Technical Memorandum

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From: Jonathan Ives, Principal Scientist

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Subject: Skokomish Core Reservation Area – Analysis of Using Wetlands for Effluent Disposal

1.0 Introduction

This technical memorandum provides an analysis of the feasibility of using natural or constructed wetlands to dispose of treated effluent from the proposed wastewater treatment plant (WWTP) to serve the core area of the Skokomish Tribal Reservation (Core Reservation Area) (Figure 1). The feasibility of using wetlands is being considered as one of several options for effluent disposal to be evaluated in the update to the Skokomish Tribe Wastewater Facility Plan.

Tasks to conduct the analysis and to prepare this memorandum included:

- Review of existing wetland, soils, topographic, and related GIS information for the project area, and research use of reclaimed water for wetlands;
- Conduct of reconnaissance-level visits to and characterization of candidate wetland sites;
- Coordination with the project team and calculations of loading capacity and planning level cost estimates.

For the purpose of this analysis, it has been assumed that the proposed WWTP would treat wastewater to a "Class A" reclaimed water quality standard as defined by RCW 90.46 and the "Water Reclamation and Reuse Standards" manual (Washington State Department of Health and Washington State Department of Ecology 1997). This high quality treatment (i.e., advanced treatment) would be achieved using a membrane bioreactor (MBR) system). This high level of quality would allow the reclaimed water to be used for a variety of beneficial reuses, including discharge to natural or constructed wetlands.

1.1 Natural and Constructed Wetlands

1.1.1 Natural Wetlands

Section 2 "Reclaimed Water Standards for Wetlands" of the Water Reclamation and Reuse Standards manual, provides guidance for the discharge of reclaimed water into natural wetlands. Appendix A of this memo presents a summary of the standards. As a general guideline, discharge of reclaimed water into Category I or to salt-water dominated wetlands is not permitted except where it can be demonstrated that no existing wetland functions would be decreased *and* that overall net environmental benefits would result from the discharge (Washington Department of Health and Washington State Department of Ecology 1997).

The standards do however, encourage and provide guidance for use of reclaimed water in Category II, III, and IV wetlands. These are wetlands that have had some degree of disturbance, such as physical changes to topography (e.g., placement of fill) or vegetation structure and diversity (e.g., clearing, invasive species), and may benefit from the introduction of reclaimed water. The following are definitions of wetland categories from the Washington State Department of Health and Washington State Department of Ecology (1997):

- Category I wetlands are wetlands that provide a documented significant life support function for threatened or endangered species, represent a high quality example of a rare wetland type, are rare within a given region, or are relatively undisturbed and contain ecological attributes that are impossible to replace within a human lifetime;
- Category II wetlands are wetlands that provide habitat for very sensitive or important wildlife or plants that are difficult to replace, or provide very high functional quality, particularly for wildlife habitat;
- Category III wetlands are wetlands that provide important functions and values, but are smaller, less diverse, and/or more isolated in the landscape than Category II wetlands; and
- Category IV wetlands are small. Isolated, and lack vegetation diversity, and may be able to be enhanced, restored, or replaced.

The U.S. Environmental Protection Agency (EPA) recognizes the value of using natural wetlands to provide "further treatment" of secondary effluent to meet receiving water standards, with the objective of further treatment being to reduce biochemical oxygen demand (BOD_5), suspended solids, and nutrients such as ammonia, other forms of nitrogen, and pathogens. EPA's primary concern regarding the use of natural wetlands is the potential to permanently alter biotic communities through the continuous discharge of wasterwater (Hammer 1989).

1.1.2 Constructed Beneficial Use Wetlands

Constructed beneficial use wetlands are artificial wetlands constructed on non-wetland sites designed to provide treatment and, in some cases, some measure of benefits to society or to the environment, relative to the following recognized wetland functions and values:

- Storm/flood water storage and retention;
- Hydrologic functions of low flow augmentation, ground water discharge and recharge, and surface water flow;
- Filtration, storage, and transformation of sediment, nutrients, and toxics;
- Shoreline protection from erosion;
- Habitat for aquatic organisms;
- Habitat for wildlife; and
- Recreational, cultural, educational, scientific, and natural aesthetic values and uses.

The construction of wetlands for treatment and beneficial uses is of particular value in arid regions where wetlands are uncommon, where development has eliminated or modified historic wetland resources and where large areas of land are available to construct wetlands (Hammer 1989). While constructed wetlands provide the important function of treating wastewater, these systems rarely achieve the biological complexity of natural wetlands, and their ecological values are correspondingly less than natural systems (Hammer 1989). This is particularly true for small wastewater facilities having relatively low flows and therefore requiring a small wetland area for treatment. In such cases the small constructed wetland area is generally insufficient to provide significant ecological functions and values.

In Washington State, constructed beneficial use wetlands can be used as mitigation for the conversion or loss of wetlands caused by the development of a proposed project. The required quality of reclaimed water discharged to constructed beneficial use wetlands differs from the use of constructed wetlands for additional wastewater treatment (i.e., treatment wetlands). Reclaimed water discharged to constructed beneficial use wetlands must be Class B or better, while a lesser standard is applicable constructed wetlands used for treatment (see Appendix A, Section 1, Article 2 General Requirements, Impoundments for Constructed Beneficial Use and Constructed Treatment Wetlands) of the Water Reclamation and Reuse Standards manual).

At the Federal level, the EPA has established guiding principles for constructed treatment wetlands (EPA 2000).

1.1.3 Constructed Treatment Wetlands

Constructed treatment wetlands are systems that are engineered and constructed in non-wetland sites and managed for the primary purpose of wastewater treatment. Constructed treatment wetlands become part of the wastewater collection and treatment system and are not considered “waters of the state” or “waters of the U.S.” (Washington Department of Health and Washington State Department of Ecology 1997; EPA 2000).

The use of constructed wetlands for treatment is of recognized value because of the ability of wetlands to transform many of the common pollutants in wastewater into harmless byproducts or essential nutrients that can be used for additional biological productivity. Additionally, these pollutant transformations can be achieved for the relatively low cost of earthwork, piping, pumping, and concrete structures (Kadlec and Knight 1996).

Constructed wetlands can be used for secondary treatment or "polishing" effluent from a mechanical wastewater treatment plant. Constructed wetlands for the Skokomish Core Reservation would most likely be used for effluent polishing since secondary treatment wetlands would require a large impoundment and large area of land (Fricke pers. comm.).

The benefit of constructed treatment wetlands is to provide further treatment of wastewater using a "natural" system rather than a mechanical process. However, constructed wetlands require the construction of an impoundment of a prescribed size to handle projected flows and to achieve desired treatment and water quality. Additionally, treatment wetlands require the ultimate discharge of the treated wastewater, either through infiltration or at a point discharge to a receiving water (e.g., stream).

The size of the wetland needed to accomplish a desired pollutant reduction involves the development of a mass balance design model that includes the calculation of influent, internal and out concentrations; water flow rates, and other factors such as temperature and seasonal variation in biological uptake and productivity (Kadlec and Knight 1996).

Surface-Flow Wetlands

Surface-flow wetlands rely a combination of water movement, evapo-transpiration, and biological activity associated with the vegetation, microbes, wildlife, and other physical and biological factors, to treat effluent to a prescribed level of quality. These wetlands mimic natural wetlands in that water flows principally above ground through a growth of emergent plants. Features common to surface-flow wetlands include an inlet device, a bermed impoundment having a variable number of cells or basins, wetland plants, and an outlet structure. The inlet device initiates a sheet flow of wastewater into the wetland. The number of cells for treatment is based on calculated treatment ability of the wetland (i.e., based on physical and biological factors) to provide compliance with regulatory limits. Wetland plants provide mineral cycling and attachment area for microbial populations. The outlet structure collects the surface water for discharge to the ultimate receiving water or point of disposal (Kadlec and Knight 1996).

Subsurface Flow Wetlands

Subsurface flow wetlands rely on effluent flowing through a porous media (e.g., gravel) planted with wetland plants to achieve the prescribed water quality. Subsurface flow wetlands are designed to achieve a continuous and uniform flow of wastewater through a porous medium without overflooding the system. The two most common reasons for overflooding are clogging of the media with particulates (i.e., caused by buildup of organic matter from vegetation and other sources) and improper hydraulic design (Kadlec and Knight 1996). The accumulation of organic material from wastewater biosolids and vegetation is an expected occurrence, and can be accounted for in the design of the media bed and wetland.

1.2 Water Quality

By definition, reclaimed water is effluent derived from a wastewater treatment system that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for beneficial use. "Class A" reclaimed water is oxidized, coagulated, filtered, and disinfected wastewater and is the highest quality for beneficial uses (Washington Department of Health and Washington State Department of Ecology 1997).

Chapter 90.46.090 (1) RCW indicates that reclaimed water may be beneficially used to discharge into constructed beneficial use wetlands provided the reclaimed water meets the Class A or B reclaimed water standards. Reclaimed water that does not meet Class A or B reclaimed water standards may be discharged into constructed treatment wetlands provided the lesser standard is approved and a comprehensive monitoring program is included. For discharge of reclaimed water to natural wetlands,

The Washington Department of Health and Washington State Department of Ecology manual (1997) indicates that reclaimed water shall, at a minimum, be treated to Class D reclaimed water standards, or Class B standards when reclaimed water would provide fisheries or potential human non-contact recreational of educational beneficial uses. Where natural wetlands receiving reclaimed water provide potential non-contact recreational or educational beneficial uses through restricted access, discharge shall, at a minimum, meet Class C reclaimed water standards. The proposed Class A quality for the Skokomish WWTP would exceed that minimum requirement.

Water quality criteria indicate that reclaimed water discharged to wetlands is not to exceed, on an average annual basis, the following concentrations unless net environmental benefits are provided:

BOD_5	20 mg/l
TSS	20 mg/l
Total Kjeldahl Nitrogen (as Nitrogen)	3 mg/l
Total Phosphorous (as Phosphorous)	1 mg/l

Source: Washington Department of Health and Washington State Department of Ecology (1997)

2.0 Methodology

2.1 Review of Existing Information

The evaluation for use of reclaimed water in wetlands for the Skokomish Core Reservation began with review of existing published and unpublished descriptions of the project area and general setting. This information included Skokomish Tribe GIS data and maps (aerial photographs, wetlands, soils, topography, streams, and other environmental factors), the Skokomish Indian

Tribe Wastewater Master Plan (KCM 1998), Mason County soils information (USDA 1960), water resources of Skokomish Indian Reservation (USDI 1973), and project information provided by the Skokomish Tribe and Cascade Design Professionals.

An analysis of GIS data and aerial photos of the project area followed review of the information. GIS data layers reviewed included aerial photographs, topography, soils, wetland boundaries and classifications, land use, roads, and surface water. Also Included in the review was a LIDAR (Light detecting and Ranging) bare earth composite map of topography and soils on the Skokomish Reservation.

Information gained during the review and analysis was used to identify candidate wetlands based on the following evaluation criteria:

- Distance from WWTP
- Access
- Wetland Class and Type
- Topography and Soils
- Land Use

Four candidate wetland disposal sites were identified as part of a "desktop" analysis (Figure 1) of the existing information. The four sites are all within 3,000 feet of the proposed WWTP and located east of Highway 101.

2.2 Field Investigation

A reconnaissance-level field investigation of the candidate wetland sites was conducted December 18, 2006. Field observations included:

- Characterizing vegetation composition and diversity;
- Shovel probes to observe soils characteristics and saturated soils;
- Observing topographic and surface water features;
- Verifying adjacent land use; and
- Characterizing access conditions.

Field investigations included completing a qualitative wetland assessment (Appendix B) of each site and taking digital photographs of the sites.

The information was used to characterize and screen the wetland candidate sites for suitability for discharge of reclaimed water.

3.0 Study Area Resources

3.1 Wetlands

Wetland information for the Skokomish Reservation was derived from GIS data and mapping (Skokomish Tribe 2006) based on the National Wetland Inventory (NWI), and a reservation-wide wetland inventory of Skokomish Tribal lands conducted by Sheldon & Associates (1994).

The GIS mapping identified approximate wetland boundaries and the general wetland classification (e.g., forested/shrub freshwater wetland, freshwater emergent wetland, estuarine and marine wetland) based on Cowardin et. al (1979). Additional information was derived from a field reconnaissance conducted December 18, 2006 by Skokomish Tribe and Jones & Stokes project personnel.

A contiguous wetland, named the North Wetland, is approximately 816 acres in size, and is located east of the proposed WWTP site and Highway 101. The wetland includes both freshwater and estuarine systems and 10 vegetation communities (KCM 1998). Based on the Washington State Department of Ecology's classification system, the North Wetland is considered a Category I wetland.

Vegetation present in the North Wetland varies from forested/shrub (Sitka spruce, cottonwood, alder, red cedar, Spirea, red-tipped dogwood) on the western edge of the wetland to tidal marsh (three-square bulrush, *Salicornia*) adjacent to Hood Canal.

Hydrology of the North Wetland is derived from a combination of groundwater contributions from uplands to the west, precipitation, and tidal influence. Additionally, several unnamed streams originating in the uplands west of the wetland also contribute to the hydrology of the wetlands. A majority of the hydrology in freshwater wetlands along the western edge of the North Wetland is provided by groundwater seepage and springs emanating from the upland slopes (HWA 1998).

Even though the North Wetland has an overall rating as Category I, variability in the quality of habitat and wetland conditions exists throughout the system. For example, some portions of the wetland adjacent to development (e.g., within the Core Reservation Area east of Highway 101) have been cleared of trees and shrubs, while some levees, roads, and drainage channels have been constructed within estuarine wetlands. These degraded portions of the wetland may offer opportunity for improvement of habitat and function using reclaimed water.

3.2 Soils

Soils information for the project area was derived from Skokomish Tribe GIS and LIDAR data and the Soil Survey for Mason County (USDA 1960). Soils at the candidate wetland sites include the following:

Puget Silt Loam (0 to 2 percent slopes)

The Puget Series consists of poorly drained, light brownish-gray soils in wetland areas. The subsoil is highly mottled, with mottling oftentimes near the surface. Subsurface soils consist of highly mottled silt and moderately plastic, stratified clay and silty clay. The soil is waterlogged much of the year. Within the project area, this soil is found east of the mouth of the unnamed dry creek to the east of Highway 101. This soil occurs at Wetland Candidate sites 1, 2, and 3.

Mukilteo Peat (0 to 2 percent slopes)

The Mukilteo Series consists of peat that is mainly partly decomposed sedges, spirea, twigs and roots. The soil is strongly acid and saturated throughout the year. Within the project area, this soil is found east of Highway 101, north of the Core Reservation and south of Enati Creek. This soil occurs at Wetland Candidate site 4.

4.0 Results

4.1 Natural Wetlands

As previously mentioned, four candidate natural wetland sites for reclaimed water disposal were identified in the vicinity of the proposed wastewater treatment facility. A reconnaissance-level survey of the four sites was conducted December 18, 2006.

These sites were evaluated following the overarching guideline that discharge of reclaimed water into wetlands would not result in a decrease in existing wetland functions and that overall net environmental benefits would result from the discharge.

4.1.1 Candidate Site 1

Using aerial photographs, Wetland Candidate Site 1 was selected because of its close proximity to the proposed wastewater treatment facility (Figure 1). Site 1 is located approximately 700 feet east of Highway 101 and 300 feet from a residential use, on the western edge of the North Wetland. A copy of the Qualitative Wetland Assessment Checklist and representative photographs for Site 1 is presented in Appendix B.1). Table 1 provides a summary of wetland conditions at Site 1.

Table 1. Summary Characteristics of Wetland Candidate Site 1

Site Evaluation Criteria	Site Characteristics
Wetland Class, Type; Vegetation	Category I Freshwater Forested/Shrub; 30 to 40% tree canopy of alder with understory of salmonberry and sword ferns (see Appendix B.1 for more detail and representative photographs).
Distance from WWTP; Access	Approximately 1,000 ft from WWTP and west of Highway 101; No existing road, access adjacent to residential use.
Topography and Soils	Approximate elevation 20 ft; slight slope (~1 to 2 %) to east; soils dark brown sandy with gravels, saturated 3 to 4 inches below surface and in pockets on the surface.
Land Use and Adjacent Land Use	Undeveloped, portions of site cleared of trees with scattered debris (old tires and remnants of vehicles). Adjacent land use undeveloped to north, south, and east, with residential upslope to west.

Suitability for Discharge of Reclaimed Water

Wetland Candidate Site 1 is a Category 1 freshwater forested wetland. Field review of the site revealed that the functional attributes of the wetland were essentially intact, and that no clearly evident environmental benefits could be derived from discharging reclaimed water at this location (see photographs in Appendix B.1). As previously mentioned, the use of natural wetland for disposal of reclaimed water is not recommended unless it can be demonstrated that no existing wetland functions would be decreased and overall net environmental benefits will result from the discharge (Washington Department of Health and Washington State Department of Ecology 1997).

Based on the hydraulic loading guidelines of 0.8 in (2 cm)/day, approximately 9.5 acres of wetland would be needed to assimilate the projected wastewater volumes for the core reservation area (see Table 5). The reclaimed water would need to be distributed into the wetland using a linear spreader line located along the western side of the wetland.

Even with consideration for hydraulic loading mentioned above, there would be the following potential impacts of discharging reclaimed water into the Site 1 wetland:

- Increasing the quantity of water to the forested wetland could lead to the loss of forested wetland habitat if water elevations and the duration of the higher elevations exceed the tolerance limits of the existing tree and shrub species.
- Application of the reclaimed water could lead to an increase in the area of open water and emergent wetland habitat, thereby resulting in incremental effects on wildlife species that are "closely associated" with forested wetland.
- Use of Site 1 would result in impacts associated with the construction of approximately 700 feet of access road from Highway 101 and a maintenance road and spreader trench to distribute the reclaimed water.

Based on field review, Site 1 was determined to not be suitable for discharge of reclaimed water because of the potential to degrade several of the existing wetland functions (e.g., potential loss of forested and shrub habitat and impacts to wildlife) and the lack of any overall net environmental benefits from the discharge.

4.1.2 Candidate Site 2

Wetland Candidate Site 2 was selected because of its close location to the mouth of the unnamed dry creek and the relatively close to the proposed wastewater treatment facility (Figure 1). Site 2 is located approximately 700 feet east of Highway 101 and 400 feet from a residential use, on the western edge of the North Wetland. A copy of the Qualitative Wetland Assessment Checklist and representative photographs for Site 2 is presented in Appendix B.2). Table 2 provides a summary of wetland conditions at Site 2.

Table 2. Summary Characteristics of Wetland Candidate Site 2

Site Evaluation Criteria	Site Characteristics
Wetland Class, Type; Vegetation	Category I Freshwater Forested/Shrub; 70% tree canopy of alder, red cedar, cottonwood with understory of vine maple, red-twig dogwood, salmonberry and sword ferns (see Appendix B.2 for more detail and representative photographs).
Distance from WWTP; Access	Approximately 1,700 ft from WWTP and west of Highway 101; No existing road, access adjacent to residential use.
Topography and Soils	Approximate elevation 20 ft; slight slope (~1 to 2 %) to east; soils dark brown coarse sandy with gravels, saturated 3 to 4 inches below surface and on the surface within a defined channel east of the gravel outwash delta formed at the end of the unnamed dry creek.
Land Use and Adjacent Land Use	Undeveloped. Adjacent land use undeveloped to north, south, and east, with residential upslope to west.

Suitability for Discharge of Reclaimed Water

As with Site 1, Wetland Candidate Site 2 is a Category 1 freshwater forested wetland. Field review of the site revealed that the functional attributes of the wetland were not only intact, but also unique due the location of the wetland abutting glacial outwash soils and gravels associated with the mouth of the unnamed dry creek (see photographs in Appendix B.2). In addition, there was no clear evidence that environmental benefits could be derived from discharging reclaimed water at this location.

Based on the hydraulic loading guidelines of 0.8 in (2 cm)/day, approximately 9.5 acres of wetland would be needed to assimilate the projected wastewater volumes for the core reservation area (see Table 5). The reclaimed water would need to be distributed into the wetland using a linear spreader line located along the western side of the wetland. Even with consideration for hydraulic loading mentioned above, there would be the following potential impacts of discharging reclaimed water into the Site 2 wetland:

- Increasing the quantity of water to the forested wetland could lead to the loss of forested wetland habitat if water elevations and the duration of the higher elevations exceed the tolerance limits of the existing tree and shrub species at that location.
- Application of the reclaimed water could lead to an increase in the area of open water and emergent wetland habitat, thereby resulting in incremental effects on wildlife species that are "closely associated" with forested wetland.
- Use of Site 2 would result in impacts associated with the construction of approximately 700 feet of access road from Highway 101 and a maintenance road and spreader trench to distribute the reclaimed water.

Based on field review, Site 2 was determined to not be suitable for discharge of reclaimed water because of the unique nature of the wetland, the potential to degrade several of the existing wetland functions (e.g., potential loss of forested and shrub habitat and impacts to wildlife) and the lack of any overall net environmental benefits from the discharge.

4.1.3 Candidate Site 3

Wetland Candidate Site 3 was selected because of the potential for using reclaimed water to enhance wetland habitat adjacent to Transmission Line Road and in the adjacent slough (Figure 1). Site 3 is located approximately 1,300 feet east of Highway 101 and 400 feet from the eastern edge of the freshwater forested portion of the North Wetland. A copy of the Qualitative Wetland Assessment Checklist and representative photographs for Site 3 is presented in Appendix B.3).

Table 3. Summary Characteristics of Wetland Candidate Site 3

Site Evaluation Criteria	Site Characteristics
Wetland Class, Type; Vegetation	Category I Tidal Emergent Estuarine wetland with an edge of shrubs consisting of wild rose, red-twig dogwood and salmonberry (see Appendix B.3 for more detail and representative photographs).
Distance from WWTP; Access	Approximately 2,500 ft from WWTP and west of Highway 101; Existing Transmission Line Road from Highway 101.
Topography and Soils	Approximate elevation 8 ft; slight slope; standing water in wetland at high tide; slough carries significant freshwater flows from groundwater and unnamed creek.
Land Use and Adjacent Land Use	Undeveloped. Adjacent land use undeveloped.

Suitability for Discharge of Reclaimed Water

Wetland Candidate Site 3 is a Category 1 tidal emergent estuarine wetland (see Table 3 above). Field review of the site revealed that the functional attributes of the wetland were not only intact, but also of unique high quality due the diversity of habitat, the large quantity of fresh water entering the estuary from upland groundwater sources, and the presence of salmon spawning (Chum salmon) (see photographs in Appendix B.3).

Based on field review, Site 3 was determined to not be suitable for discharge of reclaimed water because of the unique nature of the wetland and the lack of any overall net environmental benefits that could be derived from discharge.

4.1.4 Candidate Site 4

Wetland Candidate Site 4 was selected based on review of aerial photographs indicating possible disturbance/modification to the wetland that could benefit from the use of reclaimed water (Figure 1). Site 4 is located approximately 100 feet east of Highway 101. A copy of the Qualitative Wetland Assessment Checklist and representative photographs for Site 4 is presented in Appendix B.4). Table 4 provides a summary of wetland conditions at Site 4.

Table 4. Summary Characteristics of Wetland Candidate Site 4

Site Evaluation Criteria	Site Characteristics
Wetland Class, Type; Vegetation	Category I Freshwater tidal wetland with an edge of Sitka spruce and shrubs consisting of wild rose, red-twig dogwood (see Appendix B.4 for more detail and representative photographs).
Distance from WWTP; Access	Approximately 2,277 ft from WWTP and west of Highway 101; access directly from Highway 101.
Topography and Soils	Approximate elevation 12 ft; slight slope; standing water in wetland at high tide.
Land Use and Adjacent Land Use	Undeveloped. Due east of Highway 101; some trees cleared along 135-kV transmission line.

Suitability for Discharge of Reclaimed Water

As with Site 3, Wetland Candidate Site 4 is a Category 1 tidal emergent estuarine wetland. Field review of the site revealed that the functional attributes of the wetland are intact and that the wetland is of unique high quality due the diversity of habitat (see photographs in Appendix B.4). The wetland has a complex and diverse assemblage of wetland types (open water, emergent marsh, shrub, and forested) and diverse structure.

Based on field review, Site 4 was determined to not be suitable for discharge of reclaimed water because of the unique nature of the wetland and the lack of any overall net environmental benefits that could be derived from discharge.

4.2 Hydraulic Loading

The "Water Reclamation and Reuse Standards" manual (Washington State Department of Health and Washington State Department of Ecology 1997) has defined hydraulic loading criteria for discharging reclaimed water to Category II, III, and IV natural wetlands; no criteria were defined for Category I wetlands. The purpose of the criteria is to ensure that the hydrologic conditions of the wetland are maintained and that vegetation and other wetland functions are not adversely affected by the addition of reclaimed water.

For the purpose of this feasibility analysis, we used the Category II maximum annual loading rate of 2 cm/day (0.8 in) as a guide. The hydraulic loading rate is the ratio of the average annual flow rate of reclaimed water to the effective "wetted" area of the wetland, reported in cm/day. Table 5 presents an estimate of "wetted" wetland acreage required to meet a maximum loading rate of 2 cm/day guideline for the projected Core Reservation and Potlatch flows combined, and for the Core Reservation alone.

Table 5. Wetland Acreage to Meet Hydraulic Loading Criteria of 2 cm/day

Service Area	Estimated Average Flow (gpd)	Acreage Requirement
Core Reservation	140,000	9.5 acres
Core Reservation and Potlatch Combined	252,000	17 acres

Insufficient data are available to determine the transmissivity of Puget Silt Loam, however for the purpose of this analysis it is assumed that reclaimed water applied to the wetland would combine with existing groundwater and move laterally through the wetlands to the east and Hood Canal as described in the hydrologic evaluation technical memorandum prepared by HWA (*in* KCM 1998).

In order to meet the loading requirement and to distribute the reclaimed water, a level spreader or similar distribution system would need to be installed along the upper margin of the wetland.

5.0 Findings and Recommendations

5.1 Natural Wetlands

The use of natural wetlands for the discharge of reclaimed water is recognized as a potential benefit to Category II, III, or IV wetlands having degraded or compromised functions (Washington State Department of Health and Washington State Department of Ecology 1997). No Category II, III, or IV wetlands are present within the proposed WWTP project area, and none of the four sites evaluated within the Category I North Wetland possess degraded functions or habitat conditions that would benefit from the discharge of reclaimed water.

Based on the review of existing resource information and scientific literature, and the reconnaissance field investigations, no benefits to natural wetland resources would be derived from the discharge of reclaimed water.

5.2 Constructed Beneficial Use Wetlands

The construction of wetlands for "beneficial uses" (e.g., storm/flood water storage and retention; hydrologic functions of low flow augmentation; filtration and storage; habitat for aquatic organisms and wildlife; and recreational, cultural, educational, and scientific uses) is recognized as an environmental and social benefit. The reclaimed water standard for beneficial use is Class B or higher (Washington State Department of Health and Washington State Department of Ecology 1997). The environmental and social value of this approach is dependent on the location and size of the constructed wetland.

As a next step, the applicability and benefits of using constructed beneficial use wetlands for the Skokomish WWTP project should be determined if the Tribe is interested in using reclaimed water for cultural, educational, or scientific use. This decision should be based on such considerations as the goals and objectives for use of reclaimed wastewater, definable environmental and social benefits to be derived, and engineering considerations such as the location and size of the wetland and cost. This analysis could include the feasibility and value or using a constructed beneficial wetland as storage in conjunction with a seasonal land application (e.g., to forest land) and infiltration discharge. It is anticipated that this task could be accomplished in one technical working session.

5.3 Constructed Treatment Wetlands

The construction of treatment wetlands is recognized as a "natural" and "low-tech" approach to treating wastewater to meet discharge requirements. Constructed treatment wetlands are usually constructed in an upland setting, with the size and configuration of the wetland based on the desired pollutant reduction prior to discharge. Treatment wetlands require an ultimate discharge of the treated wastewater, either through infiltration, spray irrigation, or as a point discharge to a receiving water. Constructed treatment wetlands are recognized primarily for their value to treat wastewater rather than to provide wetland functional benefits. Most often, constructed wetlands are not considered waters of the United States (i.e., wetlands by definition).

Class A reclaimed water cannot be achieved using constructed wetlands for treatment unless the effluent from the wetland was filtered prior to discharge (Fricke pers. comm.). The feasibility of using constructed surface-flow and subsurface flow wetlands for treatment, should be explored further if the Tribe chooses to consider discharging effluent of a lesser quality than Class A. For example, a treatment wetland could possibly be used to polish Class D effluent from the WWTP to a Class C quality for discharge. The feasibility of this analysis would be dependent on type of disposal (e.g., spray irrigation or infiltration) and the water quality requirements. This analysis is largely an engineering exercise based on projected flows, projected quality of effluent to be treated, the desired quality for discharge, land availability, and costs for construction, operation, and monitoring.

6.0 References

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6.1 Personal Communications

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