rate into the pit has stabilized (constant flow rate) while maintaining the same pond water level (usually 17 hours).

After the flow rate has stabilized, turn off the water and record the rate of infiltration in inches per hour from the measuring rod data, until the pit is empty.

Data Analysis

Calculate and record the infiltration rate in inches per hour in 30 minutes or one-hour increments until one hour after the flow has stabilized.

Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.

Apply appropriate correction factors for site heterogeneity, anticipated level of maintenance and treatment to determine the site-specific design infiltration rate (see Table III-F-1 In-Situ Infiltration Measurement Correction Factors to Estimate Long-Term Infiltration Rates).

Example

The area of the bottom of the test pit is 8.5-ft. by 11.5-ft.

Water flow rate was measured and recorded at intervals ranging from 15 to 30 minutes throughout the test. Between 400 minutes and 1,000 minutes the flow rate stabilized between 10 and 12.5 gallons per minute or 600 to 750 gallons per hour, or an average of (9.8 + 12.3) / 2 = 11.1 inches per hour.

Applying a correction factor of 5.5 for gravelly sand in Table III-F-1 the design long-term infiltration rate becomes 2 inches per hour, anticipating adequate maintenance and pre-treatment.

Issue	**Partial Correction Factor**
Site variability and number of locations tested	CF_y = 1.5 to 6
Degree of long-term maintenance to prevent siltation and bio-buildup	CF_m = 2 to 6
Degree of influent control to prevent siltation and bio-buildup	CF_i = 2 to 6
Total Correction Factor (CF) = $CF_y + CF_m + CF_i$	

Table III-F-1 In-Situ Infiltration Measurement Correction Factors to Estimate Long-Term Infiltration Rates

Volume IV

Source Control BMP Library

City of Auburn Supplemental Manual

Executive Summary of Volume IV

Source Control BMPs in this Volume that are required must always be applied to the associated activity. Recommended BMPs are to be considered when and where the required BMPs are not achieving or expected to achieve the outcome of the required BMPs. The outcome of all required Source Control BMPs is to eliminate the discharge of pollutants into stormwater runoff to the maximum extent practicable.

General additions and/or changes to the SWMMWW contained in this Volume include:

- **IV-2: Cleaning or Washing Source Control BMPs**
  - **BMP S431 (amended)**
  - **BMP S441 (amended)**
- **IV-3: Roads, Ditches, and Parking Lot Source Control BMPs**
  - **BMP S630 (additional)**
  - **BMP S631 (additional)**
  - **BMP S632 (additional)**
  - **BMP S633 (additional)**
- **IV-4: Soil Erosion, Sediment Control, and Landscaping Source Control BMPs**
  - **BMP S435 (amended)**
  - **BMP S640 (additional**)
- **IV-5: Storage and Stockpiling Source Control BMPs**
  - **BMP S445 (amended)**
  - **BMP S650 (additional)**
  - **BMP S651 (additional)**
- **IV-7: Other Source Control BMPs**
  - **BMP S414 (amended)**
  - **BMP S670 (additional)**
  - **BMP S671 (additional)**
  - **BMP S672 (additional)**
  - **BMP S673 (additional)**
  - **BMP S674 (additional)**
  - **BMP S675 (additional)**
  - **BMP S676 (additional)**
- **Supplemental Appendix IV-C** contains a quick reference phone number guide for local, county, and state agencies.
- **Supplemental Appendix IV-D** provides required Source Control BMPs for homeowners.

IV-2 – Cleaning or Washing Source Control BMPs

S431: BMPs for Washing and Steam Cleaning Vehicles/Equipment/Building Structures (Amended)

General

- Wash water shall be discharged to the sanitary sewer with appropriate pretreatment to remove solids.
- If heavy accumulations of solids are to be removed during washing, then appropriate pretreatment to capture those solids must be provided. Volume II contains temporary sediment removal BMPs that can be utilized to capture solids before discharging wastewater to the sanitary sewer system.
- Two-step washing may be allowed at all facilities discharging to the sanitary sewer. Provisions must be in place to neutralize the wash water prior to introduction into the sanitary sewer system.
- Facilities with dedicated wash pads with a catch basin having a tee discharge and/or pretreatment equipment, sampling and monitoring ports will be required. Additionally, the installation of a valve may be required to prevent discharge from the system in the event of a spill. All ports must be accessible for inspection and sampling at all times. Any equipment needed for access must be available at all times.
- Contact the COA Sanitary Sewer Utility for more information 253-931-3010.

New and Used Car Dealer Lots

- If washing previously clean vehicles is accomplished only with cold water and consists of washing only the outside of the vehicles, (no soaps or detergents used) discharge to the private storm drainage system will be allow provided the site has a flow control structure that acts as the sediment and oil trap. See Ecology guidance WQ-R-95-56, “Vehicle and Equipment Washwater Discharges/Best Management Practices Manual”, November 2012 or most recent update, for more information.
- If soaps or detergents are to be used, washing must occur on a dedicated wash pad. Only the washing of the outside of the vehicles is permitted. The wash pad must be equipped with a catch basin/sediment trap that discharges through a tee outlet to the sanitary sewer. The tee outlet will allow containment of minor amounts of free-floating oil. Wastewater must meet local limitations on wastewater strength and quality. If engines and/or undercarriages are to be washed additional pretreatment will be required. Contact the COA Sewer Utility at 253-931-3010 for further information.

Other Washing Events

- Other types of washing events and their locations (such as regional used car sales, RV shows, etc.) will be evaluated on a case-by-case basis according to the discharge criteria stated above.

- Fundraising car washes may wash only the exterior of vehicles. If soap is used, the wash water must be captured and directed to the sanitary sewer. Contact COA Public Works Department at 253-931-3010 for alternative fundraising activities that do not pose a risk of pollution.
- Pressure washing of building facades, rooftops, pavement, and other large surfaces must be conducted in such a way that all of the runoff is collected for proper disposal. Sediment removal BMPs include those as described in Volume II and include measures such as check dams, sorbent booms, and catch basin inserts . Temporary curbs, dikes, or berms may be used to direct the water to a collection point or catch basins may be covered to help contain the water. The collected water, provided it meets limits established by King County Wastewater Treatment Division or defined in Chapter 13.20 of the ACC, should be disposed of to the sanitary sewer. Contact the COA Sanitary Sewer Utility at 253-931-3010 for more information on allowable discharges to the sanitary sewer.
- On a case by case basis, if runoff does not contain pollutants, following appropriate pretreatment, such as filtration or sedimentation, then this water may be allowed to be discharged to the storm drainage system. Contact the COA Storm Drainage Utility at 253-931-3010 for more information.

Automatic and Manual Car Wash

- See Chapter 13.20 Sewers of the ACC and the COA Engineering Design Standards.

Truck Washing Facilities

- Wash on a concrete or asphalt paved dedicated wash pad connected to a designed pretreatment device, which discharges to the sanitary sewer See Chapter 13.20 Sewers of the ACC and the COA Engineering Design Standards.

Mobile Vehicle Washers

The following summarizes the requirements for mobile vehicle and grocery cart washers doing work in the COA. Contact the COA Storm Drainage Utility at 253-931-3010 for more information.

- Mobile vehicle washers must possess a current COA Business License.
- Discharge all wash water to the sanitary sewer.
- Mobile vehicle washers shall capture all the wash water generated and discharge it to the sanitary sewer system through an on-site cleanout if available. The use of temporary wash pads, catch basin inserts, and vacuum systems are some possible means to capture the wash water.
- Other requirements may apply depending upon the items to be washed.
- Only wastewater generated within the COA may be discharged into its municipal sewer system.
- Mobile vehicle washers may wash only the exteriors of the vehicles. Engine washing, cleaning the undercarriage or fifth wheel is strictly prohibited unless prior approval is received from the City Engineer or designee. Additional pretreatment may be required.

Discharges from mobile washing must meet the requirements in Chapter 13.20 of the ACC regarding discharge limitations for pH.

S441: BMPs for Potable Water Line Flushing, Water Tank Maintenance, and Hydrant Testing (Amended)

Description of Pollutant Sources

Construction and operation of drinking water infrastructure, including water mains, water reservoirs, water transmission mains, hydrants, and water wells, as well as emergency response activities, can generate sediments, rust, turbidity and suspended solids, bacteria, and chlorinated water. Flushing of the water delivery system is necessary to maintain drinking water quality and ensure public health. Flushing activities can result in increased flows in downstream conveyances. These high flows may cause flooding and create erosion in downstream channels.

Pollutant Control Approach

Establish operational controls for flow rate and volume of discharges, removal of sediments, neutralization of chlorine, and maximizing the beneficial use of the resource.

Applicable Operational BMPs

- Discharges of untreated hyperchlorinated water must go to the sanitary sewer. Prior City approval is required. Contact the COA Sanitary Sewer Utility at 253-931-3010 for more information.
- Alternatively, non-emergency discharges of de-chlorinated potable water may go to the storm drainage system at prior approved flow rates provided the following limits are met:
    - Chlorine residual ≤0.1 ppm
    - pH 6.5 – 8.5
    - Turbidity ≤10 NTU

  Coordinate with the COA Storm Drainage Utility at 253-931-3010. The receiving stormwater conveyance shall be monitored for the duration of the discharge.
- Evaluation of the receiving conveyance system for capacity and/or obstructions may be required.
- City approval may be required for draining and flushing reservoirs, standpipes, wellheads, and transmission lines. Notification, monitoring, reporting, flow control measures, and other special conditions may apply. Contact the COA Public Works Department at 253-931-3010 for the requirements.
- For routine hydrant and water main flushing, coordinate with the COA Storm Maintenance and Operations section at 253-931-3048. In all cases, the receiving storm pipe shall be monitored for the duration of the discharge to maintain no more than a half full-pipe flow rate.

- Significant releases of water can have a detrimental effect on the storm and sanitary transmission system as well as receiving waters. Notification of these releases must be promptly made to the City by calling 253-931-3048.

Applicable Operational BMPs

- During emergency repairs and activities, such as mainline breaks, erosion control measures shall be taken as practicable. Use of sandbags, check dams, plastic sheeting, pumps, and other erosion control measures should be employed to minimize erosion as much as possible.
- Excavation de-watering should be managed to minimize downstream environmental impacts. Use of vactor trucks, diverting flow to grassy areas, filter bags, and retention ponds should be employed.

IV-3 – Roads, Ditches, and Parking Lot Source Control BMPs

S630: BMPs for Disposing of Contaminated Stormwater and Waste Materials Properly (Additional)

Every business and residence in Auburn must dispose of solid and liquid wastes and contaminated stormwater properly. There are generally four options for disposal depending on the type of materials. These options include:

- Sanitary sewer and septic systems
- Recycling facilities
- Public or private, permitted solid waste disposal facilities
- Permitted hazardous waste treatment, storage, and disposal facilities

Many liquid wastes and contaminated stormwater (depending on the pollutants and associated concentrations present) can be put into the sanitary sewer. Animal wastes can also be disposed of in a sanitary sewer. A permit may be required for discharges to the sanitary sewer system. Please contact the COA Utility Billing Section at 253-931-3038 for design and permit requirements. See Appendix IV-B for Management of Street Wastes.

If waste cannot be legally discharged to a sanitary sewer or septic system, one of the other three disposal options must be used. Recycling facilities are a recommended option for many commercial and household items, including used oils, used batteries, old equipment, glass, some plastics, metal scrap materials, solvents, paints, wood and land clearing wastes, and various other solid wastes.

Solid waste that cannot be recycled and that are not hazardous must be disposed of at a licensed solid waste disposal facility. Dangerous and hazardous wastes must be properly transported to an appropriate hazardous waste treatment, storage, and disposal facility. The COA Solid Waste Utility at 253-931-3038 can provide information on waste disposal options.

Maintain records for all materials that are recycled or disposed.

Appendix IV-C has a list of COA telephone numbers to contact for assistance.

S631: BMPs for Cleaning Catch Basins (Additional)

Cleaning catch basins regularly is one of the most important stormwater source control measures that a business can take. Catch basins are typically located at low spots in parking lots, along curbs and road edges, and where storm drain pipes combine flows. Catch basins collect surface runoff for storm drains that are typically located directly underneath them. Most catch basins have some storage in the bottom that never drains to an outflow pipe. This permanent storage area is intended to trap sediments, debris, and other particles that can settle out of stormwater, thus preventing clogging of downstream pipes and washing of these solids into receiving waters. All of the solids and stagnant water collected from catch basin sumps must be disposed of properly. The sump contents shall not be flushed into the catch basin outflow pipe.

For additional information on the maintenance of catch basins, refer to Appendix V-A. Perform regular inspections of the basins and their grates. Remove trash and collected sediment when 60% of the sump depth has been filled or sediments are within 6 inches of the bottom of the outlet pipe.

It should be apparent that the use of other BMPs, such as frequent sweeping of activity areas, covering activity areas, reducing activity occurrence, and containing run-off from activity areas will help reduce catch basin cleaning frequency, thus saving time and money. All businesses and agencies should set up maintenance schedules for all of their BMPs so coordinated BMP maintenance efforts results in reduced catch basin cleaning frequencies.

Use of catch basin inserts such as filter socks, absorbent pillows, and filter baskets require an increased inspection frequency to prevent plugging and flooding.

Dispose of street waste in accordance with Appendix IV-B for Management of Street Wastes.

S632: BMPs for Paving the Activity Area and Sloping to a Sump, Holding Tank, or Oil/Water Separator (Additional)

This BMP applies to several activities that cannot be covered effectively. It is particularly suited to activities with the potential for leaks and spills, but that otherwise do not generate excessive amounts of polluted runoff. The activity area shall be paved and sloped to a central collection point. A sump, holding tank, or oil/water separator (Figure IV-3-1 Paved Area with Sump Drain) serves to provide spill containment until the liquids can be pumped out and properly disposed. The minimum volume for the sump shall be equivalent to the volume generated by the anticipated activity plus rain water. Sizing justification shall be included in design submittals.

To prevent run-on, the area should be enclosed with a berm, curb, or dike. Frequent inspections of the sump, holding tank, or oil/water separator are necessary. Inspections and maintenance shall be recorded in a log in the Operations and Maintenance Manual for the site. For assistance, contact commercial services that pump sumps and holding tanks.

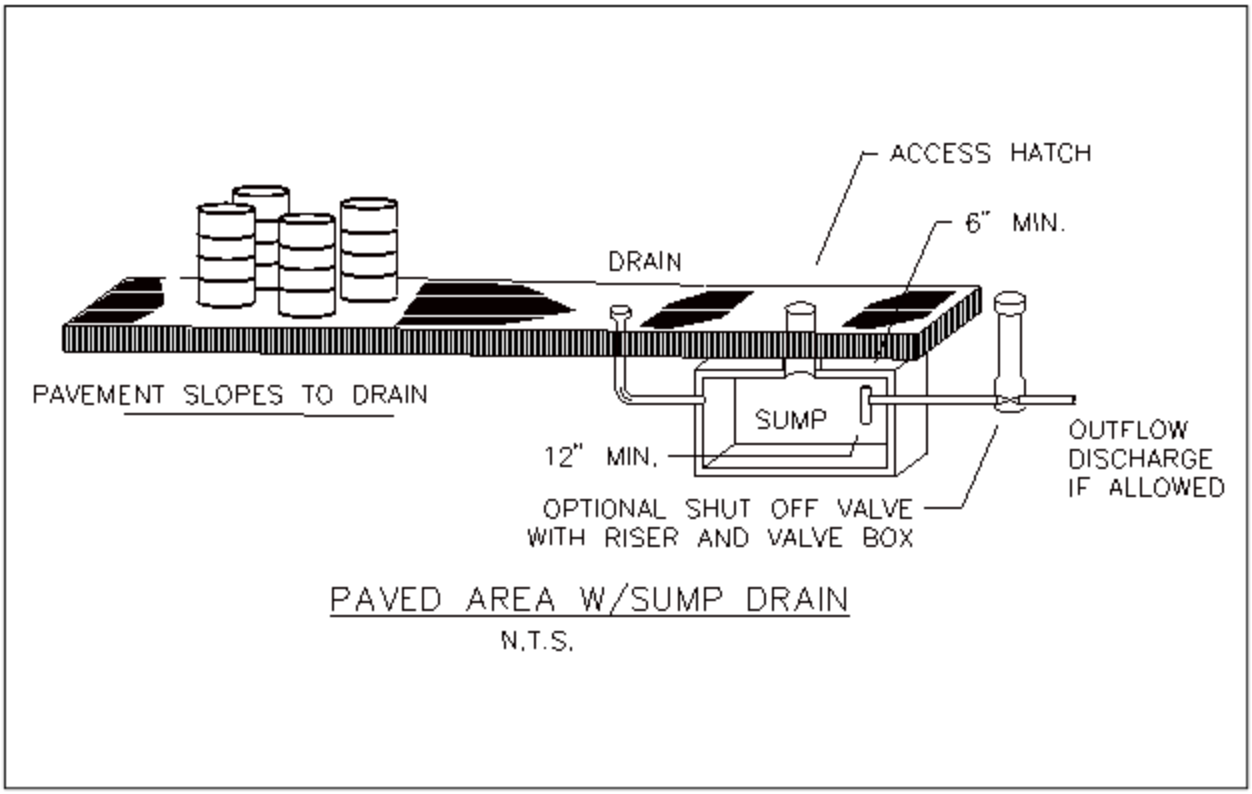


Figure IV-3-1 Paved Area with Sump Drain

S633: BMPs for Surrounding the Activity Area with a Curb, Dike, or Berm or Elevating the Activity (Additional)

This set of BMP options can be an effective means for prevention of stormwater run-on to an activity area. In addition, a curb, berm, or dike can be used for containment of spills in the activity area, or for containment of contaminated activity runoff. Generally, a containment BMP, is most applicable to spill control situations; that is, sites where runoff is relatively clean, but occasional spills may occur.

If a curb, berm, or dike is used for runoff containment, and other containment sizing regulations (such as fire codes, Environmental Protection Agency, or Department of Ecology restrictions) do not apply, the containment volume shall be 100% of the volume of the largest tank plus the volume of stormwater runoff from rain events up to the 25-year, 24-hour storm within the containment area is contained or 110% of the volume of the largest tank, whichever is greater.

Impervious containment may consist of membrane lined soil enclosures, containment pallets, plastic pools, mortar mixing tubs, and water troughs.

Regular inspections of the containment area and proper management of any collected stormwater is required.

Development of a spill plan may be necessary for storage of liquids. See **BMP S426** in Volume IV. For permanent storage facilities see **BMPs S409**, **S427**, **S428**, and **S429** in Volume IV.

IV-4 – Soil Erosion, Sediment Control, and Landscaping Source Control BMPs

S435: BMPs for Pesticides and Integrated Pest Management Program (Amended)

Description of Pollutant Sources

Use of herbicides, fungicides, and rodenticides should always be done with extreme caution, not only because of the potential harm to humans and pets, but also because of the potential harm to fish, wildlife, and our water resources. In light of the toxic nature of these compounds, special attention should be given to pesticide usage in all applications. The discussion below applies more to large-scale licensed pesticide users but should be considered for backyard applications as well.

Pollutant Control Approach

Commercial, agricultural, and other large scale pesticide users, such as golf courses and parks, shall adhere to the principles of integrated pest management (IPM), a decision-making process for pest management that strives for intelligent, environmentally sound control of pests. It is a systems approach to pest management that combines agronomic, biological, chemical, and genetic information for educated decisions on the type of control to use, the timing and extent of chemical application, and whether non-chemical means can attain an acceptable level of pest control.

IPM is a preventive measure aimed at knowing the exact pests being targeted for control, the locations and times when pests will pose problems, the level of pest-induced damage that can be tolerated without taking action, the most vulnerable life stage, and control actions that are least damaging to the environment. The major components of IPM are as follows:

- Monitoring and inventory of pest populations
- Determination of pest-induced injury and action levels
- Identification of priority pest problems
- Selection and timing of least toxic management tools
- Site-specific treatment with minimized chemical use
- Evaluation and adjustment of pesticide applications

Monitoring of pest populations is key to successful IPM implementation. Pest problems are universally easier to control if the problem can be discovered early. With IPM, pesticides are used only as a last resort. Maximization of natural controls, including biological controls and removal of pests by hand, is always the first choice.

Additional concerns are storage, equipment clean-up, spill protocols, and waste disposal.

More information on IPM is available from the Washington State Department of Agriculture and from the Washington State University Extension Service.

S640: BMPs for Concrete and Asphalt Mixing and Production at Stationary Sites (Additional)

Description of Pollutant Sources

This applies to businesses and agencies that mix raw materials onsite to produce concrete or asphalt. It also applies to subsequent uses such as pouring concrete structures and making other concrete or asphalt products. Mobile concrete pouring and asphalt application are covered in Volume II. Requirements for stockpiling of raw materials are covered under **BMP S429** in the Volume IV.

Pollutants of concern include toxic hydrocarbons, toxic organic compounds, oils and greases, heavy metals, and pH.

Pollutant Control Approach

Cover and contain processes where possible and prevent stormwater run-on and contamination, where feasible.

Any facility categorized under SIC Code 2951 or SIC Code 3273 may need to comply with Ecology's Sand and Gravel General Permit. Contact the Department of Ecology at 360-407-6979 for additional information. These facilities may also be subject to COA requirements. Contact the COA Public Works Department at 253-931-3010 for further information.

The following BMPs are required of all businesses and public agencies active in concrete and asphalt mixing and production:

- Eliminate all illicit connections to the storm drainage system. See **BMP S410** in Volume IV for a detailed discussion on identifying and eliminating these connections.
- All process water from production, pouring, and equipment cleaning must be discharged to a dead-end sump, a process water treatment system, connected to the sanitary sewer, or recycled. Never wash fresh concrete or concrete mixer washout into streets, storm drainage systems, streams, or other water bodies.
- A BMP maintenance schedule must be established, maintenance documented, and employees educated about the need to prevent stormwater contamination through the use and proper maintenance of BMPs.
- Production and pouring areas must be protected from stormwater run-on. See **BMP S633** in Volume IV for methods of run-on protection.
- Cover the production area for prevention of stormwater run-on. See **BMP S676** and **BMP S633** in Volume IV for information on covers and run-on prevention.

- Use absorbent materials or catch basin filters in and around storm drains and catch basins to filter out contaminants.
- Sweep areas that show accumulation of materials. Vacuum sweeping is also an acceptable method of removing accumulated material.

The following BMPs are not required, but can provide additional pollution protection:

- The production and pouring area should be swept at the end of each work day to collect loose chunks of aggregate and raw materials for recycling or proper disposal. See **BMP S630** in Volume IV for disposal options.
- Sweep all driveways and gutters that show accumulation of materials to minimize the amount that could be carried offsite by rain and enter the storm drainage system. Use of vacuum sweepers is most efficient.
- Asphalt plants should use an oil/water separator to treat stormwater runoff. See Volume V, Water Quality Treatment BMPs, for more information.
- Pave the mixing, production, and pouring areas. A sump drain in these areas is probably not advisable due to potential clogging problems but could be used in a curing area. Sweep these areas to remove loose aggregate and recycle or dispose of properly.
- Use storm drain covers or similarly effective containment devices to prevent runoff from entering the storm drainage system. Accumulations of dirty runoff must be disposed of properly.

IV-5 – Storage and Stockpiling Source Control BMPs

S429: BMPs for Storage or Transfer (Outside) of Solid Raw Materials, Byproducts, or Finished Products (Amended)

Description of Pollutant Sources

Some activities, such as stockpiling of raw materials, can be effectively covered with a sturdy tarp or heavy plastic sheet made of impermeable material.

Pollutant Control Approach

Weights such as bricks, tires, or sandbags should be used to anchor the cover in place. Run-on shall be prevented from reaching the activity or material. Stormwater run-off from the cover shall be directed away from the stockpile and work zone, and if uncontaminated, directed to the stormwater collection system. The tarp must be inspected daily to ensure that no holes or gaps are present in the tarp coverage. An example of this type of cover is shown in Figure IV-5.7A Stockpile Covering, which supersedes SWMMWW Figure IV-5.7.

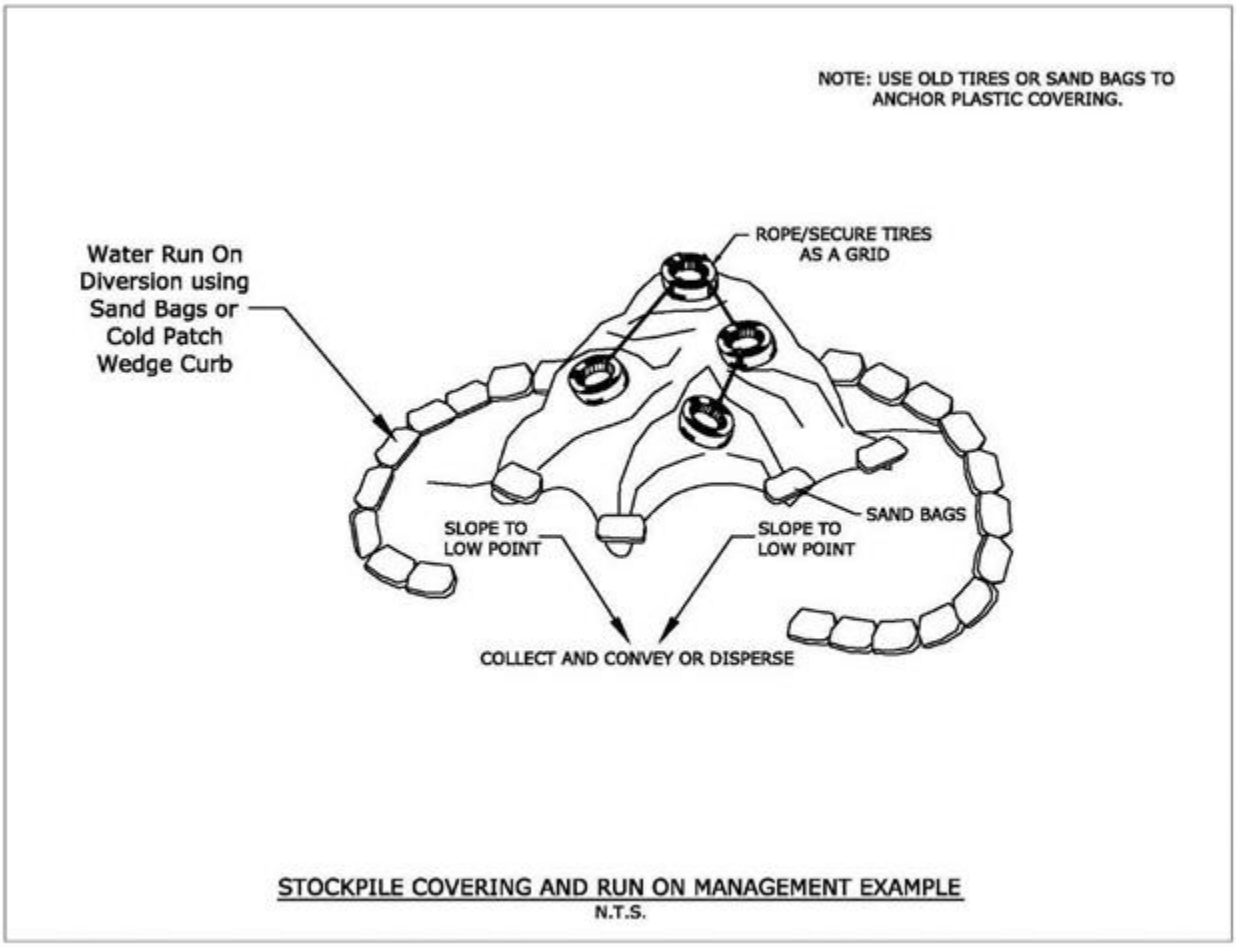


Figure IV-5.7A Stockpile Covering

S445: BMPs for Temporary Fruit Storage (Amended)

Businesses that store or process fruits and vegetables are required to be covered under an Individual NPDES Permit and may require an Industrial Wastewater Discharge Permit from King County Metro. Contact the Washington State Department of Ecology for information on BMPs

related to fruit and vegetable processing and storing. Additional permitting may be required from the County Health Department.

S650: BMPs for Storage of Solid Wastes and Food Wastes (Additional)

Description of Pollutant Sources

This applies to facilities such as hospitals, restaurants, meat and seafood markets, veterinarian clinics, schools, grocery stores, assisted living centers, multifamily residential properties and group assembly halls that store solid wastes and food wastes outdoors. This includes ordinary garbage. If improperly stored, these wastes can contribute a variety of different pollutants to stormwater, for more information call the Auburn Solid Waste and Recycling Utility at 253-931-3038.

NOTE: Dangerous solid wastes must be stored and handled under special guidelines. Businesses and agencies that store dangerous wastes must follow specific regulations outlined by the Department of Ecology. Ecology regulations are outlined in Section I-2.15. Please contact the Department of Ecology's Hazardous Waste and Toxics Reduction Program for the specific requirements and permitting information.

Pollutants of concern include toxic organic compounds, oils and greases, heavy metals, nutrients, suspended solids, chemical oxygen demand (COD), and biochemical oxygen demand (BOD).

Pollutant Control Approach

Store wastes in suitable containers with leak-proof lids. Sweep or shovel loose solids. Educate employees about the need to check for and replace leaking containers.

The following BMPs are required of all businesses and public agencies engaged in storage of non-dangerous solid wastes or food wastes:

- All solid and food wastes must be stored in suitable containers. Piling of wastes without any cover is prohibited.
- Waste storage areas and trash enclosures for food or liquid bearing wastes must be connected to the sanitary sewer and bermed or sloped to prevent stormwater run-on.
- Waste storage areas and trash enclosures over 200 square feet in area require a permanent cover.
- Trash compactors or dumpsters for food or liquid-bearing wastes shall drain to the sanitary sewer system using a design approved by the COA.
- Storage containers must be checked for leaks and replaced if they are leaking, corroded, or otherwise deteriorating. If storage containers contain liquid wastes of any kind, then the container shall be located on a pad equipped with a drainage system connected to the City sanitary sewer.

- Storage containers must have leak-proof lids or be covered by some other means. Lids must be kept closed at all times. This is especially important for dumpsters, as birds can pick out garbage and drop it, promoting rodent, health, and stormwater problems.
- Do not completely fill containers of waste grease and oil. Leave a minimum of four inches of freeboard to prevent spills when the containers are moved or handled for recycling.
- Employees must be trained to check storage containers frequently for leaks and to ensure that the lids are on tightly.
- The waste storage area must be swept or otherwise cleaned frequently to collect all loose solids for proper disposal in a storage container. Do not hose the area to collect or clean solids.
- If containers are cleaned, all rinse water from cleaning must be disposed of in a sanitary sewer or septic system.
- Inspect regularly and clean out catch basins on the property that receive drainage from waste storage area. See **BMP S631** in Volume IV for details on catch basin cleaning.

The following BMPs are not required, but can provide additional pollution protection:

- If the amount of waste accumulated appears to frequently exceed the capacity of the storage container, then another storage container should be obtained and utilized.
- Provide a backup storage container if the amount of waste accumulated appears to frequently exceed the capacity of the storage container.
- Locate drain to sanitary sewer at one end or side of the enclosure to ease cleaning the drain.
- In enclosures with drains to the sanitary sewer, provide an area for washing floor mats.
- Store containers such that wind will not be able to knock them over.
- Designate a storage area, pave the area, and slope the drainage to a holding tank or sanitary sewer drain. If a holding tank is used, the contents must be pumped out before the tank is full and properly disposed. See **BMP S630** in Volume IV for more information on disposal options.
- Compost appropriate wastes. Contact Auburn Solid Waste and Recycling Utility Recycling at 253-931-3038 for more information on composting.
- Recycle solid wastes. The Industrial Materials Exchange (IMEX) program facilitates the transfer of excess materials and wastes to those who can use them. IMEX can be reached at 206-263-8465.

S651: BMPs for Storage and Treatment of Contaminated Soils (Additional)

Description of Pollutant Sources

This applies to businesses and agencies that store and treat soils contaminated with toxic organic compounds, petroleum products, or heavy metals. Stormwater runoff that comes in

contact with contaminated soil can carry those contaminants along with loose dirt into receiving waters.

The State Department of Ecology regulates businesses disposing and treating contaminated soil. A permit from the Puget Sound Clean Air Agency is required if the treatment method for removing soil contaminants involves forcing air through, or sucking air from, the soil. The Puget Sound Clean Air Agency can be reached at 1-800-552-3565. In addition, approval from the King County Wastewater Services Department may be required if potentially contaminated water is to be discharged from the site. Contact the COA Sanitary Sewer Utility at 253-931-3010 for information on proper disposal of contaminated water.

The BMPs included here are intended as a supplement to other regulations. The following BMPs are required of all businesses engaged in storage and treatment of contaminated soils:

- The storage area for contaminated soils must be enclosed indoors, covered, or contained by a curb, dike, or berm constructed around the material storage area. If the contaminated soils are covered, stormwater run-on protection must also be provided. **BMP S633** in Volume IV provides further details on containment and run-on prevention.
- Employees must be educated on methods to prevent contamination from leaving the site.
- Cleanup materials must be stocked near the storage area.
- Gutters, storm drains, catch basins, and other drainage system features on the site must be cleaned following the completion of site work, or at least once per year, whichever comes first. Sediments from such cleaning must be disposed of properly. See **BMPs S630** and **S631** in Volume IV for disposal options and details on catch basin cleaning.

The following BMPs are not required but can provide additional pollution protection:

- If feasible, the storage area should be swept weekly for collection of stray soil, which can be added back to the piles or properly disposed. See **BMP S630** in Volume IV for information on disposal options.
- Implement a vegetated biofilter in conjunction with a runoff containment plan.
- Implement treatment BMP for the targeted pollutant (see Volume V).

The use of any treatment BMP must not result in the violation of groundwater, surface water, wastewater, or drinking water quality standards.

IV-7 – Other Source Control BMPs

S414: BMPs for Maintenance and Repair of Vehicles and Equipment (Amended)

Description of Pollutant Sources

This applies to businesses and public agencies where fuel filters, engine oil, and other fluids such as battery acid, coolants, and transmission and brake fluids are removed and replaced in

vehicles and equipment. It also applies to mobile vehicle maintenance operations, such as at construction sites. Related vehicle maintenance activities are covered under the following activity headings in the SWMMWW.

S419 BMPs for Mobile Fueling of Vehicles and Heavy Equipment

S420 BMPs for Painting/Finishing/Coating of Vehicles/Boats/Buildings/Equipment

S421 BMPs for Parking and Storage for Vehicles and Equipment

Pollutants of concern include toxic hydrocarbons, toxic organic compounds, oils and greases, pH, and heavy metals.

Applicable Operational BMPs:

The following BMPs or equivalent measures are required of all businesses and agencies engaged in engine and vehicle repair:

- Employees must be educated about the need for careful handling of automotive fluids. Employees at businesses or agencies who routinely change or handle these fluids must be trained in spill response and cleanup procedures. Spill cleanup materials, such as rags and absorbent materials, must always be kept close at hand when changing oil and other fluids. Soiled rags and other cleanup material must be properly disposed of or cleaned and reused.
- Floor drains inside buildings shall connect to sanitary sewer, be routed through an appropriately sized oil/water separator and shall be approved by the City.
- Do not hose down the maintenance/repair area. Instead, sweep the area weekly to collect dirt, and wipe up spills with rags and other absorbent materials.
- A bermed tarp, ground cloth, or drip pans must be used beneath the vehicle or equipment to capture all spills and drips. The collected drips and spills must be recycled or disposed of properly. See **BMP S630** in Volume IV for disposal options.
- If this activity occurs at a stationary business location, the activity area must be moved indoors. An exception to this requirement would be equipment that is too large to fit under a roofed area. In this case, the outdoor area must be paved, provided with a sump drain, and provision made for stormwater run-on prevention. See **BMP S632** and **S633** in in Volume IV for more on paving, sump drains and holding tanks, and run-on prevention. Contact the COA Sanitary Sewer Utility at 253-931-3010 for information on requirements for disposal to sewer. If the site utilizes a septic tank, sump contents will need to be pumped and disposed of by an oil recycler or hazardous waste company.
- Recycle oil, antifreeze, batteries, and air conditioning coolant.
- If engine washing is to be performed, then appropriate pretreatment will be required. Contact the COA Sanitary Sewer Utility at 253-931-3010 for the requirements.
- Contaminated stormwater runoff from vehicle staging and maintenance areas must be conveyed to an American Petroleum Institute (API) or Coalescing Plate (CP) oil and

water separator followed by a basic treatment BMP (see Volume V), applicable filter, or other equivalent oil treatment system.

Recommended Additional Operational BMPs:

The following BMPs are not required but can provide additional pollution prevention.

- Drain all fluids from wrecked vehicles and car parts upon arrival. Recover air conditioning gases.
- Use reusable cloth rags to clean up drips and small spills instead of disposables: these can be professionally laundered and reused. Do not attempt to launder these at home or at a coin-op laundry.
- Use absorbent pillows or booms in or around storm drains and catch basins to absorb oil and fuel.
- Maintain vehicles under cover where possible.

S670: BMPs for Cleaning or Washing of Tools, Engines and Manufacturing Equipment (Additional)

Description of Pollutant Sources

This applies to businesses and public agencies that clean manufacturing equipment such as saws, grinders, screens, and other processing devices outside of buildings, and to businesses engaged in pressure washing of engines, equipment, and portable objects.

Pollutants sources include toxic hydrocarbons, organic compounds, oils and greases, nutrients, heavy metals, pH, suspended solids, biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

Pollutant Control Approach

The preferred approach is to cover and/or contain the cleaning activity or conduct the activity inside a building, to separate the uncontaminated stormwater from the pollutant sources. Wash water must be conveyed to a sanitary sewer after approval by the COA, temporarily stored before proper disposal, or recycled, with no discharge to the ground, a storm drain, or surface water.

The quality of any discharge to the ground after proper treatment must comply with Ecology's Groundwater Quality Standards, Chapter 173-200 WAC and may require a State Waste Discharge Permit. Contact the Department of Ecology for an NPDES Permit application for discharge of washwater to surface water, storm drain or the ground.

The following BMPs are required of all businesses and public agencies engaged in cleaning or washing of tools, engines, equipment, and portable objects:

- Illicit connections to the storm drainage system must be eliminated. See **BMP S410** in Volume IV for detailed information.

- Employees shall be educated to control washing operations to prevent stormwater contamination.
- Wash water from cleaning roof-top equipment, such as exhaust fans, shall be captured and disposed to the sanitary sewer. The use of wet/dry vacuums, temporary berms or containers, such as plastic pools, are possible ways to capture this water. Wash water shall not be discharged to the storm drainage system.
- Pressure washing must be done in a designated area (such as a wash pad) provided with a sump drain and stormwater run-on prevention. See **BMPs S632** and **S633** in Volume IV for information on sumps (or holding tanks) and run-on prevention. Contact the COA Storm Drainage Utility at 253-931-3010 for washing operation policy.

The following BMPs are not required, but they can provide additional pollution control:

- If soaps or detergents are used, use the least toxic cleaner capable of doing the job. Use non-phosphate detergent, if possible, to reduce loadings at your local wastewater treatment plant.
- Limit the amount of water used in washing activities to reduce the potential of runoff carrying pollutants beyond the designated wash pad or capture system.
- Recycle wash water for subsequent washings.
- Implement one or more of the following stormwater treatment BMPs in addition to the Required BMPs:
    - Oil/water separator (do not use an oil/water separator for wash water containing soaps or detergents).
    - Wet vault for settling.
    - Infiltration basin.
    - Filtration with media designed for the pollutants present.
    - Catch basin with a filter insert for pressure washing to collect suspended solids.
- Catch basin filters and/or sorbent inserts should be selected based on the type of contaminants in the stormwater.

For discharging wash water containing soaps and detergents, the use of infiltration, biofiltration, wetponds, and wetlands must not result in the violation of groundwater quality standards.

S671: BMPs for Cleaning or Washing of Cooking Equipment (Additional)

Description of Pollutant Sources

This applies to businesses that clean cooking equipment such as vent filters, grills, hoods, and grease traps outside of buildings and clean paved areas and floor mats around cooking equipment.

Pollutants of concern consist of oil and grease, nutrients, suspended solids, biochemical oxygen demand (BOD) and chemical oxygen demand (COD).

Pollutant Control Approach

Businesses engaged in this activity that cannot connect discharges to a sanitary sewer, holding tank, or process water treatment system must contact the Department of Ecology and obtain a National Pollutant Discharge Elimination System (NPDES) wastewater permit.

The following BMPs are required of all businesses engaged in cleaning or washing of cooking equipment:

- Illicit connections to the storm drainage system must be eliminated. See **BMP S410** in Volume IV for detailed requirements.
- Employees must be educated about the need to prevent stormwater contamination from washing operations.
- Wash water cannot be discharged to the storm drainage system.
- Paved washing areas must be swept daily to collect loose solid materials for proper disposal.
- Cleaning and washing of cooking equipment shall take place indoors with drainage to the sanitary sewer system, holding tank, or process treatment system or captured using a tub or similar device to contain all the wash water. The wash water shall be recycled or disposed into the sanitary sewer system, holding tank, or process treatment system. Provisions must be in place to neutralize the wash water prior to discharge to the sanitary sewer system.
- Greasy buildup on cooking equipment must be removed and properly disposed of prior to washing to reduce the amount of material that can potentially contaminate the wash water. Washing must either take place on a wash pad connected to the sanitary sewer, or the wastewater must be collected and disposed in the sanitary sewer.
- Move the activity indoors, into either an existing building or a newly constructed building or shed, with drainage to a sanitary sewer, holding tank, or process treatment system. See **BMP S675** in Volume IV for further information on drainage alternatives. Any connection to the sanitary sewer requires the approval of the COA.
- If the washing activity cannot be moved indoors or contained in a tub, then the washing area must drain to a sanitary sewer, holding tank, or process treatment system, and provisions must be made to prevent stormwater run-on onto the washing area. See **BMP S675** in Volume IV for detailed drainage requirements and **BMP S633** in Volume IV for methods of run-on prevention. If discharging to a sanitary sewer, permits must be obtained from the COA Permit Center. Call 253-931-3020 for more information.
- If a holding tank is used for storage of wash water, the contents must be pumped out before it is full and disposed of appropriately to a sanitary sewer or wastewater treatment system.

The following BMPs are not required, but can provide additional pollution protection:

- A cover should be placed over a designated wash area to keep rain from falling on dirty equipment and producing contaminated runoff.
- Implement one or more of the following treatment BMPs in addition to the required BMPs:

- Oil/water separator.
- Wet vault for settling.
- Infiltration basin with pretreatment.
- Filtration with media designed for the pollutants present.

S672: BMPs for Collection and Disposal of Wastewater in Mobile Interior Washing Operations (Additional)

Description of Pollutant Sources

This applies to businesses that wash floors, carpets and other interior items on a mobile site-to-site basis. The typical washing process includes removing wax and use of machines that spray the wash solution onto the carpet or upholstery and then suck the dirty solution up into a portable tank with limited capacity.

Pollutants of concern consist of nutrients, suspended solids, organic compounds (such as pesticides and chemicals used for flea and odor control), biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

Pollutant Control Approach

Wastewater must be poured into a sanitary sewer drain at the site of collection, the business office, or at another proper location. If sanitary sewer disposal is not available or not allowed, the collected wastewater must be returned to the business site for process treatment or transfer to a holding tank.

- Absolutely no wastewater from mobile interior wash activities shall be disposed of outdoors, or to a drain connected to the storm drainage system.
- Wastewater from mobile washing operations shall be discharged to a sanitary sewer if it does not contain high concentrations of toxic materials. Some of the chemicals used for flea and odor control are listed by EPA as toxics. Contact the COA Sanitary Sewer Utility at 253-931-3010 if you intend to use and discharge these types of chemicals. All wastewater must be poured into a sanitary sewer drain at the site of collection, the business office, or at another proper location.
- If sanitary sewer disposal is not available or not allowed at the site of collection, the collected wastewater must be returned to the mobile business site for process treatment or transfer to a holding tank. See **BMP S675** in Volume IV for details on these drainage/disposal alternatives.
- Carpet cleaning wash water must be disposed of to the sanitary sewer. It is preferred that the dirty wash water be discharged into a toilet or sink at the place where it was generated. Alternatively, the carpet cleaner may discharge the water into the sanitary sewer back at their place of business if located in Auburn. Otherwise, they must contact the sewerage agency providing their service for that agency's approval.

The following BMPs are not required, but can provide additional pollution protection:

- Use the least toxic detergents and cleaners that will get the job done. Select non-phosphate detergents when possible.
- Limit the amount of water used in interior washing operations. This will save you time, money, and effort when it comes to proper disposal.
- Recycle wash water for more than one use.

S673: BMPs for Manufacturing and Post-Processing of Metal Products (Additional)

Description of Pollutant Sources

This applies to businesses such as mills, foundries, and fabricators that manufacture or post-process metal products. A variety of activities such as machining, grinding, soldering, cutting, welding, quenching, cooling, and rinsing may take place. These businesses may be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit from the Department of Ecology and/or an Industrial Wastewater Discharge Permit from King County-Metro. See Section I-2.4 for a discussion of NPDES requirements. Contact the COA Sanitary Sewer Utility at 253-931-3010 to determine if an industrial wastewater discharge permit is necessary.

NOTE: Painting, finishing and coating of metal products is covered under **BMP S420** in Volume IV.

Pollutants of concern include toxic organic compounds, heavy metals, oils and greases, pH, suspended solids, and biological oxygen demand (BOD).

Pollutant Control Approach

Cover and contain operations and apply good housekeeping and preventive maintenance practices to prevent the contamination of stormwater.

The following BMPs are required of all businesses engaged in metals manufacturing or post-processing:

- Eliminate illicit connections to the storm drainage system. See **BMP S410** in Volume IV for detailed information on identifying and eliminating illicit connections.
- Process wastewater (including contact cooling water, filter backwash, cooling tower blowdown, etc.) and stormwater runoff from activity areas, must discharge to a sanitary sewer, holding tank, or process treatment system before discharge to surface water or storm drain. Contact the COA Permit Center at 253-931-3020 to obtain permits for discharge to the sewer. See **BMP S675** in Volume IV for detailed requirements.
- Employees must be educated to control their work with metal products to minimize pollution.

- The activity area must be swept at the end of each work day to collect and dispose of metal fragments and product residues properly. See **BMP S630** in Volume IV for disposal alternatives.

The following BMPs are not required but can provide additional pollution protection:

- Limit the amount of water used in quenching and rinsing. Recycle used water where possible.
- Cover the activity area to prevent rain from contacting the process and reduce the amount of runoff that has to be detained or treated.
- Use a catch basin filter or screen basket insert to capture stray metal particles.
- Implement a program to track purchase and consumption of lubricants, solvents, and additives. Check with operating managers for an explanation if consumption increases. Recommend actions if significant equipment leaks or spills are identified.
- Utilize any additional BMPs which are applicable for materials storage and maintenance activities in your shop.

S674: BMPs for Mining and Quarrying of Sand, Gravel, Rock, Peat, Clay and Other Materials (Additional)

Description of Pollutant Sources

This applies to surface excavation and on-site storage of sand, gravel, and other materials that are mined. All mining operations that have stormwater runoff from the site are required to apply for a National Pollutant Discharge Elimination System (NPDES) permit with the Department of Ecology. Ecology has specific BMPs required by the permit. Some additional BMPs to help meet Ecology's discharge performance standards are listed below. Other permits from the Washington Department of Natural Resources and the COA may be required.

Pollutants of concern are suspended solids, nutrients, pH, oils, and metals.

Pollutant Control Approach

Provide containment and or cover for any on-site storage areas to prevent run-on and discharge of suspended solids and other pollutants.

Measures to control track-out and dust shall be implemented . Wheel washes, sweeping and paving high traffic areas are some common practices.

- If the material is appropriate, use excavated spoil material to form compacted berms along downslope sides of the site to contain runoff. Berms should be seeded to promote growth of grass or other vegetation to limit erosion from the berms. Safety measures to prevent flooding due to berm failure shall be considered.
- Semi-permanent stockpiles should be seeded to promote vegetation growth which can help to limit erosion from the stockpiles.

- Use sediment ponds to promote settling of suspended solids. Refer to Volume V for more information.
- Use anchored tarps to cover stockpiles at small-scale mining operations if there is a potential for contaminated stormwater to leave the site.
- Provide containment and or cover for any on-site storage areas to prevent run-on and discharge of suspended solids and other pollutants.

S675: BMPs for Discharging Process Wastewater to a Sanitary Sewer, Holding Tank, or Water Treatment System (Additional)

This BMP is a minimum requirement for all industrial and commercial activities that generate contaminated process wastewater, such as washing activities, composting activities, and production and processing activities. The water used in these activities shall not drain to surface waters or groundwater untreated. Process water must drain to a sanitary sewer, holding tank, on-site treatment system, wastewater treatment system, or be recycled.

In order to connect to the sanitary sewer, contact the COA Permit Center at 253-931-3020 for information on sanitary sewer connection permits. Call the COA Sanitary Sewer Utility at 253-931-3010 for pretreatment and permit information.

If a sanitary sewer is not available, the only remaining options are holding tanks or an on-site wastewater treatment facility.

The contents of the holding tank must be pumped out or drained before the tank is full and disposed of properly (see **BMP S630** in Volume IV).

If the on-site wastewater treatment facility option is taken, then it must be designed to receive and effectively treat all discharges of process water from the business. The Washington State Department of Ecology must be contacted for approval of such a facility.

If the activity is to remain uncovered, then define a designated area for the activity and provide a mechanism for prevention of stormwater run-on into the activity area. (e.g., a curb, dike, or berm).The designated area shall be paved and sloped to a central collection drain and be connected to the sanitary sewer, (with pretreatment if required), the on-site holding tank, or the on-site treatment facility, whichever method is selected.

Monitoring and maintaining all collection systems and keeping records of inspections and maintenance may be required.

S676: BMPs for Covering the Activity with a Roof or Awning (Additional)

In many cases, a simple roof or awning will protect the activity from coming into contact with stormwater, and usually at a lower cost than a complete building. These structures require building permits to construct. Contact the COA Permit Center at 253-931-3020 to obtain permits.

The area of the roof cover shall be sufficient to prevent any precipitation from reaching the covered materials. Provisions shall be made to prevent stormwater run-on into the covered area. The installation of sumps or sanitary sewer drains may also be necessary. Roof drains shall discharge outside and be directed away from the covered area.

Appendix IV – C Quick Reference Phone Numbers

City of Auburn		
Storm Drainage and Sewer Utilities (Public Works Department)		253-931-3010
Permit Center		253-931-3020
Community Development		253-931-3090
Utility Billing		253-931-3038
Waste Management (Garbage and Recycle)		253-939-9792
Household Hazardous Waste (King County)		206-296-4692
Valley Regional Fire Authority		253-288-5800
Environmental Protection Agency (EPA) - Region X		800-424-4372
IMEX (Industrial Materials Exchange)		206-263-8465
King County		
Wastewater Program (septic)		206-477-8050
Household Hazardous Waste		206-296-4692
Tacoma-Pierce County Health Department		
On-Site Sewage		253-798-6470
Hazardous Waste Line		800-287-6429
University of Washington Center for Urban Water Resources		253-254-7030
Washington State Department of Agriculture		360-902-1800
Washington State Department of Ecology		360-407-6000
Northwest Regional Office		206-594-0000
Dangerous/Hazardous Waste		425-649-7000
NPDES Stormwater or Wastewater Permits		360-407-6000
Spill Reporting (spill to water)		800-424-8802
	and	800-258-5990
Spill Reporting (spill to land King County)		206-594-0000
Spill Reporting (spill to land Pierce County)		360-407-6300
Recycling		800-732-9253
Groundwater Quality and Protection		360-407-6000
Underground Ground Storage Tanks		800-826-7716
Washington State University/Pierce County Cooperative Extension		253-798-7180
Puget Sound Clean Air Agency		206-343-8800

Appendix IV – D Source Control BMPs for Homeowners

Actions taken each day in and around homes have a profound effect on surface water quality and fish habitat in this region. Stormwater goes directly to rivers, streams and to Puget Sound. Stormwater does not go to the wastewater treatment plant. Any pollutants that get into the stormwater go directly to surface water. Small amounts of pollution from many different sources can significantly affect our waterways. Yard maintenance, waste storage, car washing and maintenance, and pool cleaning are some of the activities that can adversely impact water quality. The best management practices (BMPs) discussed in this section are practical ways to keep stormwater from becoming polluted in the first place. It is recommended that all residents in Auburn use these BMPs. Please note that some of these procedures are required by various state, or city laws, and are noted as required BMPs.

A general list of BMPs for homeowners is described in this chapter. Some of the BMPs described in Chapter 4 may also be applicable to homeowners.

- Automobile Washing
- Automobile Maintenance
- Storage of Solid Wastes and Food Wastes
- Composting
- Yard Maintenance and Gardening
- Swimming Pool and Spa Cleaning and Maintenance
- Household Hazardous Material Use, Storage, and Disposal
- General Home Maintenance
- Pet Waste

Automobile Washing (for Single-Family Residences)

Car washing at home will cause wash water to enter the storm system and flow untreated into surface waters. Soaps and detergents, even the biodegradable ones, can have immediate and long-term effects. Wash water from car washing could be considered an illicit discharge and is prohibited from entering the stormwater system per ACC and state requirements.

The best option is to take cars to a commercial car wash that has a recycle system and discharges wastewater to the sanitary system for treatment. If this option is not feasible, use the suggested BMPs below.

At Home

- Wash cars directly over lawn areas or make sure the wash water drains to a vegetated area.
- Ideally, no soaps or detergents should be used, but if one is used, select one without phosphates.
- Consider using commercial products that allow cleaning a vehicle without water.
- Use a hose nozzle with a shut-off valve to save water.

- Do not wash cars if rain is expected.
- Pour the bucket of soapy, dirty wash water down your sink.

Away from Home

- Take cars to a commercial car wash that has a recycle system and discharges wastewater to the sanitary sewer for treatment.
- Support fundraising activities that sell tickets for a wash at a commercial car wash.

Automobile Maintenance

- Recycle all oils, antifreeze, solvents, and batteries. Many local car parts dealers and gas stations accept used oil. The King County Household Hazardous Wastemobile makes regular, scheduled visits to Auburn and accepts oil, oil filters, antifreeze, and solvents, (website: http://www.hazwastehelp.org/HHW/proper-disposal.aspx or call 206-296-4692). Old batteries can actually be worth money. Recycle old batteries at automotive or battery shops.
- Never dump new or used automotive fluids or solvents on the ground, in a storm drain or street gutter, or in a waterbody.
- Do not mix wastes. Always keep your wastes in separate containers which are properly labeled and store them out of the weather.
- Fix all leaks, to keep the leaky material off the streets and out of the stormwater system and local waterways.
- To dispose of oil filters, punch a hole in the top and let drain for 24 hours. After draining, wrap in 2 layers of plastic and dispose of in your regular garbage or recycle by taking it to the King County Household Hazardous Waste Wastemobile. Note: used oil must be recycled at an approved facility and cannot be disposed of in your regular garbage. Use care in draining and collecting antifreeze to prevent accidental spills. Spilled antifreeze can be deadly to cats and dogs that ingest it.
- A tarp, ground cloth, sheet of cardboard, drip pans, or other materials to contain drips must be used beneath the vehicle or equipment to capture all spills and drips. Keep a bag of kitty litter on hand to absorb spills. Sprinkle a good layer on the spill, let it absorb and then sweep it up. Place the contaminated litter in a double plastic bag (bag in a bag), tie it up, and dispose of it in your regular garbage. Do not leave kitty litter out in the rain.
- If body work is performed outside, be sure to use a tarp to catch material resulting from grinding, sanding, and painting. Dispose of this waste by double bagging in plastic and placing in garbage.

Storage of Solid Wastes and Food Wastes

Improper storage of food and solid waste at residences can lead not only to water pollution problems, but problems with neighborhood pets and vermin as well. Following the BMPs listed below can help keep property a clean and healthy place to live.

All waste containers kept outside should have lids and be free of leaks. If the hauler container lid is damaged or the container is leaking, please call the COA Utility Billing at (253) 931-3038 for information on lid repair and container replacement.

- Store waste containers under cover if possible, or on grassy areas.
- Inspect the storage area regularly to pick up loose scraps of material and dispose of them properly.
- Recycle as much as you can. The COA offers curbside recycling. Also, look under "Recycling" in the phone book for firms which take other recyclables or call the COA Solid Waste Division at (253) 931-3038.
- Purchase products which have the least amount of packaging materials.
- Recycle biodegradable materials such as grass clippings and vegetable scraps in your yard waste cart instead of throwing them away. Call the COA Utility Billing at (253) 931-3038 for more information on yard and food scrap recycling.

Composting

Composting is an earth-friendly activity as long as the rules outlined below are followed. The following BMPs are applicable to composting. For more information go to the COA's website at www.auburnwa.gov or call the COA Solid Waste Division at (253) 931-3038.

Locate compost piles on an unpaved area that is not subject to stormwater run-on or runoff; that is not prone to water ponding during storms, and well away from wetlands, streams, lakes and other drainage ways.

- Compost piles must be maintained and turned over regularly to work properly. Large piles of unattended compost may create odor and vermin problems and are not allowed within City limits.
- Do not put hazardous or non-decomposable waste in the pile.
- Cover the pile for two reasons:
    - To keep excess water from cooling down the pile, which will slow down the rate of decomposition.
    - To keep stormwater from washing nutrients into waterways.
- Building a small earthen dike around a compost pile is an effective means of preventing nutrient-rich compost drainage from reaching stormwater paths.
- An alternative to traditional backyard composting is worm composting. For more information on getting started with worm composting, call the COA Solid Waste Division at (253) 931-3038.

Yard Maintenance and Gardening

This section deals with the normal yard maintenance activities typically performed at residences. Overwatering, overfertilizing, improper herbicide application, and improper disposal of trimmings and clippings can all contribute to serious water pollution problems. Following the BMPs listed below will help alleviate pollutant runoff.

- Follow the manufacturer's directions exactly for mixing and applying herbicides, fungicides, and pesticides, and use them sparingly. Never apply when it is windy or when rain is expected. Never apply over water, within 100 feet of a well-head, or

adjacent to streams, wetlands, or other waterbodies. Triple-rinse empty containers, using the rinse water for mixing your next batch of spray, and then double-bag and dispose of the empty container in your regular garbage.

- Never dispose of grass clippings or other vegetation in or near storm drains, streams, lakes, or Puget Sound.
- Make sure all fertilizers and pesticides are stored in a covered location.

    - Use natural, organic soil amendments. Visit http://your.kingcounty.gov/solidwaste/naturalyardcare/ Click on Build healthy soil.
    - Use an integrated pest management program (IPM), which is a natural, long-term, ecologically based approach to controlling pest populations. See **BMP S411** and **BMP S435** in Volume IV.
    - Follow manufacturer's directions when applying fertilizers. More is not better, either for your lawn or for local waterbodies. Never apply fertilizers over water or adjacent to ditches, streams, or other water bodies. Remember that organic fertilizers have a slow release of nitrogen, and less potential to pollute then synthetic fertilizers.
    - Save water and prevent pollution problems by watering lawns sensibly. Lawns and gardens typically need the equivalent of 1-inch of rainfall per week. Put a wide mouth jar out where watering is occurring and measure the water with a small plastic ruler. Overwatering to the point of runoff can carry polluting nutrients to the nearest waterbody.
    - Consider using native plants as a vegetated buffer zone adjacent to streams or other water bodies. Call the Garden hotline at 206-633-0224 for advice and assistance in developing a planting plan or visit http://your.kingcounty.gov/solidwaste/naturalyardcare/ Click on Plant right for your site.
    - Reduce the need for pesticides and fertilizers on lawns by improving the health of the soil. Aerating, thatching, and topdressing with compost will improve soil health and help wanted grasses compete with weeds and moss.
    - Use a mulching mower and mow higher to improve soil/grass health and reduce or eliminate pesticide use.
    - Compost all yard clippings or use them as mulch to save water and keep down weeds in your garden. See Composting BMP for more information.
    - Practice organic gardening and virtually eliminate the need to use pesticides and fertilizers. Contact King County Master Gardener Phone Clinic at 206-296-3440 for information and classes on earth-friendly gardening.
    - Pull weeds instead of spraying and get some healthy exercise, too. If you must spray, use the least toxic formulations that will get the job done. The Master Gardener program listed above can help advise you on which spray to use.
    - Work fertilizers into the soil instead of letting them lie on the ground surface exposed to the next rainstorm.
    - Plant vegetation suited to Northwest conditions because they require less water and fewer to no fertilizers and pesticides.
    - The COA has a curbside yard waste recycling program. Call 253-931-3038 for more information.

Swimming Pool and Spa Cleaning and Maintenance

Despite the fact that we immerse ourselves in it, the water from pools and spas is far from chemically clean. Nutrients, pH, and chlorine can adversely affect fish and wildlife in waterbodies. Following the requirements listed below and in **BMP S433** in Volume IV will ensure the cleanliness of your pool and the environment.

- Pool and spa water must be dechlorinated if it is to be emptied into a ditch, on the ground or a lawn, or to the storm drainage system. Contact a pool chemical supplier to obtain the neutralizing chemicals needed. The rate of flow into the ditch or drainage system must be regulated so that it does not cause problems such as erosion, surcharging, or flooding. Contact the COA Strom Drainage Utility at 253-931-3010 for the conditions for discharge approval. Water discharged to the ground or a lawn must not cross property lines and must not produce runoff.
- Swimming pool cleaning wastewater and filter backwash shall not be discharged to the municipal storm drainage system.
- If pool and spa water cannot be dechlorinated, it must be discharged to the sanitary sewer. Prior to draining a pool or spa, contact the COA Sanitary Sewer Utility at 253-931-3010 for the conditions for discharge approval. A pool service company can help determine the frequency of cleaning and backwash of filters.
- Diatomaceous earth used in pool filters cannot be disposed of in surface waters, on the ground, or into storm drainage systems or septic systems. Dry it out as much as possible, bag it in plastic, and dispose of at the landfill.

- Hire a professional pool service company to collect all pool water for proper disposal. Make sure to ask where the water will be disposed of and ensure the proper permits have been obtained.

Household Hazardous Material Use, Storage, and Disposal

Oil-based paints and stains, paint thinner, gasoline, charcoal starter fluid, cleaners, waxes, pesticides, fingernail polish remover, and wood preservatives are just a few hazardous materials typically used in a residential setting.

When hazardous materials are dumped on the ground or in a storm drain, they can be washed directly to receiving waters where fish and wildlife can be harmed. Hazardous materials can also infiltrate into the ground and contaminate drinking water supplies. If disposed of with regular garbage, hazardous chemical containers can leak at the landfill and contaminate groundwater. Groundwater contamination can also occur if hazardous products are poured down a sink or toilet into a septic system. Do not pour hazardous chemicals down the drain if household plumbing is connected to municipal sewers, either. Many compounds will "pass through" the wastewater treatment plant without treatment and contaminate receiving waters, or they can harm the biological process used at the treatment plant, reducing overall treatment efficiency.

With such a diversity of hazardous products present in all homes in Auburn, a large potential for serious environmental harm exists if improper methods of storage, usage, and disposal are employed. Using the following BMPs will help keep these materials out of soils, sediments, and waters.

- Dispose of hazardous materials and their containers properly. Never dump products labeled as poisonous, corrosive, caustic, flammable, inflammable, volatile, explosive danger, warning, caution, or dangerous outdoors, in a storm drain, or into sinks, toilets or drains. Call the King County Hazardous Waste Line at 206-296-4692 or 1-888-TOXIC ED for information on disposal methods, collection events, and alternative products. Household hazardous wastes from COA residents are accepted at King County Household Hazardous Waste Facilities.
- Store hazardous materials containers under cover and off the ground. Keep them out of the weather to avoid rusting, freezing, cracking, labels being washed off, etc.

- Store hazardous materials out of the reach of children.
- Check hazardous material containers frequently for signs of leakage. If a container is rusty and has the potential of leaking soon, place it in a secondary container before the leak occurs and prevent a clean-up problem.
- Store hazardous materials containers under cover and off the ground. Keep them out of the weather to avoid rusting, freezing, cracking, labels being washed off, etc.
- Keep appropriate spill cleanup materials on hand. Kitty litter is good for many oil-based spills.
- Ground cloths and drip pans must be used under any work outdoors which involves hazardous materials such as oil-based paints, stains, rust removers, masonry cleaners, and others bearing label warnings as outlined above.
- Latex paints are not a hazardous waste but are not accepted in liquid form at the landfill. To dispose, leave uncovered in a protected place until dry, then place in the garbage. If you wish to dry waste paint quickly, pour kitty litter in the can to absorb the paint. Once paint is dry, leave the lid off when you place it in the garbage so the garbage collector can see that it is no longer liquid.
- Use less toxic products whenever possible. The King County Household Hazards Line at 206-296-4692 or 1-888-TOXIC ED and the Washington Toxics Coalition at 206-632-1545 have information detailing alternatives to toxic products.
- If an activity involving the use of a hazardous material can be moved indoors out of the weather, then do so. Make sure proper ventilation is provided.
- Follow manufacturers' directions in the use of all materials. Over-application of yard chemicals, for instance, can result in the washing of these compounds into receiving waterbodies. Never apply pesticides when rain is expected.
- When hazardous materials are in use, place the container inside a tub or bucket to minimize spills.
- Purchase only the amount of product that is needed.

General Home Maintenance

This section deals with the normal maintenance activities typically performed in residential settings. Following the BMPs listed below will help alleviate pollutant runoff.

- Pressure washing of building facades, rooftops, pavement, and other large objects must be conducted in such a way that all the runoff is collected for proper disposal. No runoff

shall leave the site. Temporary curbs, dikes, or berms may be used to direct the water away from storm drains. Sweep up and collect debris for disposal as solid waste as an alternative to pressure washing.

- Carpet cleaning wash water must be disposed of to the sanitary sewer. It is preferred that the dirty wash water be discharged into a toilet or mop sink at the place where it was generated.
- Clean brushes and tools coated with non-water-based paints, finishes, or other materials in a manner that allow collection of used solvents (e.g., paint thinner, turpentine, xylol, etc.) for proper disposal at a Household Hazardous Waste Facility. Call the King County Household Hazards Line at 206-296-4692 or 1-888-TOXIC ED for information on disposal methods, collection events, and alternative products. Household hazardous wastes from COA residents are accepted at King County Household Hazardous Waste Facilities.

Pet Waste

Pets can generate pollutants from fecal deposits, animal washing, and cage or kennel cleaning. Pollutants include bacteria which can pollute water ways and make people sick. To prevent pet waste pollutants from entering the storm drains, follow the requirements listed below. For more information, see **BMP S440** in Volume IV.

- Regularly scoop, sweep and clean up pet waste deposited on walks and at home. Dispose of pet waste in the garbage or flush it down the toilet.
- When cleaning out cages and kennels, wash directly over lawn areas or make sure the wash water drains to a vegetated area. Alternately, dispose of the wash water down the toilet or a mop sink.
- Do not dispose of unused pet pharmaceuticals in a storm drain, or flush down a toilet, or wash down a sink. Visit www.takebackyourmeds.org for a list of locations that take back unused pharmaceuticals.
- Kennels, boarding facilities, veterinarians: Refer to **S402 BMPs for Commercial Animal Handling Areas** in Volume IV.

Volume V

Runoff Treatment, Flow Control, and LID BMP Library

City of Auburn Supplemental Manual

Executive Summary of Volume V

Additional requirements for SWMMWW BMPs for use within the COA are indicated as "Amended", as noted below.

General additions and/or changes to the SWMMWW contained in this Volume include:

- **V-1: General BMP Design** gives additional general requirements for facilities in the COA.
    - **V-1.1** provides requirements for runoff from the right of way.
    - **V-1.2** provides requirements for setbacks from slopes and embankments.
- **V-4: Roof Downspout BMPs** gives additional general requirements for installation of downspouts including setbacks and collection and conveyance requirements.
- **V-5: Infiltration BMPs**
    - **V-5.6 Site Suitability Criteria** (Amended) provides additional requirements to protect Auburn's groundwater drinking water supply.
    - **SSC-1 Setback Criteria** (Amended)
    - **BMP T5.15** (Amended) provides requirements on when Permeable Pavements can be used.
    - **BMP T7.30** (Amended) provides additional design criteria for Bioretention Facilities.
- **V-10: Manufactured Treatment Devices as BMPs**
    - **V-10.3** gives requirements on the use of proprietary products for Private and Public treatment facilities for runoff from pollution-generating hard surfaces.
- **V-11: Miscellaneous LID BMPs**
    - **BMP T5.13** (Amended) requires that projects in the COA follow the guidelines and procedures found in *Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington*.

- **V-12: Detention BMPs**
    - **V-12.2 Control Structure Design** (Amended)
    - **V-12.2 Other Detention Design Options** (Amended)
    - **BMP D.1 Detention Ponds** provides specific requirements for the design and construction of detention ponds in Auburn.
    - **BMP D.2 Detention Vaults** provides specific requirements for the design and construction of detention vaults in Auburn.

V-1 – General BMP Design

V-1.1 Sequence of Runoff Treatment and Detention BMPs

The following requirements apply to treatment of runoff from the public right of way.

- Stormwater runoff treatment systems utilized in the public right of way shall comply with all other relevant COA Engineering Design Standards including requirements for street tree clearance and height. Systems that, in the opinion of the City Engineer, do not have adequate settling/debris separation chambers/basins, may conflict with existing or future utilities, or do not have acceptable maintenance requirements shall not be allowed.

- All storm facility landscape planting and seeding plans shall be prepared and sealed by a Washington State licensed professional Landscape Architect or similar specialist approved by the COA.

- With approval from the City Engineer, stormwater runoff from required improvements in the public right-of-way may be designed to discharge onto the private property and be mitigated within the on-site storm drainage system with pretreatment of the runoff from the public right of way. In this case, the applicant would be required to enter into a Stormwater Easement and Maintenance Agreement (SWEMA) holding the City harmless for the connection, and the applicant shall agree to maintain the system. The SWEMA would be per the City's template document without revisions that would place additional liability or responsibility upon the City.

V-1.2 Setbacks, Slopes, and Embankments

Project proponents should consult the ACC's to determine all applicable setback requirements. Where a conflict between setbacks occurs, the City shall require compliance with the most stringent of the setback requirements from the various codes/regulations. ACC titles and chapters that are relevant to setback requirements are as follows:

- **Chapter 13.16 Fire Hydrants** – Requirements related to fire hydrant visibility
- **Title 15 Buildings and Construction** – Requirements meeting building and fire regulations
- **Chapter 16.10 Critical Areas** – Requirements for wetland, stream, wildlife habitat area, and geologic hazard area buffer setbacks
- **Title 18 Zoning** – Requirements for lot line setbacks in all zoning classifications

Required setbacks for storm facilities are as follows:

- Minimum spacing between trenches shall be 4 feet measured from the edge of trench.

- All systems shall be at least 10 feet from any structure. If necessary, setbacks shall be increased from the minimum 10 feet in order to maintain a 1:1 side slope for future excavation and maintenance.
- All systems shall be placed at least 5 feet from any property line. If necessary, setbacks shall be increased from the minimum 5 feet in order to maintain a 1:1 side slope for future excavation and maintenance.
- All facilities shall be setback from sensitive areas, steep slopes, landslide hazard areas, and erosion hazard areas as governed by the ACC. Runoff discharged 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 greater than 15% or above erosion hazard areas without evaluation by a geotechnical engineer or qualified geologist and City approval.
- For sites with septic systems, all infiltration systems, unlined wetponds and detention ponds shall be downgradient of the drainfield unless the site topography clearly prohibits subsurface flows from intersecting the drainfield.

Additional setbacks for specific stormwater facilities will be noted in the appropriate section.

V- 4 – Roof Downspout BMPs

V-4.1 Introduction to Roof Downspout BMPs

The roof downspout control Best Management Practices (BMPs) listed in V-4 are subject to the setback requirements defined in the ACC.

Roof Downspout Controls in Potential Landslide Hazard Areas

If or where the City has identified “geologically hazardous areas” (WAC 365-195-410), lots immediately adjacent to or within the hazard area shall collect roof runoff in a tightline system which conveys the runoff to the City system or to the base of the slope and then into the City system. Easements across adjacent properties may be necessary to convey drainage to the City system.

Collect and Convey

Conveyance of roof runoff to the City stormwater system is allowable when all roof downspout control BMPs listed in V-4 have been determined to be infeasible by the City Engineer or designee. Conveyance from roof runoff shall be connected to the City stormwater system at a catch basin or manhole. If a catch basin or manhole is not located at the discharge location, a storm main extension shall be required.

The runoff shall not be conveyed over driveways, sidewalks or other areas reserved for pedestrian traffic. A detail for the connection shall be submitted to the City for review and approval. Capacity analysis of the conveyance piping and catch basin leads will be required to ensure that adequate capacity exists.

For roof areas 10,000 sf and greater, please refer to Minimum Requirement #7, Flow Control.

Conveyance and discharge to the curb is allowable for single family homes when all roof downspout control BMPs listed in V-4 and a direct connection to the City stormwater system has been determined to be infeasible by the City Engineer or designee. Conveyance to the curb will only be allowed if a catch basin is located within 350 feet downstream of the discharge point. If a catch basin is not located within 350 feet of the discharge location, a storm main extension shall be required. Minimum pipe size for conveyance to the curb shall be 3 inches in diameter for single family homes. A detail for the curb discharge shall be submitted to the City for review and approval.

No flow credits will be allowed for the collect and convey option.

V-5 – Infiltration BMPs

V-5.6 Site Suitability Criteria (SSC) (Amended)

Perform a site suitability analysis per V-5 for all infiltration and bioretention facilities. Due to Seasonal High Groundwater, Groundwater Protection Zones, and other site conditions, the COA restricts the use of infiltration in certain areas. Refer to Appendix I-H for more information on infiltration infeasibility when selecting the List Option to meet Minimum Requirement #5 On-Site Stormwater Management.

SSC-1 Setback Criteria (Amended)

Refer to V-1.2 for general stormwater facility setback requirements and ACC titles and chapters relevant to setback requirements. Project proponents should consult the ACC's to determine all applicable setback requirements. Where a conflict occurs between setbacks, the most stringent of the setback requirements applies .

BMP T5.15 Permeable Pavements (Amended)

Permeable pavements installed within the COA, including porous asphalt, pervious concrete, and permeable pavers, shall comply with the COA Engineering Design and Construction Standards, including the following additional Design Criteria:

- All permeable pavements, including subgrade, base materials, and surface treatments, shall conform to the COA Engineering Design and Construction Standards.
- Permeable pavements shall have a minimum separation of 1 foot from the bottom of the lowest gravel base layer and/or treatment layer to the Seasonal High Groundwater Elevation, bedrock, or other low permeability layer as determined by a geologist or engineer licensed in the State of Washington.
- Geosynthetic fabrics shall be installed between the subgrade and base layer for soil separation and stabilization. Geosynthetic fabrics used with permeable pavements shall meet the specifications defined in the COA Engineering Construction Standards.
- Permeable pavement road designs shall include conventional stormwater conveyance design with sufficient capacity per Appendix III-D and the COA Engineering Design and

Construction Standards. The purpose of including conventional stormwater conveyance systems with permeable pavement designs is to provide adequate drainage capacity for storm events that exceed the capacity of the permeable pavement.

- Underdrain systems for permeable pavement surfaces are subject to approval of the City Engineer or designee.
- Acceptance and/or infiltration testing for all permeable pavement surfaces shall be performed per the COA Engineering Construction Standards.
- Permeable pavements shall not be allowed for roadways with over 400 ADT and greater than very low truck traffic. Very low truck traffic shall be 2% or less of the total ADT for the roadway and includes vehicles with a FHWA Vehicle Classification of 4 or 5. Permeable pavements shall not be allowed on any roadway with vehicle(s) with a FHWA Vehicle Classification of greater than 5.
- The adjusted native soil infiltration rate beneath all proposed permeable pavements shall be a minimum of 0.1 inches/hour for public facilities. The adjusted infiltration rate is determined by applying appropriate correction factors the measured saturated hydraulic conductivity per V-5.4.
- The entire surface of all permeable pavements shall be accessible by maintenance equipment.
- To avoid clogging permeable pavements, pervious areas such as lawn and landscape areas shall not drain to permeable pavements.
- The drainage of additional impervious area to permeable pavements located on private property shall not exceed a maximum ratio of 1:1. Downspout outlets or ground level impervious surfaces shall not drain more than 1,000 sq. ft. to a single point on the permeable pavement.
- Permeable pavements located within the public right-of-way shall not receive drainage from surfaces located on private property.
- All permeable pavement located in the public right of way shall be constructed of porous asphalt or pervious concrete. Permeable pavers and plastic or concrete grid systems shall not be used in the public right of way.
- Permeable pavement designs shall demonstrate compliance with the Site Suitability Criteria for Permeable Pavement found in V-5.4.
- The following maximum longitudinal slopes shall apply to permeable pavements:
    - Porous Asphalt – 5% maximum slope
    - Pervious Concrete – 10% maximum slope
    - Permeable Pavers – 12% maximum slope

  Permeable pavements with a longitudinal slope greater than 2% shall incorporate check dams into the subgrade design to reduce subsurface flow rates. Permeable pavements with a longitudinal slope greater than 5% shall incorporate terraced subgrades and baffles to reduce uneven ponding.
- Permeable pavements shall not be allowed in the following areas:
    - At sites defined as “high use” in the Glossary.
    - In areas with “industrial activity” as identified in 40 CFR 122.26(b)(14).

    - At sites where the risk of concentrated pollutant spills is higher than average, including but not limited to gas stations, truck stops, and industrial chemical storage sites.
    - Where routine, heavy applications of sand occur in frequent snow zones to maintain traction during weeks of snow and ice accumulation.
    - In areas of required pavement design elements where the material properties of permeable pavements present significant constructability issues as determined by the City Engineer, including but not limited to ADA ramps, driveway aprons, and curb transitions.
    - Within 50 ft of or on slopes greater than 20%.
    - Within 10 ft of any known underground storage tank and connecting underground pipes, regardless of tank size.
- Permeable pavement located on sites within the COA Groundwater Protection Zones 1 & 2 requires approval by the City Engineer. Permeable pavements within these Zones shall incorporate advanced treatment.
- If the proposed permeable pavement is considered a pollution-generating surface and is located within the public right-of-way, the subgrade shall meet all of the following criteria to a depth of one foot below the lowest gravel base layer:
    - Cation Exchange Capacity is greater than 5%
    - Organic Content is greater than 1%
    - Measured (initial) saturated hydraulic conductivity is less than 9 in./hr.
    - Depth of infiltration treatment layer is equal to or greater than 18 inches.

BMP T7.30 Bioretention (Amended)

Design Criteria:

- All bioretention facilities receiving stormwater exclusively from private sources shall be located on private property and privately maintained per the approved Operations and Maintenance manual for the facility.
- Bioretention facility designs shall be prepared by a professional engineer licensed in the State of Washington. Bioretention facility designs shall be clearly labeled and include the following components:
    - Ponding Zone: From the top of the Bioretention Soil Media to the overflow elevation provide a minimum 6 inch to maximum 12 inch ponding zone.
    - Overflow: A piped or overland overflow structure is required. The overflow shall discharge to the public system per the COA Engineering Standards. A piped overflow is required when the underlying native soil has a measured infiltration rate below 0.25 inches per hour. Overland overflow paths shall be stabilized with streambed cobble per Section 9-03.11(2) of the WSDOT Standard Specifications and direct to an approve downstream drainage area. The inlet elevation shall allow for a minimum of 6 inches freeboard.
    - Inlet: The inlet shall be designed and constructed with the appropriate slope and elevation to allow for the free flow of stormwater into the facility The facility inlet

shall include a 6 inch thick layer washed drain rock or streambed cobble per Section 9-03.11(2) of the WSDOT Standard Specifications (2 to 4 inch minimum) pad to transition from inlet or splash pad to Bioretention Soil Media to dissipate energy and/or disperse flow. The energy dispersion pad shall have a minimum width equal to the inlet width.

  - Dimensions: Provide a flat bottom with a minimum width of 1 foot. Side slopes of bioretention facilities shall be a maximum 2.5:1 adjacent to sidewalks, maximum 4:1 at sheet flow inlets, and maximum 3:1 in all other locations.

- Public bioretention planter boxes require prior approval from the City Engineer.
- Public bioretention cells and swales shall be sodded or seeded using the seed mixtures below.

Grass Seed Mixes for Public Bioretention Facilities			
Moisture Condition By Weight	**Species**	**Common Name**	**Percent**
Very Moist	Agrosotis tenuis	Colonial Bentgrass	50
	Festuca ruba	Red Fescue	10
	Alopocuris pratensis	Meadow Foxtail	40
Moist	Festuca arundinacea	Meadow Fescue	70
	Agrosotis tenuis	Colonial Bentgrass	15
	Alopecurus pratensis	Meadow Foxtail	10
	Trifolium hybridum	White Clover	5
Moist-Dry	Agrosotis tenuis	Colonial Bentgrass	10
	Festuca ruba	Red Fescue	40
	Lolium multiflorum	Annual Ryegrass	40
	Trifolium repens	White Clover	10
Application rates: Hydroseed @ 60 lbs/acre Hand seed @ 2 lbs/1000 square feet			

Table V-7.4-1 Grass Seed Mixes for Public Bioretention Facilities

V-10 – Manufactured Treatment Devices as BMPs

V-10.3 Approval Process for Manufactured Treatment Devices

All emerging technologies that have received General Use Level Designation (GULD) may be considered for use on privately owned and maintained stormwater treatment facilities.

Currently, the only proprietary technologies approved for City maintained and owned stormwater treatment facilities are the Modular Wetland without vegetation, BioPod without vegetation, and the Boxless BioPod for treatment flows equal to or greater than 3 cfs. All Modular Wetland units shall have either manhole access lids or spring assisted hatches.

V-11 – Miscellaneous LID BMPs

V-11.1 Introduction to Miscellaneous LID BMPs (Amended)

BMP T5.13 Post-Construction Soil Quality and Depth (Amended)

The COA requires using the guidelines and procedures found in *Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington* when implementing BMP T5.13. This document is available at:

https://soilsforsalmon.org/s/Soil_BMP_Manual.pdf

V-12 – Detention BMPs

V-12.2 Control Structure Design (Amended)

Design Criteria

Control structures shall meet the following requirements:

- Access opening shall be oriented in a manner to facilitate inspection and maintenance.
- The COA Standard Detail S-09 shall be used as a design guideline and be updated to be site specific, and shall supersede the control structure details found in the SWMMWW.

V-12.3 Other Detention Design Options (Amended)

Use of Parking Lots for Additional Detention

- The depth of water detained shall not exceed 0.5 feet (6 inches) at any location in the parking lot for runoff events up to and including the 100-year event.
- The emergency overflow elevation shall be a minimum of 1 foot below the finish floor elevation of adjacent building, adjacent properties, landscaping and parking stalls.
- At no time shall parking lot ponding encroach on walking paths, sidewalks, or American Disabilities Act (ADA) required parking stalls or adjacent ADA access.

Use of Alternate Storm Detention Facilities (Additional)

- Alternate Storm Detention Facilities are defined as detention facilities that are not classified as ponds, tanks, or vaults.
- Fabric-wrapped rock Storm Detention Facilities are not allowed.
- Use of Alternate Storm Detention Facilities are subject to deviation approval except if the facility is one of the following allowed proprietary Alternate Storm Detention systems or their equivalents: RTanks, StormTech, ChamberMaxx.
- Deviations require documentation that addresses ground water levels, buoyancy, owner inspection, cleaning and other maintenance activities, and City inspection requirements.

BMP D.1 Detention Ponds

Design Criteria

The design criteria in this section are specific to detention ponds located within the City. Many of the criteria also apply to infiltration ponds, water quality wetponds, and combined detention/wetponds in Volume V. All detention ponds shall be appropriately and aesthetically located, designed, and planted.

Private ponds must adhere to the design criteria for detention ponds presented in V-12 and BMP D.1.

Pre-approval of the design concept, including landscaping, is required by the City for all proposed public ponds. All proposed public ponds are subject to the following minimum design criteria in addition to the criteria presented in the SWMMWW.

General

- Plans for projects that propose to construct temporary stormwater management facilities that will ultimately become permanent facilities are required to show how those temporary facilities will be improved to become the permanent facilities including, but not limited to, sequencing/phasing.
- Detention ponds shall be designed using rounded shapes and variations in slopes to provide a more visually aesthetic appearance and avoid a uniform shape on all sides.
- The total maximum depth of the detention pond from the bottom to the emergency overflow water surface elevation shall be 15 feet.
- A 3-foot-wide bench shall be provided at the 10-year storm storage elevation except where there are walls forming the sides of the pond. In this case, the bench shall terminate at the wall.
- No rock, ecology block, gabion or mesh basket pond cell dividing walls are allowed . The design of the cell dividing wall shall meet the following criteria:
    - The minimum width of the pond adjacent to the wall shall be 10 feet.
    - The wall shall be no higher than 3’ if the width of the adjacent pond is 10-15 feet wide and a maximum of 5 feet high if the pond width is 15-30 feet. Wall

heights for areas exceeding this width will be reviewed on a case-by-case basis.
    - Constructed of minimum 3,000 psi structural reinforced concrete.
    - Walls must be watertight cast-in-place concrete.
    - The walls are designed and stamped by a structural engineer licensed in the State of Washington and structural calculations are provided.
    - Pond access must accommodate large vehicles with an inside turning radius of 48 feet.

Side Slopes

- For maintenance and aesthetic reasons, pond designs should minimize structural elements such as retaining walls. For ponds where retaining walls are required, they shall be limited to a maximum of three sides.
- Pond walls may be vertical retaining walls, provided:
    - The maximum height of pond walls shall be 15 feet.
    - All pond walls shall be retaining walls with soil backfill. Free-standing pond walls with exposed exterior sides are considered impoundments and shall not be allowed.
    - They are constructed of minimum 3,000 psi structural reinforced concrete.
    - Walls must be watertight cast-in-place concrete.
    - At least 25% of the pond perimeter shall be a vegetated soil slope not steeper than 3H:1V as measured at the 100-year water surface elevation.
    - Access for maintenance per Appendix I-J shall be provided.
    - The walls are designed and stamped by a structural engineer licensed in the State of Washington and structural calculations are provided.
    - Pond wall drains are required to be routed around the walls and connected directly into the pond.
    - Ladders or other safety measures may be required.

Emergency Overflow Spillway

- An emergency overflow spillway shall be provided and designed according to the criteria given in the SWMMWW.

Access

- Refer to Appendix I-J – Stormwater Facility Access Requirements and to COA Engineering Design Standards Chapter 6 for detention pond access criteria.
- Per COA Engineering Design Standards Chapter 6, all pond access ramps shall be constructed with a minimum of 8” compacted base course topped with a minimum of 2” compacted top course . The pond ramp subgrade shall be compacted to a minimum of 95% modified Proctor.

Fencing

The following fencing shall be provided for all detention ponds:

- Fencing is required at the 10-year storage elevation and shall be installed on the outside edge of a 3-foot-wide bench. Fencing is required at the top of all vertical walls.
- Fences shall be 48 inches in height (see WSDOT Standard Plan L-20.10-03, Type 4 chain link fence).
- Access gates to the interior of the pond shall be a minimum 15 feet in width consisting of two swinging sections of equal width.
- Access gates will be set back a minimum of 20 feet from the point of entry to the public right-of-way.
- Additional access gates may be required where access for maintenance (such as to a control structure(s) or for mowing) is limited by the configuration of the pond and fencing . Additional access roads shall be provided to the additional access gates.
- 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-20.10-03 for Types 3 or 4 chain link fence.

Setbacks

Setbacks for detention ponds shall include the following:

- 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 set back from sensitive areas, steep slopes, landslide hazard areas, and erosion hazard areas as governed by the ACC. Facilities near landslide hazard areas must be evaluated by a geotechnical engineer or qualified geologist licensed in Washington State. The discharge point shall not be placed on or above slopes 15% or greater, or above erosion hazard areas without evaluation by a geotechnical engineer or qualified geologist licensed in Washington State and approval by the City Engineer or designee.
- 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

Seeps and springs that produce continuous intercepted flows on the project site shall be considered during the design process and included in the Stormwater Site Plan report. Flow monitoring of intercepted flow may be required for design purposes.

Planting Requirements

The following planting requirements shall be provided for all detention ponds and shall be noted on the plans:

- The pond side slopes shall be scarified, and all vegetative and construction debris and rocks larger than 2 inches shall be removed prior to hydroseeding.
- Hydroseeding shall be applied over the entire detention pond bottom (or on the slopes above the water quality elevation for wetponds) up to the fence line or to the maximum design water level (overflow elevation), whichever is higher.
- The pond bottom and all interior side slopes per the requirement above shall be hydroseeded with an appropriate grass seed mixture per Table V-12.3-2 Grass Seed Mixes for Detention/Retention Facilities below, which shall be listed on the landscaping plans.
- The need for watering to establish the hydroseeding will depend on what time of year the hydroseeding is applied and how long it takes for the seed to be established. If a temporary irrigation system is used, it shall be attached to the fence or placed at locations that do not interfere with mowing.
- All pond construction, landscaping, and temporary irrigation, if used, shall be completed prior to scheduling an initial punchlist inspection. The grass shall have sprouted over at least 80% of the area to be seeded.
- The contractor is responsible for weed control and removal of litter prior to planting and throughout the plant establishment period.
- The contractor is responsible for removing the temporary irrigation system prior to expiration of the 1-year warranty period.

Landscaping

The following landscaping requirements shall be provided stormwater tracts and shall be noted on the plans:

- All remaining areas of the tract shall be planted with grass or be landscaped (except as noted below) and mulched with a 4-inch cover of shredded wood mulch. Multiple plantings and mulching may be required until grass has established itself. A bond may be required to guarantee vegetation stabilization for detention facilities.
- Public and private storm drainage facilities should enhance natural appearances and be appropriate to the use of the site and the surrounding area. Landscaping shall be designed to 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) . No tree or shrubs shall be planted at or below the 10-year storage elevation, within the fenced area of the pond, or in public easement areas.

The following criteria shall be incorporated when designing landscaping for storm drainage tracts above the 10-year storage elevation, excluding the fenced area for the pond and public easement areas.

- 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 Title 18 of the ACC. 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 6 inches or greater in diameter, or any deciduous tree 4 inches in diameter or greater as defined in Title 18 of the ACC. Diameter measurements are taken at 4 feet above grade elevation. Authorization by the City is required for removal of any significant trees.
- Select tree and shrub species from Table V-12.2-1 Plant Selection Guide below. Plant choices must reflect the functional and aesthetic needs of the site. Fall planting is recommended for optimal acclimation and survivability.
- Permanent irrigation is only allowed above the 10-year storage elevation within those portions of the Tract to be maintained by the HOA.
- Appropriate grass seed mixes for detention ponds are given in Table V-12.3-2 Grass Seed Mixes for Detention/Retention Facilities below.
- 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).
- No tree or shrub planting is allowed within pipeline easements, traveled surfaces, or over underground utilities.
- Trees shall be placed no closer than 10 feet and shrubs no closer than 5 feet from all pond fences.
- 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.

The following tables 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.

Tree Selection for Storm Drainage Facilities				
Suggested Trees		Tolerates Wet to Saturated Soils	Recommend Moderately Wet to Dry Soils	Recommend Dry Soils
1. Botanical Name	**2. 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	3. ♦		
Salix scouleriana	Scouler Willow		♦	
Salix sitchensis	Sitka Willow	♦		
Thuja plicata	Western Red Cedar		♦	
Tsuga heterophylla	Western Hemlock			♦
Shrub Selection for Storm Drainage Facilities				
Suggested Shrubs		Tolerates Wet to Saturated Soils	Recommend Moderately Wet to Dry Soils	Recommend Dry Soils
4. Botanical Name	**5. 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	6.		♦
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 for Storm Drainage Facilities				
Suggested Perennial Groundcover		Tolerates Wet to Saturated Soils	Recommend Moderately Wet to Dry Soils	Recommend Dry Soils
7. Botanical Name	**8. Common Name**			
Athyrium filix-femina	Lady Fern		♦	
Dicentra formosa	Bleeding Heart			♦
Polystichum munitum	Sword Fern			♦
Aquatic/Emergent Wetland Selection for Storm Drainage Facilities				
Suggested Aquatics/Emergent Wetland Plants			Tolerates Open Water (3’ + Depth) to Shallow Standing Water (<1’ Depth)	
9. Botanical Name	**10. Common Name**			
Potamogeton natans	Floating Pondweed		♦	
Lotus conicalitatus	Birdsfoot Trefoil		♦	
Nymphaea odorata	American Water Lily		♦	
Lemna minor	Common Duckweed		♦	

Polygonum punctatum	Dotted Smartweed	♦
Polygonum amphibium	Water Smartweed	♦
Oenanthe sarmentosa	Water Parsley	11. ♦
Alisma plantago-aquitica	American Waterplantain	♦
Sparganium spp.	Bur-reed	♦
Sagittaria spp.	Arrowhead	♦
Scirpus acutus	Hardstem Bulrush	♦
Scirpus microcarpus	Small-fruited Bulrush	♦
Carex obnupta	Slough Sedge	♦
Carex languinosa	Wooly Sedge	♦
Eleocharis spp.	Spike Rush	♦
Carex spp.	Sedge	♦
Tolmiea menziesii	Piggy back plant	♦
Hordcum brachyantherum	Meadow Barley	♦

Table V-12.2-1 Plant Selection Guide

Grass Seed Mixes for Storm Drainage Facilities		
Botanical Name	**Common Name**	**Percent**
Festuca elatior arundinacea	Turf-Type Tall Fescue	40
Lolium perenne	Turf-Type Perennial Rye	30
Festuca ruba	Red Fescue	25
Agrosotis tenuis	Colonial Bentgrass	5
Application rates: Hydroseed @ 60 lbs/acre; Hand seed @ 2 lbs/1000 square feet		

Table V-12.3-2 Grass Seed Mixes for Detention/Retention Facilities

Maintenance

All private drainage systems shall require a signed Stormwater Easement and Maintenance Agreement (SWEMA) with the City. The agreement shall designate the systems to be maintained

and the parties responsible for maintenance. Contact the City to determine the applicability of this requirement to a project.

Any standing water removed during the maintenance operation must be disposed of in a City-approved manner. See the dewatering requirements in Volume II and Appendix IV-B. *Pretreatment may be necessary.* Residuals must be disposed in accordance with state and local solid waste regulations (See Minimum Functional Standards for Solid Waste Handling, Chapter 173-304 WAC).

BMP D.3 Detention Vaults

All publicly owned and maintained detention vaults are required to meet the minimum design criteria below, in addition to the criteria provided in the SWMMWW:

- A separate building permit is required for detention vaults.
- A buoyancy analysis is required to demonstrate that the vault will not be impacted by ground water.
- The maximum allowable depth of the deepest sump shall be 20 feet from finished grade.
- Exposed concrete vault walls requires maintenance access meeting the design criteria requirements for access for detention ponds presented in BMP D.1. Exposed concrete vault walls visible from the right of way shall have a textured surface and anti-graffiti treatment applied.
- Vehicle access is required to all surface areas of the vault. The entire surface area of the vault shall have a gravel surface treatment and the access lids to the vault shall have concrete collars per COA Standard Detail T-05. The vault boundaries shall be fenced with an access gate.
- Vault floors shall slope to a central location in addition to the 5% “v” slope outlined in the SWMMWW.
- All primary access points shall meet the following requirements:
  - A 5-foot x 10-foot 2-door solid hatch shall be provided.
  - Hatch cover shall be made from ¼-inch aluminum with diamond-pattern tread plate reinforced for 150 psf live load.
  - Frame shall be made from extruded aluminum angle frame with strap anchors bolted around the perimeter.
  - A Type 316 stainless steel slam lock with fixed interior handle and removable exterior turn/lift handle with steel cam-action hinges that are concealed from the exterior of the door shall be used.
  - A spring-assisted lift with hold-open feature torsion bars shall be installed. Automatic hold-open arm with grip handle release shall be added.
  - Polypropylene rungs or an aluminum ladder shall be installed extending from the hatch or manhole opening to the bottom of the vault.
  - A ladder-up mechanism shall be installed centered over the rungs or ladder below the hatch.

    - All hardware shall be zinc-coated.
- The 5-foot x 10-foot hatch opening shall be located over the sump or low point or points in the vault.
- Vault outlet control structures shall be located in a separate manhole.
- The vault design shall include internal galvanized hooks capable of supporting 250 pounds each and located within 2 feet of each opening for the temporary attachment of lights and other maintenance equipment.
- An access opening shall be provided directly above each inlet connection to the vault, and at each opening between cells.
- A minimum of two access openings shall be provided into each cell.
- In unpaved locations, access hatches and openings shall have a collar per COA Standard Detail T-05.
- Vaults shall be located on a separate tract. Vaults shall not be located in the public right of way or access tracts.
- Vault locations shall include a drivable surface to all access openings.
- Vault access must accommodate large vehicle access with an inside turning radius of 48 feet.
- Additional site access shall be provided per Appendix I-J.

Setbacks

Vaults 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, access, or other site conditions.