Total Maximum Daily Loads for the Willamette Subbasins

Technical Support Document Appendix C: Potential Near-Stream Land Cover

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State of Oregon
DEQ Department of Environmental Quality

Preface

This document is one component of work by the Oregon Department of Environmental Quality to support development of water quality improvement plans in the Willamette Basin. Specifically, this document supports the development of surrogate measures used in temperature Total Maximum Daily Loads in the Willamette Basin, as required under 40 CFR 130 Federal Clean Water Act.

Pamela Wright, a riparian ecologist, was the primary author of this document.

Revision History

This document was revised by Erin Costello in 2023 to support the TMDL revision, Temperature TMDLs for Willamette Subbasins. Major edits include replacing the term “geomorphic unit” with “mapping unit”. The term “mapping unit” better encompasses the combination of geologic, ecoregion and vegetation GIS information used to determine potential vegetation for specific locations in the Willamette Basin. In addition, the map in **Figure 1-1** was updated to reflect this terminology change and to include the Lower Willamette Subbasin ecoregion data.

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1. Introduction

Potential near-stream land cover is an aspect of stream temperature that is critical to determining temperature Total Maximum Daily Loads (TMDLs) for surface waters in the Willamette Basin. Potential near-stream land cover is commonly referred to as system potential vegetation. In this document the Oregon Department of Environmental Quality (DEQ) explains the methodology and analysis results for predicting potential near-stream land cover in the basin. The work presented in this document reflects the analysis conducted by DEQ and knowledge from local experts from outside the agency that reviewed and gave comments regarding the analysis and assumptions made from the analysis. A list of experts who participated in this process is available in Appendix 1. DEQ also provides documentation of possible model scenarios to predict vegetation distribution given a range of potential near-stream land cover for various riparian environments in the Willamette Basin. The potential near-stream land cover approach described in this document applies to ten of the twelve subbasins in the Basin: Clackamas, Middle Willamette, Upper Willamette, North Santiam, South Santiam, McKenzie, Middle Fork Willamette, Coast Fork Willamette, Yamhill, and Molalla-Pudding. The Tualatin and Lower Willamette subbasin potential near-stream land cover approach is described in the 2001 Tualatin Subbasin TMDL, Appendix A: Temperature Technical Analysis, Tualatin River Subbasin Vegetation Conditions section starting on page A-6, http://www.deq.state.or.us/wq/TMDLs/Tualatin/AppendixA.pdf .

Temperature in many Willamette Basin streams currently exceeds the temperature criteria in Oregon's temperature standard. Riparian vegetation is known to be one of the primary factors controlling stream temperature (Boyd and Sturdevant, 1997) http://www.deq.state.or.us/wq/standards/WQStdsTempStdSciBasis.pdf . DEQ needs to determine potential near-stream land cover, or system potential vegetation, and use this information to predict stream temperatures in the absence of anthropogenic heat. The potential near-stream land cover is the basis of the load allocation for nonpoint source sectors of heat. This methodology is therefore the basis for preparing system potential vegetation and shade targets for the temperature TMDLs. The shade targets developed take into account a natural disturbance regime that is reflected in the diversity of species composition derived for each mapping unit.

The Willamette Valley is bounded on the east by the Cascade Range, and by the Coast Range on the west. To predict potential near-stream land cover in the upland forested mountainous areas, DEQ is using the plant associations developed by the U.S. Department of Agriculture Forest Service (USFS) for the Willamette Basin (Logan et al., 1987).

Currently, there are no plant association data sets available for the Willamette Valley bottom, similar to what the USFS has compiled for the upland forest mountainous area. For the valley, DEQ is using landscape level environmental data (geomorphology, ecoregions, geology, soils, Oregon Department of Fish & Wildlife (ODFW) 1998 Willamette Vegetation, in-field current conditions) and a historic 1850's vegetation layer developed from notes of General Land Office (GLO) surveys to predict potential near-stream land cover. DEQ's objective is not to model a particular point in history, but to use historic data to understand the relationship between the relatively undisturbed vegetation of the mid-1800s and the corresponding environments that currently exist along the various streams in the Willamette Valley. DEQ is using that understanding, information about plant physiology and silviculture, and environmental data to predict future potential near-stream land cover.

The Willamette Valley bottom potential near-stream land cover is assigned a vegetation component defined by the mapping unit; **Figure 1-1** below illustrates the extent of mapping units in the Willamette Subbasins project area.

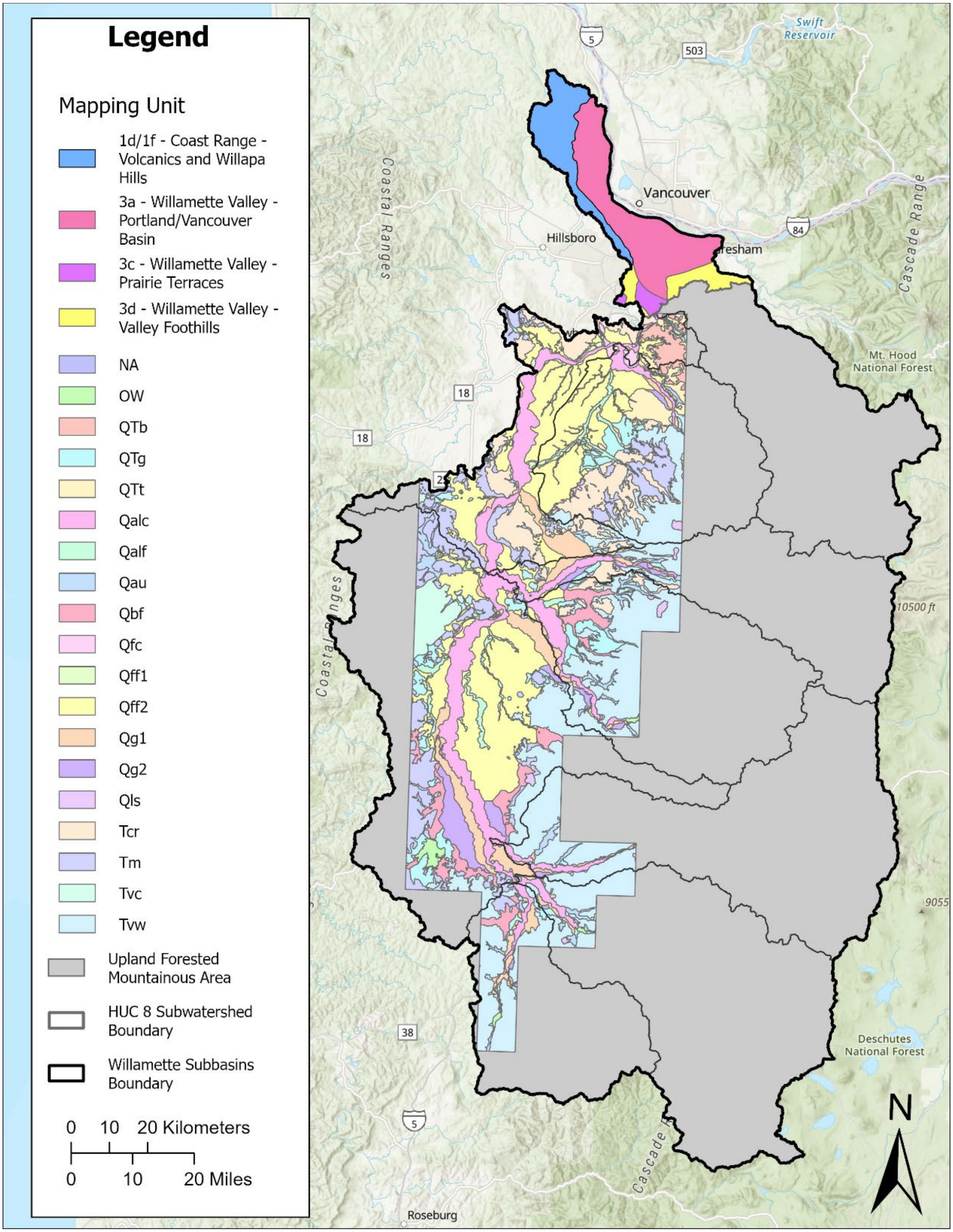

Figure 1-1: Willamette Basin mapping units used to determine potential near-stream land cover for stream temperature modeling.

In addition to describing DEQ's objectives, methodology, and results of the technical analysis, this document includes general "rules" and principles that other entities can use for implementing potential near-stream land cover to improve water quality.

2. Background and Objectives

The process of developing data on potential near-stream land cover is specific to the context in which the data are used in DEQ's TMDL methodology. In this context, potential near-stream land cover is defined as that which can grow and reproduce on a site given plant biology, site elevation, soil characteristics, and local climate. Potential near-stream land cover does not include considerations for resource management, human use, or other human disturbance, however natural disturbance regimes (i.e. fire, disease, wind-throw, etc.) are accounted for in this definition. The DEQ assumes that potential near-stream land cover types (as defined) survive and recover from natural disturbance events.

Oregon water temperature criteria's limit anthropogenic warming to a small amount of no more than 0.3ºC when specific numeric criteria are exceeded. This condition is one in which stream warming related to human activities is minimized. Because near-stream land cover is a controlling factor in stream temperature regimes, the condition and health of land cover is a primary parameter considered in determining the temperature TMDL. Reversing or removing human disturbance from near-stream land cover is a pathway for compliance with Oregon's water temperature standard even when the numeric temperature criteria are not met.

Developing potential near-stream land cover can often be complex because natural systems are highly variable. DEQ has developed simple rules to determine potential near-stream land cover data sets based on physical characteristics and clearly stated assumptions. DEQ acknowledges that determining the potential near-stream land cover type and distribution for some areas is not easily done. This is particularly true for the Willamette Valley bottom, where vegetation has been removed near low gradient streams altering channels by constructing dikes and revetments. Literature on the land cover potential and local knowledge in the universities and federal and state agencies is limited. Consequently, for areas where land cover potential is not documented in the literature or evident in ground level studies and data, DEQ is using a range of land cover types and attributes in the TMDL.

3. Methodology

3.1 The Analysis

Step 1. Mapping units, which are an amalgamation of quaternary geologic units, geology, soils, ODFW 1998 Willamette Vegetation, ecoregions, and historic 1850's vegetation maps, were examined to assess the availability of data and to understand the variability in the Basin, **Figure 3-1**.

Step 2. Using the existing data sets, together with ground level riparian data collected by DEQ in 2000 and 2001, DEQ selected a set of 30 streams that represent the various conditions that exist within the Willamette Valley. The frequency of occurrence of factors that would influence vegetation height and canopy density for each type of stream throughout the Willamette Valley was quantified by mapping unit. The water bodies selected for this analysis are representative of the Willamette Valley and include the Willamette River, it's major tributaries, and streams of large and small watersheds (4^{th}, 5^{th} and 6^{th} level hydrologic units). These waterbodies represent a range of quaternary geologic surfaces and other environmental conditions, and streams that are highly- to relatively little-altered from historic conditions. The sampled water bodies include the McKenzie, South Santiam, Pudding, Yamhill, Long Tom, Row, Mohawk, Mary's, Calapooia, and Luckiamute Rivers; Thomas, Crabtree, Mosby, Rickreall, Muddy, West Muddy, Oak, Mill, Flat, Lake, Patterson, Howell Prairie, Palmer, Ash, N. Fork Ash, Berry, and Beaver Creeks; and Walton and Sucker Sloughs. Each waterbody was sampled to 300 feet upland from the left bank and right bank. A Geographic Information System (GIS) was used to clip, intersect, and manage environmental data.

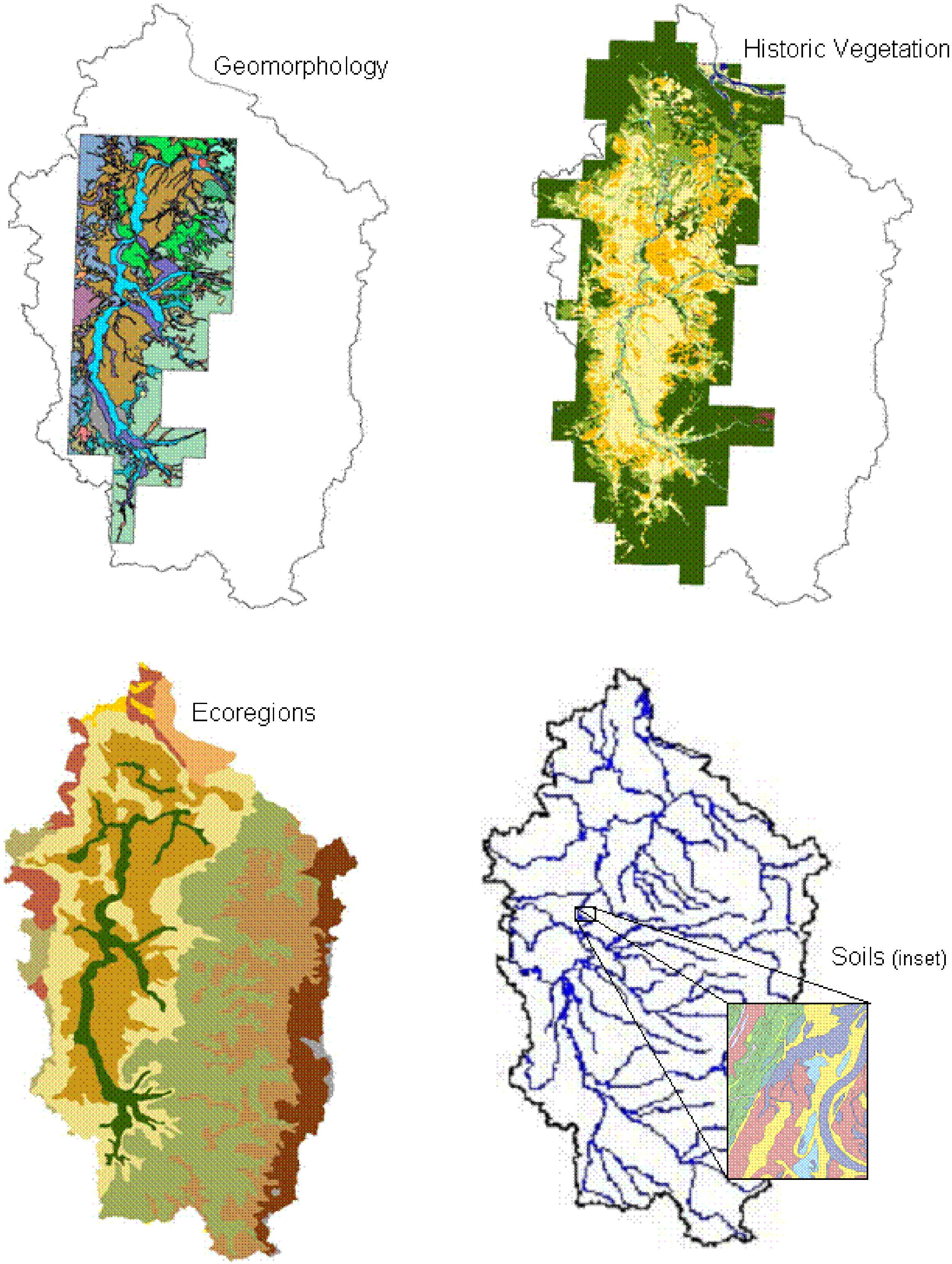

Figure 3-1: Data sets used in the analysis, from clockwise upper left: geomorphology, historic vegetation, ecoregions, and soils (inset near Willamette River).

Step 3. Analysis of geomorphology, ecoregions, geology, soils, ODFW 1998 Willamette Vegetation, and 1850s vegetation data sets examined the near-stream land cover along water bodies of different environments and characteristics. The goal was to assess the relationship between tree stands and other environmental factors along 1850s Willamette Valley water bodies. Based on this assessment, DEQ estimated which environments supported large coniferous trees, versus smaller deciduous trees, and environments that supported dense tree stands (forest) compared to sparse trees (savannas) or no trees (prairie). This approach does not attempt a return to historic conditions, but rather to establish what tree species are suitable to specific environments and determine the size of trees that may grow in a given area.

Step 4. DEQ invited experts from outside the agency to review the analysis and assumptions made from the analysis at this stage. Reviewers, listed in Appendix 1, provided suggestions that were incorporated into the final analysis to quantify the acreage for the historic vegetation of each type of mapping unit and soil drainage, as indicated in **Table 3-1**.

Table 3-1: Proportions of forest, savanna and prairie to be used in temperature models to quantify potential near-stream land cover by mapping unit.

Mapping unit[1]	Sampled streams dominated by mapping unit (surface)	Vegetation structure	Vegetation height (m)	Acres	Model Scenario: Tree Distribution
Qff1	Lower Mainstem Willamette	Forest	44.5	154	0.81
		Savanna	24.6	97	0.19
		Prairie	0.9	0	0.00
			Total	**251**	**1.00**
Qfc	Lower Mainstem Willamette	Forest	30.6	20	0.56
		Savanna	46.8	148	0.44
		Prairie	0.9	0	0.00
			Total	**168**	**1.00**
Qalc	Lower Willamette	Forest	28.0	7973	0.80
		Savanna	26.0	1132	0.17
		Prairie	0.9	1393	0.03
			Total	**10498**	**1.00**
Qg1	Mill Creek	Forest	26.8	260	0.41
		Savanna	23.9	1196	0.44
		Prairie	0.9	646	0.15
			Total	**2102**	**1.00**
Qau	Mohawk, upper Luckiamute, upper Oak Creek, middle Thomas	Forest	28.6	1337	0.60
		Savanna	23.0	288	0.23
		Prairie	0.9	811	0.17
			Total	**2436**	**1.00**
Qalf	Pudding, Muddy Creek, Marys, Yamhill, SF Yamhill, Calapooia	Forest	21.5	3112	0.52
		Savanna	21.9	1150	0.28
		Prairie	0.9	2806	0.20
			Total	**7068**	**1.00**
Qff2	Berry Creek, Ash & NF Ash Creek, upper Muddy (east), upper Lake Creek	Forest	29.9	2729	0.43
		Savanna	24.2	2261	0.35
		Prairie	0.9	4049	0.22
			Total	**9039**	**1.00**

Mapping unit[1]	Sampled streams dominated by mapping unit (surface)	Vegetation structure	Vegetation height (m)	Acres	Model Scenario: Tree Distribution
Qbf	Long Tom, upper Amazon, upper Crabtree Creek	Forest Savanna Prairie	29.7 26.1 0.9 Total	1170 479 1381 **3030**	0.47 0.30 0.23 **1.00**
Qg2	Amazon Creek, Flat Creek	Forest Savanna Prairie	0 0 0 Total	40 0 446 **486**	0.08 0.46 0.46 **1.00**
Tvc	Headwaters Rickreall Creek	Forest Savanna Prairie	31.9 22.2 0.9 Total	29 104 4 **137**	0.60 0.39 0.01 **1.00**
QTg	Small portions of upper Rickreall, Marys, Beaver Creek	Forest Savanna Prairie	47.7 26.7 0.9 Total	387 42 102 **531**	0.77 0.14 0.09 **1.00**
Tvw	Upper Thomas, upper Crabtree, Headwaters Muddy Creek (east)	Forest Savanna Prairie	45.4 23.6 0.9 Total	510 390 220 **1120**	0.57 0.39 0.04 **1.00**
Tcr	Upper Mill Creek	Forest Savanna Prairie	47.3 25.8 0.9 Total	121 972 302 **1395**	0.63 0.27 0.10 **1.00**
Tm	Upper Ash & NF Ash Creek, upper Berry Creek	Forest Savanna Prairie	36.0 24.5 0.9 Total	175 511 85 **771**	0.56 0.39 0.05 **1.00**
QTt	Small sample size (10 ac)	Forest Savanna Prairie	36.0 27.4 0.9 Total	2 8 0 **10**	

[1]Mapping units are described in Appendix 4.

Step 5. A data matrix was examined to identify the frequency of occurrence among environmental factors such as soil type, mapping unit, and the 1850s vegetation types. This information is found in Appendix 3.

Step 6. DEQ developed tables identifying the dominant paths of near-stream land cover, specifically mixed conifer-hardwood forest, hardwood forest, savanna, and prairie. DEQ and other agencies ground-verified existing vegetation during TMDL fieldwork in 2000 and 2001, and also verified it with the US Fish and Wildlife Service wetlands inventory and current vegetation maps (ODFW's 1998 Willamette Vegetation coverage). The successional path of the various 1850s vegetation types was projected and combined to produce a range of potential near-stream land cover types to be modeled for each mapping unit surface. The shade produced by the potential near-stream land cover is a surrogate target for the TMDL. Also, a healthy near-stream land cover will support important ecological processes associated with riparian vegetation.

Step 7. The final step in the analysis was to develop a set of "rules" for predicting potential near-stream land cover based on environmental conditions. These rules are intended to guide the TMDL temperature model simulations for potential land cover. Species composition for the various ecoregions in the Willamette Valley will be based on ecological knowledge of plant communities and historic vegetation. The corresponding tree heights will be estimated from current forest inventory plots for the Willamette Basin. Tree heights are listed Appendix 2.

3.2 Data Sources and Scale

DEQ analyzed sources of data that have been peer-reviewed and published, in addition to field observations conducted by DEQ. Data sources are available in an electronic format that can be used with GIS software by ESRI. Each GIS data source was clipped to 300 feet of the right and left bank.

A map of ecoregions by USGS-EPA provided the broadest scale environmental data. Ecoregions are vegetation classifications derived from physical data such as elevation, rainfall, temperature, and geology (Pater, et al. 1998). Ecoregions were used to estimate site productivity for forested areas. These are associated with the USFS derived Plant Associations, which are the basis of potential vegetation for Coast and Cascade Mountain Range forests.

The Quaternary geology map and report (O'Connor et al, 2001) provided information on the dominant mapping unit features and floodplain development for the Willamette Valley. It delineates areas of the Willamette Valley floodplain, older terraces, Missoula Flood Deposits, and other mapping unit surfaces that influence vegetation.

Soils maps were used from County Soil Surveys developed by the USDA Soil Conservation Service (SCS). Soil drainage was available from the SCS database.

The source of the historic, 1850s vegetation is a map and species list compiled by the Natural Heritage Program and Nature Conservancy from records of the GLO Surveyors, 1851 to 1865. Notes of their surveys along transects of section lines provide descriptions of streams and vegetation including tree species and size identification at each section corner.

Ecoregions were mapped at the coarsest scale, while soils were mapped at the finest scale. Geomorphology was mapped at relatively coarse scales, and historic vegetation was mapped at an intermediate scale.

3.3 Range and Assumptions for Modeling Natural Variability

An analysis that seeks to describe the relationship between plants and their physical environment must account for known natural spatial and temporal variability, and also for uncertainty. DEQ used a level of uncertainty and expected variability to determine the range of potential land cover for use in modeling stream temperatures. To achieve this, DEQ randomly distributed the range of potential vegetation types over each mapping unit surface.

Various researchers on historic fire disturbance in the Willamette Valley have drawn conclusions on the frequency, extent, and ignition sources of fires prior to Euro-American settlement. The 1850s vegetation reported in GLO Survey Notes reflects recent disturbance, including fires that may have resulted from Native American or Euro-American activity, and from lightning strikes. To consider relatively undisturbed vegetation for the purpose of modeling stream temperatures, DEQ estimated a range of potential vegetation cover given a level of disturbance. The level of disturbance is based on the belief that there are more trees today than in the 1850s due to a reduction in fire disturbance.

Savannas and prairies of the 1850s were maintained primarily by fire. Now these areas have soil and water levels capable of supporting more trees than existed at the time of the GLO surveys. Areas that were forests in the 1850s, have the potential to be forest again. Considering current knowledge about succession, DEQ estimates that today the potential vegetation of areas that were savanna in the 1850s is half forest and half savanna. For areas that were prairies in the 1850s, DEQ estimate the potential vegetation to be half savanna and half prairie.

Tree heights for hardwood and conifer species are estimated from the published literature for high quality site conditions, Appendix 2. For modeling purposes, DEQ will assign a percent density canopy cover to each of the vegetation structures. For forested areas DEQ has assigned a tree density canopy cover of 85 percent, 50 percent for savanna, and 0 percent for prairie. Density is defined as the canopy closure. DEQ assumes that stands designated as coniferous in the 1850s GLO survey data, Appendix 3, were mixed conifer-hardwoods in the riparian areas, because pure conifer riparian stands are rare or nonexistent in the Willamette Valley riparian area.

For Willamette TMDL development, DEQ modeled an expected range of variability in the coniferous upland riparian areas to account for the patchy nature of riparian vegetation. To calculate the expected range, DEQ determined the potential vegetation from USFS Plant Association Guides. Based on literature values for natural disturbance in forest stands (Teensma et al., 1991), DEQ assumes that at any given time about 25% of the near-stream vegetation would be disturbed.

4. Results of GIS Analysis and Planned Model Scenarios

The results of the analysis, summarized in **Figure 4-1**, **Figure 4-2**, and in Appendix 3, suggest that three mapping unit surfaces dominate the fluvial and riparian environments of the Willamette Valley bottom, the Willamette River floodplain deposits (Willamette River and major tributaries), alluvium of smaller streams, and the main body of the Missoula Flood deposits (medium and small streams).

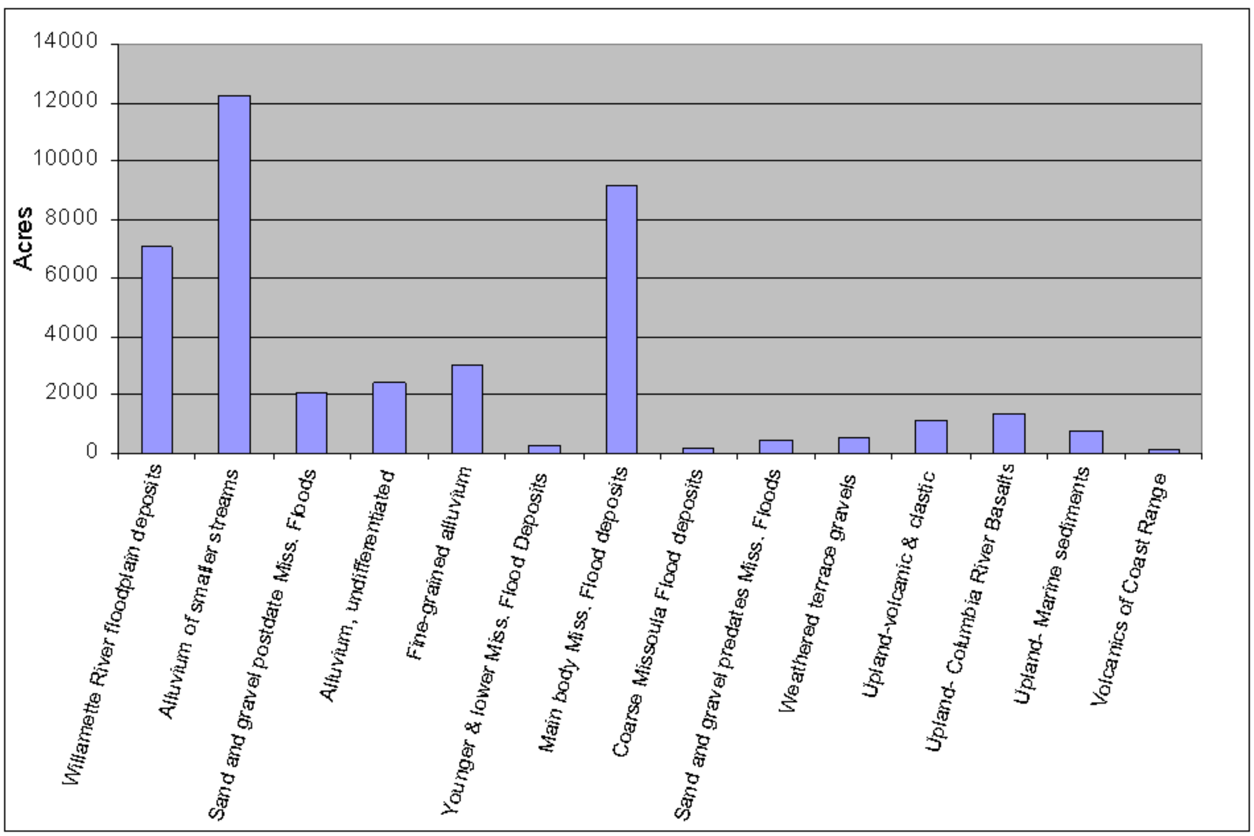

Figure 4-1: 1850s General Land Survey Vegetation (forest, savanna, or prairie) by mapping unit surface.

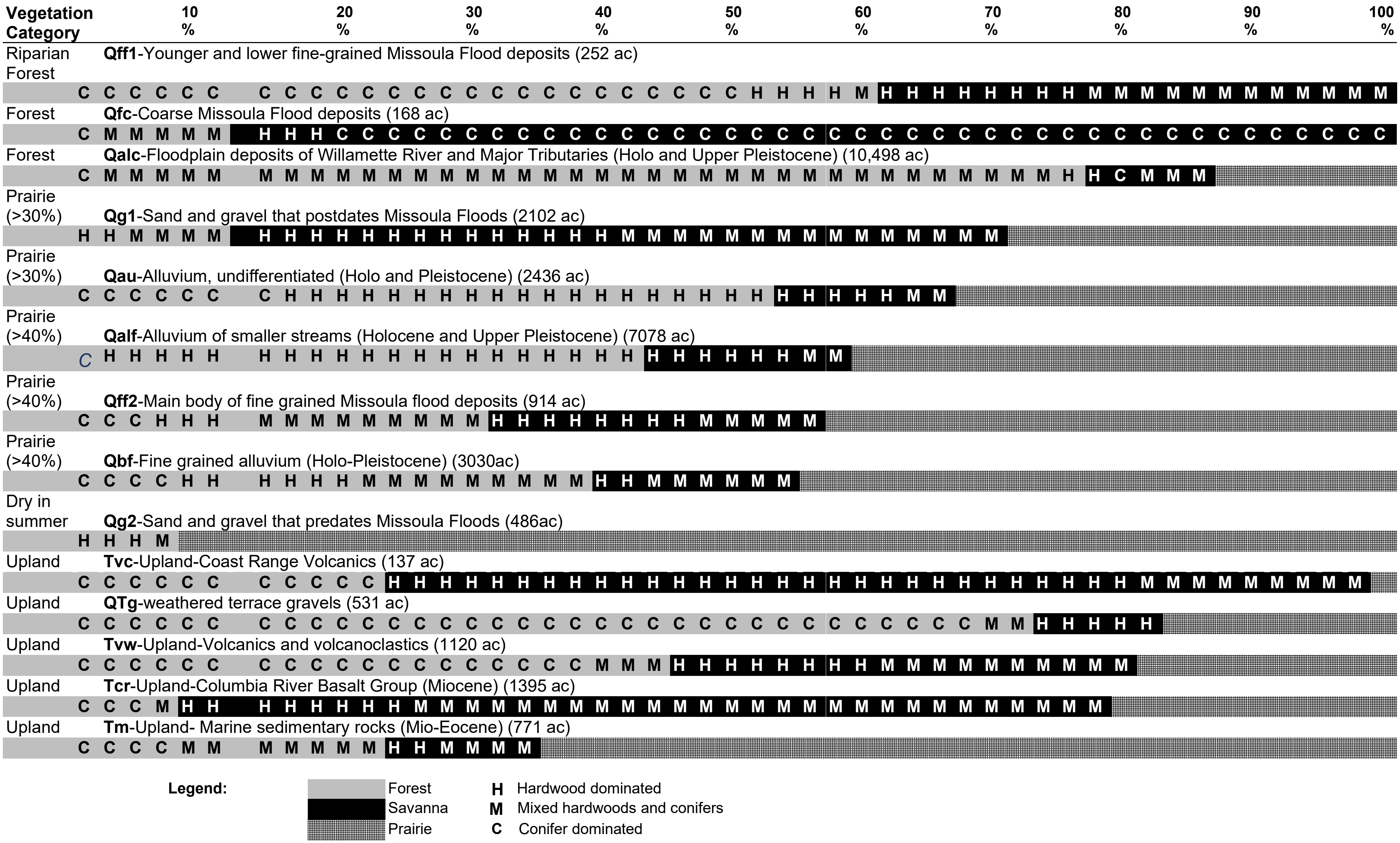

Figure 4-2: Mapping unit surfaces ordered by relative proportion of 1850s forest, savanna, and prairie vegetation.

The historic vegetation for all mapping units within the Willamette Valley, summarized in **Figure 4-2**, indicates that although there is a continuum of relationships between vegetation structure (forest, savanna, and prairie), and that the mapping units can be grouped into four broad categories. The first category is mapping units dominated by forest (Qff1, Qfc, Qalc). The second is mapping units that were dominated by forest or savanna, and had considerable non-forest (prairie) vegetation (Qg1, Qau, Qalf, Qff2, and Qbf). The third category is a mapping units that had 90% prairie, and dry streams in summer (Qg2). The fourth category is mapping units in the upland areas (Tvc, QTg, Tvw, Tcr, and Tm). As already noted, for upland surfaces USFS Plant Associations will be used where available, rather than the 1850 vegetation mapped upland surfaces. The Willamette Valley mapping units in **Figure 4-2** are ordered from those with the greatest proportion of forest and savanna (tree covered) when surveyed in the 1850s to those with the greatest proportion of prairie (non tree covered) (Qg2). **Figure 4-2** also indicates the proportion of hardwoods (H) versus mixed conifer-hardwood stands (M) for forest and savanna vegetation types. Average tree heights for conifer stands are greater than for mixed conifer-hardwood stands, which are greater than for hardwood stands.

Analysis indicates that forest dominated three mapping units in the 1850s: Qalc, Qff1, and Qfc. The vast majority of the 7498 acres of these mapping unit types occur within or adjacent to the active floodplain of the Willamette River and major tributaries. Qalc are the recent floodplain deposits of the Willamette River and its major tributaries. Qff1 are fine-grained Missoula Flood deposits, and Qfc are coarse Missoula Flood deposits. Qff1 and Qfc occur adjacent to Qalc along the lower Willamette River. Additional information about mapping units is provided in Appendix 4.

Forest and savanna dominated five mapping units, historically, though four surfaces had a considerable proportion (30 to 46 percent) of prairie vegetation, Qalf, Qff2, Qbf, and Qfb. Qalf is alluvium of relatively small streams, Qff2 is the main body of Missoula Flood deposits, and Qbf is made of fine-grained alluvium deposits. The data indicates that 42 to 46 percent of the Qalf, Qff2, and Qfb units were prairie at the time of the GLO surveys. Together Qalf, Qff2, and Qbf made up the largest area (14,442 acres) of our sampled streams, reflecting the historic vegetation of the small and medium sized valley bottom streams, **Table 3-1**.

Prairie units account for 30-34 percent of the landscape, and native prairie openings are considered an important part of the Willamette Valley ecosystem. The best function of these areas is to remain as native prairie rather than be planted with trees. According to mapping by Christy, et al, 1997, the mapping unit Qg2, sand and gravel, that pre-dates the Missoula Floods, had 90% prairie vegetation in the 1850s. The two streams sampled on this surface, Amazon Creek and Flat Creek, historically ran dry in the summer with water flowing subsurface.

The surfaces of the Cascade foothills and Coast Ranges were primarily forested in the 1850s. Where data are available, the USFS plant associations will be used to determine potential land cover for these upland coniferous forest landforms. For purposes of modeling, the upland coniferous forest vegetation types presented in Appendix 2 will be used.

5. Rules for Developing Potential Near-Stream Land Cover for Modeling Stream Temperature

The rules that follow document the logic for specific riparian vegetation inputs for modeling to predict stream temperature correlated with potential near-stream land cover for the Willamette Basin, except for the Tualatin and Lower Willamette Subbasins. The proportion of vegetation types listed in **Table 3-1** were distributed over each appropriate mapping unit and inserted into the temperature model. The temperature model potential near-stream land cover was defined for each 50 foot by 100 foot sampled polygon. The potential near-stream land cover lookup table used in the temperature model to define each polygon is provided in Appendix 5.

Shade targets defining the effective shade for each mapping unit have been developed and apply to all streams within the Willamette Basin TMDL analysis area. The shade targets are presented in the form of a shade-curve for each mapping unit and the upland forest mountainous area, they are based on the water bodies measured bankfull width and aspect. Shade-curves follow the rules presented for developing potential near-stream land cover, below. Shade-curves may be used to determine the appropriate potential effective shade for unmodeled streams, based on the extent of the specific mapping units for the waterbody.

1. In upland coniferous forests, large conifers are the potential near-stream land cover. Species composition and tree heights used are from the forested plant associations developed by the USFS (Logan et al., 1987).

2. Where native Willamette Valley wet and dry prairies remain well-established, native prairie ecosystems should be preserved and/or maintained.

3. Willamette Valley mapping units for which plant associations have not been developed; the vegetation types should be managed according to the following rules and ranges, after examining the results of temperature modeling. The proportion of hardwood stands and mixed conifer-hardwood stands have been derived from the 1850s GLO Survey vegetation database, Appendix 3. The proportions of forest, savanna, and prairie composition for each mapping unit are listed in **Table 3-1**.

   A. For Qalc, Qff1, and Qfc, which were historically forested mapping unit surfaces, the potential near-stream land cover is primarily mixed conifer hardwood forest.

   - For Qalc (Lower Willamette), DEQ will model forest cover at 80%, savanna 17%, and prairie 3%. For forestland cover, the portion of conifer is 4%, the portion of mixed hardwood-conifer is 93% and the portion of hardwoods is 3%. For savanna land cover, the portion of mixed hardwood-conifer is 80%, and the portion of hardwoods is 20% (Appendix 2).

   - For Qff1 (Lower Mainstem Willamette), DEQ will model forest cover at 81%, savanna 19% and no prairie. For forestland cover, the portion of conifer is 84%, the portion of mixed hardwood-conifer is 3%, and the portion of hardwoods is 13%. For savanna land cover, the portion of mixed hardwood-conifer is 60%, and the portion of hardwoods is 40%.

   - For Qfc (Lower Mainstem Willamette), DEQ will model forest at 56%, savanna 44% and no prairie. For forestland cover, the portion of conifer is 15%, and the portion of mixed hardwood-conifer is 85%. For savanna land cover, the portion of conifer is 93%, and the portion of hardwoods is 7%.

   B. The Qg1, Qau, Qalf, Qff2, Qbf, and Qg2 mapping units historically had primarily forest and savanna vegetation, but also had considerable prairie. For these units, DEQ will model forest, savanna and prairie similar to historic conditions and an increased tree cover based on knowledge of current vegetation and soil conditions.

   - For Qg1 (Mill Creek), DEQ will model forest cover at 41%, 44% savanna, and 15% prairie. For forestland cover, the portion of conifer is 8%, the portion of mixed hardwood-conifer is 59% and the portion of hardwoods is 33%. For savanna land cover, the portion of mixed hardwood-conifer is 50%, and the portion of hardwoods is 50%.

   - For Qau (Mohawk, upper Luckiamute, upper Oak, middle Thomas Creeks), DEQ will model forest cover at 60%, 23% savanna, and 17% prairie. For forestland cover, the portion of conifer is 29% and the portion of hardwoods is 71%. For savanna land cover, the portion of conifer is 5%, the portion of mixed hardwood-conifer is 17%, and the portion of hardwoods is 78%.

   - For Qalf (Pudding, Muddy Creek, Marys, Yamhill, South Fork Yamhill, Calapooia Rivers), DEQ will model forest at 52%, 28% savanna, and 20% prairie. For forestland cover, the portion of conifer is 4% and the portion of hardwoods is 96%. For savanna land cover, the portion of mixed hardwood-conifer is 22%, and the portion of hardwoods is 78%.

- For Qff2 (Berry, Ash and North Fork Ash Creeks, upper Muddy (east), upper Lake Creek), DEQ will model forest at 43%, 35% savanna, and 22% prairie. For forestland cover, the portion of conifer is 19%, the portion of mixed hardwood-conifer is 59% and the portion of hardwoods is 22%. For savanna land cover, the portion of conifer is 5%, the portion of mixed hardwood-conifer is 34%, and the portion of hardwoods is 61%.

- For Qbf (Long Tom, upper Amazon, upper Crabtree Creek), DEQ will model forest cover at 47%, 30% savanna, and 23% prairie. For forestland cover, the portion of conifer is 21%, the portion of mixed hardwood-conifer is 48% and the portion of hardwoods is 31%. For savanna land cover, the portion of mixed hardwood-conifer is 81%, and the portion of hardwoods is 19%.

C. For Qg2 (Amazon and Flat Creeks), which had 90% prairie vegetation along streams that historically became subsurface in the summer and for which water is currently artificially diverted to maintain summer flows, historic vegetation is probably not a good guideline for modeling potential present day stream temperature. Instead, DEQ will use nearest adjacent land potential land cover (see Upper Klamath TMDL for example).

D. For the upland mapping units, Tvc, QTg, Tvw, Tcr, and Tm, DEQ will model using USFS plant associations and the Plant Association Group Model, and incorporate a range of land cover using disturbance suggested by the GIS analysis.

- Where plant associations are not available, for Tvc (Rickreall Creek headwaters), DEQ will model forest at 60%, 39% savanna, and 1% prairie. For forestland cover, the portion of conifer is 21%, the portion of mixed hardwood-conifer is 79%. For savanna land cover, the portion of mixed hardwood-conifer is 26%, and the portion of hardwoods is 74%.

- For QTg (Small portions of upper Rickreall, Marys, Beaver Creek), DEQ will model forest cover at 77%, 14% savanna, and 9% prairie. For forestland cover, the portion of conifer is 95%, the portion of mixed hardwood-conifer is 4% and the portion of hardwoods is 1%. For savanna land cover, the portion of mixed hardwood-conifer is 90%, and the portion of hardwoods is 10%.

- For Tvw (Upper Thomas, upper Crabtree, and east headwaters Muddy Creeks), DEQ will model forest cover at 57%, 39% savanna, and 4% prairie. For forestland cover, the portion of conifer is 84%, the portion of mixed hardwood-conifer is 16%. For savanna land cover, the portion of mixed hardwood-conifer is 45%, and the portion of hardwoods is 55%.

- For Tcr (Upper Mill Creek), DEQ will model forest cover at 63%, 27% savanna, and 10% prairie. For forestland cover, the portion of conifer is 93 %, the portion of mixed hardwood-conifer is 7%. For savanna land cover, the portion of mixed hardwood-conifer is 77%, and the portion of hardwoods is 23%.

- For Tm (Upper Ash, North Fork Ash, and upper Berry Creeks), DEQ will model forest cover at 56%,39% savanna, and 5% prairie. For forestland cover, the portion of conifer is 40%, and the portion of mixed hardwood-conifer is 60%. For savanna land cover, the portion of mixed hardwood-conifer is 59%, and the portion of hardwoods is 41%.

6. Principles for Implementing Willamette Valley Potential Near-Stream Land Cover

The implementation of the modeling and analysis of potential land cover types, to meet temperature TMDL requirements, will be based on three principles. This analysis is not intended to provide a blanket prescription for near-stream vegetation, but rather to recommend appropriate management direction for the areas pertinent to each recommendation.

The first principle is to plant trees in places that previously had tree cover, as indicated by the analysis. Areas that were historically forested and are currently not forested are the highest priority for reforestation.

The second principle is that areas that were historically savanna or prairie, but are currently forested, do not offer further opportunities for increasing stream shade. Existing trees should be retained on these areas.

The third principle is that areas that historically had prairie vegetation, due to fire or to soil and moisture conditions, are the lowest priority for establishing of tree cover. The analysis indicates that landscape diversity in the Willamette Valley is important. Maintaining some open areas can be ecologically important; however, other public goals may lead to establishing trees in these open areas.

In general, areas where the greatest difference is observed between historic/potential land cover and current land cover are the areas that provide the greatest opportunity for establishing near-stream vegetation. These areas are DEQ's highest priority for improving stream temperature for aquatic life.

7. References

Allison, I. S. 1978. Late Pleistocene sediments and floods in the Willamette Valley: Portland, Oregon: Oregon Department of Geology and Mineral Industries, Ore Bin, v. 40, no. 12, p. 193-202.

Alverson, Edward. 1992. Wetland Type Map for West Eugene. Unpublished document prepared for Lane Council of Governments. Nature Conservancy.

Balster, C.A. and R.B. Parsons. 1968. Geomorphology and Soils Willamette Valley, Oregon. Special Report 265. Agricultural Experiment Station Oregon State University, Corvallis and Soil Conservation Service, United States Department of Agriculture

Boyd, Matthew, and Debra Sturdevant. 1997. The Scientific basis for Oregon's Stream Temperature Standard: Common Questions and Straight Answers. Oregon Department of Environmental Quality, Portland OR. 29 pp.

Brenner, P.A., and J.R. Sedell. 1997. Upper Willamette River landscape: a historical perspective. Pages 23-47, in A. Laenen and D.A. Dunnette (eds.), River quality: dynamics and restoration. CRC Press, Boca Raton, Florida.

Christy, J., E. Alverson, M. Dougherty, S. Kolar, L. Ashkenas, and P. Minear. 1998. Presettlement Vegetation for the Willamette Valley, Oregon, (map and species list compiled from records of the General Land Office Surveyors circa 1980). Oregon Natural Heritage Program, Portland, OR.

Christy, John, Edward R. Alverson, Molly P. Dougherty and Susan C. Kolar. 1997. Provisional Classification of "Presettlement" Vegetation in Oregon, As Recorded by General Land Office Surveyors. Oregon Natural Heritage Program, the Nature Conservancy of Oregon.

Cowardin L.M., V. Carter, F.C. Golet and E.T. La Rue. 1979. Classification of Wetlands and Deepwater Habitats of the United States FWS/OBS-79/31. US Fish and Wildlife Service.

Dykaar, B.B. and P.J. Wigington, Jr. 2000. Floodplain Formation and Cottonwood Colonization Patterns on the Willamette River, Oregon, USA. In. Environmental Management Vol. 25 (1): 87-104.

Fowells, H.A. Silvics of Forest Trees of the United States. 1965. USDA Forest Service. Agriculture Handbook No. 271. Washington, D.C.

Frenkel, R.E., S. N. Wickramaratne, and E.F. Heinitz. 1984. Vegetation and land cover change in the Willamette River greenway in Benton and Linn counties, Oregon: 1972-1981. Association of Pacific Coast Geographers 1984 Yearbook 46:63-77.

Gannett M.W., and Caldwell, R.C., 1998, Geologic framework of the Willamette lowland aquifer system, Oregon and Washington: U.S. Geological Survey Professional Paper 1424–A, 32 p.

Glenn, Jerry L., 1965. Late Quaternary sedimentation and geologic history of the North Willamette Valley, Oregon. Ph.D. Graduate Dissertation. Oregon State University. https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/dv13zw812

Gregory, Stanley, K., S. Kaufman, J.B., Hall, J., Dwire, K.A., Baxter, C. Brookshire, J. 2000. Scientists as citizens: Integrating ecological considerations with riverfront development. In : Wigington, P.J. and Beschta, R.L. (editors) International Conference on Riparian Ecology and Management in Multi-land Use Watersheds. American Water Resources Association.

Gutowsky, S. and J.A. Jones. 2000. Riparian Cover Changes Along the Upper Willamette River, 1939 to 1996. In: Wigington, P.J. and Beschta, R.L. (editors) International Conference on Riparian Ecology and Management in Multi-land Use Watersheds. American Water Resources Association.

Hampton, E.R., 1972, Geology and ground water of the Molalla-Salem slope area, norther Willamette Valley, Oregon: U.S. Geological Survey Water-Supply Paper 1997, 83 p.
Heritage Research Associates 1982. Historic use of six reservoir areas in the Upper Willamette Valley, Lane County, Oregon. Report prepared by US Army Corps of Engineers.

Hoerauf, E.A. 1970. Willamette River: riverlands and river boundaries. Water Resources Research Institute, Oregon State University, Corvallis, Oregon. Report number WRRI-1.

Johanessen, C.I., WA Davenport, Millet, McWilliams. 1971. The vegetation of the Willamette Valley. Association of American Geographers. 61:286-302.

Klock, C., S. Smith, T. O'Neil, R. Goggans, C., Barrett. 1998. Willamette Valley Land Use/ Land Cover Map Information Report and Map. Oregon Department Fish and Wildlife.

Knox, Margaret Ann. 2000. Ecological Change in the Willamette Valley at the time of Euro-American contact ca. 1800-1850. M.A. Thesis. University of Oregon.

Landers, D.H. P.K. Haggerty, S. Cline, W. Carson, and F. Faure. . 1999. The role of regionalization in large river restoration. Verh. International. Verein. Limnology, 27:1-8.

Logan, Sheila E., Hemstrom, Miles A., and Pavlat, Warren. 1987 Plant Association and Management Guide Willamette and Siuslaw National Forests. USDA Forest Service, Pacific NorthWest Region.

Madin, I.P. 1994, Geologic map of the Damascus quadrangle, Clackamas and Multnomah Counties, Oregon: Oregon Department of Geology and Mineral Industries Geological Map Series GMS–60, scale 1:24,000.

McAllister, L.S., Dwire, K.A., Griffith, S.M 2000. In: Wigington, P.J. and Beschta, R.L. (editors) International Conference on Riparian Ecology and Management in Multi-land Use Watersheds. American Water Resources Association.

O'Connor, Jim E., Sarna-Wojcicki, Andre, Wozniak, Karl C., Polette, Danial J. Fleck, Robert J. 2001. Origin , Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon. U.S. Geological Survey Professional Paper 1620. Denver, Co.

Pater, D.E., S. A. Bryce, T.D. Thorson, J.S. Kagan, C. Chappell, J.M. Omernik, S.H. Azevedo, and A.J. Woods. 1998. Ecoregions of Western Washington and Oregon. USGS/USEPA, Denver, Co

Taylor, Trevor. 1999. Long term vegetation response to fire of the Willamette Valley Wet prairie species. M.A. Thesis. University of Oregon.

Teensma, Peter D.A., Rienstra, John T., Yeiter, Mark A.. 1991. Preliminary Reconstruction and Analysis of Change in Forest Stand Age Classess of the Oregon Coast Range form 1850 to 1940. Technical Note. United States Department of the Interior.

Trimble, D.E., 1963, Geology of Portland, Oregon, and adjacent areas: U.S. Geological Survey Bulletin 1119, 119 p.

USDA Soil Conservation Service. 1975. Soils Survey of Benton County, Oregon

USDA Soil Conservation Service. 1987. Soils Survey of Lane County, Oregon

USDA Soil Conservation Service. 1977. Soils Survey of Linn County, Oregon

USDA Soil Conservation Service. 1987. Soils Survey of Yamhill Area, Oregon

USDA Soil Conservation Service. 1974. Soils Survey of Polk County

USGS. Oregon State Geology map

Walker, G.W., and MacLeod, N.S., 1991, Geologic map of Oregon: U.S. Geological Survey, scale 1:500,000.

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Appendix 2. Tree heights used for modeling coniferous forest, mixed forest (hardwood and conifer), hardwood forest, and prairie.

System Potential Vegetation for Willamette Valley Ecoregion. Savanna tree heights are the same as forest, except the density of the canopy cover is reduced.

Vegetation type	Height (ft)	Density (%)	Overhang (m)	Height (m)
Forest--Mature Coniferous	160	75%	4.9	48.8
Forest--Mature Mixed Conifer-Hardwood	90	75%	3.3	27.4
Forest--Mature Hardwood	67	75%	3.1	20.4
Savanna--Mature Coniferous	160	50%	4.9	48.8
Savanna--Mature Mixed Conifer-Hardwood	90	50%	3.3	27.4
Savanna--Mature Hardwood	67	50%	3.1	20.4
Prairie--Grassland	3	75%	0.0	0.9

System Potential Vegetation for upland forest mountainous area with USFS Plant Associations available (Logan et al., 1987). Range for forests with and without disturbance.

Vegetation type		Height (ft)	Density (%)	Overhang (m)	Height (m)
Disturbed	Forest Semi-closed mixed--25% probability	56	25%	2.0	17.1
No Disturbance	Forest--Mature Coniferous-75% probability	160	75%	4.9	48.8

Appendix 3. Mapping unit surface, 1850s vegetation type, and soil drainage acres

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Ash swamp and ash swale, sometimes with alder	Qalc	H			4	8	*12*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qalc	H				10	*10*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qalc	H				5	*5*	
Forest	Black cottonwood forest, sometimes with willow	Qalc	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qalc	H	10	109	13	31	*163*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qalc	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qalc	H					*0*	
Forest	Swamp, composition unknown	Qalc	H		5		5	*10*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qalc	H		7		27	*34*	234
Forest	Conifer-dominated woodland; various combinations of Douglas	Qalc	C		3	16		*19*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qalc	C		90	5	88	*183*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qalc	C	3	44	4	10	*61*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qalc	C		6			*6*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qalc	C		72	4	3	*79*	348
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qalc	M	9	453	62	164	*688*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qalc	M			3		*3*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qalc	M	392	4835	534	939	*6700*	7391
	Total Qalc Forest			**414**	**5624**	**645**	**1290**	***7973***	**7973**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qalc	H					*0*	
Savanna	White oak savanna	Qalc	H		123	53	52	*228*	
Savanna	White oak-ash savanna	Qalc	H					*0*	
Savanna	White oak-black oak savanna	Qalc	H					*0*	228
Savanna	Douglas fir savanna	Qalc	C		26	9		*35*	
Savanna	Douglas fir-ponderosa pine savanna	Qalc	C			17	6	*23*	
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qalc	C	5	35	25		*65*	
Savanna	Ponderosa pine savanna.	Qalc	C	29	19			*48*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qalc	C		10	3		*13*	184
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qalc	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qalc	M		64	22	60	*146*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qalc	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qalc	M	20				*20*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qalc	M		8	16	4	*28*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qalc	M		353	25	45	*423*	
Savanna	White oak-ponderosa pine savanna	Qalc	M	5	83	5		*93*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qalc	M		10			*10*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qalc	M					*0*	720
	Total Qalc Savanna			**59**	**731**	**175**	**167**	***1132***	**1132**
Prairie	Seasonally Wet prairie	Qalc	O				56	*56*	
Prairie	Upland prairie, xeric	Qalc	O	109	1043	128	5	*1285*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qalc	O	149	1023	53	489	*0*	
Prairie	Gravel bar	Qalc	O	4	42			*46*	
Prairie	Sand bar and sandy barrens	Qalc	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qalc	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qalc	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Qalc	O				6	*6*	
	Total Qalc Prairie			**262**	**2108**	**181**	**556**	***1393***	**10498**
Forest	Ash swamp and ash swale, sometimes with alder	Qalf	H				19	*19*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qalf	H			5	156	*161*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qalf	H	14		1492	715	*2221*	
Forest	Black cottonwood forest, sometimes with willow	Qalf	H			18	26	*44*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qalf	H			260	265	*525*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qalf	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qalf	H					*0*	
Forest	Swamp, composition unknown	Qalf	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qalf	H			7	19	*26*	2996
Forest	Conifer-dominated woodland; various combinations of Douglas	Qalf	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qalf	C		22	80	9	*111*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qalf	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qalf	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qalf	C					*0*	111
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qalf	M				5	*5*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qalf	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qalf	M					*0*	5
	Total Qalf Forest			**14**	**22**	**1862**	**1214**	***3112***	**3112**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qalf	H		3	19	5	*27*	
Savanna	White oak savanna	Qalf	H		115	227	264	*606*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	White oak-ash savanna	Qalf	H		53	94	113	*260*	
Savanna	White oak-black oak savanna	Qalf	H					*0*	893
Savanna	Douglas fir savanna	Qalf	C			6		*6*	
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qalf	C				4	*4*	
Savanna	Douglas fir-ponderosa pine savanna	Qalf	C					*0*	
Savanna	Ponderosa pine savanna.	Qalf	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qalf	C					*0*	10
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qalf	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qalf	M		19	66	12	*97*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qalf	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qalf	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qalf	M					*0*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qalf	M					*0*	
Savanna	White oak-ponderosa pine savanna	Qalf	M		68	45	37	*150*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qalf	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qalf	M					*0*	247
	Total Qalf Savanna			**0**	**258**	**457**	**435**	***1150***	**1150**
Prairie	Seasonally Wet prairie	Qalf	O				1099	*1099*	
Prairie	Upland prairie, xeric	Qalf	O		484	1134	65	*1683*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qalf	O		5	5		*10*	
Prairie	Gravel bar	Qalf	O					*0*	
Prairie	Sand bar and sandy barrens	Qalf	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qalf	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qalf	O		6	4	14	*24*	
Prairie	Fern openings, fern hills, or open fern land	Qalf	O					*0*	
	Total Qalf Prairie			**0**	**495**	**1143**	**1178**	***2816***	**7078**
Forest	Ash swamp and ash swale, sometimes with alder	Qau	H				13	*13*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qau	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qau	H	48	448	210	40	*746*	
Forest	Black cottonwood forest, sometimes with willow	Qau	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qau	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qau	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qau	H					*0*	
Forest	Swamp, composition unknown	Qau	H					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Willow swamp, sometimes with ninebark, including riparian	Qau	H				188	*188*	947
Forest	Conifer-dominated woodland; various combinations of Douglas	Qau	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qau	C	7	105	140	65	*317*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qau	C		9			*9*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qau	C		3			*3*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qau	C		52	4		*56*	385
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qau	M		5			*5*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qau	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qau	M					*0*	5
	Total Qau Forest			**55**	**622**	**354**	**306**	***1337***	**1337**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qau	H					*0*	
Savanna	White oak savanna	Qau	H	4	89	114	19	*226*	
Savanna	White oak-ash savanna	Qau	H					*0*	
Savanna	White oak-black oak savanna	Qau	H					*0*	226
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qau	C					*0*	
Savanna	Douglas fir savanna	Qau	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	Qau	C			13		*13*	
Savanna	Ponderosa pine savanna.	Qau	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qau	C					*0*	13
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qau	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qau	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qau	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qau	M	8				*8*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qau	M		13	8		*21*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qau	M				14	*14*	
Savanna	White oak-ponderosa pine savanna	Qau	M		6			*6*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qau	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qau	M					*0*	49
	Total Qau Savanna			**12**	**108**	**135**	**33**	***288***	**288**
Prairie	Seasonally Wet prairie	Qau	O				238	*238*	
Prairie	Upland prairie, xeric	Qau	O	17	213	239	90	*559*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qau	O					*0*	
Prairie	Gravel bar	Qau	O					*0*	
Prairie	Sand bar and sandy barrens	Qau	O					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qau	O				10	*10*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qau	O		4			*4*	
Prairie	Fern openings, fern hills, or open fern land	Qau	O					*0*	
	Total Qau Prairie			**17**	**217**	**239**	**338**	***811***	**2436**
Forest	Ash swamp and ash swale, sometimes with alder	Qbf	H			7	33	*40*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qbf	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qbf	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Qbf	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qbf	H	2	14	115	193	*324*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qbf	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qbf	H					*0*	
Forest	Swamp, composition unknown	Qbf	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qbf	H					*0*	364
Forest	Conifer-dominated woodland; various combinations of Douglas	Qbf	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qbf	C		221	14		*235*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qbf	C			15		*15*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qbf	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qbf	C					*0*	250
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qbf	M					*0*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qbf	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qbf	M	8	297	157	94	*556*	556
	Total Qbf Forest			**10**	**532**	**308**	**320**	***1170***	**1170**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qbf	H			4		*4*	
Savanna	White oak savanna	Qbf	H		24	45	16	*85*	
Savanna	White oak-ash savanna	Qbf	H					*0*	
Savanna	White oak-black oak savanna	Qbf	H					*0*	89
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qbf	C					*0*	
Savanna	Douglas fir savanna	Qbf	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	Qbf	C					*0*	
Savanna	Ponderosa pine savanna.	Qbf	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qbf	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qbf	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qbf	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qbf	M					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	White oak-black oak-ponderosa pine savanna	Qbf	M			29		*29*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qbf	M		161	49	43	*253*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qbf	M				18	*18*	
Savanna	White oak-ponderosa pine savanna	Qbf	M	4	59	27		*90*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qbf	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qbf	M					*0*	390
	Total Qbf Savanna			**4**	**244**	**154**	**77**	***479***	**479**
Prairie	Seasonally Wet prairie	Qbf	O				826	*826*	
Prairie	Upland prairie, xeric	Qbf	O	5	103	357	90	*555*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qbf	O					*0*	
Prairie	Gravel bar	Qbf	O					*0*	
Prairie	Sand bar and sandy barrens	Qbf	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qbf	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qbf	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Qbf	O					*0*	
	Total Qbf Prairie			**5**	**103**	**357**	**916**	***1381***	**3030**
Forest	Ash swamp and ash swale, sometimes with alder	Qfc	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qfc	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qfc	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Qfc	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qfc	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qfc	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qfc	H					*0*	
Forest	Swamp, composition unknown	Qfc	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qfc	H					*0*	0
Forest	Conifer-dominated woodland; various combinations of Douglas	Qfc	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qfc	C					*0*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qfc	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qfc	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qfc	C		3			*3*	3
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qfc	M		3	14		*17*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qfc	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qfc	M					*0*	17
	Total Qfc Forest			**0**	**6**	**14**	**0**	***20***	**20**

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qfc	H		11			*11*	
Savanna	White oak savanna	Qfc	H					*0*	
Savanna	White oak-ash savanna	Qfc	H					*0*	
Savanna	White oak-black oak savanna	Qfc	H					*0*	11
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qfc	C		39			*39*	
Savanna	Douglas fir savanna	Qfc	C			98		*98*	
Savanna	Douglas fir-ponderosa pine savanna	Qfc	C					*0*	
Savanna	Ponderosa pine savanna.	Qfc	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qfc	C					*0*	137
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qfc	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qfc	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qfc	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qfc	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qfc	M					*0*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qfc	M					*0*	
Savanna	White oak-ponderosa pine savanna	Qfc	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qfc	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qfc	M					*0*	0
	Total Qfc Savanna			**0**	**50**	**98**	**0**	***148***	**148**
Prairie	Seasonally Wet prairie	Qfc	O					*0*	
Prairie	Upland prairie, xeric	Qfc	O					*0*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qfc	O					*0*	
Prairie	Gravel bar	Qfc	O					*0*	
Prairie	Sand bar and sandy barrens	Qfc	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qfc	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qfc	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Qfc	O					*0*	
	Total Qfc Prairie			**0**	**0**	**0**	**0**	***0***	**168**
Forest	Ash swamp and ash swale, sometimes with alder	Qff1	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qff1	H			6	7	*13*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qff1	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Qff1	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qff1	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qff1	H					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qff1	H					*0*	
Forest	Swamp, composition unknown	Qff1	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qff1	H			8		*8*	21
Forest	Conifer-dominated woodland; various combinations of Douglas	Qff1	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qff1	C		16	49	7	*72*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qff1	C		36	16	5	*57*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qff1	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qff1	C					*0*	129
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qff1	M			4		*4*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qff1	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qff1	M					*0*	4
	Total Qff1 Forest			**0**	**52**	**83**	**19**	***154***	**154**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qff1	H			25	14	*39*	
Savanna	White oak savanna	Qff1	H					*0*	
Savanna	White oak-ash savanna	Qff1	H					*0*	
Savanna	White oak-black oak savanna	Qff1	H					*0*	39
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qff1	C					*0*	
Savanna	Douglas fir savanna	Qff1	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	Qff1	C					*0*	
Savanna	Ponderosa pine savanna.	Qff1	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qff1	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qff1	M		7			*7*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qff1	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qff1	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qff1	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qff1	M			51		*51*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qff1	M					*0*	
Savanna	White oak-ponderosa pine savanna	Qff1	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qff1	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qff1	M					*0*	58
	Total Qff1 Savanna			**0**	**7**	**76**	**14**	***97***	**97**
Prairie	Seasonally Wet prairie	Qff1	O					*0*	
Prairie	Upland prairie, xeric	Qff1	O					*0*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qff1	O					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Prairie	Gravel bar	Qff1	O					*0*	
Prairie	Sand bar and sandy barrens	Qff1	O					*0*	
Prairie	Marsh, composition unknown; includes "wet meadow"	Qff1	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qff1	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Qff1	O					*0*	
	Total Qff1 Prairie			**0**	**0**	**0**	**0**	***0***	**251**
Forest	Ash swamp and ash swale, sometimes with alder	Qff2	H			25	175	*200*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qff2	H				3	*3*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qff2	H			26	33	*59*	
Forest	Black cottonwood forest, sometimes with willow	Qff2	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qff2	H		26	118	159	*303*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qff2	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qff2	H					*0*	
Forest	Swamp, composition unknown	Qff2	H		6			*6*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qff2	H		8	26		*34*	605
Forest	Conifer-dominated woodland; various combinations of Douglas	Qff2	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qff2	C		50	390	72	*512*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qff2	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qff2	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qff2	C					*0*	512
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qff2	M			6		*6*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qff2	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qff2	M	3	419	780	404	*1606*	1612
	Total Qff2 Forest			**3**	**509**	**1371**	**846**	***2729***	**2729**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qff2	H		17	5	9	*31*	
Savanna	White oak savanna	Qff2	H		99	430	720	*1249*	
Savanna	White oak-ash savanna	Qff2	H		7	32	63	*102*	
Savanna	White oak-black oak savanna	Qff2	H					*0*	1382
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qff2	C		5	88	8	*101*	
Savanna	Douglas fir savanna	Qff2	C		8	84		*92*	
Savanna	Douglas fir-ponderosa pine savanna	Qff2	C			26		*26*	
Savanna	Ponderosa pine savanna.	Qff2	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qff2	C					*0*	118
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qff2	M					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qff2	M			543	121	*664*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qff2	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qff2	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qff2	M	7	7	32	13	*59*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qff2	M					*0*	
Savanna	White oak-ponderosa pine savanna	Qff2	M		6	16	16	*38*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qff2	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qff2	M					*0*	761
	Total Qff2 Savanna			**7**	**149**	**1256**	**950**	***2362***	**2261**
Prairie	Seasonally Wet prairie	Qff2	O		4		1391	*1395*	
Prairie	Upland prairie, xeric	Qff2	O		396	1544	625	*2565*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qff2	O		4	9	4	*17*	
Prairie	Gravel bar	Qff2	O					*0*	
Prairie	Sand bar and sandy barrens	Qff2	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qff2	O				41	*41*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qff2	O			18	13	*31*	
Prairie	Fern openings, fern hills, or open fern land	Qff2	O					*0*	
	Total Qff2 Prairie			**0**	**404**	**1571**	**2074**	***4049***	**9140**
Forest	Ash swamp and ash swale, sometimes with alder	Qg1	H				3	*3*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qg1	H			3	9	*12*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qg1	H				36	*36*	
Forest	Black cottonwood forest, sometimes with willow	Qg1	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qg1	H			8	6	*14*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qg1	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qg1	H					*0*	
Forest	Swamp, composition unknown	Qg1	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qg1	H				22	*22*	87
Forest	Conifer-dominated woodland; various combinations of Douglas	Qg1	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qg1	C		11			*11*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qg1	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qg1	C		10			*10*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qg1	C					*0*	21
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qg1	M		47		5	*52*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qg1	M					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qg1	M	5	51	36	8	*100*	152
	Total Qg1 Forest			**5**	**119**	**47**	**89**	***260***	**260**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qg1	H					*0*	
Savanna	White oak savanna	Qg1	H		105	43	97	*245*	
Savanna	White oak-ash savanna	Qg1	H		39	15	298	*352*	
Savanna	White oak-black oak savanna	Qg1	H					*0*	597
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qg1	C					*0*	
Savanna	Douglas fir savanna	Qg1	C			10		*10*	
Savanna	Douglas fir-ponderosa pine savanna	Qg1	C					*0*	
Savanna	Ponderosa pine savanna.	Qg1	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qg1	C					*0*	10
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qg1	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qg1	M		111		48	*159*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qg1	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qg1	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qg1	M		63	109	253	*425*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qg1	M			5		*5*	
Savanna	White oak-ponderosa pine savanna	Qg1	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qg1	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qg1	M					*0*	589
	Total Qg1 Savanna			**0**	**318**	**182**	**696**	***1196***	**1196**
Prairie	Seasonally Wet prairie	Qg1	O				131	*131*	
Prairie	Upland prairie, xeric	Qg1	O		161	240	89	*490*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qg1	O		25			*25*	
Prairie	Gravel bar	Qg1	O					*0*	
Prairie	Sand bar and sandy barrens	Qg1	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qg1	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qg1	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Qg1	O					*0*	
	Total Qg1 Prairie			**0**	**186**	**240**	**220**	***646***	**2102**
Forest	Ash swamp and ash swale, sometimes with alder	Qg2	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Qg2	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Qg2	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Qg2	H					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Qg2	H			14	11	*25*	
Forest	White oak forest, oak brush, or oak and hazel brush	Qg2	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Qg2	H					*0*	
Forest	Swamp, composition unknown	Qg2	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Qg2	H					*0*	25
Forest	Conifer-dominated woodland; various combinations of Douglas	Qg2	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Qg2	C					*0*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Qg2	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Qg2	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Qg2	C					*0*	0
Forest	Red alder-mixed conifer riparian forest; combinations of red	Qg2	M					*0*	
Forest	White oak-Douglas fir-ponderosa pine forest	Qg2	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Qg2	M		6	6	3	*15*	15
	Total Qg2 Forest			**0**	**6**	**20**	**14**	***40***	**40**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Qg2	H					*0*	
Savanna	White oak savanna	Qg2	H					*0*	
Savanna	White oak-ash savanna	Qg2	H					*0*	
Savanna	White oak-black oak savanna	Qg2	H					*0*	0
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Qg2	C					*0*	
Savanna	Douglas fir savanna	Qg2	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	Qg2	C					*0*	
Savanna	Ponderosa pine savanna.	Qg2	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Qg2	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Qg2	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Qg2	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Qg2	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Qg2	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Qg2	M					*0*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Qg2	M					*0*	
Savanna	White oak-ponderosa pine savanna	Qg2	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Qg2	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Qg2	M					*0*	0
	Total Qg2 Savanna			**0**	**0**	**0**	**0**	***0***	**0**
Prairie	Seasonally Wet prairie	Qg2	O				238	*238*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Prairie	Upland prairie, xeric	Qg2	O		20	103	85	*208*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Qg2	O					*0*	
Prairie	Gravel bar	Qg2	O					*0*	
Prairie	Sand bar and sandy barrens	Qg2	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Qg2	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Qg2	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Qg2	O					*0*	
	Total Qg2 Prairie			**0**	**20**	**103**	**323**	***446***	**486**
Forest	Ash swamp and ash swale, sometimes with alder	QTg	H				4	*4*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	QTg	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	QTg	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	QTg	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	QTg	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	QTg	H					*0*	
Forest	DEQ Wetland, composition unknown; includes "slough" & "swale" in	QTg	H					*0*	
Forest	Swamp, composition unknown	QTg	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	QTg	H					*0*	4
Forest	Conifer-dominated woodland; various combinations of Douglas	QTg	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	QTg	C		106	206	31	*343*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	QTg	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	QTg	C		4			*4*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	QTg	C		19			*19*	366
Forest	Red alder-mixed conifer riparian forest; combinations of red	QTg	M					*0*	
Forest	White oak-Douglas fir-ponderosa pine forest	QTg	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	QTg	M			17		*17*	17
	Total QTg Forest			**0**	**129**	**223**	**35**	***387***	**387**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	QTg	H					*0*	
Savanna	White oak savanna	QTg	H		27	6	5	*38*	
Savanna	White oak-ash savanna	QTg	H					*0*	
Savanna	White oak-black oak savanna	QTg	H					*0*	38
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	QTg	C					*0*	
Savanna	Douglas fir savanna	QTg	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	QTg	C					*0*	
Savanna	Ponderosa pine savanna.	QTg	C					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	FF, but burned, often with scattered trees surviving fire	QTg	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	QTg	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	QTg	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	QTg	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	QTg	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	QTg	M		4			*4*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	QTg	M					*0*	
Savanna	White oak-ponderosa pine savanna	QTg	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	QTg	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	QTg	M					*0*	4
	Total QTg Savanna			**0**	**31**	**6**	**5**	***42***	**42**
Prairie	Seasonally Wet prairie	QTg	O				34	*34*	
Prairie	Upland prairie, xeric	QTg	O		17	20	24	*61*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	QTg	O	3	4			*7*	
Prairie	Gravel bar	QTg	O					*0*	
Prairie	Sand bar and sandy barrens	QTg	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	QTg	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	QTg	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	QTg	O					*0*	
	Total QTg Prairie			**3**	**21**	**20**	**58**	***102***	**531**
Forest	Ash swamp and ash swale, sometimes with alder	QTt	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	QTt	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	QTt	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	QTt	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	QTt	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	QTt	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	QTt	H					*0*	
Forest	Swamp, composition unknown	QTt	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	QTt	H					*0*	0
Forest	Conifer-dominated woodland; various combinations of Douglas	QTt	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	QTt	C					*0*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	QTt	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	QTt	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	QTt	C					*0*	0

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Red alder-mixed conifer riparian forest; combinations of red	QTt	M					*0*	
Forest	White oak-Douglas fir-ponderosa pine forest	QTt	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	QTt	M		2			*2*	2
	Total QTt Forest			**0**	**2**	**0**	**0**	***2***	**2**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	QTt	H					*0*	
Savanna	White oak savanna	QTt	H					*0*	
Savanna	White oak-ash savanna	QTt	H					*0*	
Savanna	White oak-black oak savanna	QTt	H					*0*	0
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	QTt	C		5	3		*8*	
Savanna	Douglas fir savanna	QTt	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	QTt	C					*0*	
Savanna	Ponderosa pine savanna.	QTt	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	QTt	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	QTt	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	QTt	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	QTt	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	QTt	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	QTt	M					*0*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	QTt	M					*0*	
Savanna	White oak-ponderosa pine savanna	QTt	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	QTt	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	QTt	M					*0*	0
	Total QTt Savanna			**0**	**5**	**3**	**0**	***8***	**0**
Prairie	Seasonally Wet prairie	QTt	O					*0*	
Prairie	Upland prairie, xeric	QTt	O					*0*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	QTt	O					*0*	
Prairie	Gravel bar	QTt	O					*0*	
Prairie	Sand bar and sandy barrens	QTt	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	QTt	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	QTt	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	QTt	O					*0*	
	Total QTt Prairie			**0**	**0**	**0**	**0**	***0***	**10**
Forest	Ash swamp and ash swale, sometimes with alder	Tcr	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Tcr	H					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Tcr	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Tcr	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Tcr	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	Tcr	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Tcr	H					*0*	
Forest	Swamp, composition unknown	Tcr	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Tcr	H					*0*	0
Forest	Conifer-dominated woodland; various combinations of Douglas	Tcr	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Tcr	C		47	41	24	*112*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Tcr	C					*0*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Tcr	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Tcr	C					*0*	112
Forest	Red alder-mixed conifer riparian forest; combinations of red	Tcr	M					*0*	
Forest	White oak-Douglas fir-ponderosa pine forest	Tcr	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Tcr	M			9		*9*	9
	Total Tcr Forest			**0**	**47**	**50**	**24**	***121***	**121**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Tcr	H					*0*	
Savanna	White oak savanna	Tcr	H		120	81	25	*226*	
Savanna	White oak-ash savanna	Tcr	H					*0*	
Savanna	White oak-black oak savanna	Tcr	H					*0*	226
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Tcr	C		46	61	31	*138*	
Savanna	Douglas fir savanna	Tcr	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	Tcr	C					*0*	
Savanna	Ponderosa pine savanna.	Tcr	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Tcr	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Tcr	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Tcr	M		46	17	33	*96*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Tcr	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Tcr	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Tcr	M		322	185	5	*512*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Tcr	M					*0*	
Savanna	White oak-ponderosa pine savanna	Tcr	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Tcr	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Tcr	M					*0*	746

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
	Total Tcr Savanna			**0**	**534**	**344**	**94**	***972***	**972**
Prairie	Seasonally Wet prairie	Tcr	O				19	*19*	
Prairie	Upland prairie, xeric	Tcr	O		193	42	23	*258*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Tcr	O				22	*22*	
Prairie	Gravel bar	Tcr	O					*0*	
Prairie	Sand bar and sandy barrens	Tcr	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Tcr	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Tcr	O			3		*3*	
Prairie	Fern openings, fern hills, or open fern land	Tcr	O					*0*	
	Total Tcr Prairie			**0**	**193**	**45**	**45**	***302***	**1395**
Forest	Ash swamp and ash swale, sometimes with alder	Tm	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Tm	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Tm	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Tm	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Tm	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	Tm	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Tm	H					*0*	
Forest	Swamp, composition unknown	Tm	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Tm	H					*0*	0
Forest	Conifer-dominated woodland; various combinations of Douglas	Tm	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Tm	C					*0*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Tm	C		40			*40*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Tm	C			30		*30*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Tm	C					*0*	70
Forest	Red alder-mixed conifer riparian forest; combinations of red	Tm	M					*0*	
Forest	White oak-Douglas fir-ponderosa pine forest	Tm	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Tm	M		20	26	59	*105*	105
	Total Tm Forest			**0**	**60**	**56**	**59**	***175***	**175**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Tm	H					*0*	
Savanna	White oak savanna	Tm	H		27	120	60	*207*	
Savanna	White oak-ash savanna	Tm	H					*0*	
Savanna	White oak-black oak savanna	Tm	H					*0*	207
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Tm	C					*0*	
Savanna	Douglas fir savanna	Tm	C					*0*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	Douglas fir-ponderosa pine savanna	Tm	C					*0*	
Savanna	Ponderosa pine savanna.	Tm	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Tm	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Tm	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Tm	M		151	118	28	*297*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Tm	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Tm	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Tm	M		7			*7*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Tm	M					*0*	
Savanna	White oak-ponderosa pine savanna	Tm	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Tm	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Tm	M					*0*	304
	Total Tm Savanna			**0**	**185**	**238**	**88**	***511***	**511**
Prairie	Seasonally Wet prairie	Tm	O				9	*9*	
Prairie	Upland prairie, xeric	Tm	O		13	48	15	*76*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Tm	O					*0*	
Prairie	Gravel bar	Tm	O					*0*	
Prairie	Sand bar and sandy barrens	Tm	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Tm	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Tm	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Tm	O					*0*	
	Total Tm Prairie			**0**	**13**	**48**	**24**	***85***	**771**
Forest	Ash swamp and ash swale, sometimes with alder	Tvc	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Tvc	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Tvc	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Tvc	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Tvc	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	Tvc	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Tvc	H					*0*	
Forest	Swamp, composition unknown	Tvc	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Tvc	H					*0*	0
Forest	Conifer-dominated woodland; various combinations of Douglas	Tvc	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Tvc	C					*0*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Tvc	C		6			*6*	

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Tvc	C					*0*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Tvc	C					*0*	6
Forest	Red alder-mixed conifer riparian forest; combinations of red	Tvc	M					*0*	
Forest	White oak-Douglas fir-ponderosa pine forest	Tvc	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Tvc	M		20	3		*23*	23
	Total Tvc Forest			**0**	**26**	**3**	**0**	***29***	**29**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Tvc	H					*0*	
Savanna	White oak savanna	Tvc	H	5	27	35	10	*77*	
Savanna	White oak-ash savanna	Tvc	H					*0*	
Savanna	White oak-black oak savanna	Tvc	H					*0*	77
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Tvc	C					*0*	
Savanna	Douglas fir savanna	Tvc	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	Tvc	C					*0*	
Savanna	Ponderosa pine savanna.	Tvc	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Tvc	C					*0*	0
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Tvc	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Tvc	M		18	7	2	*27*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Tvc	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Tvc	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Tvc	M					*0*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Tvc	M					*0*	
Savanna	White oak-ponderosa pine savanna	Tvc	M					*0*	
Savanna	FFA, but burned, often with scattered trees surviving fire	Tvc	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Tvc	M					*0*	27
	Total Tvc Savanna			**5**	**45**	**42**	**12**	***104***	**104**
Prairie	Seasonally Wet prairie	Tvc	O					*0*	
Prairie	Upland prairie, xeric	Tvc	O		4			*4*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Tvc	O					*0*	
Prairie	Gravel bar	Tvc	O					*0*	
Prairie	Sand bar and sandy barrens	Tvc	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Tvc	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Tvc	O					*0*	
Prairie	Fern openings, fern hills, or open fern land	Tvc	O					*0*	
	Total Tvc Prairie			**0**	**4**	**0**	**0**	***4***	**137**

Vegetation Type	General Land Survey Vegetation Type	Geomor-phic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Forest	Ash swamp and ash swale, sometimes with alder	Tvw	H					*0*	
Forest	Ash-alder-willow swamp, sometimes with bigleaf maple	Tvw	H					*0*	
Forest	Ash-willow swamp, sometimes w/ ninebark & briars; "very thick"	Tvw	H					*0*	
Forest	Black cottonwood forest, sometimes with willow	Tvw	H					*0*	
Forest	White oak-ash riparian forest, sometimes with ponderosa pine,	Tvw	H					*0*	
Forest	White oak forest, oak brush, or oak and hazel brush	Tvw	H					*0*	
Forest	Wetland, composition unknown; includes "slough" & "swale" in	Tvw	H					*0*	
Forest	Swamp, composition unknown	Tvw	H					*0*	
Forest	Willow swamp, sometimes with ninebark, including riparian	Tvw	H					*0*	0
Forest	Conifer-dominated woodland; various combinations of Douglas	Tvw	C					*0*	
Forest	Douglas fir forest, often with bigleaf maple, grand fir,	Tvw	C	3	76	139	16	*234*	
Forest	Douglas fir-white oak (bigleaf maple) forest,	Tvw	C		20	4		*24*	
Forest	Low-elevation mix of (1) xeric Douglas fir-chinquapin-madrone	Tvw	C		11			*11*	
Forest	Mesic mixed conifer forest with mostly deciduous understory	Tvw	C		104	57		*161*	430
Forest	Red alder-mixed conifer riparian forest; combinations of red	Tvw	M		14	4		*18*	
Forest	White oak-Douglas fir-ponderosa pine forest	Tvw	M					*0*	
Forest	Ash-mixed deciduous riparian forest with combinations of red	Tvw	M	5	30	15	12	*62*	80
	Total Tvw Forest			**8**	**255**	**219**	**28**	***510***	**510**
Savanna	"Scattering" or "thinly timbered" white oak woodland, brushy	Tvw	H					*0*	
Savanna	White oak savanna	Tvw	H		31	96	87	*214*	
Savanna	White oak-ash savanna	Tvw	H					*0*	
Savanna	White oak-black oak savanna	Tvw	H					*0*	214
Savanna	Douglas fir woodland or "timber" often with bigleaf maple, alder	Tvw	C			3		*3*	
Savanna	Douglas fir savanna	Tvw	C					*0*	
Savanna	Douglas fir-ponderosa pine savanna	Tvw	C					*0*	
Savanna	Ponderosa pine savanna.	Tvw	C					*0*	
Savanna	FF, but burned, often with scattered trees surviving fire	Tvw	C					*0*	3
Savanna	"Scattering" or "thinly timbered" Douglas fir-white oak-ponderosa	Tvw	M					*0*	
Savanna	Scattering or thinly timbered Douglas fir-white oak woodland	Tvw	M					*0*	
Savanna	White oak-black oak-Douglas fir-ponderosa pine savanna	Tvw	M					*0*	
Savanna	White oak-black oak-ponderosa pine savanna	Tvw	M					*0*	
Savanna	White oak-Douglas fir savanna, mostly herbaceous undergrowth	Tvw	M		91	51		*142*	
Savanna	White oak-Douglas fir-ponderosa pine savanna	Tvw	M				26	*26*	
Savanna	White oak-ponderosa pine savanna	Tvw	M			5		*5*	

Vegetation Type	General Land Survey Vegetation Type	Geomorphic surface		Acres					
				Excessively drained	Well-drained	Mod.-Well drained	Poorly drained	Total Veg.	Hdwd, Con, Mix
Savanna	FFA, but burned, often with scattered trees surviving fire	Tvw	M					*0*	
Savanna	FFHC, but burned, often with scattered trees surviving fire	Tvw	M					*0*	173
	Total Tvw Savanna			**0**	**122**	**155**	**113**	***390***	**390**
Prairie	Seasonally Wet prairie	Tvw	O				33	*33*	
Prairie	Upland prairie, xeric	Tvw	O		86	75	13	*174*	
Prairie	Water bodies 1 or more chains across, including rivers, sloughs,	Tvw	O		7			*7*	
Prairie	Gravel bar	Tvw	O					*0*	
Prairie	Sand bar and sandy barrens	Tvw	O					*0*	
Prairie	Marsh, composition unknown; includes "Wet meadow"	Tvw	O					*0*	
Prairie	Brush, unknown; includes "thickets" if no species or other	Tvw	O		6			*6*	
Prairie	Fern openings, fern hills, or open fern land	Tvw	O					*0*	
	Total Tvw Prairie			**0**	**99**	**75**	**46**	***220***	**1120**

Appendix 4. Mapping Unit Surfaces identified in Origin, Extent, and Thickness of Quaternary Geologic Units in the Willamette Valley, Oregon. (O'Connor et al., 2001)

Qalc - Floodplain deposits of the Willamette River and major tributaries (Holocene and upper Pleistocene) - Unconsolidated silt, sand, and gravel of the Willamette River and major Cascade Range tributaries. Includes active channel and modern floodplain surfaces. Meander-scroll topography with surfaces as high as 15 m above summer water stage. Drillers' logs and exposures indicate that unit thickness ranges up to 15 m. Isotopic dating, tephrochronology, and stratigraphic relations within the Willamette Valley indicate that these deposits are mostly younger than 12 ka.

Qalf - Alluvium of smaller streams (Holocene and upper Pleistocene) - Unconsolidated clay, silt, sand, and minor gravel deposited in floodplains and active channels of smaller streams and rivers. Variable surface morphology. Thickness not defined, but probably less than 10 m. Differentiated from units Qbf and Qau where clearly younger than Missoula Flood deposits. Mostly younger than 12 ka.

Qg1 - Sand and Gravel that postdates Missoula Floods (upper Pleistocene) - Alluvial sand and gravel deposited in broad braidplains within Willamette Valley and traced upstream as alluvial fills in major Cascade Range tributary valleys. Forms surfaces of large fans where major Cascade Range tributaries enter the Willamette Valley. Deposits now preserved as planar to slightly undulating terraces 0 to 15 m above the modern floodplain. Drillers' logs and stratigraphic exposures indicate that unit is up to 30 m thick. Stratigraphic relations and isotopic dating indicate that deposits primarily date from about 12 ka, although some areas mapped as Qg1 in the Eugene-Springfield area within the Cascade Range foothills may be substantially older.

Missoula Flood deposits (upper Pleistocene) - Unconsolidated clay, silt, sand, and gravel deposited by floods originating in glacial Lake Missoula that flowed down the Columbia River and backflooded into the Willamette Valley (Glenn, 1965; Allison, 1978). Largest flows reached stages of about 120 m above sea level in the map area. Maximum thickness of deposits about 35 m in northern Willamette Valley, thins to less than 1 meter at elevations above about 100 m. Radiocarbon dating, tephrochronology, and straigraphic relations from within and outside the map area indicate that most units date from about 15 to 12.7 ka. Divided into the following three types:

> **Qff1 - Younger and lower fine-grained Missoula Flood deposits** - Clay, silt, sand, and minor gravel forming benches along Labish channel and Pudding River, and locally flanking Willamette River in northern Willamette Valley. Planar to undulating surface almost everywhere 40-50 m above sea level. Set into main-body fine facies (Qff2). Probably mostly deposited by latest Pleistocene Missoula Floods between 13.5 and 12.7 ka, but possibly includes late Pleistocene and early Holocene deposits of units Qalf and Qalc.
>
> **Qff2 - Main body of fine-grained Missoula Flood deposits -** Stratified silt and clay with minor sand. Underlies much of Willamette Valley lowland floor. Many sections show rhythmic bedding, with up to 40 individual beds between 0.1 and 1.0 meter thick. Encloses sparse pebbles to boulders of types exotic to Willamette Basin. Forms undulating to planar topography in lowlands; mantles foothills below altitudes of 120 m. Mapped where thickness is sufficient to obscure previous topography. Commonly capped by up to two meters of late Pleistocene and Holocene alluvium, colluvium, and loess.
>
> **Qfc - Coarse Missoula Flood deposits** - Bouldery, cobbly, sandy gravel fans deposited by Missoula Floods as they spilled into northern Willamette Valley through the Oregon City and Rock Creek gaps. Crudely stratified commonly with south-dipping foresets. Commonly capped by several meters of sandy silt, especially south of Willamette River. Drillers' logs indicate that thickness locally exceeds 30 m.

Qg2 - Sand and gravel that predates Missoula Floods (Pleistocene) - Unconsolidated to semiconsolidated sand and gravel deposited in broad braidplains and meandering floodplain environments within Willamette Valley and upstream as alluvial fills along major Cascade Range tributaries. Locally contains lahar deposits. Forms planar to slightly undulating terrace surfaces 0 m to 20 m above the modern floodplain and generally at slightly higher elevations than adjacent surfaces of unit Qg1. Thickness not systematically determined but locally exceeds 100 m in broad fans formed where major Cascade Range tributaries enter the Willamette lowlands. Isotopic dating and tephrochronology indicate these deposits range from greater than 0.41 Ma to about 22 ka.

Qau - Alluvium, Undifferentiated (Holocene and Pleistocene) - Sand, silt, clay, and minor gravel deposited by smaller streams and rivers that enter the Willamette Valley, and by larger streams and rivers outside the area of detailed mapping. Age and thickness not determined.

Qbf - Fine-grained alluvium (Holocene and Pleistocene) - Clay, silt, sand, and minor gravel deposited in small basins flanking the Willamette Valley. Planar surfaces. Age and thickness not determined. Distinction with unit Qau locally arbitrary.

Qls - Landslide deposits and colluvium (Holocene and Pleistocene) - Unconsolidated and heterogeneous mixtures of rock fragments and soil. Some landslide deposits have hummocky surfaces. Colluvium mapped on steep debris-mantled slopes where underlying bedrock is not known. Only larger deposits mapped, mostly after Walker and McLeod (1991). Age and thickness not defined.

QTg - Weathered terrace gravel (Pleistocene and Pliocene?) - Alluvial sand and gravel preserved as terraces flanking Willamette Valley and tributary valleys. Terrace surfaces planar to undulating, with thick, strongly-developed soils, and severely weathered clasts. Terrace surfaces up to 100 m above modern floodplains. Drillers' logs and stratigraphic exposures indicate sand and gravel 0 to 60 m thick. May be in part equivalent to Troutdale Formation (QTt) as mapped near Molalla. Probably mostly deposited between 2.5 and 0.5 Ma.

UPLAND UNITS (primarily compiled from previous sources.)

QTb - Boring Lava (Pleistocene and Pliocene) - Gray to light-gray, open-textured olivine basalt lava flows. Only mapped in the northern part of map area after Hampton (1973). Up to 60 m thick. Ten radiometric ages on separate flows near Oregon City span 0.427+/-0.026 Ma to 3.15 +/-0.062 Ma (Madin, 1994).

QTt - Troutdale Formation (Pleistocene? And Pliocene) - Sand, gravel, sandstone, conglomerate, siltstone, and mudstone. Only mapped in northern part of map area after Trimble (1963) and Hampton (1972) where it is up to 150 m thick. May be locally equivalent to the weathered terrace gravel (QTg) near Molalla. Overlain by Boring Lava near Oregon City.

Tvw - Volcanic and volcaniclastic rocks in the Western Cascade Range, undivided (upper Eocene to Pliocene) - Lava flows, tuff, breccia, and volcaniclastic sediment of variable composition. Locally interfingers with marine sedimentary rocks (Tm) in the southern portion of map area. Includes the Fisher Formation, "volcanic rocks of the Western Cascade Range", and Sardine Formation as compiled by Gannett and Caldwell (1998). Youngest rocks are ridge-capping basalt flows in Santiam River drainage with reported ages as young as 2.8 +/- 0.3 Ma (Verplanck, 1985, cited in Walker and Duncan, 1989).

Tcr - Columbia River Basalt Group (Miocene) - Lava flows of dark gray to black, locally porphyritic basalt. Locally deeply weathered. Mostly between 16 and 15 Main northern Willamette Valley (M.H. Beeson, Portland State University, written communication, 1998). Also includes small areas of alluvium, colluvium, loess, and landslide debris. Distribution after Gannett and Caldwell (1998).

Tm - Marine sedimentary rocks (lower Miocene to Eocene) - Marine sandstone, siltstone, shale, and claystone,with lesser conglomerate; locally tuffaceous. Also includes numerous small mafic intrusions, and small areas of alluvium, colluvium, loess, and landslide debris. Distribution after Gannett and Caldwell (1998).

Tvc - Volcanic rocks of the Coast Range (Eocene) - Basaltic pillow lava, tuff breccia, subaerial basalt lava flows, and sills, with interbeds of basaltic sandstone, siltstone, and conglomerate. Includes small areas of alluvium, colluvium, loess, and landslide debris. Distribution after Gannett and Caldwell (1998).

Note: "Am" refers to millions of years before present, and in this report is used to indicate radiometric and fission track ages on volcanic rocks. "ka" refers to kiloannum, indicating thousands of radiocarbon years before present.

Appendix 5. Mapping Unit Potential Near-Stream Land Cover Quantitative Look-up Table for the Temperature Model Input

Code	Source	Description	Height (m)	Density (%)	OH (m)
3011	DEQ	Water	0.0	0%	0.0
101	DEQ	Qff1 Forest	44.5	75%	5.3
102	DEQ	Qff1 Savanna	24.6	50%	3.0
103	DEQ	Qff1 Prairie	0.9	75%	0.0
111	DEQ	Qff1 Forest	44.5	75%	5.3
112	DEQ	Qff1 Savanna	24.6	50%	3.0
113	DEQ	Qff1 Prairie	0.9	75%	0.0
201	DEQ	Qfc Forest	30.6	75%	3.7
202	DEQ	Qfc Savanna	46.8	50%	5.6
203	DEQ	Qfc Prairie	0.9	75%	0.0
211	DEQ	Qfc Forest	30.6	75%	3.7
212	DEQ	Qfc Savanna	46.8	50%	5.6
213	DEQ	Qfc Prairie	0.9	75%	0.0
301	DEQ	Qalc Forest	28.0	75%	3.4
302	DEQ	Qalc Savanna	26.0	50%	3.1
303	DEQ	Qalc Prairie	0.9	75%	0.0
311	DEQ	Qalc Forest	28.0	75%	3.4
312	DEQ	Qalc Savanna	26.0	50%	3.1
313	DEQ	Qalc Prairie	0.9	75%	0.0
401	DEQ	Qg1 Forest	26.8	75%	3.2
402	DEQ	Qg1 Savanna	23.9	50%	2.9
403	DEQ	Qg1 Prairie	0.9	75%	0.0
411	DEQ	Qg1 Forest	26.8	75%	3.2
412	DEQ	Qg1 Savanna	23.9	50%	2.9
413	DEQ	Qg1 Prairie	0.9	75%	0.0
501	DEQ	Qau Forest	28.6	75%	3.4
502	DEQ	Qau Savanna	23.0	50%	2.8
503	DEQ	Qau Prairie	0.9	75%	0.0
511	DEQ	Qau Forest	28.6	75%	3.4
512	DEQ	Qau Savanna	23.0	50%	2.8
513	DEQ	Qau Prairie	0.9	75%	0.0
601	DEQ	Qalf Forest	21.5	75%	2.6
602	DEQ	Qalf Savanna	21.9	50%	2.6
603	DEQ	Qalf Prairie	0.9	75%	0.0
611	DEQ	Qalf Forest	21.5	75%	2.6
612	DEQ	Qalf Savanna	21.9	50%	2.6
613	DEQ	Qalf Prairie	0.9	75%	0.0
701	DEQ	Qff2 Forest	29.9	75%	3.6
702	DEQ	Qff2 Savanna	24.2	50%	2.9
703	DEQ	Qff2 Prairie	0.9	75%	0.0
711	DEQ	Qff2 Forest	29.9	75%	3.6
712	DEQ	Qff2 Savanna	24.2	50%	2.9
713	DEQ	Qff2 Prairie	0.9	75%	0.0
801	DEQ	Qbf Forest	29.7	75%	3.6
802	DEQ	Qbf Savanna	26.1	50%	3.1
803	DEQ	Qbf Prairie	0.9	75%	0.0
811	DEQ	Qbf Forest	29.7	75%	3.6
812	DEQ	Qbf Savanna	26.1	50%	3.1
813	DEQ	Qbf Prairie	0.9	75%	0.0

Code	Source	Description	Height (m)	Density (%)	OH (m)
1001	DEQ	Tvc Forest	31.9	75%	3.8
1002	DEQ	Tvc Savanna	22.2	50%	2.7
1003	DEQ	Tvc Prairie	0.9	75%	0.0
1011	DEQ	Tvc Forest	31.9	75%	3.8
1012	DEQ	Tvc Savanna	22.2	50%	2.7
1013	DEQ	Tvc Prairie	0.9	75%	0.0
1101	DEQ	Qtg Forest	47.7	75%	5.7
1102	DEQ	Qtg Savanna	26.7	50%	3.2
1103	DEQ	Qtg Prairie	0.9	75%	0.0
1111	DEQ	Qtg Forest	47.7	75%	5.7
1112	DEQ	Qtg Savanna	26.7	50%	3.2
1113	DEQ	Qtg Prairie	0.9	75%	0.0
1201	DEQ	Tvw Forest	45.4	75%	5.4
1202	DEQ	Tvw Savanna	23.6	50%	2.8
1203	DEQ	Tvw Prairie	0.9	75%	0.0
1211	DEQ	Tvw Forest	45.4	75%	5.4
1212	DEQ	Tvw Savanna	23.6	50%	2.8
1213	DEQ	Tvw Prairie	0.9	75%	0.0
1301	DEQ	Tcr Forest	47.3	75%	5.7
1302	DEQ	Tcr Savanna	25.8	50%	3.1
1303	DEQ	Tcr Prairie	0.9	75%	0.0
1311	DEQ	Tcr Forest	47.3	75%	5.7
1312	DEQ	Tcr Savanna	25.8	50%	3.1
1313	DEQ	Tcr Prairie	0.9	75%	0.0
1401	DEQ	Tm Forest	36.0	75%	4.3
1402	DEQ	Tm Savanna	24.5	50%	2.9
1403	DEQ	Tm Prairie	0.9	75%	0.0
1411	DEQ	Tm Forest	36.0	75%	4.3
1412	DEQ	Tm Savanna	24.5	50%	2.9
1413	DEQ	Tm Prairie	0.9	75%	0.0
1925	DEQ / USFS	Disturbed: Forest Mature Conifer	17.1	25%	1.7
1950	DEQ / USFS	lot Disturbed: Forest Mature Conife	48.8	75%	4.9
1511	DEQ	Qtt Forest	36.0	75%	4.3
1512	DEQ	Qtt Savanna	27.4	50%	2.9
1513	DEQ	Qtt Prairie	0.9	75%	0.0
2011	DEQ	Ow Forest	0.0	75%	4.3
2012	DEQ	Ow Savanna	20.4	50%	2.9
2013	DEQ	Ow Prairie	0.9	75%	0.0
2111	DEQ	Qtb Forest	40.2	75%	4.3
2112	DEQ	Qtb Savanna	33.3	50%	2.9
2113	DEQ	Qtb Prairie	0.9	75%	0.0
2211	DEQ	Qls Forest	48.8	75%	4.3
2212	DEQ	Qls Savanna	37.0	50%	2.9
2213	DEQ	Qls Prairie	0.9	75%	0.0