



**Snohomish County**

## Swamp Creek Drainage Needs Report

### 7.0 CIP Design Guidelines

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### **7.1 Introduction**

The Drainage Needs Report (DNR) project was developed to assess the capacity, conditions, and impacts of drainage systems and streams within the Urban Growth Areas (UGAs) of unincorporated Snohomish County. To have a consistent basis throughout all of the DNR areas for identifying what was defined as a “surface water problem,” problem definition criteria were established for different surface water categories. These categories are flooding, aquatic habitat, water quality, and erosion. Likewise, to evaluate and design the proposed improvements for inclusion in the Capital Improvements Program (CIP), design guidelines were established for these surface water categories. For those CIP projects that address more than one type of problem, such as flooding and habitat, they will be designed according to each of the applicable guidelines presented in this section.

To the extent possible, these criteria and guidelines were based on current County regulations and requirements. In many cases, though, the guidelines also identified potential opportunities to improve surface water conditions that may not be specifically required by current County regulations.

The criteria and guidelines described in the following sections were developed so that they could be applied regardless of whether the implementation of a given project is the responsibility of the County, a local jurisdiction, a private property owner, or some combination. The responsibility to implement surface water projects is often uncertain since drainage systems and streams, and their associated impacts, commonly cross through jurisdictional boundaries and public/private boundaries. This particular implementation issue is addressed in more detail in Section 10.3.1.

Finally, while the CIP projects developed for this DNR generally follow the guidelines below, some variations for individual projects were necessary. It should also be kept in mind that additional site-specific information, such as more accurate survey data than were available (and appropriate) for this report and utility conflicts, will be collected during the final design phase of a given project that could affect its design and feasibility.

### **7.2 Flooding and Drainage Design Guidelines**

#### **7.2.1 Problem Definition Criteria**

Flooding problems are typically evaluated in terms of how often a particular problem is likely to occur. For example, flooding problems that occur an average of once every two years are defined as having a 2-year return period while problems that only occur once every 25 years are defined as having a 25-year return period. A 25-year return period indicates that flooding has a 4 percent probability of occurring in any given year. In the DNR analysis, flooding problems were evaluated along stream and drainage

conveyance systems for a variety of different return periods, such as the 2-year, 10-year, 25-year, and 100-year return periods.

Because the County does not have specific regulations or policies to define how frequent a flooding problem will occur before it is addressed, the decision was made that solutions to flooding problems would only be developed for those problems that are predicted to occur an average of at least once every 25 years. No solutions were developed for problems that occur less frequently, such as once every 100 years, except in the case of bridges. This criterion was applied to problems that were predicted for either existing or future land use conditions. In the future, the County may wish to evaluate other options for defining flooding problems, such as the 10-year or 100-year return periods.

While the above criterion used to define a flooding problem is not specifically required by any current County regulations, it is consistent with the minimum County requirements for the design of new conveyance systems and for the evaluation of existing conveyance systems that are impacted by new development. The County currently requires that new conveyance systems have sufficient capacity to convey the peak flow from the 25-year storm event for smaller development activity and from the 100-year storm event for larger development activity. These requirements are contained in S.C.C. 24.30.010 (3)(a), and in Chapter 5 of Snohomish County's *Engineering Design and Development Standards* (EDDS) (Snohomish County, 1992). Smaller development activity is defined as development that would create less than 5,000 square feet of new impervious surfaces while larger development activity would create more than 5,000 square feet. Since most projects designed to alleviate flooding problems would not add any new impervious surfaces, the criterion for smaller development activity was considered to be more appropriate.

The analysis of existing conveyance system capacities and flooding frequencies was dependent on the accuracy of the hydrologic and hydraulic models. Because the models are not 100 percent accurate, some margin of error should be considered in the model results. Based on professional judgment, it was generally decided that if the models predicted water surface elevations within 0.2 foot of the elevation at which flooding would occur, then this should be considered a flooding problem.

## 7.2.2 Design Guidelines

Similar to the criteria used to define flooding problems, the guidelines used to design the proposed improvements are based on conveying the peak flow for the 25-year storm event. This is again based on the requirements of Title 24 and EDDS for the design of new conveyance systems associated with smaller development activity. Again, the County may wish, in the future, to evaluate the use of other storm events for the design of the proposed improvements.

One potential exception to this guideline is for conveyance systems that are particularly difficult to replace, such as culverts under a Washington State Department of Transportation (WSDOT) highway, culverts under a high embankment, and all bridges. In such cases, where culvert replacements would be particularly infrequent, the design should use the 100-year peak flow instead of the 25-year peak flow.

For culverts that cause flooding of roads or property along a stream corridor, additional design criteria were used. In addition to the flooding criterion, all new or replacement stream culverts were designed to meet the fish passage criteria established by the

Washington Department of Fish and Wildlife (WDFW) in its design manual *Fish Passage Design at Road Culverts* (WDFW, 1999). This general requirement applies to all new stream culverts since a Hydraulic Project Approval (HPA) must be obtained from WDFW. This is also consistent with S.C.C. 24.30.010(3)(c), which states that “bridges or bottomless arch culverts shall be installed instead of culverts at stream crossings.” In most cases, these criteria were only applied to culverts located along fish-bearing streams, which are defined by the County as Type 1, 2, and 3 streams.

Additional design criteria that are required by either Title 24 or EDDS for new conveyance systems include factors such as channel and pipe roughness coefficients, minimum pipe diameter and slope, minimum freeboard, pipe materials, catch basin spacing, and detention pond configurations. Some of these more pertinent requirements are listed in Table 7-1 and were also generally followed in the design of the proposed improvements.

<b>Table 7-1 Selected Drainage Design Criteria from EDDS<sup>a</sup></b>	
<b>Drainage Component</b>	<b>Design Criteria</b>
Open channels, roughness coeff. (n)	Grass lined, n = 0.025 Rock lined (less than 8-inch diameter), n = 0.030 Rock lined (greater than 8-inch diameter), n = 0.050 Smooth concrete or asphalt lined, n = 0.015
Open channels, freeboard	Flow > 10 cfs, freeboard = 1 foot Flow < 10 cfs, freeboard = 0.5 foot
Drainage pipes/culverts	Minimum pipe diameter = 12 inches Minimum slope = 0.5% (pipes 18 inch dia or less)
Catch basins & inlets, spacing	Road grade < 1%, max spacing = 150 feet Road grade 1-3%, max spacing = 200 feet Road grade > 3%, max spacing = 300 feet
Detention ponds, dimensions	Max interior slope = 3H:1V Max exterior slope = 2H:1V
<sup>a</sup> Engineering Design and Development Standards, Snohomish County Public Works 1992.	

One criterion of interest is the minimum freeboard used to design new conveyance systems. EDDS requires that open channels designed to convey greater than 10 cfs have a minimum freeboard of 1.0 foot and that open channels designed to convey less than 10 cfs have a minimum freeboard of 0.5 foot. Although this criterion applies only to new conveyance systems, the designs of retrofitted existing conveyance systems also attempted to meet this criterion. However, there were some cases in which the criterion were extremely difficult to achieve. In these unusual cases, a minimum freeboard of 0.2 foot was used. In addition, the minimum freeboard criterion specified in EDDS does not apply to the design of enclosed pipe systems. For these systems, a minimum freeboard of 0.2 foot was also used.

In general, some of the alternatives that were considered to alleviate flooding problems included increasing the capacity of the conveyance system, bypassing flows around a

flooding problem, and installing detention facilities to reduce flows at the problem location. Of these options, the first two have the potential to increase upstream or downstream flows, which could directly cause impacts, such as increased flooding, increased erosion, fish passage problems, or degraded aquatic habitat. Consequently, upstream and downstream impacts were considered when evaluating the solutions to a given flooding problem. This is consistent with the upstream and downstream analyses required in S.C.C. 24.30.010(2)(b). Solutions to those impacts were developed as part of the flooding problem solution.

## 7.3 Aquatic Habitat Design Guidelines

### 7.3.1 Problem Definition Criteria

The primary regulations adopted by the County to protect aquatic habitat are contained in the Critical Areas Regulations in SCC Chapter 32.10. While these regulations are intended to protect habitat from potential impacts due to development activity, they do not define what constitutes an aquatic habitat problem for the purposes of this project. Also, while the County's General Policy Plan (GPP) contains general guidance for the County to pursue opportunities to restore degraded aquatic habitat, specific criteria to accomplish these goals have not been developed.

At the federal level, the Endangered Species Act prohibits the "take" of species listed as endangered or threatened, but is not specific about requirements to reduce or eliminate a "take." Within Snohomish County, two species of salmonids are currently listed as threatened chinook salmon and bull trout; both species are found within the DNR study area.

In the absence of specific guidance in County code, instream and riparian habitat problems were defined using criteria developed by a regional watershed-based salmon conservation planning effort that included Snohomish County and a variety of regional jurisdictions. The definitions of instream habitat conditions are listed in Table 7-2 and documented in *Wadable Stream Habitat Survey Preliminary Results for the Year 2001* (SWM, 2002). The definitions of riparian habitat conditions, developed for this DNR project, are listed in Table 7-3. In both tables, habitat conditions defined as either degraded or unsuitable were considered to be habitat problems for the purposes of this project.

In addition, stream culverts that impede or completely prevent fish from swimming upstream were defined as habitat problems. The criteria specified in *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (WDFW, 2000) were used to assess whether a culvert is a fish passage problem. These criteria are primarily based on a field assessment to evaluate whether a culvert is perched, in which the stream channel has dropped below the bottom of the culvert, or has excessive velocities that would impede or prevent fish from swimming through the culvert. Because not all culverts could be assessed in the field, the results of the hydraulic models were also used to check for culverts with high velocities. Velocity problems were identified using the criteria in *Fish Passage Design at Road Culverts* (WDFW, 1999), which applies to velocities from either the 2-year peak flow or the flow that is exceeded an average of 10 percent of the time.

<b>Table 7-2 Instream Habitat Condition Criteria</b>			
<b>Habitat Component</b>	<b>Suitable</b>	<b>Degraded</b>	<b>Unsuitable</b>
Large Woody Debris (LWD)	>2 pieces LWD/channel width <sup>a</sup> (cw) >10 cm diam & 2 m long	1 to 2 pieces LWD/cw	< 1 piece LWD/cw
LWD <sup>b</sup>	Properly Functioning Conditions: >80 pieces/mile >24-inch (50.8 cm) diameter and >50-foot (15.2 meter) length	At Risk Conditions: Currently meets standards for properly functioning, but lacks potential sources from riparian areas of woody debris recruitment to maintain that standard.	Not Properly Functioning Conditions: Does not meet standards for properly functioning and lacks potential LWD recruitment.
Pool Habitat	Pool habitat is > 50% of the low-flow surface area.	Pool habitat is 35 to 50% of the low-flow surface area.	Pool habitat is < 35% of the low-flow surface area.
Bank Stability <sup>b</sup>	Shoreline hardening or unstable banks affect < 10% of shorelines.	Shoreline hardening or unstable banks affect 10 to 20% of shorelines.	Shoreline hardening or unstable banks affect > 20% of shorelines.
Bank Armoring <sup>b</sup>	Shoreline hardening or overwater structures affect < 10% of shorelines.	Shoreline hardening or overwater structures affect 10 to 25% of shorelines.	Shoreline hardening or overwater structures affect > 25% of shorelines.
<sup>a</sup> LWD/cw is the number of pieces of LWD per length of channel that is equal to the channel width (cw). <sup>b</sup> Criteria based on NMFS (1996). Note: Criteria based on SWM (2002) unless noted otherwise.			

<b>Table 7-3 Habitat Condition Criteria for Riparian Areas</b>			
<b>Habitat Component</b>	<b>Suitable</b>	<b>Degraded</b>	<b>Unsuitable</b>
Riparian Buffer	> 80% of riparian zone within 300 feet composed of Land Cover Class 1 or 2.	65 to 80% of riparian zone within 300 feet composed of Land Cover Class 1 or 2.	< 65% of riparian zone within 300 feet composed of Land Cover Class 1 or 2.
Forest Cover	> 70% of subbasin composed of Land Cover Class 1 or 2.	50 to 70% of subbasin composed of Land Cover Class 1 or 2.	< 50% of subbasin composed of Land Cover Class 1 or 2.
Notes: Criteria based on SWM (2002). Land Cover Class 1 = Mature evergreen forest: hydrologically mature and contributes to LWD, late seral, old growth. Land Cover Class 2 = Mixed forest: hydrologically mature, does not contribute to LWD, mixed in age/species.			

### 7.3.2 Design Guidelines

Snohomish County’s Critical Areas Regulations (SCC 32.10) contain some guidance regarding the mitigation of impacts to aquatic habitat, such as creating new wetlands to mitigate wetland filling, but they do not specifically define how habitat improvements should be designed. In addition, the County’s GPP contains general guidance for the County to pursue opportunities to restore damaged aquatic habitat. Section 3.F.1 of the GPP states that “the County shall pursue opportunities to restore and enhance aquatic ecosystems and aquifers that have been damaged by past activities.” While this policy

likewise does not provide specific design guidance, it nevertheless served as the basis for the design of habitat improvements.

Based on this GPP policy in section 3.F.1, the proposed instream and riparian habitat projects were primarily designed as opportunities to improve damaged habitat, to prevent further damage, and in a few cases, to create new habitat. Although, in theory, the goal could be to raise the habitat condition to the next highest rating in Tables 7-2 and 7-3 (e.g., from “unsuitable” to “degraded” or from “degraded” to “suitable”), this tended to result in very costly CIP projects. As a result, most of the instream and riparian habitat projects were designed to provide the most beneficial and cost-effective improvements without trying to satisfy any specific criteria.

Similarly, land acquisitions were primarily proposed as opportunities to preserve some of the more valuable habitat areas that were most likely to be impacted by urbanization. In general, the best opportunities for land acquisition were considered to include one or more of the following features: (1) habitat-forming riparian and wetland vegetation, (2) important salmon spawning and rearing habitat, and (3) access for rehabilitation of habitat adjacent to these areas.

Culverts defined as fish passage problems were designed according to the criteria in *Fish Passage Design at Road Culverts* (WDFW, 1999).

While the above guidelines are generally applied to problems at a specific location or within a specific stream reach, other conditions can only be addressed on a basin-wide scale. For example, the altered hydrology of a basin and the resulting erosion and transport of sediment may be the primary limiting factors in some of the County’s urban streams. Booth et al. (2001) contends that rehabilitation of urban streams cannot be achieved without hydrologic restoration on a watershed scale. Therefore, some of the basin-wide alternatives were evaluated with this in mind. Many solutions to basin-wide habitat problems are reflected in drainage solutions that include rerouted conveyance systems, regional detention facilities, or similar projects.

Because the guidelines used to design habitat projects are not mandated, the County may wish to consider modifying these guidelines in the future, such as during the final design of phase individual projects. It is likely that the use of different guidelines will alter the design of the habitat projects presented in this report.

## **7.4 Water Quality Design Guidelines**

### **7.4.1 Problem Definition Criteria**

In S.C.C. 7.53.070, the County prohibits discharges that cause or contribute to a violation of the State Water Quality Standards. These standards are defined in Washington Administrative Code (WAC) 173-201A. Using available water quality data, these standards were used to define water quality problems within the study area.

### **7.4.2 Design Guidelines**

The DNR project was not intended to provide a comprehensive evaluation of water quality problems and solutions in the study area. The proposed water quality projects were designed as opportunities to improve existing water quality without attempting to reach specific targets.

Water quality improvements are inherent in many of the drainage solutions. For example, regional stormwater detention facilities create conditions that can allow pollutants to settle, thereby helping to remove pollutants within the facility. Regional stormwater facilities also tend to reduce downstream erosion and sedimentation. Some solutions to water quality problems may consist of non-project recommendations for modifying how systems, such as ditches, are maintained.

## **7.5 Channel Erosion Design Guidelines**

### **7.5.1 Problem Definition Criteria**

Snohomish County also does not currently have any adopted regulations that define what constitutes a channel erosion problem. However, some criteria were developed by SWM related to the erosion of stream channels, as documented in *Wadable Stream Habitat Survey Preliminary Results for the Year 2001* (SWM, 2002). These criteria are listed in Table 7-2. In general, if erosion was observed during a field investigation that was likely to endanger a road, structure, or cause a continuing unraveling of the ditch or streambed, then this was considered to be an erosion problem.

### **7.5.1 Design Guidelines**

The DNR project was not intended to provide a comprehensive evaluation of channel erosion problems and solutions in the study area. Therefore, the proposed erosion projects were designed as opportunities to solve existing erosion problems without the requirement to meet any specific design standards.

Many solutions to erosion problems are directly connected to drainage solutions. For example, a drainage system that bypasses a sensitive or flooded area may provide not only flood reduction, but also reduction of erosion and improved slope stability.