Appendix B: Detailed Methods

The main text of this report, "Groundwater-Dependent Biodiversity and Associated Threats: A Statewide Screening Methodology and Spatial Assessment of Oregon," is available online at http://conserveonline.org.

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I. OVERVIEW OF APPROACH:

To complete this assessment of groundwater-dependent ecosystems and their threats, we identified and mapped: i) groundwater-dependent ecosystems and species (termed GDEs) and ii) threats to GDEs due to changes in groundwater quantity and quality. The methods we used to complete these two steps are discussed in detail in this section. Appendix C contains tables of the data we incorporated into these analyses and is referenced below where relevant.

To manage the information and summarize the results at an appropriate scale, we divided the state into regional analysis units, which are based on the administrative basins of Oregon Water Resource Department. This included 14 regions (Atlas Map 1) that had similar biota and groundwater processes due to the relative homogeneity of hydrogeologic, ecological, and climatic conditions. We then further subdivided each region and summarized the findings by watershed, using the sixth level Hydrologic Units of the USGS (referred to as HUC6; BLM and USFS, 2006; Atlas Map 2) as the watershed boundaries (mean size = 8055 ha or 19905 acres). So in the end, we evaluated each HUC6 for the presence of GDEs and activities that threaten groundwater quality and quantity; our analysis was conducted at the HUC6 scale, rather than on the exact locations of the GDEs and land use activities. Data were analyzed using a Geographic Information System (GIS; ArcGIS v. 9.2).

II. MAPPING GROUNDWATER-DEPENDENT ECOSYSTEMS AND SPECIES:

Five ecosystem types have the potential to be dependent upon groundwater (Eamus and Froend, 2006): springs, wetlands, rivers, lakes, and subterranean areas. Excluding subterranean areas, we developed digital datalayers locating these ecosystems and then conducted analyses to identify those that are likely to depend upon groundwater due to their hydrogeologic setting. We also identified species and ecological communities of conservation concern that rely on habitat conditions maintained by groundwater.

Below, we present i) the datasets used to map the ecosystems or species and ii) the analyses that we conducted to determine groundwater dependence. In addition, if there are other approaches that we identified as potentially useful, these are discussed in gray boxes.

A. SPRINGS:

1. Data sources:

- 1:24,000 Pacific Northwest Hydrography Framework water points (PNWHF, 2005)
- USGS Geographic Names Information System (GNIS) (USGS, 1996)
- Idaho EPSCoR Alvord Desert data (2006)

2. Mapping springs:

Even though we used three sets of data to locate springs in Oregon, our final map is still probably incomplete. Our final map contains those USGS GNIS points for which the field DESIG was 'spring'; those Pacific Northwest Hydrography Framework water points for which the WP_HYDR_FTR_CD field was 'SP' for spring or seep; and hot springs identified by the University of Idaho's mapping of Alvord Desert springs. Two springs were added in the Umpqua Region by Jeff Dose of the U.S. Forest Service.

3. Determining potential groundwater dependence:

All springs were assumed to be groundwater dependent.

B. WETLANDS:

To date neither a comprehensive map of wetlands nor a map of groundwater-dependent wetlands exists for Oregon. As a result, we first developed as complete a map as possible of wetland locations and then analyzed those for potential groundwater dependence.

1. Data used:

- Palustrine wetlands: National Wetland Inventory (USFWS, 2007)
- Hydric and organic soils: SSURGO soil survey datasets (USDA NRCS, 2006a)
- Pacific Northwest Hydrography Framework water bodies data (PNWHF, 2005)
- Ecological systems identified from remote sensing (TNC eds., 2007)
- Wetland communities identified during ecoregional assessments (Vander Schaaf et al., 2004; Floberg et al., 2004)
- Rare species and community data tracked by NatureServe and Oregon Natural Heritage Information Center (TNC and NatureServe, 2007)
- Fen locations (TNC Preserve locations and expert input)
- Spring locations: GNIS (USGS, 1996); Pacific Northwest Hydrography Framework water points (PNWHF, 2005); Idaho EPSCoR Alvord Desert data (2006)

2. Mapping wetlands:

We used seven data layers to develop a more comprehensive map of wetlands in Oregon; however, the final result is still far from complete.

a. National Wetland Inventory (NWI): This is a national program, led by the U.S. Fish and Wildlife Service, to map existing wetlands across the United States based on aerial photos (USFWS, 2007). We also used a pre–quality-control version of updates made by the Oregon Watershed Enhancement Board (OWEB) in 2006 that was not yet part of the statewide database (USFWS, 2007). Digital information was available for approximately half of Oregon (Atlas Map 6). We began by assuming that both riparian and lacustrine wetlands in the NWI datalayer (those with an R or L at the beginning of the wetland code) were groundwater dependent if their associated river and lake

ecosystems relied on groundwater; as a result, these are not included in our final maps or analyses. Estuarine wetlands in the NWI datalayer (those starting with an E at the beginning of the wetland code) were also removed from the analysis. As a result, in our analysis we used only palustrine wetlands from NWI - those wetlands with a P as the first letter of the wetland code.

b. County soil surveys (SSURGO): This is also a national program to map soils in areas potentially suitable for agricultural activities (USDA NRCS, 2006a). Areas with 20% or more hydric soils in the map unit were assumed to be existing or historic wetland. These data are available digitally for about two-thirds of Oregon (Atlas Map 6).

c. Pacific Northwest Hydrography Framework water bodies data: We used polygons for which the field WB_HYDR_FTR_CD was 'WT' (for wet areas).

d. Remote sensing data: The Nature Conservancy recently produced a data layer of ecosystems across Oregon, based on an analysis of Landsat imagery (TNC eds., 2007). From the 35 total wetland ecosystems in this dataset, we excluded all riparian and estuarine wetlands. We used the remaining 21 ecosystems as wetland locations in our analysis (Appendix C, Table C-2). We assumed all riparian wetlands in the remote sensing data layers (see Appendix C, Table C-2) are groundwater dependent if the river they are associated with is groundwater dependent, but did not include them in our maps or analyses.

e. Ecoregional assessment data: The Nature Conservancy conducted ecoregional assessments across the state of Oregon; we evaluated the targets used in these plans for rare wetland communities and included those identified in the Klamath and Willamette Valley-Puget Trough-Georgia Basin ecoregions (Vander Schaaf et al., 2004; Floberg et al., 2004; Appendix C, Table C-3).

f. Rare species and community data: The Oregon Natural Heritage Information Center and NatureServe track the location of rare species and communities in Oregon (TNC and NatureServe, 2007). Of the data available from these sources, we used those communities known to be associated with wetlands as additional indicators of wetland locations (Appendix C, Table C-4).

g. Known fen locations: Five fen locations were added to the wetlands map: Gearhart fen, Sharon Lake fen, Eight Dollar Mountain fen, Fanno Meadows, and Camp Polk Fens.

3. Determining potential groundwater dependence:

Because fens and spring ecosystems are by definition obligately groundwater dependent, we located fens using those wetlands classified as obligately

groundwater dependent in the remote sensing, ecoregional assessment, and rare community data layers, as well as known fens (Appendix C, Tables C-2, C-3 and C-4).

The groundwater dependence of the remaining wetlands was identified using the following analyses:

a. Presence of organic soils: In much of Oregon, organic soils tend to form in locations of groundwater discharge. Wetlands in which soils contain a component that is classified as Order Histosol or the subgroup histic on the SSURGO county soil survey database (USDA NRCS, 2006a) were classified as groundwater dependent.
b. Proximity to springs: Wetlands associated with spring locations (those within 100 meters of a mapped spring) were assumed to be groundwater dependent.

Other Approaches:
Identification wetlands on slopes or at breaks in slopes: Wetlands that form on slopes or where steep slopes intersect relatively flat slopes (termed 'break in slope') are often groundwater dependent as these are often locations of groundwater discharge to the surface (Brown et al., 2007). It may be possible to use 10m DEMs to identify locations of wetlands that are adjacent to much steeper slopes. We experimented with 30 m DEMs, but the computing power needed was beyond our capabilities for a statewide perspective. We experimented with 30 m and 90 m DEMs to assess wetlands that occur on slopes, but found that this scale of information was too coarse for our purposes.

C. RIVERS:

1. Data used:

- 1:100,000 NHDPlus streams (USGS, 2006)
- 1:500,000 surficial geology (Miller et al., 2002)
- USGS stream gaging data in the National Water Information System (USGS, 2007)

2. Mapping rivers:

We included all perennial rivers from the NHD Plus database in our analysis.

3. Determining potential groundwater dependence:

In certain hydrogeologic settings, groundwater can maintain the hydrologic regime of rivers and streams and their associated riparian ecosystems; in particular, the base flow component of the hydrograph is generally a result of groundwater inputs to rivers. We used two sets of data to identify the likelihood that groundwater was

important to rivers across Oregon: an assessment of the permeability of surficial geologic deposits and an analysis of flow data from gaging stations.

a. Permeability of surficial geologic deposits: The vertical and horizontal permeability of geologic deposits in the watershed play a major role in determining the importance of groundwater to the hydrologic regime of a river (Wolock et al., 2004; Higgins et al., 2005). Generally, in a watershed dominated by more permeable surficial geologic deposits, precipitation and snowmelt will infiltrate downwards, recharging the groundwater that supplies streams and rivers. Using a 1:500,000 surficial geology datalayer of Oregon (Miller et al., 2002), relative permeability ratings were assigned to each geologic deposit by Wendy Gerstel, geologist (Appendix C, Table C-1).

b. Flow gaging data: We downloaded all stream gage data for both active and inactive gages in Oregon from the USGS National Water Information System (USGS, 2007). Hydrologic experts evaluated data from those gages with at least two years of record, excluding those rivers that are affected by dams or diversions or dominated by glacial snowmelt. Of these, rivers with mean monthly low flows more than 15 percent of the mean monthly flows were identified as receiving significant groundwater inputs.

We then used these two sets of data to identify as containing groundwater-dependent rivers those HUC6s that fully contained perennial reaches (USGS, 2006) and:

- are composed of ≥ 70% more-permeable geologic deposits; OR
- contribute to the USGS gaging stations at which the flow data analysis indicated significant groundwater contributions; OR
- are composed of 50–69% permeable geologic deposits, if those deposits either intersected most of the perennial streams or form large valleys through which the perennial rivers flow.

Another approach would be to follow these same rules but to identify HUCs that intersected perennial reaches (USGS, 2006). We tried this approach but found that, particularly along the coast where HUCs do not truly follow watershed boundaries, one perennial stream caused fairly large HUCs, dominated by ephemeral streams, to be selected. However, our approach (identifying HUCs that fully contain perennial reaches) caused HUCs in some lower sections of rivers in the Deschutes and Klamath to be excluded from the final maps.

Other Approaches:
Base flow indices: The USGS has developed Base Flow Indices (BFI) for watersheds across the entire nation (Wolock, 2003). BFIs range from 0 to 1.0 and are the ratio of base flow to total flow in a river. Base flow is presumed to represent the relative importance of groundwater to a river system; for instance, a base flow of .45 indicates that about 45% of the flow in a river is from groundwater. As these data already exist across the nation, they can readily serve as a first cut of where groundwater-dependent rivers may exist. Using these data requires setting a BFI threshold above which the rivers in a watershed are determined to be groundwater dependent; it appears that one might be able to use the gaging data analysis to help establish that threshold.

Drainage density: To identify rivers dependent on groundwater, it is possible to use drainage density, defined as stream miles per area of watershed. Several studies suggest that in watersheds dominated by subsurface water movement the drainage density is lower than in watersheds dominated by surface runoff (Tague and Grant, 2004; O'Connor et al., 2003). We tried conducting this analysis using two hydrography data layers for Oregon, but our results varied depending upon the amount of detail in the digital stream network data layer rather than the actual differences in stream density across the state. In the future, stream density calculated using a synthetic stream network developed from topographic data could be used as an initial assessment of groundwater-dependent rivers.

D. LAKES:

1. Data used:

- 1:24,000 Pacific Northwest Hydrography Framework water bodies (PNWHF, 2005)

2. Mapping lakes:

Based on the Cowardin classification of wetlands (Cowardin et al., 1978), which classifies water bodies greater than 8.1 ha (20 acres) and more than 2 m deep as lacustrine, we included all permanent water bodies more than 20 acres in size that are not reservoirs in the lakes assessment.

3. Determining potential groundwater dependence:

Most lakes in the Pacific Northwest probably receive groundwater inputs. Even small inputs of groundwater can be ecologically important (Sebeysten and Schneider, 2004; Rosenberry et al., 2000), so we assumed that all natural, perennial lakes in Oregon are groundwater dependent.

E. SUBTERRANEAN AREAS:

We did not include subterranean areas in our analysis. It was difficult to obtain good data on the locations of these ecosystems and experts suggested that caves alone are not a good indicator of those ecosystems that depend upon groundwater.

F. SPECIES AND ECOLOGICAL COMMUNITIES OF CONSERVATION CONCERN:

1. Data sources:

- Rare and/or declining species and communities from The Nature Conservancy's ecoregional assessments (Popper et al., 2007; Andelman et al., 1999; Vander Schaaf et al., 2004; Vander Schaaf et al., 2006; Klahr et al., 2000)
- Rare species and community occurrences compiled by The Nature Conservancy of Oregon, with contributions from NatureServe and their member programs and partners, and tracked by Oregon Natural Heritage Information Center (TNC and NatureServe, 2007)
- Expert opinion

2. Mapping species and communities of conservation concern:

As we were not able to map occurrences of all species on these lists, we only included those we could map based on existing datasets (TNC and NatureServe, 2007).

3. Determining groundwater dependence:

We classified the groundwater dependence of all species on the lists of conservation concern from The Nature Conservancy's ecoregional assessments, regardless of whether we could map their locations; these lists included nearly 1650 species and nearly 70 communities. Of these, 1230 species and 66 communities were mappable using GIS datasets. We evaluated groundwater dependence based on habitat requirements indicated in on-line databases (e.g. NatureServe Explorer and Flora of North America) or in published and gray literature. Details for each taxonomic group are provided below and the corresponding data tables in Appendix C include all relevant species, not just those with location information:

a. Vascular plants:

To determine the groundwater dependence of vascular plants, we first assessed the dependence of each species on wetlands, using the Wetland Indicator Status of each plant as assigned by the USFWS. Those species with a wetland indicator of FACW or OBL were identified as being wetland dependent.[1] Information on the Wetland Indicator Status of each species was obtained from the USDA PLANTS Database (USDA NRCS, 2008) Additionally, we assessed the fidelity of species to wet prairie ecosystems of the Willamette Valley-Puget Trough. Using

[1] Wetland indicators of UPL through FAC were indicative of non-wetland dependent species; FACW and OBL wetland indicators were used to identify those species that did depend upon wetlands. FACW indicates that the species is generally found in wetlands 67-99% of the time; it is usually found in wetlands but with rare occurrences in uplands. OBL indicates that the species only occurs in wetlands.

fidelity ratings developed by Ed Alverson (personal communication, 2006), those species with a high fidelity to wet prairies were retained as wetland-dependent while those with medium or low fidelity were retained only if their other likely habitats were wetlands.

For those species known to depend on wetlands, an additional assessment was completed of the likelihood that the species occurs exclusively in fens or other groundwater-dependent wetlands. Additional information on the habitat requirements of the species was obtained from the following sources:

- NatureServe Explorer (NatureServe, 2008)
- Flora of North America (Flora of North America Editorial Committee, eds., 1993+).
- CalFlora Database (CalFlora, 2000).
- Center for Plant Conservation National Collection of Endangered Plants (Center for Plant Conservation, 2008).
- Washington Natural Heritage Program Field Guide to Selected Rare Plants (WNHP and US BLM, 2005)
- Comer et al., 2005

Assignments of groundwater dependence were reviewed by Ed Alverson, botanist in Oregon with The Nature Conservancy (Appendix C, Table C-5).

b. Non-vascular plants:

Non-vascular plants include bryophytes, fungi, lichens, and liverworts. We began with a list of non-vascular plants from the ecoregional assessments conducted in Oregon and then added a group of groundwater-dependent bryophytes and one lichen (*Hydrotheria venosa)* per guidance from our reviewers.

The habitat needs of each species were initially assessed using the following resources:

- USDA PLANTS Database (USDA NRCS, 2008)
- NatureServe Explorer (NatureServe, 2008)
- Derr et al., 2002
- Ryan, 1996
- Survey Protocols for Bryophytes, Northwest Forest Plan (USFS and US BLM, 1997)
- Draft Management Recommendations for Bryophytes, Northwest Forest Plan (USFS and US BLM, 1996)
- Worley, 1969
- Washington Natural Heritage Program Field Guide to Selected Rare Plants (WNHP and US BLM, 2005)
- United States Forest Service Land Management Plans (USFS, 2006; USFS, 2003)
- Marino, 1991
- Bryophyte Flora of North America (Flora of North America Editorial Center for Bryophytes, 2001).

- US 26: Wildwood to Wemme Environmental Assessment (ODOT, 2006)
- Tahoe National Forest Sensitive Plants and Fungi list (Sagehen Creek Field Station, 2006).

Assignments of groundwater dependence were reviewed for lichens by Peter Neitlich (National Park Service) and for bryophytes by John Christy (Oregon Natural Heritage Information Center). See Appendix C, Tables C-6 to C-9 for the final lists.

c. Amphibians and Reptiles:

We began with a list of amphibians and reptiles from the ecoregional assessments conducted in Oregon. Two new species were added to the list by Brome McCreary (USGS) – *Ascaphus montanus* and *Batrachoseps attenuatus* – both of which were the result of new species designations. In addition, McCreary converted species names to be consistent with Crother (2001) and Crother et al. (2003). The habitat needs of species were initially assessed using the NatureServe Explorer. McCreary reviewed the final list (Appendix C, Tables C-10 and C-11), using St. John (2002) and Lannoo (2005).

d. Beetles:

We began with a list of beetles from the ecoregional assessments completed for Oregon. We added one additional species, *Stygoporus oregonensis*, per guidance from Jim Labonte (Oregon Department of Agriculture); this is a subterranean species that occurs only in aquifers.

An initial assessment of groundwater dependence was made using NatureServe Explorer (NatureServe, 2008) and Washington Department of Fish and Wildlife archives (WDFW, 1991). Final review of this assessment was conducted by Jim Labonte (Appendix C, Table C-12).

e. Birds:

We began with a list of bird species from the ecoregional assessments completed for Oregon. An initial assessment of groundwater dependence was made using NatureServe Explorer (NatureServe, 2008) and Lewis et al. (2003). Jerry Martin (TNC volunteer and avid birder) reviewed the list (Appendix C, Table C-13) and modified the assessment of groundwater dependence using the following:

- Birds of North America Software (Thayer, 1998).
- Paulson, 2005
- Wheeler, 2003
- Ehrlich et al., 1988
- Neel, 1999
- Riparian Habitat Joint Venture, 2004
- Altman, 1999, 2000a, 2000b, and 2000c
- Altman and Holmes, 2000

f. Butterflies:

We began with a list of butterflies and moths from the ecoregional assessments completed for Oregon. Nine species were added to this list per John Fleckenstein's (Washington Natural Heritage Program) recommendation. An initial assessment of the groundwater dependence of these species was made using Miller et al. (2000) and Pyle (2002). John Fleckenstein reviewed this assessment (Appendix C, Table C-14).

g. Caddisflies:

We began with a list of caddisflies from the ecoregional assessments completed for Oregon. An initial assessment of groundwater dependence was made using NatureServe Explorer (NatureServe, 2008). Bob Wisseman (aquatic biologist, private consulting) reviewed this assessment and provided a list of species believed to be associated with springs, seeps and headwater streams in Oregon (Ruiter et al., 2006) which confirmed a number of Wisseman's modifications (Appendix C, Table C-15).

h. Dragonflies, mayflies, and stoneflies:

We began with a list of dragonflies from the ecoregional assessments completed for Oregon. Jim Johnson (Clark County, Washington) added twelve more species to the list. An initial assessment of groundwater dependence, completed using NatureServe Explorer (NatureServe, 2008), was reviewed by Jim Johnson (Appendix C, Table C-16).

i. Fish:

We began with a list of fish from the ecoregional assessments completed for Oregon. An initial assessment of groundwater dependence was made using NatureServe Explorer (NatureServe, 2008). John Crandall (fish biologist, TNC) reviewed this assessment; modifications were made per comments from Darren Brumback (fisheries biologist, US BLM) regarding the Alvord cutthroat trout (*Oncorhynchus clarkii alvordensis*), which is believed to be extinct (Appendix C, Table C-17).

j. Mollusks:

We began with a list of mollusks from the ecoregional assessments completed for Oregon. One additional species (*Pyrgulopsis intermedia*) was added based on Ruiter et al. (2006). Thirty-four G1 and G2 species from an additional list of mollusks compiled for the Northwest Forest Plan (Hohenlohe, 2002) were added to this list. An initial assessment of groundwater dependence was made using:

- Oregon Natural Heritage Information Center (ORNHIC), 2002
- Frest and Johannes (1995, 1999)
- NatureServe Explorer (NatureServe, 2008)

Robert Hershler (Smithsonian Institution) and Nancy Duncan (US BLM) reviewed this assessment (Appendix C, Table C-18).

k. Bats:

We used a list of bats from the ecoregional assessments completed for Oregon (Appendix C, Table C-19). Jerry Martin, volunteer for TNC, researched the groundwater dependence of each species using the following references:

- Eder, 2002
- Bat Conservation International (BCI, 2007)
- BC Environment, 1997
- Oregon Department of Fish and Wildlife (ODFW), 2006
- Morgan and Lashmar, 1993

No external review of these findings was completed.

l. Other species:

We began with a list of species of concern from the ecoregional assessments for Oregon from the following groups: mammals, grasshoppers, marine invertebrates, other invertebrates, and bugs (Appendix C, Table C-20). An assessment of groundwater dependence was made using NatureServe Explorer (NatureServe, 2008) and the following resources:

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- Whittaker, 1996

No external review of these findings was completed.

m. Ecological communities:

To assess groundwater dependence of the ecological communities, we identified those associated with wetlands in Oregon using Christy (2004). Of these, 20 are obligately groundwater dependent and 44 are facultatively groundwater dependent. The remaining two are not dependent on groundwater, as they are either primarily vernal pools, which are usually isolated from groundwater, or uplands (Appendix C, Table C-21).

Other Approaches:
Only evaluate the groundwater dependence of mappable species and communities: The process of identifying groundwater dependence could be significantly streamlined by its completion for only those elements that are mappable. The disadvantage of this approach is that it provides a much less complete summary of the importance of groundwater to species and communities.

III. SUMMARIZING THE DISTRIBUTION OF GDEs IN OREGON:

The presence of groundwater-dependent ecosystems and species in Oregon was summarized by HUC6 (Table 1). In general, if any groundwater-dependent ecosystem or species occurred in a HUC6, it was highlighted; however, we used indicators of abundance to select HUC6s in the case of springs or groundwater-dependent wetlands.

Table 1: Criteria used to identify HUC6s in which GDEs occur in Oregon

GDE	*Criteria*
Springs	Contains >1 spring/2236 ha (5525 acres)
Wetlands	Contains a fen OR Area of groundwater-dependent wetlands ≥1% of HUC6 area
Rivers	Contains groundwater-dependent river
Lakes	Contains a lake
Species and communities	Contains an obligately groundwater-dependent species or community

The number of GDEs in a HUC6 can serve as one way to prioritize focal areas for conservation work. Using the criteria established in Table 1, we have identified the number of GDEs in each HUC6 and highlighted **GDE clusters**. GDE clusters are HUC6s which meet at least two of the criteria in Table 1.

IV. THREATS TO GROUNDWATER QUANTITY:

The threat of altered quantity of groundwater discharging at a groundwater-dependent ecosystem was examined under both current conditions and future projected growth conditions (Table 2).

Table 2: Criteria for identifying HUC6s with a threat of altered groundwater quantity

Threat	*Criteria*
Known water table decline	Presence of Groundwater Restricted Area
Current groundwater extraction	≥1 large well/ 2130 ha (5263 acres)
	≥1 small well per 43.5 ha (108 acres)
Future groundwater extraction	Presence of rural residential zoning in counties expected to grow by more than 15%
	≥1 pending groundwater permit application

A. KNOWN WATER TABLE DECLINES:

Parts of the state in which the rate of groundwater pumping exceeds the natural rate of groundwater replenishment have been classified as Groundwater Restricted

Areas by the Oregon Water Resources Department (OWRD, 2007a). These are grouped into four categories with varying restrictions on existing and future groundwater use:

- Critical: No new permits for groundwater use are allowed; restrictions can be placed on existing uses
- Limited: Future uses or appropriations are allowed for only a few specific designated uses
- Withdrawn: Future appropriations or development of groundwater are not allowed
- Classified: Christmas Valley/Fort Rock and Ella Butte (Willow Creek area). Large scale development of groundwater for irrigation or industrial uses is prevented; exempt uses are allowed. Data from Ella Butte indicate water table declines are still occurring (OWRD, 2003).

All categories were used in our analysis to indicate known water table declines (Table 2).

B. CURRENT THREATS:

We used the density of wells as an indicator of the potential threat to nearby ecosystems of reduced groundwater discharge due to extraction (Table 2). As wells can be extracting water from a different aquifer than that supplying the ecosystem, this assumption may not be valid at a specific site; however, we believe it is a reasonable indicator for a statewide analysis of risk.

We mapped well locations using the well log database maintained by the Oregon Water Resources Department (OWRD, 2007b). Every well drilled in Oregon since the 1950s is required to have a well log filed by the driller. Well locations are recorded in this database by township, range, section, and (in many cases) quarter-quarter section; we assigned wells to the centroid of the highest resolution location provided in the dataset. We included only those records for wells of type 'W' (indicating water rather than gas) and for newly constructed wells ('work new' field was checked).

Each well was identified by its intended use and classified as either large (irrigation, community and industrial use fields checked) or small (domestic or livestock use fields checked).

Other Approaches:
Water rights database: If well log data do not exist, it is possible to use water rights data. In Oregon, the Water Rights Information System (OWRD, 2005) contains both places of use and points of diversion data. It is possible to use points of diversion data to map the location of groundwater rights, and therefore wells; the field 'Wr_type' is 'GW' for these locations. The relative size of wells can be obtained from the 'rate cfs' field, which indicates the amount of water that can be legally diverted. We did not use this database because it only includes permitted wells, whereas the well logs include all wells, exempt and regulated.

C. FUTURE THREATS:

The future threat of altered groundwater discharge to ecosystems was assessed for both large and small wells. We used surrogate indicators to identify areas most likely to be threatened by increased density of each type of well.

1. Large wells:

We identified HUC6s threatened by future increased groundwater extraction from large wells (e.g. irrigation, commercial or municipal use) as those with at least one pending application for a groundwater right. We received the list of pending groundwater right applications from Kathy Boles (OWRD) on January 15, 2008. We mapped individual 'pod location id' numbers and assigned these well locations to the centroid of the township, range and section indicated in the database.

2. Small wells:

We identified HUC6s threatened by future domestic (or exempt) well installations as those zoned for rural residential development in counties with an expected population growth rate of more than 15 percent between 2005 and 2020. Rural residential areas are those most likely to be associated with increased groundwater extraction, as rural homes tend to obtain drinking water from groundwater (Bartholomay et al., 2007).

We used expected county population growth rates developed by the Population Research Center at Portland State University and the Oregon Office of Economic Analysis (OOEA, 2004). Zoning maps developed between 1983 and 1986 by Oregon Department of Land Conservation and Development (ODLCD, 2007) provided the most complete statewide data layer of zoning in Oregon. Only areas outside of urban growth boundaries for which the Land_Use field of the database was ‘rural residential’ were used to indicate areas likely to develop rural housing.

V. THREATS TO GROUNDWATER QUALITY:

For the most part, we used a risk-assessment approach to evaluate risks to the quality of groundwater; however, where existing water quality data were available, they were incorporated into the analysis. The risk of groundwater quality impairment was evaluated in terms of the likelihood of contamination by nutrients (both nitrate and phosphorus), pesticides, and other toxic contaminants, as well as by the potential of altered thermal regime in hot springs.

A. KNOWN GROUNDWATER CONTAMINATION:

We located known contamination of groundwater by nutrients using Groundwater Management Areas and contamination by nutrients, pesticides or other toxic contaminants using two databases of groundwater samples (Table 3).

Table 3: Criteria for identifying HUC6s with threats of altered groundwater quality due to known groundwater contamination

Threat	*Criteria*
Known groundwater contamination	Presence of groundwater sample with N concentrations in excess of 10 mg/L nitrate-N and 1 mg/L nitrite N
	Presence of groundwater sample with P concentrations in excess of 0.01 mg/L total phosphorus
	Presence of a Groundwater Management Area
	Presence of groundwater sample with detectable concentrations of pesticides or pesticide degradates
	Presence of groundwater sample with detectable concentrations of other toxic chemicals

1. Nutrients:

a. Draft Groundwater Management Areas: The Oregon Department of Environmental Quality (ODEQ) has identified areas within the state where groundwater is known to exceed the drinking water standard for nitrate (10 mg/l; ODEQ, 2003). We identified those HUCs that occur within these Draft Groundwater Management Areas.

b. Groundwater quality data: We examined three sources of groundwater quality data to identify places where groundwater is known to have exceeded thresholds for nitrogen and phosphorus contaminants since January 1, 1996; however, no exceedances were found in the EPA STORET database described below so only two databases are referred to in the report.

Thresholds used for nitrogen contamination were the same as the drinking water standards: 10 mg/l of N for nitrates and 1 mg/l of N for nitrites (US EPA,

2003). The threshold used for phosphorus contamination was the EPA's recommended level of total phosphorus for streams and lakes in the western forested areas of Oregon: 0.01 mg/l total phosphorus (US EPA, 2002). Total phosphorus recommendations for other ecoregions in Oregon are higher (0.02 and 0.04 mg/l), so we used the more conservative value. Exceedances of the above thresholds were used to locate HUC6s with contaminated groundwater.

- **ODEQ LASAR database:** We downloaded groundwater quality data from the ODEQ LASAR database (ODEQ, 2007c) on August 6, 2007.
  - Two parameters, *Nitrate/nitrite as N (mg/L)* and *Nitrate/nitrite (mg/L as N),* were used for the nitrogen analysis. We assumed these samples had been filtered and compared the measured value for each of these parameters with a value of 11 mg/l of N, the total of the nitrate and nitrite standards.
  - Two parameters, *Total Phosphorus (mg/l)* and *Total Total Phosphorus (mg/l)*, were used in the phosphorus analysis. We assumed that the samples were unfiltered and compared the measured values with the 0.01 mg/l standard.
- **USGS National Water Information System (NWIS):** We downloaded groundwater and spring water quality data from the NWIS (USGS, 2007) on January 5, 2007. Only the nitrogen analysis was possible using these data. We used one parameter, *Nitrite plus nitrate, water, filtered, mg/l as nitrogen.* Measured values of this parameter were compared with 11 mg/l of N, the sum of the nitrate and nitrite standards.
- **EPA STORET database:** We downloaded groundwater water quality data from the EPA STORET Legacy Data Center website (US EPA, 2007) on August 14, 2007. We used one parameter, *Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N*. We assumed that these samples were filtered and compared their measured results with 11 mg/l, the sum of the nitrate and nitrite standards. As mentioned above, no samples meeting this criteria were found.

2. Pesticides:

We used a suite of parameters with detected quantities of pesticides from the NWIS (Appendix C, Table C-25) and LASAR (Appendix C, Table C-26) databases (see details above in the nutrients section). These excluded all occurrences with the '<' symbol in the results field.

3. Other toxic contaminants:

We used a suite of parameters with detected quantities of industrial contaminants from the NWIS (Appendix C, Table C-23) and LASAR (Appendix C, Table C-24) databases (see details above in the nutrients section). These excluded all occurrences with the '<' symbol in the results field.

B. THREAT OF GROUNDWATER CONTAMINATION — NUTRIENTS:

We evaluated locations of potential groundwater contamination by either nitrates or phosphorus.

1. Nitrates:

Threats of groundwater contamination by nitrates were identified using the following indicators: agricultural fertilizer use, septic system density, concentrated animal feeding operations, and Underground Injection Control sites (Table 4).

Table 4: Criteria for identifying HUC6s with threats of altered groundwater quality due to potential contamination by nitrates

Threat	*Criteria*
Agricultural use of N fertilizer	Risk level ≥ 3 in USGS nationwide model of risk of nitrate contamination in shallow groundwater
	Presence of agricultural land use or irrigated land on permeable geologic deposits in counties with >1401 kg/km^2 (4 tons/ mile^2) of N fertilizer use
Septic systems	Presence of a census block with ≥ 6.15 people/ha (2.46 people / acre)
Concentrated animal feeding operations	≥1 Concentrated animal feeding operation
Underground Injection Control wells	Presence of Class V UICs posing nutrient contamination risk

a. Agricultural fertilizer use and septic system density:

We approached this analysis using two scales of data – one set of national level predictions and a suite of additional analyses using Oregon statewide data.

- On the national scale, we used the Oregon portion of the results of a nationwide logistics regression model developed by USGS to predict the probability of nitrate contamination of shallow (<5 m) groundwater (Nolan et al., 2002a, 2002b). Three vulnerability factors were integrated into this model: 1) nitrogen loading from fertilizer use (statistics obtained from the Association of American Plant Food Control Officials); 2) percent of area in cropland or pasture (agricultural land use); and 3) natural log of human population density. In addition, they used two sensitivity indicators, well-drained soils and depth to seasonally high water table. The results are presented in terms of values between 1 and 6; we used areas with grid cell values of 3 through 6 to identify HUC6s at risk of groundwater contamination by nitrates.

We supplemented the results of this nationwide model with more detailed data from Oregon on agricultural fertilizer use and population density (as a surrogate for septic system density).

- For the agricultural fertilizer-use analysis with Oregon data, we used the following datasets:
  - Nitrogen fertilizer use rates: Using 1991 county-level estimates of the rate of nitrogen fertilizer use (tons of nitrogen per square mile; Battaglin and Goolsby, 1994), we identified those counties with the highest use rates (>1401 kg/km^2 or 4 tons/ mile^2). Use rates are based upon reported values from the US EPA and estimates by Jerald Fletcher of West Virginia University. This threshold eliminated the lower quarter of the fertilizer use rates from the analysis.

  - Agricultural land use: We used the National Land Cover Database dataset (USGS, 2003) to locate agricultural land use.

  - Irrigated areas on permeable deposits: We located irrigated areas using the Water Rights Information System (WRIS) places of use data maintained by the Oregon Water Resources Department (OWRD, 2005). We included all water rights that had not been canceled (WR status = NC) and which permitted any of the uses listed in Table 5. Permeable geologic deposits were located using the geologic analysis explained in section II.C.3 and presented in Appendix C (Table C-1).

Table 5: Use codes used to identify irrigated areas from the points of use data in the OWRD water rights database.

Use Code	Use	Use Code	Use	Use Code	Use
AG	Agriculture	CI	Irrigation of cranberries	IR	Irrigation
CF	Supplemental flood harvest cranberries	I*	Irrigation of livestock and domestic	IS	Supplemental irrigation
CH	Harvest cranberries	IC	Primary and supplemental irrigation	OI	Out of season irrigation
CR	Cranberries	ID	Irrigation and domestic	DN	Domestic including non-commercial garden
DB	Dairy Barn	IL	Irrigation and livestock	GR	Groundwater recharge
NU	Nursery uses	DI	Domestic including lawn and garden		

For an area to be mapped as at risk of nitrate contamination of groundwater using the Oregon data it had to be: 1) located in a county with a high rate of fertilizer use, and 2) within either agricultural or irrigated lands, and 3) located on permeable deposits.

- For the septic system density analysis with Oregon data, we used population density (density of residences) as a surrogate for density of septic systems. We began with population estimates of those census blocks (US Census Bureau, 2000) that are outside of urban growth boundaries in Oregon (ODOT et al., 1995). We calculated the population density of each census block by dividing the population estimates by the census block area. As the average household size in Oregon is 2.46 people (US Census Bureau, 2004), we assumed that all census blocks with a population density above 2.46 people per acre had more than one house per acre and therefore more than 1 septic system / acre (or 2.5 septic systems/ ha). Census blocks meeting this population density criteria were identified as areas with a higher risk of contamination by septic systems. This is the same septic density used by the Oregon Department of Environmental Quality (ODEQ) to assess risk in their Source Water Assessment Plan (ODEQ and OHD, 2000).

b. Concentrated Animal Feeding Operations: Concentrated animal feeding operations (CAFOs) have been linked to increased risk of groundwater contamination by nitrates (Gurian-Sherman, 2008). We used the Oregon Department of Agriculture database of CAFOs (ODA, 2007) to locate these operations in Oregon.

c. Underground Injection Control sites for septic systems: To identify areas at higher risk of nutrient contamination of groundwater from Underground Injection Control (UIC) site wells, we used the subset of Class V wells that are most likely to contain waste that has a high nutrient content (ODEQ, 2007e; see 'How to Map' field in Appendix C, Table C-22).

2. Phosphorus:

Threats of groundwater contamination by phosphorus were evaluated for fertilizer use in both agricultural and urban settings (Table 6).

Table 6: Criteria for identifying HUC6s with threats of altered groundwater quality due to potential contamination by phosphorus

Threat	*Criteria*
Agricultural use of P fertilizer	Contains agricultural land use and is in a county with a phosphorus fertilizer use rate > 420 kg/km^2 (1.2 tons/mile^2)
Urban use of fertilizers	Presence of urban land use

a. Agricultural fertilizer use: Using 1991 county-level estimates of the rate of phosphorus fertilizer use (tons of fertilizer per square mile, P20591_USE field; Battaglin and Goolsby, 1994), we identified those counties with the highest use rates (>420 kg/km^2 or 1.2 tons/mile^2). This threshold eliminates from the analysis the lower quarter of the range of fertilizer use rates. We then used the National Land Cover Database dataset (USGS, 2003) to locate agricultural land use. HUC6s with a threat of groundwater contamination by phosphorus were located in counties with high fertilizer use rates and contained agricultural areas.

b. Urban fertilizer use: Nationally, phosphorus contamination of groundwater was much more associated with urban land use than agricultural land use (Hamilton et al., 2004). We used developed areas, both high and medium intensity, from the National Land Cover Database dataset (USGS, 2003) to identify urban areas.

C. THREAT OF GROUNDWATER CONTAMINATION — PESTICIDES:

We identified threats of groundwater contamination by both agricultural and urban use of pesticides (Table 7).

Table 7: Criteria used to assess risk to HUC6 of groundwater contamination by pesticides

Threat	*Criteria*
Urban use of pesticides	Presence of urban land use
Agricultural use of pesticides	Presence of ≥2 high risk pesticides in places where they are likely to contaminate groundwater

1. Urban use:

As we were not able to find specific data on usage of pesticides by homeowners or industry across Oregon, urban use of pesticides was assessed by using high and medium density development from the National Land Cover Database dataset (USGS, 2003) to locate urban areas.

2. Agricultural use:

A total of 220 pesticides are used by agriculture in Oregon (Thelin, 2005; Thelin and Giannessi, 2000). Data on the general locations of agricultural pesticide use in the mid to late 1990s are available for 43 of these pesticides in Oregon (Nakagaki and Wolock, 2005; Appendix C, Table C-27). Nakagaki and Wolock developed these data by apportioning the total pesticide use within a county to specific crops based on landuse mapping from USGS (2003). For instance, if a pesticide is generally used on orchards then the use of that pesticide within a county was attributed only to lands categorized as orchard agriculture within that county. Three categories of crops were used: corn/grain/fallow (CGF), orchards/vineyards/etc (ORCH), and pasture/hay.

The risk of groundwater contamination by a pesticide is a function of both the properties of the pesticide, which determine its likelihood of moving towards groundwater, and the properties of the soils at a specific site, which determine whether the pesticide is likely to leach or to be retained by the soil particles. We assessed the groundwater contamination potential for each of the 43 pesticides and then assessed the likely toxicity to aquatic life of those pesticides most likely to contaminate groundwater. The final risk for groundwater contamination, based on soil characteristics, was then assessed for those pesticides deemed most likely to contaminate groundwater and most toxic to aquatic life. Details of these analyses are as follows:

- *Pesticide characteristics:* Pesticides most likely to contaminate groundwater are those that have low volatility, high solubility, and a long half-life. The Natural Resources Conservation Service (NRCS) describes pesticides with these characteristics as having a high pesticide leaching potential (PLP). We used three databases to assess these parameters for each of the 43 agricultural pesticides in Table C-26: the Oregon State University Extension Pesticide Properties Database (Vogue et al., 1994), the Pesticide Action Network Pesticides Database (Kegley et al., 2008), and the Natural Resources Conservation Service (NRCS) Pesticides Properties Database (USDA NRCS, 2006b). The final risk to groundwater, according to each of these databases, is summarized in Appendix C, Table C-27**.** More details on each of these databases are provided in Box A.

- *Toxicity to aquatic life:* For those pesticides in Table C-26 identified as having a high, intermediate, or potential risk of contaminating groundwater, we assessed the toxicity to aquatic life (Appendix C, Table C-28). Two ecotoxicology databases were used to make this assessment: the Pesticides Action Network Pesticides Database (Kegley et al., 2008) and Extoxnet (Pesticide Management Education Program, various dates). All pesticides except for Nicosulfuron were either toxic or harmful to aquatic biota.

- *Soil characteristics:* We used the soil leaching potential (SLP) to evaluate the soil characteristics associated with the risk of a pesticide contaminating groundwater. We approached this in two different ways, depending upon the scale at which soils data were available digitally:

  a. Places with SSURGO data: For these areas, Steve Campbell from the NRCS used the NRCS Windows Pesticide Screening Tool (WIN-PST; USDA NRCS, 2005) to calculate the soil leaching potential of soils mapped by the SSURGO database in Oregon (USDA NRCS, 2006a). The soil leaching potential (SLP) is calculated as follows (Goss and Wauchope, 1990):

  High SLP:
  1. Hydrologic group A and OM X horizon depth ≤30
  OR
  2. Hydrologic group B and OM X horizon depth ≤9 and soil K factor ≤0.48 *OR*
  3. Hydrologic group B and OM X horizon depth ≤15 and soil K factor ≤0.26

  Low SLP:
  1. Hydrologic group B and OM X horizon depth ≥35 and soil K factor ≥0.4
  OR
  2. Hydrologic group B and OM X horizon depth ≥45 and soil K factor ≥0.2
  OR
  3. Hydrologic group C and OM X horizon depth ≤10 and soil K factor ≥0.28
  OR
  4. Hydrologic group C and OM X horizon depth ≥10

  Very Low SLP:
  Hydrologic group D

  Intermediate SLP:
  Everything else

  b. Places without SSURGO data: In the portion of the state where SSURGO data do not exist, Steve Campbell provided us with the weighted average of the soil leaching potential (SLP) for each soil polygon in the STATSGO database (USDA NRCS, 2006a). Each polygon is composed of multiple components; each component is assigned an SLP rating and these are averaged, according to dominance of the component, to produce a single value for each polygon. The resulting weighted averages ranged from 1.071 to 4. We assigned

ratings of very low SLP to values from 1-1.5, ratings of low SLP to values from 1.5-2.5, ratings of intermediate SLP to values from 2.5-3.5, and ratings of high SLP to values from 3.5-4.

Mapping threats of groundwater contamination by agricultural pesticides: Using the information on the risk of groundwater contamination for the 43 pesticides with spatially explicit data in Oregon, we restricted our analysis to those with a rating of 'high' or 'yes' for groundwater contamination in all three databases (a total of 10; Appendix C, Table C-27). Four other pesticides with conflicting ratings were not included in our analysis: Alachlor, cyanazine, diuron, and norflurazon. Each of the pesticides selected for analysis was found to be toxic to aquatic life (Appendix C, Table C-28) and so was included in our risk assessment.

For these 10 pesticides, we used the NRCS guidelines (Goss and Wauchope, 1990) to identify locations in which pesticides are likely to contaminate groundwater (Figure 1). As each of the ten pesticides has a high pesticide leaching potential (PLP), we identified locations at high risk of groundwater contamination as those areas in which these pesticides were estimated to be used (Nakagaki and Wolock, 2005), and for which the SSURGO or STATSGO analysis indicated a high or intermediate soil leaching potential. Because some of the values for pesticide use were very low, we multiplied each of the 10 pesticide grids by 1,000,000 to convert them to integers. We then reclassed each grid as either containing pesticide use or not, regardless of the amount of pesticide estimated to be used.

We identified a HUC6s as being at risk for groundwater pesticide contamination if it exhibited a high risk of pesticide contamination (i.e. interaction of the PLP and SLP, per Figure 1, was either high or intermediate) for at least two pesticides. We did this by using the high and intermediate SLP ratings from both SSURGO and STATGO data separately as masks to calculate the presence of estimated pesticide use in areas only with high or intermediate SLP. We first used the SSURGO data where it existed, then in those HUCs without SSURGO, we used the STATSGO SLP. These results are best used at a watershed scale.

Figure 1: Interaction of soil leaching potential (SLP) and pesticide leaching potential (PLP) to determine likelihood that a particular pesticide used in a specific location will move towards groundwater. Our analysis identified as higher risk those places with a combination of high PLP and either high or intermediate SLP.

		PLP			
		High	**Intermediate**	**Low**	**Very Low**
SLP	**High**	High	High	Intermediate	Low
	Intermediate	High	Intermediate	Low	Very Low
	Low	Intermediate	Low	Low	Very Low
	Very Low	Low	Low	Very Low	Very Low

Other Approaches:

Assessing other pesticides: To facilitate use of future, more complete, datasets of pesticide use, we have put together a summary of the likelihood that each of the 220 agricultural pesticides used in Oregon will contaminate groundwater. These data are available from the Oregon Chapter of The Nature Conservancy and could be used to evaluate agricultural pesticides beyond those listed in Table C-26.

BOX A: Details of pesticide attribute databases:

i. *OSU Extension Pesticide Database (Vogue et al., 1994*): Relies heavily on the NRCS pesticide database for values of pesticide half-life, water solubility, and sorption coefficient (soil K_{oc}) but uses other sources when needed. From these values, the Groundwater Ubiquity Score (GUS) indicates the likelihood that a pesticide will move towards groundwater and is calculated based on the half-life and sorption coefficient [GUS = log10 (half-life) x [4 - log10 (Koc)]. Pesticides with a GUS less than 0.1 have an extremely low likelihood of moving towards groundwater; 1-2 are low; 2-3 are moderate; 3-4 are high; more than 4 is extremely high.

ii. Pesticide Action Network Pesticide Database (Kegley et al., 2008):
If a pesticide has been found repeatedly in California groundwater, then it is identified as a groundwater contaminant by PAN. Pesticides are considered potential groundwater contaminants if:

One of the following is true:

- Water solubility: > 3 ppm (mg/L), or
- Soil adsorption coefficient (K_{oc}): < 1,900 cm^3/g

and one of the following is also true:

- Hydrolysis half-life: > 14 days, or
- Aerobic soil metabolism half-life: > 610 days, or
- Anaerobic soil metabolism half-life: > 9 days

iii. NRCS Pesticide Properties Database (USDA NRCS, 2006b):
This database contains values for the half-life, water solubility and soil adsorption potential of different pesticides. The NRCS calculates a Pesticide Leaching Potential algorithm based on these factors as follows (Goss and Wauchope, 1990):

High:	log (half life in days) X(4- log Koc) >=2.8
Low:	log (half life in days) X (4- log Koc) <=1.8
Very low:	log (half life in days) X (4- log Koc) <0.0 OR Solubility <1 ppm and half life <1 day
Intermediate: all else	

D. THREAT OF GROUNDWATER CONTAMINATION — OTHER TOXIC CONTAMINANTS:

The potential for groundwater contamination from non-nutrient and non-pesticide chemicals is increased in the general vicinity of the industries that use the chemicals and in the vicinity of storage tanks and spills. We used these threats to identify areas at higher risk of groundwater contamination by toxic contaminants if they were located within 0.8 km (0.5 miles) of a groundwater-dependent ecosystem or species (Hart Crowser Inc. et al., 2007). Criteria for locating HUC6s with threats of groundwater contamination from other toxic contaminants are summarized in Table 8.

Table 8: Criteria to identify HUC6s with threat of altered groundwater quality due to contamination by other toxic chemicals

Threat	***Criteria***
Leaking underground storage tanks	Presence of Leaking Underground Storage Tank that has not undergone cleanup, located within 0.8 km (0.5 miles) of a GDE or species
Underground Injection Control sites	Presence of Class V UICs associated with either all or industrial contaminants within 0.8 km (0.5 miles) of GDE or species
Hazardous waste spills	Presence of environmental cleanup sites needing current or future action within 0.8 km (0.5 miles) of GDE or species
Spills and leaching from specific land uses	Presence of activities that increase risk of spills within 0.8 km (0.5 miles) of a GDE: • gas stations • dry cleaners • active mines • military bases • airports

1. Leaking underground storage tanks:

Using the Oregon Department of Environmental Quality facility profiler (ODEQ, 2007f) we downloaded all data for Leaking Underground Storage Tanks (LUST) on January 2, 2007. Tanks with confirmed leaks (Program Type = LUST, Interest = Unregulated, and any STATUS except for 'cleanup completed') were included in the analysis. This approach corresponds with the procedure used to identify high risks from leaking underground storage tanks to source water areas for drinking water supplies (ODEQ and OHD, 2000; ODEQ, 2005).

2. Underground Injection Control wells:

Underground Injection Control wells (UICs) are wells into which waste liquid is injected for disposal. Unlike other types, Class V UICs are shallow and their construction does not necessarily provide protection against contamination of nearby

groundwater (Groundwater Protection Council, 2007). We used the ODEQ database of Underground Injection Control wells (UICs; ODEQ, 2007e) to map the location of all Class V UICs (well type class code = V) that were not clearly used for gray or drinking water disposal. These well types are identified as 'industrial chemicals' or 'all contaminants' in the 'how to map' field of Table C-22 (Appendix C).

3. Hazardous waste spills:

We used the hazardous waste spill and environmental clean up data from the ODEQ facility profiler (ODEQ, 2007a) to locate areas at risk for groundwater contamination from existing spills of potentially toxic chemicals. In the database, these are identified as Program Type = ECSI. We included all occurrences except those with a status = 'no further action needed'.

4. Specific land use activities:

A number of land uses create an increased risk of contaminant spills and subsequent groundwater contamination. Following the work by the ODEQ (2005), we used the locations of the following activities to indicate an increased risk of groundwater contamination:

A number of land uses create an increased risk of contaminant spills and subsequent groundwater contamination. Following work by the ODEQ (2005), we used the locations of the following activities to indicate an increased risk of groundwater contamination:

- Gas stations: Gas stations, or other land uses with underground storage tanks for petroleum pose an increased risk of contamination by petrochemicals and other industrial solvents (ODEQ, 2005). We located gas stations by extracting Underground Storage Tanks (program type = UST) with certification numbers (indicating they are permitted to receive fuel; Mitch Scheel, personal communication 1/4/07) from the ODEQ facility profiler (ODEQ, 2007f).

- Dry cleaners: We included dry cleaners in our analysis as the dry cleaning chemical PERC (also known as tetrachoroethylene, PCE, or perchlorethylene) is likely to contaminate groundwater and is moderately toxic to aquatic life (Kegley et al., 2008). When initially spilled, this chemical volatilizes easily; however, the liquid that does not volatilize can move into soil and groundwater. As this chemical is more dense than water, it sinks lower part of the aquifer where it persists for a long time and is difficult to remove (Technical Outreach Services for Communities, 2001).

  We requested and received a copy of the Oregon Dry Cleaners Database on January 8, 2007 (ODEQ, 2007b). All dry cleaners, except those identified as using a PERC alternative, were mapped (Ed Patnode, personal communication).

- Mines: Active mines are most likely to pose a risk to the water table level or to water quality; however, even inactive or abandoned mines, if not reclaimed, can leach toxic materials and potentially contaminate groundwater or alter groundwater flow paths. We use the Oregon Department of Geology and Mineral Industries database of active permitted mines as an indicator of active mine locations (ODGAMI, 2007). According to Vaughn Belzer of ODGAMI's Mined Land Regulation and Reclamation Program (MLRR), an active permit does not mean that active mining is occurring, but that it can occur in the future (personal communication 8/15/07). All mines in this database were mapped. This includes mines that are not active now but for which a permit has been requested (status = 'new') or which are exploratory mines (permit type = 'xpm' (exploratory permit)).

- Airports and military bases: Both airports and military bases have been associated with an increased risk of chemical spills and subsequent groundwater contamination (ODEQ, 2005). In their source water assessment, the ODEQ placed high risk on these land uses (ODEQ, 2007d). We used the USGS Geographic Names Information System (GNIS; USGS, 1996) data layer to locate military bases and airports. No military bases intersected GDE clusters in Oregon.

E. THREAT OF ALTERED THERMAL REGIME – HOT SPRINGS:

The risk of alteration of the thermal regime of hot springs was assessed by locating areas in the state with the potential for geothermal development (Niewendorp et al., 2007). We identified those HUC6s with hot springs that are most at risk for alteration of the thermal regime (Table 9). Such risk was identified if either:

1) areas in the HUC6 are known to be favorable for discovery and development of local sources of low-temperature (90°C and above) water OR

2) areas in the HUC6 exist which, because of their geologic history and similarity to areas with know geothermal/hydrothermal systems, have the potential to contain geothermal resources suitable for direct heat applications (20°C and above).

We identified HUC6s with hot springs (Niewendorp et al., 2007) at risk for alteration of the thermal regime (Table 9).

Table 9: Criteria to identify HUC6s with hot springs and the threat of altered thermal regime due to the presence of geothermal resources

Threat	***Criteria***
Geothermal development	Presence of known geothermal resource areas
	Presence of potential geothermal resources

VI. THREAT SYNTHESIS:

After assessing the threats to groundwater quantity and quality across the state of Oregon, we summarized our findings in terms of their potential effects on GDEs. To do this, we intersected each threat criteria in Tables 2-4 and Tables 6-9 with GDE clusters (HUC6s with at least 2 GDEs, per the criteria in Table 1). It is these findings that are summarized in the results section of the main text.

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Appendix C: Data Tables

The main text of this report, "Groundwater-Dependent Biodiversity and Associated Threats: A Statewide Screening Methodology and Spatial Assessment of Oregon," is available online at http://conserveonline.org.

Table C-1: Permeability Ratings for Surficial Geology, based on Oregon statewide geology datalayer (Miller et al., 2002). Map unit, lithology, deposit description, and permeability assignment.

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
Jv	volcanic	VOLCANIC ROCKS (JURASSIC)	H
Qa	volcanic	ANDESITE (HOLOCENE AND PLEISTOCENE)	H
Qal	sedimentary	ALLUVIAL DEPOSITS	H
Qb	volcanic	BASALT AND BASALTIC ANDESITE (HOLOCENE AND PLEISTOCENE)	H
Qb?		*BASALT AND BASALTIC ANDESITE (HOLOCENE AND PLEISTOCENE)*	H
Qba	volcanic	BASALTIC ANDESITE AND BASALT (HOLOCENE)	H
Qba?	volcanic	BASALTIC ANDESITE AND BASALT (HOLOCENE)	H
Qd	sedimentary	DUNE SAND (HOLOCENE)	H
Qf	sedimentary	FANGLOMERATE (HOLOCENE? AND PLEISTOCENE)	H
Qf?	sedimentary	FANGLOMERATE (HOLOCENE? AND PLEISTOCENE)	H
Qg	sedimentary	GLACIAL DEPOSITS	H
Qlb		LATE BASALT (HOLOCENE, PLEISTOCENE)	H
Qmp	volcanic	MAZAMA PUMICE DEPOSITS (HOLOCENE)	H
Qrd	volcanic	RHYOLITE AND DACITE (HOLOCENE AND PLEISTOCENE)	H
Qs	sedimentary	LACUSTRIAN AND FLUVIAL SEDIMENTARY ROCKS (PLEISTOCENE)	H
Qs?	sedimentary	LACUSTRIAN AND FLUVIAL SEDIMENTARY ROCKS (PLEISTOCENE)	H
Qt	sedimentary	TERRACE; PEDIMENT; AND LAG GRAVELS (HOLOCENE AND PLEISTOCENE)	H
Qt?	sedimentary	TERRACE; PEDIMENT; AND LAG GRAVELS (HOLOCENE AND PLEISTOCENE)	H
QTa	volcanic	ANDESITE (PLEISTOCENE AND PLIOCENE)	H
QTb	volcanic	BASALT (PLEISTOCENE AND PLIOCENE)	H
QTb?	volcanic	BASALT (PLEISTOCENE AND PLIOCENE)	H
QTba	volcanic	BASALT AND BASALTIC ANDESITE (PLEISTOCENE AND PLIOCENE)	H
QTg	sedimentary	TERRACE AND PEDIMENT GRAVELS (PLEISTOCENE AND PLIOCENE)	H
QTib	volcanic	INTRUSIVE BASALT AND ANDESITE (PLEISTOCENE, PLIOCENE, AND MIOCENE)	H
QTib?			H
QTmv	volcanic	MAFIC VENT COMPLEXES (PLEISTOCENE; PLIOCENE; AND MIOCENE?)	H
QTmv?			H

Table C-1 *(continued)*

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
QTp	volcanic	PYROCLASTIC ROCKS OF BASALTIC AND ANDESITIC CINDER CONES: BASALTIC AND ANDESITIC EJECTA	H
QTp?	volcanic	PYROCLASTIC ROCKS OF BASALTIC AND ANDESITIC CINDER CONES: BASALTIC AND ANDESITIC EJECTA	H
QTps	volcanic	PYROCLASTIC ROCKS OF BASALTIC AND ANDESITIC CINDER CONES: SUBAQUEOUS BASALTIC AND ANDESITIC EJECTA	H
QTs	sedimentary	SEDIMENTARY ROCKS (PLEISTOCENE AND PLIOCENE)	H
QTvm	volcanic	MAFIC VENT DEPOSITS (PLEISTOCENE; PLIOCENE; AND MIOCENE?)	H
QTvm?		*MAFIC VENT DEPOSITS (PLEISTOCENE; PLIOCENE; AND MIOCENE?)*	H
QTvs	volcanic	SILICIC VENT DEPOSITS (PLEISTOCENE AND PLIOCENE)	H
Qyb	volcanic	YOUNGEST BASALT AND BASALTIC ANDESITE (HOLOCENE)	H
Qyb?	volcanic	YOUNGEST BASALT AND BASALTIC ANDESITE (HOLOCENE)	H
Tb	volcanic	BASALT (UPPER AND MIDDLE MIOCENE)	H
Tb?		*BASALT (UPPER AND MIDDLE MIOCENE)*	H
Tba	volcanic	BASALT AND ANDESITE (MIOCENE)	H
Tba?	volcanic	BASALT AND ANDESITE (MIOCENE)	H
Tbaa	volcanic	BASALTIC AND ANDESITIC ROCKS (UPPER AND MIDDLE MIOCENE)	H
Tbaa?			H
Tbas		ANDESITIC AND BASALTIC ROCKS ON STEENS MOUNTIAN	H
Tc	volcanic	COLUMBIA RIVER BASALT GROUP AND RELATED FLOWS (MIOCENE)	H
Tc?		*COLUMBIA RIVER BASALT GROUP AND RELATED FLOWS (MIOCENE)*	H
Tcg	volcanic	GRANDE RONDE BASALT (MIDDLE AND LOWER MIOCENE)	H
Tcg?	volcanic	GRANDE RONDE BASALT (MIDDLE AND LOWER MIOCENE)	H
Tcp	volcanic	PICTURE GORGE BASALT (MIDDLE AND LOWER MIOCENE)	H
Tcs	volcanic	SADDLE MOUNTAINS BASALT (UPPER AND MIDDLE MIOCENE)	H
Tcw	volcanic	WANAPUM BASALT (MIDDLE MIOCENE)	H
Tfc	sedimentary and volc	FLOWS AND CLASTIC ROCKS, UNDIFFERENTIATED (MIOCENE)	H
Tfeb	volcanic	FISHER AND EUGENE FORMATIONS AND CORRELATIVE ROCKS (OLIGOCENE AND UPPER EOCENE)-BASALTIC ROCKS	H
Tib	intrusive rocks	BASALT AND ANDESITE INTRUSIONS (PLIOCENE; MIOCENE; AND OLIGOCENE)	H
Tib?	intrusive rocks	BASALT AND ANDESITE INTRUSIONS (PLIOCENE; MIOCENE; AND OLIGOCENE)	H

Table C-1 *(continued)*

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
Tmsc	sedimentary	MARINE SILTSTONE, SANDSTONE, AND CONGLOMERATE (LOWER EOCENE)	H
Tmv	sedimentary and volc	MAFIC VENT COMPLEXES (MIOCENE)	H
Tmv?	sedimentary and volc	MAFIC VENT COMPLEXES (MIOCENE)	H
Tob	sedimentary and volc	OLIVINE BASALT (PLIOCENE AND MIOCENE)	H
Tob?	sedimentary and volc	OLIVINE BASALT (PLIOCENE AND MIOCENE)	H
Tp	sedimentary and volc	PYROCLASTIC ROCKS OF BASALTIC CINDER CONES (LOWER PLIOCENE? AND MIOCENE?)-BASALTIC AND ANDESITIC EJ	H
Tpb	volcanic	PORPHYRITIC BASALT (UPPER EOCENE)	H
Trb	volcanic	RIDGE-CAPPING BASALT AND BASALTIC ANDESITE (PLIOCENE AND UPPER MIOCENE)	H
Trb?	volcanic	RIDGE-CAPPING BASALT AND BASALTIC ANDESITE (PLIOCENE AND UPPER MIOCENE)	H
Trh	volcanic	RHYOLITIE AND DACITE (PLIOCENE? AND MIOCENE)	H
Trh?	volcanic	RHYOLITIE AND DACITE (PLIOCENE? AND MIOCENE)	H
Tstv		STRAWBERRY VOLCANICS- *basalt, basaltic andesite, andesite* (PLIOCENE?, MIOCENE)	H
Tsv	volcanic	SILICIC VENT COMPLEXES (PLIOCENE, MIOCENE, AND UPPER OLIGOCENE)	H
Tsv?	volcanic	SILICIC VENT COMPLEXES (PLIOCENE, MIOCENE, AND UPPER OLIGOCENE)	H
Tts	sedimentary and volc	TUFFACEOUS SEDIMENTARY ROKCS; TUFFS; PUMICITES; AND SILCIC FLOWS (MIOCENE)	H
Tts?	sedimentary and volc	TUFFACEOUS SEDIMENTARY ROKCS; TUFFS; PUMICITES; AND SILCIC FLOWS (MIOCENE)	H
Tub	sedimentary and volc	BASALTIC LAVA FLOWS	H
Tub?	sedimentary and volc	BASALTIC LAVA FLOWS	H
Tvm	sedimentary and volc	MAFIC AND INTERMEDIATE VENT ROCKS (PLIOCENE? AND MIOCENE)	H
Tvm?	sedimentary and volc	MAFIC AND INTERMEDIATE VENT ROCKS (PLIOCENE? AND MIOCENE)	H
Tvs	sedimentary and volc	SILICIC VENT ROCKS (PLIOCENE; MIOCENE; OLIGOCENE AND EOCENE?)	H
bc	metamorphic	AMPHIBOLITE OF BRIGGS CREEK (MESOZOIC OR PALEOZOIC)	L
cm	metamorphic	CONDREY MOUNTAIN SCHIST (TRIASSIC? AND PALEOZOIC?)	L
cs	metamorphic	COLEBROOKE SCHIST (MESOZOIC OR PALEOZOIC)	L

Table C-1 *(continued)*

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
Jc	volcanic	CHETCO COMPLEX OF HOTZ (1971) (JURASSIC)	L
Jm	mixed	MELANGE (JURASSIC)	L
Jop		OTTER POINT FORMATION OF DOTT (1971) AND RELATED ROCKS (UPPER JURASSIC)	L
Jop?		OTTER POINT FORMATION OF DOTT (1971) AND RELATED ROCKS (UPPER JURASSIC)	L
Js	sedimentary and volc	SEDIMENTARY ROCKS (JURASSIC)	L
Js?	sedimentary and volc	SEDIMENTARY ROCKS (JURASSIC)	L
Jss	sedimentary	SHALE, MUDSTONE, AND SANDSTONE (JURASSIC)	L
JTRgd		GRANITE AND DIORITE (JURASSIC AND TRIASSIC	L
JTRs		SEDIMENTARY ROCKS (JURASSIC AND UPPER TRIASSIC)	L
JTRsv		SEDIMENTARY AND VOLCANIC ROCKS (JURASSIC AND UPPER TRIASSIC)	L
Ju	intrusive rocks	ULTRAMAFIC AND RELATED ROCKS OF OPHIOLITE SEQUENCES (JURASSIC)	L
Ju?	intrusive rocks	ULTRAMAFIC AND RELATED ROCKS OF OPHIOLITE SEQUENCES (JURASSIC)	L
Jub	intrusive rocks	ULTRAMAFIC AND RELATED ROCKS OF OPHIOLITE SEQUENCES (JURASSIC)-BASALTIC VOLCANIC AND SEDIMENTARY ROCKS	L
Kc	sedimentary and volc	CLASTIC SEDIMENTARY ROCKS (UPPER AND LOWER CRETACEOUS)	L
KJds	sedimentary	DOTHAN FORMATION AND RELATED ROCKS (LOWER CRETACEOUS AND UPPER JURASSIC)-SEDIMENTARY ROCKS	L
KJds?			L
KJdv	volcanic	DOTHAN FORMATION AND RELATED ROCKS (LOWER CRETACEOUS AND UPPER JURASSIC)-VOLCANIC ROCKS	L
KJg	intrusive rocks	GRANITIC ROCKS (CRETACEOUS AND JURASSIC)	L
KJgu	intrusive rocks	GABBRO AND ULTRAMAFIC ROCKS ASSOCIATED WITH GRANITIC PLUTONS (CRETACEOUS AND JURASSIC)	L
KJi		INTRUSIVE ROCKS (CRETACEOUS AND JURASSIC)	L
KJi?		*INTRUSIVE ROCKS (CRETACEOUS AND JURASSIC)*	L
KJm	sedimentary	MYRTLE GROUP (LOWER CRETACEOUS AND UPPER JURASSIC)	L
Ks	sedimentary	SEDIMENTARY ROCKS (CRETACEOUS)	L
mc	metamorphic	MAY CREEK SCHIST (PALEOZOIC)	L

Table C-1 *(continued)*

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
mr	mixed rocks	(BURNT RIVER SCHIST?) MESOZOIC AND PALEOZOIC SHEARED METASEDIMENTS (TECTONIC SERPENTINITE, MELANGE)	L
Psv		SEDIMENTARY AND VOLCANIC ROCKS, PARTLY METAMORPHOSED (PERMIAN AND PERMIAN?)	L
Pzs		SEDIMENTARY ROCKS, PARTLY METAMORPHOSED (PALEOZOIC)	L
Pzsv		SEDIMENTARY AND VOLCANIC ROCKS, PARTLY METAMORPHOSED (PALEOZOIC)	L
Qgf	sedimentary	GLACIAL DEPOSITS (PLEISTOCENE)-GLACIOFLUVIAL DEPOSITS	L
Qgs	sedimentary	GLACIOFLUVIAL, LACUSTRINE, AND PEDIMENT SEDIMENTARY DEPOSITS (PLEISTOCENE)	L
Qgs?	sedimentary	GLACIOFLUVIAL, LACUSTRINE, AND PEDIMENT SEDIMENTARY DEPOSITS (PLEISTOCENE)	L
Ql	sedimentary, loess	LOESS HOLOCENE AND PLEISTOCENE, INCLUDES PALOUSE FM	L
Qls	sedimentary	LANDSLIDE AND DEBRIS-FLOW DEPOSITS (HOLOCENE AND PLEISTOCENE)	L
Qma	volcanic	MAZAMA ASH DEPOSITS (HOLOCENE)	L
Qpl	sedimentary	PLAYA DEPOSITS (HOLOCENE)	L
QTst	sedimentary and volc	TUFFACEOUS SEDIMENTARY ROCKS AND TUFFS (LOWER? PLEISTOCENE OR PLIOCENE)	L
Ta	sedimentary	ALSEA FORMATION (OLIGOCENE AND UPPER EOCENE)	L
Tas	volcanic	ANDESITE AND DACITE AND SEIDMENTARY ROCKS (MIOCENE? AND OLIGIOCENE)	L
Tas?		*ANDESITE AND DACITE AND SEIDMENTARY ROCKS (MIOCENE? AND OLIGIOCENE)*	L
Tat	volcanic	SILICIC ASH-FLOW TUFF (LOWER PLIOCENE AND UPPER MIOCENE)	L
Tca	sedimentary and volc	CLASTIC ROCKS AND ANDESITE FLOWS (LOWER OLIGIOCENE?; EOCENE; AND PALEOCENE)	L
Tca?	sedimentary and volc	CLASTIC ROCKS AND ANDESITE FLOWS (LOWER OLIGIOCENE?; EOCENE; AND PALEOCENE)	L
Tci		*probably volcanic interbed exposed in canyon walls*	L
Tco	volcanic	COWLITZ FORMATION (UPPER AND MIDDLE EOCENE)	L
Tcss	sedimentary	CONTINENTAL SEDIMENTARY ROCKS (UPPER AND MIDDLE MIOCENE)	L
Tct	volcanic	PREDOMINANTLY TUFFACEOUS FACIES OF CLARNO FORMATION (LOWER OLIGOCENE? AND EOCENE)	L

Table C-1 *(continued)*

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
Tct?	volcanic	PREDOMINANTLY TUFFACEOUS FACIES OF CLARNO FORMATION (LOWER OLIGOCENE? AND EOCENE)	L
Tfe	sedimentary and volc	FISHER AND EUGENE FORMATIONS AND CORRELATIVE ROCKS (OLIGOCENE AND UPPER EOCENE)	L
Tfee	sedimentary and volc	FISHER AND EUGENE FORMATIONS AND CORRELATIVE ROCKS (OLIGOCENE AND UPPER EOCENE)-MARINE EUGENE FORMA	L
Tfee?			L
Thi	intrusive rocks	HYPABYSSAL INTRUSIVE ROCKS (MIOCENE AND MIOCENE?)	L
Thi?	intrusive rocks	HYPABYSSAL INTRUSIVE ROCKS (MIOCENE AND MIOCENE?)	L
Ti	intrusive rocks	MAFIC INTRUSIONS (OLIGOCENE)	L
Tia	intrusive rocks	ALKALIC INTRUSIVE ROCKS (OLIGOCENE AND EOCENE)	L
Tig	intrusive rocks	INTRUSIVE GABBROIC ROCKS (OLIGOCENE AND EOCENE)	L
Tim	intrusive rocks	MAFIC AND INTERMEDIATE INTRUSIVE ROCKS (PLIOCENE AND MIOCENE)	L
Tim?		*MAFIC AND INTERMEDIATE INTRUSIVE ROCKS (PLIOCENE AND MIOCENE)*	L
Tlf		LACUSTRINE AND FLUVIAL DEPOSITS (MIOCENE)	L
Tm	sedimentary	MARINE SEDIMENTARY ROCKS (LOWER PLIOCENE? AND UPPER MIOCENE)	L
Tms	sedimentary	MARINE SEDIMENTARY ROCKS (MIDDLE AND LOWER MIOCENE)	L
Tmsm	sedimentary	MARINE SANDSTONE, SILTSTONE, AND MUDSTONE (LOWER EOCENE AND PALEOCENE?)	L
Tmss	sedimentary	MARINE SANDSTONE AND SILTSTONE (MIDDLE EOCENE)	L
Tmst	sedimentary and volc	MARINE SEDIMENTARY AND TUFFACEOUS ROCKS (MIDDLE MIOCENE TO UPPER EOCENE)	L
Tn	sedimentary	NONMARINE SEDIMENTARY ROCKS (EOCENE)	L
Tps	volcanic	PYROCLASTIC ROCKS OF BASALTIC CINDER CONES (LOWER PLIOCENE? AND MIOCENE?)-SUBAQUEOUS PYROCLASTIC RO	L
Tps?	volcanic	PYROCLASTIC ROCKS OF BASALTIC CINDER CONES (LOWER PLIOCENE? AND MIOCENE?)-SUBAQUEOUS PYROCLASTIC RO	L
Tr	volcanic	RHYOLITE AND DACITE DOMES AND FLOWS AND SMALL HYPABYSSAL INTRUSIVE BODIES (MIOCENE TO UPPER EOCENE?	L
TRPsv		*older volcanic sediments*	L

Table C-1 *(continued)*

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
TRPv	sedimentary and volc	VOLCANIC ROCKS (TRIASSIC AND PERMAIN)	L
TRs		MARINE SEDIMENTARY ROCKS (UPPER AND MIDDLE JURASSIC AND UPPER TRIASSIC)	L
TRsv		*older volcanic sediments*	L
TRv		ULTRAMAFIC AND MAFIC INTRUSIVE ROCKS AND SERPENTINIZED EQUIVALENTS (TRIASSIC AND PALEOZOIC)	L
Ts	sedimentary and volc	TUFFACEOUS SEDIMENTARY ROCKS AND TUFF (PLIOCENE AND MIOCENE)	L
Ts?		*TUFFACEOUS SEDIMENTARY ROCKS AND TUFF (PLIOCENE AND MIOCENE)*	L
Tsd	sedimentary	SEDIMENTARY ROCKS (OLIGOCENE AND UPPER EOCENE)	L
Tsf	sedimentary and volc	RHYOLITIC TUFF; TUFFACEOUS SEDIMENTARY ROCKS; AND LAVA FLOWS (LOWER MIOCENE; OLIGIOCENE; AND UPPERM	L
Tsff	sedimentary and volc	RHYOLITIC TUFF; TUFFACEOUS SEDIMENTARY ROCKS; AND LAVA FLOWS (LOWER MIOCENE; OLIGIOCENE; AND UPPERM	L
Tsfj	sedimentary and volc	JOHN DAY FORMATION OF EAST-CENTRAL OREGON (LOWER MIOCENE, OLIGOCENE, AND UPPERMOST EOCENE?)	L
Tsfj?			L
Tsm	sedimentary	MARINE SEDIMENTARY ROCKS (LOWER MIOCENE AND OLIGOCENE)	L
Tsr	sedimentary and volc	SILETZ RIVER VOLCANICS AND RELATED ROCKS (MIDDLE AND LOWER EOCENE AND PALEOCENE)	L
Tss	sedimentary	TUFFACEOUS SILTSTONE AND SANDSTONE (UPPER AND MIDDLE EOCENE)	L
Tt	sedimentary and volc	TYEE FORMATION (MIDDLE EOCENE)	L
Ttv	volcanic	TILLAMOOK VOLCANICS (UPPER AND MIDDLE EOCENE)	L
Ttv?	volcanic	TILLAMOOK VOLCANICS (UPPER AND MIDDLE EOCENE)	L
Ttvm	volcanic	TILLAMOOK VOLCANICS (UPPER AND MIDDLE EOCENE)-MARINE FACIES	L
Ttvm?			L
Tu	sedimentary and volc	UNDIFFERENTIATED TUFFACEOUS SEDIMENTARY ROCKS; TUFFS; AND BASALT (MIOCENE AND OLIGOCENE)	L
Tus	sedimentary and volc	SEDIMENTARY AND VOLCANICLASTIC ROCKS	L
Tut		UNDIFFERENTIATED TUFFACEOUS SEDIMENTARY ROCKS. TUFFS, AND BASALT (MIOCENE AND OLIGOCENE)-TUFF	L

Table C-1 *(continued)*

MAP_UNIT	LITHOLOGY	DESCRIPTION	Relative permeability
Tvi	intrusive rocks	MAFIC VENT AND INTRUSIVE ROCKS (EOCENE?)	L
Twt		WELDED TUFFS AND TUFFACEOUS SEDIMENTARY ROCKS (UPPER? AND MIDDLE MIOCENE)	L
Twt?	sedimentary and volc	WELDED TUFFS AND TUFFACEOUS SEDIMENTARY ROCKS (UPPER? AND MIDDLE MIOCENE)	L
Ty	sedimentary	YAMHILL FORMATION AND RELATED ROCKS (UPPER AND MIDDLE EOCENE)	L
Tyq	sedimentary	YAQUINA FORMATION (LOWER MIOCENE AND UPPER OLIGOCENE)	L
TRPzg		GABBROIC ROCKS (TRIASSIC AND PALEOZIC)	L
TRPzm		*MELANGE OF DUTCHMAN'S PEAK????*	L
TRPzs			L
TRPzsn		MARBLE (TRIASSIC AND PALEOZOIC	L
TRPzu		ULTRAMAFIC (TRIASSIC AND PALEOZOIC)	L
Water	Water		H

Table C-2: Wetland Ecosystems Mapped Using Ecological Systems Datalayer (TNC eds., 2007).

Ecosystem	Wetland	Riparian or Estuarine	Facultatively Groundwater-Dependent Wetland	Obligately Groundwater-Dependent Wetland (Fen)
California Montane Riparian Systems		X		
Columbia Basin Foothill Riparian Woodland and Shrubland		X		
Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-S	X		X	
Columbia Plateau Vernal Pool	X			
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland		X		
Inter-Mountain Basins Alkaline Closed Depression	X		X	
Inter-Mountain Basins Montane Riparian Systems		X		
Mediterranean California Alkali Marsh	X		X	
Mediterranean California Serpentine Foothill and Lower Montane Riparian Woodland and Seep	X		X	
Mediterranean California Subalpine Meadow	X		X	
North American Arid West Emergent Marsh	X		X	
North Pacific Bog and Fen	X			X
North Pacific Hardwood-Conifer Swamp	X		X	
North Pacific Intertidal Freshwater Wetland	X		X	
North Pacific Lowland Riparian Forest and Shrubland	X		X	
North Pacific Mesic Low Shrubland	X		X	
North Pacific Montane Riparian Woodland and Shrubland		X		
North Pacific Shrub Swamp	X		X	
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland		X		
Rocky Mountain Alpine Dwarf-Shrubland	X		X	
Rocky Mountain Alpine-Montane Wet Meadow	X		X	
Rocky Mountain Lower Montane Riparian Woodland and Shrubland		X		
Rocky Mountain Montane Riparian Systems		X		
Rocky Mountain Subalpine/Upper Montane Riparian Systems		X		
Rocky Mountain Subalpine-Montane Fen	X			X
Rocky Mountain Subalpine-Montane Mesic Meadow	X		X	
Rocky Mountain Subalpine-Montane Riparian Shrubland		X		
Rocky Mountain Subalpine-Montane Riparian Woodland		X		
Temperate Pacific Freshwater Aquatic Bed	X		X	
Temperate Pacific Freshwater Emergent Marsh	X		X	
Temperate Pacific Freshwater Mudflat	X		X	
Temperate Pacific Intertidal Mudflat		X	X	
Temperate Pacific Subalpine-Montane Wet Meadow	X		X	
Temperate Pacific Tidal Salt and Brackish Marsh		X	X	
Willamette Valley Wet Prairie	X		X	

Table C-3: Wetland Communities Identified in the Klamath and Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessments (Vander Schaaf et al., 2004; Floberg et al., 2004).

Ecoregion	Ecosystem	Wetland	Riparian or Estuarine	Facultatively Groundwater-Dependent Wetland	Obligately Groundwater-Dependent Wetland (fen)
Klamath Mountains	Serpentine wetlands (Darlingtonia/ California oatgrass)	X			X
	Port Orford Cedar	X		X	
Puget Trough	Sphagnum bogs and fens	X			X

Table C-4: Wetland Communities of Conservation Concern Tracked by the Oregon Natural Heritage Program (ORNHIC, 2007). ELCODE = element occurrence code: GW_DEP = groundwater dependence: ? = facultatively groundwater-dependent and used to map wetlands that were further analyzed for groundwater dependence; Y = obligately groundwater dependent and used to locate fens; and N = not groundwater dependent. NEW NAME = Name used in our analysis.

ELCODE	Scientific name	Common Name	GW_DEP	NEW_NAME
CES200.876	Nuphar lutea ssp. polysepalum	Temperate Pacific Freshwater Aquatic Bed	?	Temperate Pacific Freshwater Aquatic Bed
CES200.876	Potamogeton natans	Temperate Pacific Freshwater Aquatic Bed	?	Temperate Pacific Freshwater Aquatic Bed
CES200.877	Carex aquatilis var. aquatilis	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Carex exsiccata	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Carex lasiocarpa	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Carex obnupta	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Carex utriculata	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Carex vesicaria var. vesicaria	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Glyceria borealis	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Juncus nevadensis	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Menyanthes trifoliata	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Phalaris arundinacea	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh

Table C-4 *(continued)*

ELCODE	Scientific name	Common Name	GW_DEP	NEW_NAME
CES200.877	Schoenoplectus acutus	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.877	Scirpus microcarpus	Temperate Pacific Freshwater Emergent Marsh	?	Temperate Pacific Freshwater Emergent Marsh
CES200.998	Carex nebrascensis	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Deschampsia caespitosa	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Deschampsia caespitosa - Carex nebrascensis	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Deschampsia caespitosa - Danthonia unispicata	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Deschampsia caespitosa - Juncus balticus	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Juncus balticus	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Pinus contorta var. latifolia / Carex aquatilis var. aquatilis	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Pinus contorta var. latifolia / Deschampsia caespitosa	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES200.998	Pinus contorta var. latifolia / Spiraea douglasii	Temperate Pacific Subalpine-Montane Wet Meadow	?	Temperate Pacific Subalpine-Montane Wet Meadow
CES204.063	Betula nana / Carex utriculata	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Caltha leptosepala ssp. howellii	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Carex aquatilis var. dives	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Carex buxbaumii	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Carex cusickii - (Comarum palustre)	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Carex limosa	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Carex luzulina	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Carex simulata	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Dulichium arundinaceum	North Pacific Bog and Fen	Y	North Pacific Bog and Fen

Table C-4 *(continued)*

ELCODE	Scientific name	Common Name	GW_DEP	NEW_NAME
CES204.063	Eleocharis quinqueflora	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Nephrophyllidium crista-galli	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	North Pacific Bog and Fen	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	North Pacific Bog and Fen	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Pinus contorta var. latifolia / Vaccinium uliginosum	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Sanguisorba officinalis - Carex aquatilis var. dives	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Unmapped peatland	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.063	Vaccinium uliginosum / Eleocharis quinqueflora	North Pacific Bog and Fen	Y	North Pacific Bog and Fen
CES204.090	Thuja plicata / Lysichiton americanus	North Pacific Hardwood-Conifer Swamp	?	North Pacific Hardwood-Conifer Swamp
CES204.865	Alnus incana - Salix barclayi	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Alnus viridis ssp. sinuata	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Alnus viridis ssp. sinuata / Athyrium filix-femina	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Cornus sericea / Lysichiton americanus	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Salix	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Salix geyeriana	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Salix geyeriana - Salix hookeriana	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Spiraea douglasii	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Spiraea douglasii - Salix	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Vaccinium uliginosum / Deschampsia caespitosa	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Vaccinium uliginosum / Carex aquatilis var. dives	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp
CES204.865	Vaccinium uliginosum / Carex utriculata	North Pacific Shrub Swamp	?	North Pacific Shrub Swamp

Table C-4 *(continued)*

ELCODE	Scientific name	Common Name	GW_DEP	NEW_NAME
CES304.057	Northern Columbia Plateau Vernal Pool	Columbia Plateau Vernal Pool	N	Columbia Plateau Vernal Pool
CES304.058	Northern Columbia Plateau Basalt Pothole Ponds	Northern Columbia Plateau Basalt Pothole Ponds	?	Northern Columbia Plateau Basalt Pothole Ponds
MNRLSPRING	Mineral spring	Mineral spring	Y	Mineral spring
new.BN_AV_	Betula nana - Alnus viridis ssp. sinuata - Salix geyeriana		?	Betula nana - Alnus viridis ssp. sinuata - Salix g
new.BO_VU_	Betula occidentalis - Vaccinium uliginosum - Salix geyeriana		?	Betula occidentalis - Vaccinium uliginosum - Salix
new.FPCS	Flowing and pooled cold springs	Flowing and pooled cold springs	Y	Flowing and pooled cold springs
new.Mnd_Sp	Mounded spring	Mounded spring	Y	Mounded spring
new.Mu_Fl	Mud flat	Mud flat	?	Mud flat
new.SB	Meadow		?	Meadow
new.SL_SS_	Alnus incana - Salix lemmonii - Salix sitchensis - Alnus viridis ssp. sinu		?	Alnus incana - Salix lemmonii - Salix sitchensis -
new.Up_bog	Upland	Upland	N	

Table C-5: Vascular Plant Species of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Scientific Name	Groundwater Dependence
Abronia latifolia	N
Abronia turbinata	N
Abronia umbellata ssp acutalata	N
Abronia umbellata ssp breviflora	N
Achnatherum hendersonii	N
Achnatherum speciosum	N
Achnatherum wallowaensis	N
Actaea elata	N
Adiantum jordanii	N
Agastache cusickii	N
Agoseris elata	?
Agropyron smithii	N
Agrostis hallii	N
Agrostis hendersonii	N
Agrostis howellii	N
Agrostis microphylla	N
AIvesia pickeringii	No info
Alisma gramineum	?
Allenrolfea occidentalis	?
Allium bolanderi	N
Allium bolanderi var. mir	N
Allium brandegeei	N
Allium campanulatum	No info
Allium crenulatum	N
Allium dictuon	N
Allium geyeri var tenerum	N
Allium geyeri var. geyeri	N
Allium madidum	?
Allium nevii	?
Allium pleianthum	N
Allium robinsonii	N
Allium sanbornii var. san	N
Allium tolmiei var. platy	N
Allium unifolium	N
Alopecurus carolinianus	N
Ammannia robusta	?
Amsinckia carinata	N
Androsace filiformis	N
Anemone nuttalliana	N
Anemone oregana var felix	N

Scientific Name	Groundwater Dependence
Anemone tetonensis	N
Antennaria aromatica	N
Apocynum medium	No info
Apocynum sibiricum var salignum	N
Apocynum x floribundum	N
Arabis cobrensis	N
Arabis crucisetosa	N
Arabis furcata	N
Arabis hastatula	N
Arabis koehleri var koehleri	N
Arabis koehleri var stipitata	N
Arabis macdonaldiana	N
Arabis modesta	N
Arabis platysperma var. platysperma	N
Arabis sparsiflora var. atrorubens	No info
Arabis suffrutescens var. horizontalis	N
Arctostaphylos hispidula	N
Arenaria franklinii var.	N
Arenaria paludicola	?
Argemone munita	N
Aristida oligantha	N
Arnica fulgens	N
Arnica viscosa	N
Artemisia campestris ssp caudata	N
Artemisia campestris ssp scouleriana	N
Artemisia campestris var.	N
Artemisia ludoviciana ssp	?
Artemisia ludoviciana ssp estesii	N
Artemisia packardiae	N
Artemisia papposa	N
Artemisia pycnocephala	N
Asarum caudatum	N
Asarum caudatum var. viri	N
Asarum caudatum var. viridiflorum	N
Asarum marmoratum	N
Asclepias fascicularis	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Asclepias speciosa	N
Asplenium septentrionale	N
Asplenium trichomanes-ram	N
Aster borealis	?
Aster curtus	No info
Aster eatonii	N
Aster ericoides ssp pansus	N
Aster gormanii	N
Aster hallii	N
Aster laevis var geyeri	No info
Aster occidentalis var occidentalis	N
Aster oregonensis	N
Aster radulinus	N
Aster vialis	N
Astragalus agrestis	N
Astragalus applegatei	N
Astragalus arrectus	N
Astragalus atratus var. owyheensis	N
Astragalus californicus	N
Astragalus calycosus	N
Astragalus ceramicus var. apus	N
Astragalus collinus var laurentii	N
Astragalus conjunctus var. rickardii	N
Astragalus cusickii var.	N
Astragalus diaphanus var diurnus	N
Astragalus diaphanus var. diaphanus	N
Astragalus gambelianus	N
Astragalus geyeri	N
Astragalus hoodianus	N
Astragalus howellii	N
Astragalus lemmonii	?
Astragalus misellus var. pauper	N
Astragalus mulfordiae	N
Astragalus peckii	N
Astragalus platytropis	NI
Astragalus purshii var ophiogenes	No info
Astragalus robbinsii var. alpiniformis	N
Astragalus solitarius	N
Astragalus sterilis	No info
Astragalus tegetarioides	N
Astragalus tetrapterus	N
Astragalus tyghensis	N
Astragalus umbraticus	No info
Atriplex argentea var. hillmanii	N
Atriplex gardneri var. falcata	N
Atriplex leucophylla	N
Atriplex powellii	N
Baccharis douglasii	?
Balsamorhiza deltoidea	N
Balsamorhiza hookeri	N
Balsamorhiza hookeri var lanata	No info
Balsamorhiza rosea	N
Balsamorhiza sericea	N
Balsamorhiza serrata	No info
Bensoniella oregana	N
Bergia texana	N
Berula erecta var incisa	?
Betula papyrifera var. co	N
Betula pumila var glandulifera	?
Blepharipappus scaber	N
Boisduvalia stricta	N
Bolandra oregana	N
Botrychium ascendens	N
Botrychium campestre	N
Botrychium crenulatum	N
Botrychium glacum sp. nov.	No info
Botrychium hesperium	N
Botrychium lanceolatum	N
Botrychium lineare	N
Botrychium lunaria	N
Botrychium minganense	N
Botrychium montanum	N
Botrychium paradoxum	N
Botrychium pedunculosum	N
Botrychium pinnatum	N
Botrychium pumicola	N
Botrychium simplex	N
Brodiaea terrestris	N
Bulbostylis capillaris	N
Bupleurum americanum	NI
Calamagrostis breweri	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Calamagrostis howellii	N
Calamagrostis tweedyi	N
Callitriche marginata	?
Calochortus coxii	N
Calochortus greenei	N
Calochortus howellii	N
Calochortus indecorus	N
Calochortus longebarbatus	N
Calochortus longebarbatus var. longebarbatus	N
Calochortus longebarbatus var. peckii	N
Calochortus macrocarpus var. maculosus	N
Calochortus monophyllus	No info
Calochortus nitidus	N
Calochortus nudus	N
Calochortus persistens	N
Calochortus umpquaensis	N
Calochortus uniflorus	?
Calycadenia truncata	N
Camassia howellii	?
Camassia quamash ssp maxima	No info
Camissonia claviformis ssp. cruciformis	N
Camissonia contorta (= Oenothera contorta)	N
Camissonia graciliflora	NI
Camissonia ovata	N
Camissonia palmeri	N
Camissonia pygmaea	N
Campanula shelteri	No info
Cardamine nuttallii var.	N
Cardamine parviflora	N
Cardamine pattersonii	N
Cardamine penduliflora	?
Carex abrupta	?
Carex atherodes	?
Carex atrosquama	N
Carex barbarae	N
Carex bebbii	?
Carex brevicaulis	N
Carex brunnescens ssp. brunnes	?
Carex capillaris	?
Carex capitata	N
Carex comosa	?
Carex concinna	N
Carex cordillerana	N
Carex crawfordii	N
Carex densa	?
Carex diandra	?
Carex duriuscula	N
Carex gigas	N
Carex gynocrates	?
Carex gynodynama	N
Carex halliana	N
Carex haydeniana	N
Carex heteroneura var. epapillosa	N
Carex hystericina	?
Carex idahoa	N
Carex integra	N
Carex interior	N
Carex interrupta	?
Carex lasiocarpa	?
Carex lasiocarpa var. americana	?
Carex leptalea ssp. leptalea	?
Carex limosa	?
Carex livida	?
Carex macrochaeta	N
Carex magellanica ssp. irrigua	?
Carex microptera	N
Carex nervina	N
Carex norvegica ssp. infe	?
Carex parryana ssp. idahoa	N
Carex pelocarpa	N
Carex petasata	N
Carex pluriflora	?
Carex praeceptorum	?
Carex praticola	?
Carex pyrenaica ssp. micr	N
Carex retrorsa	N
Carex saxatilis	?
Carex scabriuscula	?
Carex scirpoidea ssp. stenochlaena	N
Carex serratodens	N
Carex sheldonii	?
Carex sp. 10	No info

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Carex subnigricans	N
Carex tenera	No info
Carex vallicola	N
Carex vernacula	N
Carex vulpinoidea	?
Castilleja chambersii	N
Castilleja chlorotica	N
Castilleja elata	N
Castilleja flava var. rus	N
Castilleja fraterna	N
Castilleja levisecta	N
Castilleja mendocinensis	N
Castilleja pallescens var	N
Castilleja pilosa var steenensis	N
Castilleja rubida	N
Castilleja rupicola	N
Castilleja schizotricha	N
Castilleja tenuis	N
Castilleja thompsonii	No info
Castilleja viscidula	N
Castilleja xanthotricha	N
Caulanthus lasiophyllus var lasiophyllus	No info
Caulanthus major var. nev	No info
Centaurium muehlenbergii	N
Centunculus minimus	?
Ceratophyllum echinatum	?
Chaenactis cusickii	N
Chaenactis macrantha	N
Chaenactis nevii	N
Chaenactis stevioides	N
Chaenactis xantiana	N
Chaetadelpha wheeleri	N
Cheilanthes covillei	N
Cheilanthes feei	N
Cheilanthes intertexta	N
Chlorogalum angustifolium	NI
Chrysolepis chrysophylla	N
Cicendia quadrangularis	N
Cicuta bulbifera	?
Cimicifuga elata	N
Cirsium ciliolatum	N
Clarkia borealis ssp arida	No info
Clarkia gracilis ssp albicaulis	No info

Scientific Name	Groundwater Dependence
Clarkia heterandra	No info
Clarkia purpurea ssp viminea	N
Claytonia megarhiza	N
Cleomella hillmanii	N
Cochlearia officinalis	N
Collinsia sparsiflora var. bruceae	N
Collomia debilis var. larsenii	No info
Collomia macrocalyx	N
Collomia mazama	N
Collomia renacta	N
Coptis trifolia	N
Corallorhiza trifida	N
Cordylanthus capitatus	No info
Cordylanthus maritimus ssp palustris	?
Corydalis aurea	N
Corydalis caseana ssp. aquae-gelidae	?
Crassula connata	N
Cryptantha humilis	NI
Cryptantha leiocarpa	N
Cryptantha leucophaea	N
Cryptantha milo-bakeri	N
Cryptantha propria	N
Cryptantha rostellata	N
Cryptantha simulans	N
Cryptantha spiculifera	No info
Cryptantha thompsonii	N
Cryptogramma stelleri	N
Cupressus bakeri	N
Cusickiella douglasii	N
Cymopterus acaulis var greeleyorum	N
Cymopterus ibapensis	NI
Cymopterus nivalis	No info
Cymopterus purpurascens	NI
Cyperus acuminatus	?
Cyperus bipartitus	?
Cyperus lupulinus ssp. lu	N
Cyperus schweinitzii	N
Cypripedium californicum	?
Cypripedium fasciculatum	N
Cypripedium montanum	?
Dalea ornata	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Damasonium californicum	?
Darmera peltata	?
Delphineum multiplex	No info
Delphinium leucophaeum	N
Delphinium nudicaule	N
Delphinium nuttallii	N
Delphinium nuttallii ssp. ochroleucum	N
Delphinium oreganum	N
Delphinium pavonaceum	N
Descurainia pinnata ssp filipes	No info
Dicentra pauciflora	N
Dichelostemma ida-maia	N
Dimeresia howellii	N
Dodecatheon austrofrigidum	N
Dodecatheon sp. 1	No info
Douglasia laevigata	N
Douglasia laevigata var ciliolata	No info
Downingia insignis	N
Downingia laeta	?
Draba aureola	N
Draba cusickii var. cusic	N
Draba howellii	NI
Draba lemmonii var. cyclomorpha	No info
Draba longipes	N
Drosera anglica	?
Dryopteris carthusiana	N
Dryopteris filix-mas	N
Dudleya farinosa	N
Elatine rubella	N
Elatine triandra	?
Eleocharis bolanderi	N
Eleocharis parvula	?
Eleocharis rostellata	?
Elodea nuttallii	?
Enemion stipitatum	N
Epilobium luteum	N
Epilobium oreganum	?
Epilobium palustre	?
Epilobium rigidum	NI
Epilobium siskiyouense	N
Epilobium torreyi	N
Equisetum palustre	N

Scientific Name	Groundwater Dependence
Eremocarpus setigerus	N
Ericameria arborescens	N
Erigeron cascadensis	N
Erigeron cervinus	N
Erigeron chrysopsidis var	N
Erigeron decumbens var. decumbens	N
Erigeron disparipilus	No info
Erigeron engelmannii var. davisii	N
Erigeron howellii	N
Erigeron latus	N
Erigeron oreganus	N
Erigeron peregrinus ssp peregrinus	N
Erigeron petrophilus	N
Erigeron speciosus var speciosus	N
Eriogonum brachyanthum	N
Eriogonum chrysops	N
Eriogonum crosbyae	N
Eriogonum cusickii	N
Eriogonum diclinum	N
Eriogonum hirtellum	N
Eriogonum incanum	NI
Eriogonum lobbii	N
Eriogonum nudum var. para	N
Eriogonum ochrocephalum var. calcareum	N
Eriogonum prociduum	N
Eriogonum pyrolifolium var. pyrolifolium	N
Eriogonum salicornioides	N
Eriogonum scopulorum	N
Eriogonum ternatum	N
Eriogonum umbellatum var. glaberrimum	N
Eriophorum chamissonis	?
Eritrichium nanum var. elongatum	N
Erodium macrophyllum	N
Eryngium alismifolium	No info
Eryngium petiolatum	?
Erysimum arenicola var torulosum	N
Erysimum menziesii ssp concinnum	N
Erythronium elegans	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Erythronium howellii	N
Erythronium oregonum ssp oregonum	N
Eschscholzia caespitosa	N
Escobaria vivipara var. v	N
Eucephalus gormanii	N
Eucephalus vialis	N
Euonymus occidentalis	No info
Eupatorium maculatum var bruneri	?
Fauria crista-galli	?
Festuca brachyphylla	N
Festuca elmeri	N
Filipendula occidentalis	Y
Floerkea proserpinacoides	?
Frasera umpquaensis	No info
Fritillaria camschatcensis	?
Fritillaria gentneri	N
Fritillaria glauca	N
Fritillaria purdyi	N
Gaillardia aristata	N
Galium mexicanum ssp asperulum	?
Galium serpenticum ssp. warnerense	No info
Gentiana newberryi	No info
Gentiana plurisetosa	No info
Gentiana prostrata	?
Gentiana setigera	?
Gentianella tenella ssp.	N
Geranium oreganum	N
Geum aleppicum	N
Geum rossii var. turbinat	N
Geum triflorum var campanulatum	N
Geum triflorum var. campa	N
Gilia millefoliata	N
Gilia sinistra ssp sinistra	N
Githopsis specularioides	N
Glyceria leptostachya	?
Gratiola heterosepala	?
Grindelia integrifolia	N
Hackelia bella	N
Hackelia cronquistii	N
Hackelia diffusa var. diffusa	N
Hackelia mundula	N
Hackelia ophiobia	No info
Hackelia patens var. pate	No info
Haplopappus hirtus var. sonchifolius	No info
Hastingsia atropurpurea	?
Hastingsia bracteosa	?
Hastingsia bracteosa var.	?
Hazardia whitneyi var. discoidea	No info
Hedysarum occidentale	N
Helianthus nuttallii ssp nuttallii	N
Heliotropium curassavicum	?
Hesperevax sparsiflora va	N
Heterodermia sitchensis	N
Heterotheca oregona	N
Heterotheca villosa var villosa	N
Heuchera grossulariifolia	N
Heuchera grossulariifolia var. tenuifolia	N
Heuchera merriamii	N
Hieracium bolanderi	N
Hieracium canadense var canadense	No info
Hieracium greenei	N
Hieracium horridum	N
Hieracium longiberbe	N
Hieracium parryi	N
Hierochloe odorata	?
Horkelia congesta ssp. congesta	N
Horkelia hendersonii	N
Horkelia tridentata ssp. tridentata	No info
Howellia aquatilis	?
Hulsea nana	N
Huperzia occidentalis	N
Hutchinsia procumbens	N
Hydrocotyle ranunculoides	?
Hydrocotyle verticillata	?
Hymenoxys lemmonii	N
Hypericum scouleri ssp nortoniae	N
Hypogymnia heterophylla	N
Idahoa scapigera	N
Iliamna bakeri	N
Iliamna latibracteata	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Ipomopsis minutiflora	No info
Iris missouriensis	?
Isoetes nuttallii	?
Isopyrum stipitatum	N
Ivesia baileyi var baileyi	N
Ivesia baileyi var. beneolens	N
Ivesia rhypara var rhypara	N
Ivesia rhypara var shellyi	N
Ivesia shockleyi	No info
Juncus albescens	?
Juncus bryoides	?
Juncus gerardii	?
Juncus hemiendytus var hemiendytus	N
Juncus hemiendytus var. abjectus	?
Juncus howellii	N
Juncus kelloggii	?
Juncus torreyi	N
Kalmiopsis sp. 1	N
Kalmiopsis sp. 1	N
Keckiella lemmonii	No info
Kobresia myosuroides	N
Kobresia simpliciuscula	N
Lactuca pulchella	N
Lactuca tatarica var. pul	N
Lagophylla ramosissima	No info
Langloisia setosissima ss	No info
Lasthenia glaberrima	?
Lasthenia macrantha ssp prisca	N
Lasthenia maritima	N
Lathyrus delnorticus	No info
Lathyrus holochlorus	N
Lathyrus lanszwertii var lanszwertii	N
Lathyrus lanszwertii var. tracyi	N
Lathyrus rigidus	N
Lathyrus torreyi	No info
Lathyrus vestitus ssp. bolanderi	N
Lepidium davisii	N
Lepidium montanum var. ne	N
Lepidium nitidum	No info
Leptodactylon pungens ssp hazeliae	N

Scientific Name	Groundwater Dependence
Lesquerella douglasii	N
Lesquerella kingii ssp. diversifolia	N
Leucothoe davisiae	?
Lewisia columbiana var. columbiana	N
Lewisia columbiana var. r	N
Lewisia cotyledon var. co	N
Lewisia cotyledon var. ho	N
Lewisia leeana	N
Lewisia oppositifolia	N
Lewisia tweedii	No info
Leymus triticoides	N
Lilaea scilloides	?
Lilium kelloggii	N
Lilium occidentale	?
Lilium parvum	?
Lilium rubescens	N
Limanthes floccosa ssp pumila	No info
Limnanthes floccosa ssp. bellingeriana	?
Limnanthes floccosa ssp. grandiflora	?
Limnanthes gracilis ssp. gracilis	?
Limonium californicum	N
Linanthus bakeri	N
Linanthus bolanderi	N
Linaria canadensis var texana	No info
Linum (sclerolinon) digynum	N
Linum digynum	N
Liparis loeselii	?
Lipocarpha aristulata	?
Lipocarpha occidentalis	?
Listera borealis	N
Lithophragma heterophyllum	No info
Lithospermum ruderale	No info
Lloydia serotina ssp. ser	N
Lobelia dortmanna	?
Loeflingia squarrosa var. artemisiarum	N
Lomatium bradshawii	N
Lomatium columbianum	N
Lomatium cookii	N
Lomatium dissectum var dissectum	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Lomatium engelmannii	N
Lomatium erythrocarpum	N
Lomatium farinosum var. hambleniae	N
Lomatium foeniculaceum var. macdougalii	N
Lomatium grayi	N
Lomatium greenmanii	N
Lomatium hendersonii	N
Lomatium laevigatum	N
Lomatium macrocarpum	N
Lomatium oreganum	N
Lomatium packardiae	N
Lomatium ravenii	N
Lomatium rollinsii	N
Lomatium roseanum	N
Lomatium salmoniflorum	N
Lomatium sp. 2	No iinfo
Lomatium suksdorfii	No info
Lomatium tracyi	N
Lomatium watsonii	No info
Lophochlaena oregona	?
Lotus formosissimus	N
Lotus pinnatus	?
Lotus stipularis	N
Luina serpentina	N
Lupinus affinis	N
Lupinus aridus ssp Ashlanensis	N
Lupinus breweri	NI
Lupinus burkei ssp. caeru	NI
Lupinus cusickii	N
Lupinus cusickii ssp. cus	N
Lupinus densiflorus var densiflorus	No info
Lupinus latifolius var. barbatus	N
Lupinus lepidus var lepidus	N
Lupinus lyallii ssp. minu	NI
Lupinus nevadensis	N
Lupinus oreganus var kincaidii	N
Lupinus oreganus var. ore	N
Lupinus rivularis	N
Lupinus sabinianus	NI
Lupinus sericeus var egglestonianus	No info
Lupinus sulphureus var kincaidii	N
Lupinus tracyi	NI
Lupinus uncialis	N
Luzula arcuata	N
Luzula arcuata ssp. unalaschcensis	N
Luzula orestera	N
Lycopodiella inundata	?
Lycopodium annotinum	N
Lycopodium complanatum	N
Lygodesmia juncea	N
Lysimachia (Steironema) ciliata	N
Malacothrix sonchoides	N
Malacothrix stebbinsii	N
Marah oreganus	N
Marsilea vestita	?
Matteuccia struthiopteris	N
Meconella oregana	N
Melica harfordii	N
Melica smithii	No info
Melica stricta	N
Mentzelia mollis	N
Mentzelia packardiae	N
Mertensia cusickii	No info
Mertensia longiflora	N
Mertensia oblongifolia var. amoena	N
Mertensia oblongifolia var. oblongifolia	N
Microseris bigelovii	N
Microseris borealis	?
Microseris douglasii ssp. douglasii	N
Microseris howellii	N
Microseris laciniata ssp. detlingii	N
Mimulus ampliatus	?
Mimulus bolanderi	No info
Mimulus cardinalis	N
Mimulus clivicola	N
Mimulus congdonii	No info
Mimulus cusickii	N
Mimulus douglasii	?
Mimulus evanescens	N
Mimulus hymenophyllus	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Mimulus jepsonii	N
Mimulus jungermannioides	Y
Mimulus kelloggii	N
Mimulus latidens	?
Mimulus patulus	?
Mimulus pulsiferae	N
Mimulus pygmaeus	N
Mimulus suksdorfii	N
Mimulus tricolor	?
Mimulus washingtonensis ssp 1	No info
Minuartia californica	N
Minuartia cismontana	N
Minuartia pusilla	N
Minuartia stricta var. pu	No info
Mirabilis bigelovii var.	No info
Mirabilis macfarlanei	N
Monardella odoratissima ssp. glauca	N
Monardella purpurea	N
Montia diffusa	N
Montia howellii	N
Muhlenbergia glomerata	N
Muhlenbergia minutissima	N
Muhlenbergia racemosa	N
Myosurus clavicaulis	N
Myosurus minimus var sessiliflorus	N
Myosurus sessilis	N
Myriophyllum sibiricum	?
Myriophyllum ussuriense	No info
Navarretia heterandra	No info
Navarretia leucocephala	?
Navarretia leucocephala ssp leucocephala	?
Navarretia subuligera	N
Navarretia tagetina	N
Navarretia willamettensis	N
Nemacladus capillaris	No info
Nemophila breviflora	N
Nicotiana attenuata	N
Nuttallanthus texanus	No info
Oenothera pygmaea	N
Oenothera wolfii	N
Ophioglossum pusillum	?

Scientific Name	Groundwater Dependence
Orobanche ludoviciana var. arenosa	No info
Orthocarpus bracteosus	N
Orthocarpus imbricatus	N
Oryzopsis exigua	N
Oryzopsis hendersonii	N
Osmorhiza depauperata	N
Oxypolis occidentalis	?
Oxytropis sericea var. se	N
Packera dimorphophylla	NI
Packera flettii	N
Packera hesperia	N
Packera macounii	N
Packera porteri	N
Parnassia fimbriata var. hoodiana	?
Pedicularis centranthera	N
Pedicularis howellii	N
Pediocactus simpsonii var. robustior	N
Pellaea andromedifolia	N
Pellaea brachyptera	N
Pellaea breweri	N
Pellaea bridgesii	N
Pellaea mucronata ssp. mu	N
Penstemon barrettiae	N
Penstemon davidsonii var.	N
Penstemon deustus var variabilis	N
Penstemon elegantulus	No info
Penstemon glaucinus	N
Penstemon janishiae	No info
Penstemon kingii	NI
Penstemon peckii	N
Penstemon perpulcher	N
Penstemon rydbergii (hesperius)	N
Penstemon seorsus	No info
Penstemon spatulatus	No info
Perideridia erythrorhiza	N
Perideridia howellii	?
Perideridia oregana	N
Phacelia argentea	N
Phacelia gymnoclada	NI
Phacelia inundata	N
Phacelia leonis	?

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Phacelia linearis	N
Phacelia lutea var calva	No info
Phacelia lutea var. macke	N
Phacelia minutissima	No info
Phacelia sericea var. ciliosa	N
Phacelia verna	No info
Phlox hendersonii	N
Phlox multiflora	N
Phlox muscoides	N
Physaria chambersii	NI
Physostegia parviflora	?
Picea engelmannii	N
Pilularia americana	N
Pinus sabiniana	N
Pinus washoensis	N
Pityopus californica	N
Plagiobothrys austiniae	N
Plagiobothrys figuratus	N
Plagiobothrys figuratus ssp. corallicarpus	N
Plagiobothrys glyptocarpus	?
Plagiobothrys greenei	N
Plagiobothrys hirtus	N
Plagiobothrys lamprocarpus	?
Plagiobothrys nothofulvus	N
Plagiobothrys salsus	N
Plagiobothrys tenellus	N
Plantago aristata	N
Plantago eriopoda	?
Plantago macrocarpa	No info
Platanthera obtusata	?
Plectritis ciliosa	N
Poa arctica ssp. arctica	N
Poa howellii	N
Poa laxiflora	N
Poa marcida	N
Poa nervosa	N
Poa piperi	N
Poa rhizomata	N
Poa suksdorfii	No info
Poa unilateralis	N
Pogogyne floribunda	N
Polemonium carneum	N
Polemonium micranthum	N
Polyctenium williamsiae	?

Scientific Name	Groundwater Dependence
Polygonum californicum	N
Polygonum confertifolium	No info
Polygonum parryi	N
Polygonum polygaloides ssp. esotericum	N
Polygonum polygaloides var confertiflorum	N
Polygonum punctatum	?
Polypodium calirhiza	N
Polystichum californicum	N
Polystichum lemmonii	N
Potamogeton diversifolius	?
Potamogeton epihydrus ssp. nuttallii	?
Potamogeton filiformis	No info
Potamogeton foliosus var fibrillosus	?
Potamogeton zosteriformis	?
Potentilla biennis	N
Potentilla glandulosa ssp. globosa	N
Potentilla newberryi	?
Potentilla rivalis	N
Potentilla villosa	N
Primula cusickiana	N
Primula sp 1	No info
Prunus subcordata	N
Psilocarphus elatior	N
Psilocarphus tenellus var tenellus	?
Puccinellia kurilensis	?
Pyrrocoma (haplopappus) racemosa var r	N
Pyrrocoma hirta var sonchifolia	No info
Pyrrocoma racemosa	N
Pyrrocoma racemosa var. r	N
Pyrrocoma radiata	No info
Pyrrocoma uniflora var 1	N
Rafinesquia californica	N
Ranunculus alismaefolius var alismaefolius	N
Ranunculus austrooreganus	No info
Ranunculus californicus	N
Ranunculus glaberrimus var. reconditus	N
Ranunculus lobbii	?
Ranunculus macounii	?

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Ranunculus oresterus	?
Ranunculus populago	N
Ranunculus reconditus	N
Rhamnus crocea ssp. ilicifolia	N
Rhynchospora alba	?
Rhynchospora capitellata	?
Ribes hudsonianum var. petiolare	N
Ribes inerme var. klamathense	N
Ribes marshallii	N
Ribes oxyacanthoides ssp irriguum	N
Romanzoffia thompsonii	?
Rorippa columbiae	?
Rotala ramosior	?
Rubus bartonianus	N
Sairocarpus kingii	N
Salix bebbiana	?
Salix bonplandiana	N
Salix delnortensis	?
Salix farriae	?
Salix lasiolepis var. las	?
Salix lemmonii	?
Salix orestera	?
Salix prolixa	No info
Salix prolixa (rigida var macrogemma)	N
Salix vestita	N
Salix wolfii	?
Samolus valerandi ssp. pa	?
Sanicula arctopoides	N
Sanicula crassicaulis var tripartita	N
Saxifraga adscendens ssp.	?
Saxifraga cespitosa	N
Saxifraga hitchcockiana	N
Saxifraga oppositifolia	N
Saxifraga rivularis	N
Saxifragopsis fragarioides	N
Scheuchzeria palustris ssp. americana	?
Schizachyrium scoparium var. scoparium	N
Schoenoplectus heterochae	?
Schoenoplectus subtermina	?

Scientific Name	Groundwater Dependence
Scirpus cyperinus	?
Scirpus heterochaetus	?
Scirpus pendulus	N
Scirpus subterminalis	?
Scribneria bolanderi	N
Scutellaria angustifolia	N
Scutellaria antirrhinoides	No info
Scutellaria galericulata	?
Scutellaria holmgreniorum	N
Sedum debile	N
Sedum laxum ssp. heckneri	N
Sedum moranii	N
Sedum oblanceolatum	N
Sedum spathulifolium ssp.	N
Senecio ertterae	N
Senecio flettii	N
Senecio hesperius	N
Senecio hydrophilus	?
Senecio macounii	N
Senecio streptanthifolius var laetiflorus	N
Sericocarpus rigidus	N
Sesuvium verrucosum	?
Shorebird concentration a	N
Sidalcea campestris	?
Sidalcea cusickii	N
Sidalcea hendersonii	?
Sidalcea hickmanii ssp. 1	No info
Sidalcea hirtipes	N
Sidalcea malachroides	N
Sidalcea malviflora ssp virgata	N
Sidalcea malviflora ssp.	No info
Sidalcea nelsoniana	N
Silene douglasii var oraria	N
Silene douglasii var. monantha	N
Silene hookeri ssp. bolan	No info
Silene lemmonii	N
Silene nuda ssp. insectivora	N
Silene oregana	N
Silene scaposa var. scaposa	N
Silene scouleri ssp. gran	No info
Silene spaldingii	N
Sisyrinchium hitchcockii	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Sisyrinchium idahoense var segetum	N
Sisyrinchium sarmentosum	?
Smelowskia calycina	No info
Smilax californica	N
Smilax jamesii	?
Solanum parishii	N
Solidago gigantea	N
Sophora leachiana	N
Sorbus californica	N
Spiranthes porrifolia	?
Stachys palustris ssp. pilosa	N
Stanleya confertiflora	N
Stanleya viridiflora	N
Steironema ciliata	N
Stellaria humifusa	?
Stenotus lanuginosus	No info
Stephanomeria malheurensis	N
Stipa hendersonii	N
Streptanthus glandulosus	N
Streptanthus howellii	N
Streptopus streptopoides	No info
Stylocline psilocarphoide	N
Suaeda occidentalis	N
Suksdorfia violacea	N
Sullivantia hapemanii var. hapemanii	N
Sullivantia oregana	N
Swertia perennis	?
Symphoricarpos longiflorum	N
Symphyotrichum hallii	N
Synthyris missurica ssp stellata	No info
Synthyris missurica ssp. hirsuta	N
Synthyris missurica ssp. missurica	N
Synthyris schizantha	No info
Talinum spinescens	N
Taraxacum officinale ssp.	N
Tauschia howellii	N
Tauschia stricklandii	No info
Tauschia stricklandii	NI
Thalictrum alpinum var. h	N
Thelypodium brachycarpum	N
Thelypodium eucosmum	?
Thelypodium howellii ssp howellii	N
Thelypodium howellii ssp spectabilis	N
Thelypodium howellii ssp.	N
Thelypodium lasiophyllum	N
Thelypodium milleflorum	N
Thelypteris nevadensis	?
Thlaspi montanum var. sis	No info
Tonella tenella	No info
Townsendia alpigena	No info
Townsendia parryi	N
Triantha glutinosa	?
Trichostema lanceolatum	N
Trichostema oblongum	N
Trifolium ciliolatum	N
Trifolium cyathiferum	N
Trifolium dichotomum	N
Trifolium douglasii	?
Trifolium eriocephalum ssp eriocephalum	N
Trifolium eriocephalum ssp. arcuatum	N
Trifolium gymnocarpon var. plummerae	N
Trifolium leibergii	N
Trifolium owyheense	N
Trifolium plumosum ssp amplifolium	N
Triglochin concinnum var concinnum	?
Trillium kurabayashii	N
Trillium ovatum var hibbersonii	No info
Trillium parviflorum	N
Trimorpha acris var. debilis	N
Triphysaria versicolor ssp versicolor	No info
Triteleia (brodiaea) grandiflora var howellii	N
Triteleia crocea var. cro	N
Triteleia grandiflora var	N
Triteleia hendersonii var leachiae	N
Triteleia ixioides ssp. s	N
Triteleia laxa	N
Trollius laxus ssp. albif	?
Uropappus (microseris) lindleyi	N

Table C-5 *(continued)*

Scientific Name	Groundwater Dependence
Utricularia gibba	?
Utricularia intermedia	?
Utricularia minor	?
Utricularia ochroleuca	N
Vaccinium oxycoccos	?
Valeriana occidentalis	N
Vancouveria chrysantha	N
Veratrum insolitum	N
Verbena hastata	N
Veronica anagallis-aquatica	?
Viola hallii	N
Viola lanceolata ssp occidentalis	?
Viola langsdorfii	?
Viola praemorsa ssp praemorsa	N
Wolffia borealis	?
Wolffia columbiana	?
Yabea microcarpa	N
Zigadenus fontanus	?
Zigadenus paniculatus	N
Zizia aptera	N
Zizia aptera var occidentalis	N

Table C-6: Bryophytes of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Scientific Name	Groundwater Dependence
Andreaea rothii	N
Andreaea schofieldiana	N
Aulacomnium palustre (Hedw.) Schwaegr.	?
Barbula eustegia	N
Brachydontium olympicum	N
Brachythecium frigidum (C. Muell.) Besch.	?
Brachythecium rivulare Schimp. in B.S.G.	?
Bruchia bolanderi	N
Bruchia flexuosa	?
Bryoerythrophyllum columbianum	N
Bryum calobryoides	N
Bryum meesioides Kindb. in Mac.	?
Bryum miniatum Lesq.	?
Bryum pallens (Brid.) Sw. in Roehl.	?
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb.	?
Bryum violaceum	N
Buxbaumia aphylla	N
Calliergon cordifolium (Hedw.) Kindb.	?
Calliergon giganteum (Schimp.) Kindb.	?
Calliergon stramineum (Brid.) Kindb.	?
Calliergon trifarium	Y
Calliergonella cuspidata (Hedw.) Loeske	?
Campylium chrysophyllum (Brid.) J. Lange	?
Campylium polygamum (Schimp. in B.S.G.) C. Jens.	?
Campylium stellatum (Hedw.) C. Jens.	?
Campylopus schmidii	?
Climacium dendroides (Hedw.) Web. & Mohr	?
Conardia compacta (C. Muell.) Robins.	?
Conostomum tetragonum	N
Crumia latifolia	Y
Desmatodon heimii (Hedw.) Mitt.	?
Dichelyma falcatum (Hedw.) Myr.	?
Dichelyma uncinatum Mitt.	?
Dichodontium pellucidum (Hedw.) Schimp.	?
Dicranella palustris (Dicks.) Crundw. ex Warb.	?
Didymodon tophaceus (Brid.) Lisa	?
Ditrichum schimperi	N
Drepanocladus aduncus var. aduncus	?
Drepanocladus aduncus var. kneiffii (Schimp. in B.S.G.) Moenk.	?
Drepanocladus crassicostatus	?
Encalypta brevicolla var. crumiana	N
Encalypta brevipes	N
Encalypta intermedia	No info
Entosthodon fascicularis	N
Ephemerum crassinervium	?

Table C-6 *(continued)*

Scientific Name	Groundwater Dependence
Ephemerum serratum	?
Eurhynchium praelongum (Hedw.) Schimp. in B.S.G.	?
Fissidens adianthoides Hedw.	?
Fissidens fontanus (B. Pyl.) Steud.	?
Fissidens grandifrons	?
Fissidens osmundioides Hedw.	?
Fissidens pauperculus	N
Fissidens ventricosus Lesq.	?
Fontinalis antipyretica var. antipyretica	?
Fontinalis antipyretica var. oregonensis	?
Fontinalis neomexicana Sull. & Lesq.	?
Funaria muhlenbergii	N
Grimmia anomala	N
Hamatocaulis vernicosus (Mitt.) Hedenas	?
Helodium blandowii	Y
Helodium blandowii var. blandowii	Y
Homalia trichomanioides	N
Hookeria acutifolia Hook. & Grev.	?
Hookeria lucens (Hedw.) Sm.	?
Hygroamblystegium tenax (Hedw.) Jenn.	?
Hygrohypnum bestii (Ren. & Bryhn in Ren.) Broth.	?
Hygrohypnum luridum (Hedw.) Jenn.	?
Hygrohypnum molle (Hedw.) Loeske	?
Hygrohypnum montanum (Lindb.) Broth.	?
Hygrohypnum norvegicum (Schimp. in B.S.G.) Amann	?
Hygrohypnum ochraceum (Turn. ex Wils.) Loeske	?
Hygrohypnum smithii (Sw. in Lilj.) Broth.	?
Iwatsukiella leucotricha	N
Jamesoniella autumnalis var. heterostipa	Y
Leptodictyum riparium (Hedw.) Warnst.	?
Limbella fryei	Y
Meesia triquetra (Richt.) Aongstr.	?
Meesia uliginosa	Y
Micromitrium synoicum	Y
Myurella julacea	N
Orthotrichum hallii	N
Orthotrichum pylaisii	N
Orthotrichum rivulare Turn.	?
Palustriella commutata (Brid.) Ochyra	?
Philonotis capillaris Lindb. in Hartm.	?
Philonotis fontana var. americana (Dism.) Flow.	?
Philonotis fontana var. fontana(Hedw.) Brid.	?
Philonotis fontana var. pumila (Turn.) Brid.	?
Physcomitrella patens	Y
Physcomitrium immersum	Y
Plagiomnium ellipticum (Brid.) T. Kop.	?
Plagiopus oederiana	N
Platyhypnidium riparioides	?
Pohlia sphagnicola	Y

Table C-6 *(continued)*

Scientific Name	Groundwater Dependence
Pohlia wahlenbergii (Web. & Mohr) Andrews	?
Polytrichum sphaerothecium	N
Polytrichum strictum	Y
Porotrichum bigelovii (Sull.) Kindb.	?
Pseudephemerum nitidum	Y
Racomitrium aciculare (Hedw.) Brid.	?
Racomitrium aquaticum (Brid. ex Schrad.) Brid.	?
Rhizomnium magnifolium (Horik.) T. Kop.	?
Rhizomnium nudum	Y
Rhizomnium pseudopunctatum (Bruch & Schimp.) T. Kop.	?
Rhytidiadelphus squarrosus	?
Rhytidium rugosum	N
Sanionia uncinata var. symmetrica OBL	?
Sanionia uncinata var. uncinata	?
Schistostega pennata	N
Scouleria aquatica Hook. in Drumm.	?
Scouleria marginata	?
Sphagnum angustifolium (C. Jens. in Russ.) C. Jens. in Tolf	?
Sphagnum capillifolium (Ehrh.) Hedw.	?
Sphagnum compactum DC. in Lam. & DC.	?
Sphagnum contortum Schultz	?
Sphagnum fallax (Klinggr.) Klinggr.	?
Sphagnum fimbriatum Wils. in Wils. & Hook. f. in Hook. f.	?
Sphagnum fuscum (Schimp.) Klinggr.	?
Sphagnum girgensohnii Russ.	?
Sphagnum henryense Warst.	?
Sphagnum mendocinum Sull. & Lesq. in Sull.	?
Sphagnum palustre L.	?
Sphagnum papillosum Lindb.	?
Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.	?
Sphagnum quinquefarium (Lindb. ex Braithw.) Warnst.	?
Sphagnum rubellum Wils.	?
Sphagnum russowii Warnst.	?
Sphagnum squarrosum Crome	?
Sphagnum subnitens Russ. & Warnst. in Warnst.	?
Sphagnum subsecundum Nees in Sturm	?
Sphagnum tenellum (Brid.) Bory	?
Sphagnum teres (Schimp.) Aongstr. in Hartm.	?
Sphagnum warnstorfii Russ.	?
Splachnum ampullaceum	Y
Splachnum ampullaceum Hedw.	?
Tayloria serrata (Hedw.) Bruch & Schimp. in B.S.G.	?
Tetraphis geniculata	N
Tetraplodon mnioides	?
Thamnobryum neckeroides	Y
Tomentypnum nitens	Y
Trematodon boasii	?
Trichostomopsis australasiae	N
Tripterocladium leucocladulum	N

Table C-6 *(continued)*

Scientific Name	Groundwater Dependence
Triquetrella californica	N
Tritomaria quinquedentata	N
Warnstorfia exannulata (Schimp. in B.S.G.) Loeske	?
Warnstorfia fluitans (Hedw.) Loeske	?

Table C-7: Fungi of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Scientific Name	Groundwater Dependence
Amanita farinosa	N
Amanita lanei	N
Cyphellostereum laeve	No info
Oxyporus nobilissimus	?
Phaeocollybia gregaria	N
Phaeocollybia oregonensis	N
Ramaria celerivirescens	N
Ramaria maculatipes	N
Ramaria verlotensis	N

Table C-8: Lichens of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Scientific Name	Groundwater Dependence
Ahtiana pallidula	N
Ahtiana sphaerosporella	N
Alectoria lata	N
Alectoria nigricans	N
Aloina bifrons	N
Brodoa oroarctica	N
Bryoria bicolor	N
Bryoria pseudocapillaris	N
Bryoria spiralifera	N
Bryoria subcana	N
Bryoria tortuosa	N
Calicium adaequatum	N
Calicium glaucellum	N
Cetraria subalpina	N
Cetrelia cetrarioides	N
Chaenotheca brunneola	N
Chaenotheca chrysocephala	N
Chaenotheca furfuracea	N
Cladidium bolanderi	N
Cladonia luteoalba	N
Cladonia norvegica	N
Dendriscocaulon intricatulum	N
Dermatocarpom lorenzianum	N
Erioderma sorediatum	N
Heterodermia japonica	N
Heterodermia leucomelos	N
Hypogymnia duplicata	N
Hypogymnia heterophylla	N
Hypogymnia oceanica	N
Hypogymnia pulverata	N
Hypogymnia subphysodes	N
Kaernefeltia californica	N
Lecanora pringlei	N
Leioderma sorediatum	N
Leptogium brebissonii	N
Leptogium rivale	N
Lobaria hallii	N
Lobaria linita	N
Lobaria scrobiculata	N
Nephroma occultum	N
Niebla cephalota	N
Ophioparma lapponica	N
Pannaria rubiginosa	N
Pilophorus nigricaulis	N
Protoparmelia ochrococca	N

Table C-8 *(continued)*

Scientific Name	Groundwater Dependence
Pseudocyphellaria crocata	N
Pseudocyphellaria mallota	N
Pseudocyphellaria perpetua	N
Pseudocyphellaria rainierensis	N
Pseudoleskeella serpentinensis	N
Pyrrhospora quernea	N
Ramalina thrausta	N
Stereocaulon spathuliferum	N
Sticta arctica	N
Sticta weigelii	N
Sulcaria badia	N
Teloschistes flavicans	N
Texosporium sancti-jacobi	N
Thelomma mammosum	N
Tholurna dissimilis	N
Umbilicaria angulata	N
Umbilicaria cylindrica	N
Umbilicaria havaasii	N
Umbilicaria phaea	N
Umbilicaria polyrrhiza	N
Umbilicaria proboscidea	N
Umbilicaria vellea	N
Usnea hesperina	N
Usnea longissima	N
Usnea sphacelata	N
Usnea wirthii	N
Vestergrenopsis isidiata	N
Xanthoparmelia mougeotii	N

Table C-9: Liverworts of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Scientific Name	Groundwater Dependence
Anastrophyllum minutum	N
Barbilophozia lycopodioides	No info
Calypogeia sphagnicola	Y
Cephaloziella spinigera	Y
Chiloscyphus gemmiparus	Y
Cryptomitrium tenerum	No info
Diplophyllum plicatum	N
Gymnomitrion concinnatum	N
Haplomitrium hookeri	Y
Herbertus aduncus	N
Herbertus sakuraii	N
Jungermannia polaris	No info
Kurzia makinoana	N
Lophozia laxa	Y
Marsupella condensata	N
Marsupella emarginata var. aquatica	?
Marsupella sparsifolia	N
Metzgeria temperata	N
Nardia japonica	N
Peltolepis quadrata	No info
Plagiochila semidecurrens var alaskana	N
Porella vernicosa var. fauriei	N
Preissia quadrata	?
Radula brunnea	N
Scapania gymnostomophila	N
Scapania obscura	N
Schofieldia monticola	?
Sphaerocarpos hians	?
Tritomaria exsectiformis	Y
Tritomaria quinquedentata	N

Table C-10: Amphibians of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common name	Scientific Name	Scientific Name Used in Ecoregional Assessments	Groundwater Dependence
Blotched Tiger Salamander	Ambystoma tigrinum melanostict		?
Tiger Salamander	Ambystoma tigrinum	Ambystoma tigrinum	?
Clouded Salamander	Aneides ferreus	Aneides ferreus	N
Black Salamander	Aneides flavipunctatus	Aneides flavipunctatus	N
Rocky Mountain Tailed frog	Ascaphus montanus		?
Coastal Tailed Frog	Ascaphus truei	Ascaphus truei	?
California Slender Salamander	Batrachoseps attenuatus		N
Oregon slender salamander	Batrachoseps wrighti	Batrachoseps wrighti	N
Boreal toad	Bufo boreas boreas	Bufo boreas	?
Rocky Mountain toad	Bufo woodhousii woodhousii	Bufo woodhousii	?
Cope's Giant Salamander	Dicamptodon copei	Dicamptodon copei	?
Coastal giant salamander	Dicamptodon tenebrosus	Dicamptodon tenebrosus	?
Dunn's Salamander	Plethodon dunni	Plethodon dunni	N
Del Norte salamander	Plethodon elongatus	Plethodon elongatus	N
Larch mountain salamander	Plethodon larselli	Plethodon larselli	N
Siskiyou Mountains Salamander	Plethodon stormi	Plethodon stormi	N
Pacific Chorus Frog	Pseudacris regilla		?
Northern Red-legged Frog	Rana aurora	Rana aurora aurora	?
Foothill Yellow-legged Frog	Rana boylii	Rana boylii	?
Cascades Frog	Rana cascadae	Rana cascadae	?
Red-legged Frog	Rana draytoni	Rana aurora	?
Columbia Spotted Frog	Rana luteiventris	Rana luteiventrus	?
Northern Leopard Frog	Rana pipiens	Rana pipiens	?
Oregon spotted frog	Rana pretiosa	Rana pretiosa	?
Cascade Torrent Salamander	Rhyacotriton cascadae	Rhyacotriton cascadae	?
Columbia torrent salamander	Rhyacotriton kezeri	Rhyacotriton kezeri	?
Olympic Torrent Salamander	Rhyacotriton olympicus	Rhyacotriton olympicus	?
Southern torrent salamander	Rhyacotriton variegatus	Rhyacotriton variegatus	?
Roughskin Newt	Taricha granulosa		?
Crater Lake Newt	Taricha granulosa mazamae	Taricha granulosa mazamae	?

Table C-11: Reptiles of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common name	Scientific Name	Scientific Name Used in Ecoregional Assessments	Groundwater Dependence
Northern Pacific Pond Turtle	Actinemys marmorata marmorata	Clemmys marmorata	?
Northern Pacific Pond Turtle	Actinemys marmorata marmorata	Clemmys marmorata marmorata	?
Northern Pacific Pond Turtle	Actinemys marmorata marmorata	Emys marmorata	?
Northern Pacific Pond Turtle	Actinemys marmorata marmorata	Emys marmorata marmorata	?
California Slender Salamander	Batrachoseps attenuatus		N
Western Painted Turtle	Chrysemys picta bellii	Chrysemys picta	?
Western Yellow-Bellied Racer	Coluber constrictor mormon	Coluber constrictor	N
Sharptail Snake	Contia tenuis	Contia tenuis	N
Great Basin Rattlesnake	Crotalus viridis lutosus	Crotalus viridis	N
Northern Pacific Rattlesnake	Crotalus viridis oreganus	Crotalus viridis	N
Great Basin Collared Lizard	Crotaphytus bicinctores	Crotaphytus bicinctores	N
Northwestern Ring-necked snake	Diadophis punctatus occidentalis	Diadophis punctatus amabilis	N
Ensatina	Ensatina eschscholtzii		N
Nightsnake	Hypsiglena torquata		N
California Kingsnake	Lampropeltis getula californiae	Lampropeltis getula	N
California Mountain Kingsnake	Lampropeltis zonata	Lampropeltis zonata	N
Desert Striped Whipsnake	Masticophis taeniatus taeniatus	Masticophis taeniatus	N
Pigmy Short-Horned Lizard	Phrynosoma douglasii	Phrynosoma douglasii	N
Northern Desert Horned Lizard	Phrynosoma platyrhinos platyrhinos	Phrynosoma platyrhinos	N
Pacific gopher snake	Pituophis catenifer catenifer	Pituophis catenifer catenifer	N
Great Basin gopher snake	Pituophis catenifer deserticola		N
Western Redback Salamander	Plethodon vehiculum		N
Western Longnose Snake	Rhinocheilus lecontei lecontei	Rhinocheilus lecontei	N
Northern Sagebrush Lizard	Sceloporus graciosus graciosus		N
Great Basin fence lizard	Sceloporus occidentalis longipes		N
Northwestern fence lizard	Sceloporus occidentalis occidentalis	Sceloporus occidentalis	N
Variable Ground Snake	Sonora semiannulata semiannulata	Sonora semiannulata	N

Table C-12: Beetles of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common Name	Scientific name	Groundwater Dependence
Marsh carabid beetle	Acupalpus punctulatus	?
Beller's Ground Beetle	Agonum belleri	?
	Bradycellus fenderi	N
Acneus burnelli	Burnell's false water penny beetle	?
Potentilla Root Borer Beetle	Chrysobothris potentillae	N
St Anthony Sand Dunes Tiger Beetle	Cicindela arenicola	N
Columbia river tiger beetle	Cicindela columbica	?
Siuslaw Sand Tiger Beetle	Cicindela hirticollis siuslawensis	?
Big idol leaf beetle	Donacia idola	?
Hatch's click beetle	Eanus hatchi	?
	Gilbertiola helferi	N
Blind cave leiodid beetle	Glacicavicola bathyscioides	Y
	Nebria acuta quileuta	?
	Nebria danmanni	N
	Nebria meanyi sylvatica	?
Wood-borer beetle	Oistus edmonstoni	N
	Platyceropsis keeni	N
	Pterostichus campbelli	?
	Pterostichus humidulus	?
	Pterostichus lanei	N
Roth's Blind Ground Beetle	Pterostichus rothi	N
Hatch's Scaphinotus	Scaphinotus hatchi	N
	Scaphinotus johnsoni	N
	Stomis termitiformis	N
	Stygoporus oregonensis	Y
	Trechus humboldti	N
Weevil	Trigonoscuta pilosa	N

Table C-13: Birds of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent; I = indirectly groundwater dependent. Includes complete species list, not just those with location information.

Common Name	Scientific Name	Groundwater Dependence
Cooper's hawk	Accipiter cooperii	I
Northern Goshawk	Accipiter gentilis	N
Clark's Grebe	Aechmophorus clarkii	?
Western Grebe	Aechmophorus occidentalis	?
Boreal Owl	Aegolius funereus	N
Tricolored Blackbird	Agelaius tricolor	?
Grasshopper Sparrow	Ammodramus savannarum	N
Sage Sparrow	Amphispiza belli	N
Black-Throated Sparrow	Amphispiza bilineata	N
Tule White-Fronted Goose	Anser albifrons frontalis	?
American Pipit	Anthus rubescens	?
Surfbird	Aphriza virgata	?
Golden Eagle	Aquila chrysaetos	N
Black-Chinned Hummingbird	Archilochus alexandri	N
Ruby-throated Hummingbird	Archilochus colubris	N
Great Egret	Ardea alba	?
Great Blue Heron	Ardea herodias	?
Black Turnstone	Arenaria melanocephala	?
Short-Eared Owl	Asio flammeus	I
Long-Eared Owl	Asio otus	I
Burrowing Owl	Athene cunicularia	N
Lesser Scaup	Aythya affinis	?
Ring-necked Duck	Aythya collaris	?
Upland sandpiper	Bartramia longicauda	N
Marbled Murrelet	Brachyramphus marmoratus	I
Brant	Branta bernicla	?
Aleutian Canada Goose	Branta canadensis leucopareia	?
Dusky Canada Goose	Branta canadensis occidentalis	?
Aleutian Canada Goose	Branta hutchinsii leucopa	?
Cackling Canada Goose	Branta hutchinsii minima	?
Bufflehead	Bucephala albeola	?
Common Goldeneye	Bucephala clangula	?
Barrow's Goldeneye	Bucephala islandica	?
Ferruginous Hawk	Buteo regalis	N
Swainson's hawk	Buteo swainsoni	I
Dunlin	Calidris alpina	?
Rock Sandpiper	Calidris ptilocnemis	?
Willet	Catoptrophorus semipalmate	?
Greater Sage-Grouse	Centrocercus urophasianus	N
Western Sage Grouse	Centrocercus urophasianus phaios	N
Pigeon Guillemot	Cepphus columba	N
Rhinoceros Auklet	Cerorhinca monocerata	N
Brown Creeper	Certhia americana	N
Vaux's Swift	Chaetura vauxi	N
Western Snowy Plover	Charadrius alexandrinus nivosus	?

Table C-13 *(continued)*

Common Name	Scientific Name	Groundwater Dependence
Semipalmated Plover	Charadrius semipalmatus	N
Killdeer	Charadrius vociferus	?
Snow Goose	Chen caerulescens	?
Lesser Snow Goose	Chen caerulescens caerulescens	?
Ross's Goose	Chen Rossii	?
Black Tern	Chlidonias niger	?
Common Nighthawk	Chordeiles minor	N
Yellow-Billed Cuckoo	Coccyzus americanus	N
Band-Tailed Pigeon	Columba fasciata **(**Patagioenas fasciata)	Y
Olive-Sided Flycatcher	Contopus cooperi	N
Western Wood-Peewee	Contopus sordidulus	N
Yellow Rail	Coturnicops noveboracensis	?
Trumpeter Swan	Cygnus buccinator	?
Tundra Swan	Cygnus columbianus	?
Black Swift	Cypseloides niger	?
Blue Grouse	Dendragapus obscurus	N
Black-Throated Gray Warbler	Dendroica nigrescens	N
Hermit Warbler	Dendroica occidentalis	N
Townsend's Warbler	Dendroica townsendi	N
Bobolink	Dolichonyx oryzivorus	?
Pileated Woodpecker	Dryocopus pileatus	N
Snowy Egret	Egretta thula	?
Pacific-Slope Flycatcher	Empidonax difficilis	?
Willow Flycatcher	Empidonax traillii brewsteri	?
Gray Flycatcher	Empidonax wrightii	N
Streaked Horned Lark	Eremophila alpestris strigata	N
Prairie Falcon	Falco mexicanus	N
American Peregrine Falcon	Falco peregrinus anatum	N
Peale's Peregrine Falcon]	Falco peregrinus pealei	N
Tufted Puffin	Fratercula cirrhata	N
Common Loon	Gavia immer	?
Greater Sandhill Crane	Grus canadensis tabida	?
Black Oystercatcher	Haematopus bachmani	?
Bald Eagle	Haliaeetus leucocephalus	N
Harlequin Duck	Histrionicus histrionicus	?
Bullock's Oriole	Icterus galbula	N
Western Least Bittern	Ixobrychus exilis hesperis	?
White-Tailed Ptarmigan	Lagopus leucurus	N
Loggerhead Shrike	Lanius ludovicianus	N
California gull	Larus californicus	?
Glaucous-winged Gull	Larus glaucescens	N
Western Gull	Larus occidentalis	?
Franklin's Gull	Larus pipixcan	?
Wallowa rosy-finch	Leucosticte tephrocotis wallowa	N
Acorn Woodpecker	Melanerpes formicivorus	N
Lewis' Woodpecker	Melanerpes lewis	I
Surf Scoter	Melanitta perspicillata	?
Long-billed Curlew	Numenius americanus	?
Whimbrel	Numenius phaeopus	?

Table C-13 *(continued)*

Common Name	Scientific Name	Groundwater Dependence
Fork-tailed Storm-petrel	Oceanodroma furcata	N
Leach's Storm-Petrel	Oceanodroma leucorhoa	N
Mountain quail	Oreortyx pictus	N
Sage Thrasher	Oreoscoptes montanus	N
Flammulated owl	Otus flammeolus	N
Osprey	Pandion haliaetus	?
American white pelican	Pelecanus erythrorhynchos	?
California Brown Pelican	Pelecanus occidentalis ca	N
Double-Crested Cormorant	Phalacrocorax auritus	?
Pelagic Cormorant	Phalacrocorax pelagicus	N
Brandt's Cormorant	Phalacrocorax penicillatu	N
White-Headed Woodpecker	Picoides albolarvatus	N
Black-Backed Woodpecker	Picoides arcticus	N
Three-toed Woodpecker	Picoides dorsalis	N
Green-Tailed Towhee	Pipilo chlorurus	N
White-Faced Ibis	Plegadis chihi	?
Horned Grebe	Podiceps auritus	?
Red-necked Grebe	Podiceps grisegena	?
Chestnut-Backed Chickadee	Poecile rufescens	N
Blue-gray Gnatcatcher	Polioptila caerulea	N
Oregon Vesper Sparrow	Pooecetes gramineus affinis	N
Purple Martin	Progne subis	N
Cassin's Auklet	Ptychoramphus aleuticus	N
Golden-Crowned Kinglet	Regulus satrapa	N
Bank Swallow	Riparia riparia	?
Northern Waterthrush	Seiurus noveboracensis	?
Rufous Hummingbird	Selasphorus rufous	N
Allen's Hummingbird	Selasphorus sasin	N
Western Bluebird	Sialia mexicana	N
White-Breasted Nuthatch	Sitta carolinensis aculeata	N
Pygmy nuthatch	Sitta pygmaea	N
Western Burrowing Owl	Speotyto cunicularia hypugaea	N
Red-Breasted Sapsucker	Sphyrapicus ruber	N
Williamson's Sapsucker	Sphyrapicus thyroideus	N
Calliope Hummingbird	Stellula calliope	?
Caspian Tern	Sterna caspia	?
Forster's Tern	Sterna forsteri	?
Great Gray Owl	Strix nebulosa	I
Northern Spotted Owl	Strix occidentalis caurina	N
Western Meadowlark	Sturnella neglecta	N
Greater Yellowlegs	Tringa melanoleuca	?
Columbian sharp-tailed grouse	Tympanuchus phasianellus columbianus	N
Common Murre	Uria aalge	N

Table C-14: Butterflies and Moths of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common Name	Scientific Name	Groundwater Dependence
Roadside Skipper	Amblyscirtes vialis	?
Astarte Fritillary	Boloria astarte astarte	N
Meadow Fritillary	Boloria bellona	?
Dark-bordered Fritillary	Boloria selene atrocostalis	?
Silver-bordered fritillary butterfly	Boloria selene tollandensis	?
Barry's Hairstreak	Callophrys gryneus barryi	N
Johnson's (Mistletoe) Hairstreak	Callophrys johnsoni (mitoura johnsoni)	N
Rosner's Hairstreak	Callophrys nelsoni rosneri	N
Obscure Elfin (Butterfly)	Callophrys polios maritima (incisalia p. M.)	N
Endemic moth	Catocala allusa	No info
Newly Discovered Moth Of Or & Wa Sphagnum Bogs	Cerastius gloriosum (or cerastis gloriosa)	?
Dark-Bordered Fritillary	Clossiana selene atrocostalis	Y
Ringlet	Coenonympha tullia eunomia	?
Subspecies Of Ringlet Only	Coenonympha tullia insulana	?
Golden Sulphur	Colias occidentalis chrysomelas	N
Western sulphur	Colias occidentalis occidentalis	?
Intermountain Sulphur	Colias occidentalis pseudochristina	?
Island marble (Large marble new subspecies?)	Euchloe ausonides insulanus	N
Edith's Checkerspot	Euphydryas editha colonia	N
Taylor's checkerspot	Euphydryas editha taylori	N
Golden Hairstreak	Habrodais grunus	N
Oregon branded skipper	Hesperia comma oregonia	N
Fender's blue	Icaricia icarioides fenderi	N
Lustrous Copper	Lycaena cupreus	N
Edith's copper	Lycaena editha	?
Makah (Queen Charlotte) Copper	Lycaena mariposa charlottensis	Y
Johnson's hairstreak	Mitoura johnsoni	N
Juniper hairstreak	Mitoura siva	N
Compton tortoise shell	Nymphalis vau-album	?
Woodland Skipper - Coastal Subspecies	Ochlodes sylvanoides orecoastus	N
Yuma Skipper	Ochlodes yuma	?
Spring White	Pieris sisymbrii flavitincta	N
Greenish Blue	Plebeius saepiolus (all ssp in area)	?
Acmon Blue	Plebejus acmon spangelatus	N
Fender's Blue	Plebejus icarioides fenderi	N
Insular Blue Butterfly	Plebejus saepiolus littoralis	?
Mardon skipper	Polites mardon	N
Long Dash	Polites mystic	?
Peck's Skipper	Polites peckius	?
Sandhill Skipper	Polites sabuleti	?

Table C-14 *(continued)*

Common Name	Scientific Name	Groundwater Dependence
Dog star skipper	Polites sonora siris	N
Clark's sphinx moth	Proserpinus clarkiae	N
Sylvan Hairstreak	Satyrium sylvinum	?
Sylvan hairstreak	Satyrium sylvinum sylvinum	?
Willamette callippe fritillary	Speyeria callippe ssp 1	N
Great Basin fritillary	Speyeria egleis	N
Egleis fritillary	Speyeria egleis mcdunnoughi	?
Valley Silverspot Butterfly	Speyeria zerene bremnerii	?
Bremner's silverspot	Speyeria zerene bremnerii	?
Oregon Silverspot Butterfly	Speyeria zerene hippolyta	?

Table C-15: Caddisflies of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common Name	Scientific Name	Groundwater Dependence
An agapetus caddisfly	Agapetus montanus	Not found in OR
Scott's Caddisfly	Allomyia scotti	Y
Cascades apatanian caddisfly	Apatania tavala	?
Vertrees's ceraclean caddisfly	Ceraclea vertreesi	?
Caddisfly Ceratopsyche abella	Ceratopsyche abella	?
A Caddisfly	Ceratopsyche amblis	?
Blue mountains cryptochian caddisfly	Cryptochia neosa	?
Oregon Dolophilodes Caddisfly	Dolophilodes oregonus	?
Mt Hood Primitive Brachycentrid Caddisfly	Eobrachycentrus gelidae	Y
Green Springs Mountain Farulan Caddisfly	Farula davisi	Y
Mt Hood Farulan Caddisfly	Farula jewetti	Y
Tombstone Prairie Farulan Caddisfly	Farula reapiri	Y
Schuh's Homoplectran Caddisfly	Homoplectra schuhi	Y
A Caddisfly	Lepidostoma astaneum	?
Fort Dick Limnephilus Caddisfly	Limnephilus atercus	?
Columbia Gorge Neothremman Caddisfly	Neothremma andersoni	Y
Alsea Ochrotrichian Micro Caddisfly	Ochrotrichia alsea	?
Deschutes Ochrotrichian Micro Caddisfly	Ochrotrichia phenosa	?
Vertrees's Ochrotrichian Micro Caddisfly	Ochrotrichia vertreesi	?
Tombstone Prairie Oligophiebodes Caddisfly	Oligophlebodes mostbento	?
Obrien Rhyacophilan Caddisfly	Rhyacophila colonus	?
Fender's Rhyacophilan Caddisfly	Rhyacophila fenderi	Y
Haddock's Rhyacophilan Cad	Rhyacophila haddocki	Y
One-spot Rhyacophilan Caddisfly	Rhyacophila unipunctata	Y
Caddisfly Tinodes siskiyou	Tinodes siskiyou	?

Table C-16: Dragonflies, Mayflies, and Stoneflies of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Scientific Name	Groundwater Dependence
Aeshna juncea	Y
Aeshna sitchensis	Y
Aeshna subarctica	Y
Argia alberta	Y
Argia nahuana	Y
Capnia kersti	?
Coenagrion interrogatum	Not found in OR
Enallagma optimolocus	Not found in OR
Ischnura denticollis	Y
Isoperla muir	?
Libellula comanche	Y
Libellula composita	Y
Libellula nodisticta	Y
Libellula subornata	Y
Nehalennia irene	Y
Somatochlora albicincta	?
Somatochlora franklini	Not found in OR
Somatochlora walshii	Y
Somatochlora whitehousei	Not found in OR
Tanypteryx hageni	Y
Zapada cordillera	?
Zapada wahkeena	?

Table C-17: Fish of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common name	Scientific Name	Groundwater Dependence
Green Sturgeon	Acipenser medirostris	?
White sturgeon	Acipenser transmontanus	?
Bridgelip Sucker	Catostomus columbianus	?
Modoc Sucker	Catostomus microps	?
Goose Lake Sucker	Catostomus occidentalis lacusanserinus	?
Jenny Creek Sucker	Catostomus rimiculus pop. 1	?
Klamath smallscale sucker (Jenny Creek pop)	Catostomus riminculus ssp.	?
Klamath Largescale Sucker	Catostomus snyderi	?
Tahoe Sucker	Catostomus tahoensis	?
Warner Sucker	Catostomus warnerensis	?
Shortnose Sucker	Chasmistes brevirostris	?
Pacific herring spawning	Clupea pallasi	N
Malheur mottled sculpin	Cottus bairdi ssp 1	?
Malheur Sculpin	Cottus bendirei	?
Margined sculpin	Cottus marginatus	?
Pit Sculpin	Cottus pitensis	?
Klamath Lake Sculpin	Cottus princeps	?
Slender Sculpin	Cottus tenuis	?
Lost River Sucker	Deltistes luxatus	?
Klamath Brook Lamprey	Entosphenus sp.	?
Pacific lamprey	Entosphenus tridentatus	?
Alvord Chub	Gila alvordensis	?
Sheldon Tui Chub	Gila bicolor eurysoma	?
X-L Spring Tui Chub	Gila bicolor oregonensis	Y
Hutton Tui Chub	Gila bicolor ssp. 1	Y
Summer Basin Tui Chub	Gila bicolor ssp. 13	?
Catlow Tui Chub	Gila bicolor ssp. 2	?
Borax Lake Chub	Gila boraxobius	Y
River lamprey	Lampetra ayresi	?
Pit-klamath Brook Lamprey	Lampetra lethophaga	?
Miller Lake Lamprey	Lampetra minima	?
Pacific Lamprey	Lampetra tridentata	?
Goose Lake Lamprey	Lampetra tridentata ssp. 1	?
Pit Roach	Lavinia symmetricus mitrulus	?
Westslope cutthroat trout	Oncorhynchus clarki lewisi	?
Lahontan Cutthroat Trout	Oncorhynchus clarkii henshawi	?
Cutthroat Trout - Southwestern Washington/Columbia River	Oncorhynchus clarkii pop. 2	?
Chum salmon	Oncorhynchus keta	?
Chum Salmon - Columbia River	Oncorhynchus keta pop. 3	?
Chum Salmon - Pacific Coast	Oncorhynchus keta pop. 4	?
Coho Salmon - Southern Oregon/northern California Coast	Oncorhynchus kisutch pop. 2	?
Coho Salmon - Oregon Coast	Oncorhynchus kisutch pop. 3	?

Table C-17 *(continued)*

Common name	Scientific Name	Groundwater Dependence
Inland columbia basin redband trout	Oncorhynchus mykiss gairdneri	?
Snake river basin steelhead	Oncorhynchus mykiss pop 13	?
Oregon great basin redband trout	Oncorhynchus mykiss pop 18	?
Steelhead - middle columbia river summer run	Oncorhynchus mykiss pop 28	?
Redband Trout - Klamath Basin	Oncorhynchus mykiss pop. 19	?
Redband Trout - Jenny Creek	Oncorhynchus mykiss pop. 2	?
Steelhead - Klamath Mountains Province Summer Run	Oncorhynchus mykiss pop. 24	?
Steelhead - Klamath Mountains Province Winter Run	Oncorhynchus mykiss pop. 25	?
Steelhead - Lower Columbia River Summer Run	Oncorhynchus mykiss pop. 26	?
Steelhead - Lower Columbia River Winter Run	Oncorhynchus mykiss pop. 27	?
Steelhead - Middle Columbia River Winter Run	Oncorhynchus mykiss pop. 29	?
Redband Trout - Catlow Valley	Oncorhynchus mykiss pop. 3	?
Steelhead - Oregon Coast Summer Run	Oncorhynchus mykiss pop. 30	?
Steelhead - Oregon Coast Winter Run	Oncorhynchus mykiss pop. 31	?
Steelhead - Upper Willamette River Winter Run	Oncorhynchus mykiss pop. 33	?
Steelhead - Southwest Washington Winter Run	Oncorhynchus mykiss pop. 35	?
Redband Trout - Warner Valley	Oncorhynchus mykiss pop. 4	?
Redband Trout - Goose Lake	Oncorhynchus mykiss pop. 6	?
Sockeye salmon (kokanee)	Oncorhynchus nerka	?
Chinook salmon (snake river, fall run)	Oncorhynchus tshawytscha pop 2	?
Chinook salmon (snake river, spring/summer run)	Oncorhynchus tshawytscha pop 8	?
Chinook Salmon - Lower Columbia River Spring Run	Oncorhynchus tshawytscha pop. 21	?
Chinook Salmon - Lower Columbia River Fall Run	Oncorhynchus tshawytscha pop. 22	?
Chinook Salmon - Upper Willamette River Spring Run	Oncorhynchus tshawytscha pop. 23	?
Chinook Salmon - Southern Oregon/Northern California Coast Fall Run	Oncorhynchus tshawytscha pop. 26	?
Oregon Chub	Oregonichthys crameri	?
Umpqua Oregon Chub	Oregonichthys kalawatseti	?
Sand Roller	Percopsis transmontanus	?
Millicoma Dace	Rhinichthys cataractae ssp 1	?
Umpqua Dace	Rhinichthys evermanni	?
Foskett Speckled Dace	Rhinichthys osculus ssp. 3	Y
Lahontan Redside	Richardsonius egregius	?
Bull Trout (runnotused)	Salvelinus confluentus	?
Bull trout (columbia river population)	Salvelinus confluentus pop 2	?
Bull Trout - Klamath River	Salvelinus confluentus pop. 1	?
Lahontan Tui Chub	Siphateles obesus oregonensis	?

Table C-18: Mollusks of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007; expert input). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common name	Scientific Name	Groundwater Dependence
Newcomb's Littorine Snail (Periwinkle)	Algamorda newcombiana (subrotunda?)	?
Columbia Duskysnail	Amnicola sp. 4	Y
Klamath Duskysnail	Amnicola sp. 5	?
Mare's Egg Duskysnail	Amnicola sp. 7	?
Nodose Duskysnail	Amnicola sp. 8	Y
Little River Lancetooth	Ancotrema sp. 1	N
California Floater	Anodonta californiensis	?
Western Floater	Anodonta kennerlyi	?
Oregon Floater	Anodonta oregonensis	?
Harney Basin duskysnail	Colligyrus depressus	?
Columbia Duskysnail	Colligyrus sp. 4	Y
Klamath Duskysnail	Colligyrus sp. 5	Y
Mare's Egg Duskysnail	Colligyrus sp. 7	Y
Nodose Duskysnail	Colligyrus sp. 8	Y
Puget Oregonian	Cryptomastix devia	N
Columbia Oregonian	Cryptomastix hendersoni	N
Evening Fieldslug	Deroceras hesperium	Y
Shortface Lanx	Fisherola nuttalli	?
Columbia Pebblesnail	Fluminicola columbiana	?
Ashy Pebblesnail	Fluminicola fuscus	Y
Donner & Blitzen Pebblesnail	Fluminicola insolitus	Y
Modoc Pebblesnail	Fluminicola modoci	Y
Dusky Pebblesnail	Fluminicola nuttallianus	?
Nerite Pebblesnail	Fluminicola sp. 11	Y
Odessa Pebblesnail	Fluminicola sp. 12	Y
Ouxy Spring Pebblesnail	Fluminicola sp. 13	Y
Tall Pebblesnail	Fluminicola sp. 14	Y
Tiger Lily Pebblesnail	Fluminicola sp. 15	Y
Toothed Pebblesnail	Fluminicola sp. 16	Y
Wood River Pebblesnail	Fluminicola sp. 18	Y
Keene Creek Pebblesnail	Fluminicola sp. 19	Y
Casebeer Pebblesnail	Fluminicola sp. 2	Y
Crooked Creek Pebblesnail	Fluminicola sp. 20	Y
Topaz Pebblesnail	Fluminicola sp. 22	Y
Contrary Pebblesnail	Fluminicola sp. 24	Y
Fredenburg Pebblesnail	Fluminicola sp. 26	Y
Umpquaq Pebblesnail	Fluminicola sp. 27	?
Diminutive Pebblesnail	Fluminicola sp. 3	Y
Rogue Pebblesnail	Fluminicola sp. 32	?
Stewart Pebblesnail	Fluminicola sp. 33	Y
Evergreen Pebblesnail	Fluminicola sp. 34	Y
Camp Creek Pebblesnail	Fluminicola sp. 35	Y
Clarke Pebblesnail	Fluminicola sp. 36	Y
Beaverdam Pebblesnail	Fluminicola sp. 37	Y

Table C-18 *(continued)*

Common name	Scientific Name	Groundwater Dependence
Little Butte Pebblesnail	Fluminicola sp. 38	Y
Chinquapin Pebblesnail	Fluminicola sp. 39	Y
Fall Creek Pebblesnail	Fluminicola sp. 4	Y
Pilot Rock Pebblesnail	Fluminicola sp. 40	Y
Klamath Pebblesnail	Fluminicola sp. 5	Y
Klamath Rim Pebblesnail	Fluminicola sp. 6	Y
Lake of the Woods Pebblesnail	Fluminicola sp. 7	Y
Lost River Pebblesnail	Fluminicola sp. 8	Y
Malheur Pebblesnail	Fluminicola sp.n. Malheur	Y
Metolius Pebblesnail	Fluminicola sp.n. Metolius	Y
Tuscan Pebblesnail	Fluminicola sp.n. tuscan	Y
Turban Pebblesnail	Fluminicola turbiniformis	Y
Olympia Pebblesnail	Fluminicola virens	?
Jackson Lake Springsnail	Pyrgulopsis robusta	Y
Western Ridged Mussel	Gonidea angulata	?
Applegate Lancetooth	Haplotrema sp. 1	N
Great Basin Rams-horn	Helisoma newberryi newberryi	Y
Oregon Shoulderband	Helminthoglypta hertleini	N
Umpqua Shoulderband	Helminthoglypta sp. 1	N
Warty Jumping-slug	Hemphillia glandulosa	N
Malone Jumping-slug	Hemphillia malonei	N
Tillamook Westernslug	Hesperarion mariae	N
Sisters Hesperian	Hochbergellus hirsutus	N
Mixer Riffle Shoulderband	Hochbergellus sp. 1	N
Barren Juga	Juga (J.) hemphilli	?
Brown Juga	Juga (J.) sp.n. 1 brown	Y
Three-banded Juga	Juga (J.) sp.n. three-band	Y
Basalt Juga	Juga (O.) sp.n. 2 basalt	Y
Blue Mountain Juga	Juga (O.) sp.n. Blue Mountain	?
Crooked River Juga	Juga (O.) sp.n. Crooked River	?
Purple (=Oak Springs) Juga	Juga (O.) sp.n. purple	?
Topaz Juga	Juga acutifilosa	Y
Bulb Juga	Juga bulbosa	Y
Dalles Juga	Juga hemphilli dallesensis	?
Purple-Lipped Juga	Juga hemphilli maupinensis	?
Indian Ford Juga	Juga hemphilli ssp.n.	Y
Opal Springs Juga	Juga sp.n. Opal Springs	?
Highcap Lanx	Lanx alta	?
Scale Lanx	Lanx klamathensis	Y
Banbury Springs Limpet	Lanx sp 1	Y
Rotund Lanx	Lanx subrotunda	?
Newcomb's Littorine Snail	Littorina subrotundata	?
Blue Mountains Duskysnail	Lyogyrus sp.n. Blue Mountains	?
Columbia Duskysnail	Lyogyrus sp.n. Columbia	Y
Klamath Duskysnail	Lyogyrus sp.n. Klamath	?
Link River Duskysnail	Lyogyrus sp.n. Link River	?
Mare's Egg Duskysnail	Lyogyrus sp.n. mare's-egg	?
Nodose Duskysnail	Lyogyrus sp.n. nodose	Y

Table C-18 *(continued)*

Common name	Scientific Name	Groundwater Dependence
Western Pearlshell	Margaritifera falcata	?
Oregon Megomphix	Megomphix hemphilli	N
Siskiyou Shoulderband	Monadenia chaceana	N
Klamath Sideband	Monadenia churchi	N
Pacific Sideband	Monadenia fidelis	N
Sisters Sideband	Monadenia fidelis baxteri	N
Pacific Sideband	Monadenia fidelis berylli	N
Pacific Sideband	Monadenia fidelis celeuth	N
A Terrestrial Snail	Monadenia fidelis minor	N
Winema Sideband	Monadenia fidelis ssp. 10	N
Umpqua Sideband	Monadenia fidelis ssp. 2	N
Duncan Sideband	Monadenia fidelis ssp. 3	N
Roseburg Sideband	Monadenia fidelis ssp. 5	N
Greer Springs Sideband	Monadenia fidelis ssp. 6	N
Canyonville Sideband	Monadenia fidelis ssp. 7	N
Oregon Caves Sideband	Monadenia fidelis ssp. 8	N
Star Gulch Sideband	Monadenia fidelis ssp. 9	N
	Oreohelix variabilis	N
Fotund Physa	Physella columbiana	?
Grain Physa	Physella hordacea	?
Owyhee Wet-rock Physa	Physella sp.n. Owyhee wet rock	?
Sunset Physa	Physella virginea	?
Modoc Peaclam	Pisidium sp. 1	Y
Montane Peaclam	Pisidium ultramontanum	Y
Lamb Rams-Horn	Planorbella oregonensis	Y
Robust Walker	Pomatiopsis binneyi	Y
Pacific Walker	Pomatiopsis californica	Y
Swamp (Marsh) Walker	Pomatiopsis chacei	Y
Crater Lake Tightcoil	Pristiloma arcticum crateris	Y
Pristine springsnail	Pristinicola hemphilli	Y
Blue-gray Taildropper	Prophysaon coeruleum	N
A Terrestrial Slug	Prophysaon sp. 1	N
	Prophysaon vanattae var.	N
Archimedes Pyrg	Pyrgulopsis archimedis	Y
Bruneau Hot Springsnail	Pyrgulopsis bruneauensis	Y
Harney Lake Springsnail	Pyrgulopsis hendersoni	Y
Idaho Springsnail	Pyrgulopsis idahoensis	Y
Crooked Creek Springsnail	Pyrgulopsis intermedia	Y
Jackson Lake Springsnail	Pyrgulopsis robusta	?
Lost River Springsnail	Pyrgulopsis sp. 7	Y
Klamath Lake Springsnail	Pyrgulopsis sp. 9	Y
Columbia springsnail	Pyrgulopsis sp.n. Columbia	?
Lake Abert springsnail	Pyrgulopsis sp.n. Lake Abert	?
Malheur springsnail	Pyrgulopsis sp.n. Malheur	Y
Owyhee hot springsnail	Pyrgulopsis sp.n. Owyhee hot springs	Y
XL springsnail	Pyrgulopsis sp.n. XL	Y
Bliss Rapids Snail	Taylorconcha serpenticola	Y
Umpqua Chaparral	Trilobopsis sp. 1	N
Rogue Chaparral	Trilobopsis sp. 2	N

Table C-18 *(continued)*

Common name	Scientific Name	Groundwater Dependence
Ashland Chaparral	Trilobopsis sp. 3	N
Lost Creek Chaparral	Trilobopsis sp. 4	N
Cow Creek Chaparral	Trilobopsis sp. 5	N
Sixes Chaparral	Trilobopsis sp. 6	N
Oregon Chaparral	Trilobopsis sp. 7	N
Horseshoe Vertigo	Vertigo dalliana	N
Dalles Hesperian	Vespericola depressa	N
Siskiyou Hesperian	Vespericola sierranus	N
Rogue Hesperian	Vespericola sp. 10	N
Mowich Hesperian	Vespericola sp. 11	N
Bandon Marsh Hesperian	Vespericola sp. 12	N
Tawnka Hesperian	Vespericola sp. 13	N
Sixes Hesperian	Vespericola sp. 14	N
Port Oxford Hesperian	Vespericola sp. 15	N
Nail Keg Hesperian	Vespericola sp. 16	N
Deep Creek Hesperian	Vespericola sp. 17	N
Winchuck Hesperian	Vespericola sp. 18	N
Chetco Hesperian	Vespericola sp. 19	N
Oregon Hesperian, Discove	Vespericola sp. 2	N
Deer Creek Hesperian	Vespericola sp. 21	N
Micromphalous Hesperian	Vespericola sp. 22	N
Cocklebur Hesperian	Vespericola sp. 23	N
Little River Hesperian	Vespericola sp. 24	N
Wolf Creek Hesperian	Vespericola sp. 25	N
Coolwater Hesperian	Vespericola sp. 26	N
Graceful Hesperian	Vespericola sp. 27	N
Jackson Creek Hesperian	Vespericola sp. 28	N
Soda Creek Hesperian	Vespericola sp. 29	N
Contorted Hesperian	Vespericola sp. 30	N
Bristly Hesperian	Vespericola sp. 4	N
Umpqua Hesperian	Vespericola sp. 5	N
Idylwyld Hesperian	Vespericola sp. 7	N
Bastendorf Hesperian	Vespericola sp. 8	N
Cryptic Hesperian	Vespericola sp. 9	N
Dall Rams-horn	Vorticifex effusus dalli	Y
Lined Rams-horn	Vorticifex effusus diagonalis	Y
Klamath Rams-horn	Vorticifex klamathensis klamathensis	Y
Sinitsin Rams-horn	Vorticifex klamathensis sinitsini	Y
Nerite Rams-horn	Vorticifex neritoides	?

Table C-19: Bats of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Common name	Scientific Name	Groundwater Dependence
Pallid Bat	Antrozous pallidus	N
Townsend's Big-Eared Bat	Corynorhinus townsendii	N
Pale Western Lumped Nose Bat	Corynorhinus townsendii pallescens	N
Townsend's western big-eared bat, Pacific Townsend's Big-eared Bat, Pacific western big-eared bat	Corynorhinus townsendii townsendii	N
Spotted Bat	Euderma maculatum	?
Silver-haired Bat	Lasionycteris noctivagans	?
Western Red Bat	Lasiurus blossevillii	N
Western Small-Footed Myotis	Myotis ciliolabrum	N
Long-eared Myotis	Myotis evotis	N
Fringed Myotis	Myotis thysanodes	N
Long-legged Myotis	Myotis volans	?
Yuma Myotis	Myotis yumanensis	?
Brazilian Free-tailed Bat	Tadarida brasiliensis	N

Table C-20: Other Species of Conservation Concern and their Groundwater Dependence (TNC and NatureServe, 2007). N = not groundwater dependent; ? = facultatively groundwater dependent; Y = obligately groundwater dependent. Includes complete species list, not just those with location information.

Taxa	Common Name	Scientific Name	Groundwater Dependence
Mammals	White-Tailed Antelope Squirrel	Ammospermophilus leucurus	N
Mammals	White-Footed Vole	Arborimus albipes	?
Mammals	Oregon Red Tree Vole	Arborimus longicaudus	N
Mammals	Ringtail	Bassariscus astutus	?
Mammals	Pygmy Rabbit	Brachylagus idahoensis	N
Mammals	Gray Wolf	Canis lupus	N
	Steller Sea Lion	Eumetopias jubatus	N
Mammals	California Wolverine	Gulo gulo	N
Mammals	North american wolverine	Gulo gulo luscus	N
Mammals	Sagebrush Vole	Lemmiscus curtatus	N
Mammals	Black-tailed jackrabbit	Lepus californicus	N
Mammals	White-tailed Jackrabbit	Lepus townsendii	N
Mammals	Canada Lynx	Lynx canadensis	N
Mammals	American Marten	Martes americana	N
Mammals	Fisher	Martes pennanti	N
Mammals	Pacific fisher	Martes pennanti pacifica	N
Mammals	Humpback whale	Megaptera novaeangliae	N
Mammals	Dark Kangaroo Mouse	Microdipodops megacephalus	N
Mammals	Gray-tailed vole	Microtus canicaudus	N
Mammals	Columbia White-Tailed Deer	Odocoileus virginianus leucurus	N
Mammals	Northern Grasshopper Mouse	Onychomys leucogaster	N
Mammals	Mountain Goat	Oreamos americana	N
Mammals	Bighorn Sheep	Ovis canadensis	N
Mammals	California Bighorn	Ovis canadensis californiana	N
	Rocky Mountain Bighorn Sheep	Ovis canadensis canadensis	N
	Desert Bighorn Sheep	Ovis canadensis nelsoni	N
Mammals	Townsend's mole	Scapanus townsendii	N
Mammals	Olymypic Snow Mole	Scapanus townsendii olympicus	N
Mammals	Western Gray Squirrel	Sciurus griseus	N
Mammals	Baird's shrew	Sorex bairdi	?
Mammals	Baird's Shrew	Sorex bairdi bairdi	?
Mammals	Baird's Shrew	Sorex bairdii permilensis	?
Mammals	Pacific water shrew	Sorex bendirii	?
Mammals	Merriam's Shrew	Sorex merriami	N
Mammals	Pacific Shrew	Sorex pacificus cascadensis	?
Mammals	Pacific Shrew	Sorex pacificus pacificus	?
Mammals	Preble's Shrew	Sorex preblei	?
	Wyoming Ground Squirrel	Spermophilus elegans nevadensis	N
Mammals	Washington Ground Squirrel	Spermophilus washingtoni	N
Mammals	Olympic Yellow-Pine Chipmunk	Tamias amoenus caurinus	N

Table C-20 *(continued)*

Taxa	Common Name	Scientific Name	Groundwater Dependence
	Pistol River Pocket Gopher	Thomomys bottae detumidus	N
Mammals	Camas pocket gopher	Thomomys bulbivorus	N
Mammals	Western Pocket Gopher-Rogue River	Thomomys mazama helleri	N
Mammals	Western pocket gopher, ssp pugetensis	Thomomys mazama pugetensis	N
Mammals	Western pocket gopher, ssp tumuli	Thomomys mazama tumuli	N
Mammals	Brush prairie pocket gopher	Thomomys talpoides douglasii	N
Mammals	Kit Fox	Vulpes macrotis	N
Mammals	Sierra Nevada Red Fox	Vulpes vulpes necator	N
grasshopper	Siskiyou Chloealtis Grasshopper	Chloealtis aspasma	N
grasshopper	Siskiyou chloealtis grasshopper	Chloealtis aspasma	N
grasshopper	Helfer's Grasshopper	Microtes helferi	N
Marine invertebrates	Seawhips; virgularia spp	Virgularia spp	N
Marine Invertebrates	Six-rayed glass skeleton sponges	Various	N
Other Invertebrates	Franklin's Bumble Bee	Bombus franklini	N
Other Invertebrates	Malheur Isopod	Amerigoniscus malheurensis	Y
Other Invertebrates	Malheur Pseudoscorpion	Apochthonius malheuri	Y
Other Invertebrates	Vernal Pool Fairy Shrimp	Branchinecta lynchi	N
Other Invertebrates	Siskiyou Chloealtis Grass	Chloealtis aspasma	N
Other Invertebrates	Oregon Giant Earthworm	Driloleirus macelfreshi	N
Other Invertebrates	A Flatworm	Kenkia rhynchida	Y
Other Invertebrates	Oregon Cave Amphipod	Stygobromus oregonensis	Y
Other nvertebrates	Malheur Cave Amphipod	Stygobromus hubbsi	Y
bug	Grass Bug	Acetropis americana	?
bug	Foliaceous Lace Bug	Derephysia foliacea	No info
bug	Oregon Plant Bug	Lygus oregonae	No info
bug	Hairy Shore Bug	Saldula villosa	No info

Table C-21: Communities Used to Map Obligately Groundwater-Dependent Communities (TNC and NatureServe, 2007). ELCODE = element occurrence code; Groundwater Dependence: Y = obligately groundwater-dependent; ? = facultatively groundwater-dependent (not used in mapping); N = not groundwater-dependent (not used in mapping).

ELCODE	SCIENTIFIC NAME	COMMON NAME	Groundwater Dependence
CES200.876	Nuphar lutea ssp. polysepalum	Temperate Pacific Freshwater Aquatic Bed	?
CES200.876	Potamogeton natans	Temperate Pacific Freshwater Aquatic Bed	?
CES200.877	Carex aquatilis var. aquatilis	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Carex exsiccata	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Carex lasiocarpa	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Carex obnupta	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Carex utriculata	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Carex vesicaria var. vesicaria	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Glyceria borealis	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Juncus nevadensis	Temperate Pacific Freshwater Emergent Marsh	?

Table C-21 *(continued)*

ELCODE	SCIENTIFIC NAME	COMMON NAME	Groundwater Dependence
CES200.877	Menyanthes trifoliata	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Schoenoplectus acutus	Temperate Pacific Freshwater Emergent Marsh	?
CES200.877	Scirpus microcarpus	Temperate Pacific Freshwater Emergent Marsh	?
CES200.998	Carex nebrascensis	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES200.998	Deschampsia caespitosa	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES200.998	Deschampsia caespitosa - Carex nebrascensis	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES200.998	Deschampsia caespitosa - Danthonia unispicata	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES200.998	Deschampsia caespitosa - Juncus balticus	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES200.998	Juncus balticus	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES200.998	Pinus contorta var. latifolia / Carex aquatilis var. aquatilis	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES200.998	Pinus contorta var. latifolia / Deschampsia caespitosa	Temperate Pacific Subalpine-Montane Wet Meadow	?

Table C-21 *(continued)*

ELCODE	SCIENTIFIC NAME	COMMON NAME	Groundwater Dependence
CES200.998	Pinus contorta var. latifolia / Spiraea douglasii	Temperate Pacific Subalpine-Montane Wet Meadow	?
CES204.063	Betula nana / Carex utriculata	North Pacific Bog and Fen	Y
CES204.063	Caltha leptosepala ssp. howellii	North Pacific Bog and Fen	Y
CES204.063	Carex aquatilis var. dives	North Pacific Bog and Fen	Y
CES204.063	Carex buxbaumii	North Pacific Bog and Fen	Y
CES204.063	Carex cusickii - (Comarum palustre)	North Pacific Bog and Fen	Y
CES204.063	Carex limosa	North Pacific Bog and Fen	Y
CES204.063	Carex luzulina	North Pacific Bog and Fen	Y
CES204.063	Carex simulata	North Pacific Bog and Fen	Y
CES204.063	Dulichium arundinaceum	North Pacific Bog and Fen	Y
CES204.063	Eleocharis quinqueflora	North Pacific Bog and Fen	Y
CES204.063	Nephrophyllidium crista-galli	North Pacific Bog and Fen	Y
CES204.063	North Pacific Bog and Fen	North Pacific Bog and Fen	Y
CES204.063	North Pacific Bog and Fen	North Pacific Bog and Fen	Y
CES204.063	Pinus contorta var. latifolia / Vaccinium uliginosum	North Pacific Bog and Fen	Y
CES204.063	Sanguisorba officinalis - Carex aquatilis var. dives	North Pacific Bog and Fen	Y
CES204.063	Ultraoligotrophic lake	North Pacific Bog and Fen	Y
CES204.063	Unmapped peatland	North Pacific Bog and Fen	Y
CES204.063	Vaccinium uliginosum / Eleocharis quinqueflora	North Pacific Bog and Fen	Y
CES204.090	Thuja plicata / Lysichiton americanus	North Pacific Hardwood-Conifer Swamp	?
CES204.865	Alnus incana - Salix barclayi	North Pacific Shrub Swamp	?
CES204.865	Alnus viridis ssp. sinuata	North Pacific Shrub Swamp	?

Table C-21 *(continued)*

ELCODE	SCIENTIFIC NAME	COMMON NAME	Groundwater Dependence
CES204.865	Alnus viridis ssp. sinuata / Athyrium filix-femina	North Pacific Shrub Swamp	?
CES204.865	Cornus sericea / Lysichiton americanus	North Pacific Shrub Swamp	?
CES204.865	Salix	North Pacific Shrub Swamp	?
CES204.865	Salix geyeriana	North Pacific Shrub Swamp	?
CES204.865	Salix geyeriana - Salix hookeriana	North Pacific Shrub Swamp	?
CES204.865	Spiraea douglasii	North Pacific Shrub Swamp	?
CES204.865	Spiraea douglasii - Salix	North Pacific Shrub Swamp	?
CES204.865	Vaccinium uliginosum / Deschampsia caespitosa	North Pacific Shrub Swamp	?
CES204.865	Vaccinium uliginosum / Carex aquatilis var. dives	North Pacific Shrub Swamp	?
CES204.865	Vaccinium uliginosum / Carex utriculata	North Pacific Shrub Swamp	?
CES304.057	Northern Columbia Plateau Vernal Pool	Columbia Plateau Vernal Pool	N
CES304.058	Northern Columbia Plateau Basalt Pothole Ponds	Northern Columbia Plateau Basalt Pothole Ponds	?
new.BN_AV_	Betula nana - Alnus viridis ssp. sinuata - Salix geyeriana		?
new.BO_VU_	Betula occidentalis - Vaccinium uliginosum - Salix geyeriana		?
new.FPCS	Flowing and pooled cold springs	Flowing and pooled cold springs	Y
new.Mnd_Sp	Mounded spring	Mounded spring	Y
new.Mu_Fl	Mud flat	Mud flat	?
new.SB	Meadow		?
new.SL_SS_	Alnus incana - Salix lemmonii - Salix sitchensis - Alnus viridis ssp. sinu		?
new_sycan	Sycan Marsh	Sycan Marsh	N

Table C-22: UIC Codes and How Each Was Included in the Threat Mapping.

[1] From ODEQ, 2007b [2] US EPA, 2007. [3] Indicates how data were used in the analysis.

Well Type Code[1]	Total[1]	Risk[2]	Description[1]	Potential contaminant[2]	How to map[3]
5A19	3	L-M	Cooling water return flows	antisealing additives, thermal pollution, potential for industrial spills reaching gw	Not used
5A6	9	M	Direct heat reinjection wells (deep);	hot geothermal brines with TDS 2000-325000 plus CaSO, Co, Sr and Ba, As	Not used
5A7	48	L-M	Heat pump/AC return flow wells;	potable water of T 90-110F; may have corrosion inhibitors	Not used
5D2	30268	M	Stormwater drainage wells - from paved areas	heavy metals, organics, coliform, pesticides, etc…	Other Toxic Contaminants only if Discharge Type is NOT 'drinking water' or 'grey water'
5D3	444	M-H	Improved sinkholes - in karst areas;	pesticides, nutrients bacteria	Other Toxic Contaminants only if Discharge Type is NOT 'drinking water' or 'grey water'
5D4	265	H-M	Industrial drainage wells;	organic solvents, acids, pesticides, indust waste, ~ storm drainage wells but higher concentration	Other toxic contaminants
5F1	20	H	Agricultural drainage wells -	irrigation tailwater, field drainage, feedlot/animal yard/dairy r/o (not allowed in OR); pesticides, nutrients, pathogens, metals, salts	Other toxic contaminants – (banned in OR)
5G30	104	M-L	Special drainage wells -	used to dispose of water from sources other than precip - swimmin pool drainage wells, lake level ctrl wells, potable water tank overflow, landslide control drainage wells. Chlorinated or treated water, pH imbalance, algaecides, fungicides, muriatic acid	Not used
5R21	67	H-L	Aquifer recharge wells -	water of good quality	Other toxic contaminants
5W10	88	H	Cesspools	- raw sewage and household chemicals	Nutrients
5W11	31	H-L	Septic system - undifferentiated disposal method;	nutrients, coliforms	Nutrients

Table C-22 *(continued)*

Well Type Code[1]	Total[1]	Risk[2]	Description[1]	Potential contaminant[2]	How to map[3]
5W12	5	H-L	domestic wastewater treatment plant effluent		Not used
5W20	120	H	Industrial process water and water disposal wells;	potentially any fluid disposed by industries, should be specified type of industry	Other toxic contaminants
5W31	69	H-L	Septic system well disposal methods	nutrients, coliforms	Nutrients
5W32	1055	H-L	Septic system drainfield disposal method - septic tank with drainfield	nutrients, coliforms	Nutrients
5W9	39	H	Untreated sewage waste disposal wells - from pumping trucks, no treatment	nutrients, coliforms	Nutrients
5X26	206	Unkn	Aquifer remediation related wells- wells to prevent /control/ remediate aquifer pollution;	nutrients for biodegradation, oil/grease, phenols, toluene	Industrial contaminants
5X27	1383	Unkn	Other wells		Other Toxic Contaminants only if Discharge Type is NOT 'drinking water' or 'grey water'
5X28	135	H	Automobile service station disposal well -	Oil/gas, solvents.	Other Toxic Contaminants
5X29	12	M	Abandoned drinking water wells -	any type of fluid	Other Toxic Contaminants only if Discharge Type is NOT 'drinking water'

Table C-23: Industrial Chemical Parameter Names, NWIS Database (USGS, 2007).

Parameter Name	Primary Use
1,1,1,2-Tetrachloroethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,1,1-Trichloroethane, water, unfiltered, recoverable, micrograms per liter	dry cleaning
1,1,2,2-Tetrachloroethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,1,2-Trichloro-1,2,2-trifluoroethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,1,2-Trichloro-1,2,2-trifluoroethane, water, unfiltered, under nitrogen atmosphere, recoverable, pi	industrial/manufacturing
1,1,2-Trichloroethane, water, unfiltered, recoverable, micrograms per liter	dry cleaning
1,1-Dichloroethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,1-Dichloroethene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,1-Dichloropropene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2,3,4-Tetramethylbenzene, water, unfiltered, recoverable, micrograms per liter	petrochemical
1,2,3,5-Tetramethylbenzene, water, unfiltered, recoverable, micrograms per liter	petrochemical
1,2,3-Trichlorobenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2,3-Trichloropropane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2,3-Trimethylbenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2,4-Trichlorobenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2,4-Trimethylbenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2-Dibromo-3-chloropropane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2-Dibromoethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2-Dichlorobenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2-Dichloroethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,2-Dichloroethane-d4, surrogate, Schedule 2090, water, unfiltered, percent recovery	industrial/manufacturing
1,2-Dichloropropane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,3,5-Trimethylbenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,3-Dichloropropane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1,4-Dichlorobenzene, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
1,4-Dichlorobenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
1-Bromo-4-fluorobenzene, surrogate, VOC schedules, water, unfiltered, percent recovery	industrial/manufacturing
1-Methylnaphthalene, water, filtered, recoverable, micrograms per liter	petrochemical
2,2-Dichloropropane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
2,6-Dimethylnaphthalene, water, filtered, recoverable, micrograms per liter	petrochemical
2-Chlorotoluene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
2-Ethyltoluene, water, unfiltered, recoverable, micrograms per liter	petrochemical
2-Methylnaphthalene, water, filtered, recoverable, micrograms per liter	petrochemical
3-Chloropropene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
4-Chlorotoluene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
4-Cumylphenol, water, filtered, recoverable, micrograms per liter	domestic

Table C-23 *(continued)*

Parameter Name	Primary Use
4-Isopropyltoluene, water, unfiltered, recoverable, micrograms per liter	petrochemical
4-Nonylphenol, water, filtered, recoverable, micrograms per liter	domestic
4-Octylphenol, water, filtered, recoverable, micrograms per liter	domestic
4-tert-Octylphenol, water, filtered, recoverable, micrograms per liter	domestic
5-Methyl-1H-benzotriazole, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
9,10-Anthraquinone, water, filtered, recoverable, micrograms per liter	pharmeceuticals
Acetone, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Acetophenone, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Acetyl hexamethyl tetrahydro naphthalene, water, filtered, recoverable, micrograms/l	industrial/manufacturing
Acrolein, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Acrylonitrile, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Anthracene, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Benzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Benzo[a]pyrene, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Benzophenone, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
beta-Sitosterol, water, filtered, recoverable, micrograms per liter	pharmeceuticals
beta-Stigmastanol, water, filtered, recoverable, micrograms per liter	pharmeceuticals
Bisphenol A, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Bisphenol A-d3, surrogate, Schedule/lab code 2033/8033, water, filtered, percent recovery	industrial/manufacturing
Bromobenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Bromochloromethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Bromoethene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Bromomethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Camphor, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Carbazole, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Chlorobenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Chloroethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Chloromethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
cis-1,2-Dichloroethene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Decafluorobiphenyl, surrogate, Schedule/lab code 2033/8033, water, filtered, % recovery	petrochemical
DEET, water, filtered, recoverable, micrograms per liter	?
Dichlorodifluoromethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Dichlorodifluoromethane, water, unfiltered, under nitrogen atmosphere, recoverable, picograms per ki	industrial/manufacturing
Dichloromethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Diethoxynonylphenol, water, filtered, recoverable, micrograms per liter	domestic
Diethyl ether, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Diisopropyl ether, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
D-Limonene, water, filtered, recoverable, micrograms per liter	pharmeceuticals
Ethyl methacrylate, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Ethyl methyl ketone, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing

Table C-23 *(continued)*

Parameter Name	Primary Use
Ethylbenzene, water, unfiltered, recoverable, micrograms per liter	petrochemical
Fluoranthene, water, filtered, recoverable, micrograms per liter	petrochemical
Fluoranthene-d10, surrogate, Schedule/lab code 2033/8033, water, filtered, percent recovery	petrochemical
Hexachlorobutadiene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Hexachloroethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Hexahydrohexamethyl cyclopentabenzopyran, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Indole, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Isobutyl methyl ketone, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Isophorone, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Isopropylbenzene, water, filtered, recoverable, micrograms per liter	petrochemical
Isopropylbenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Isoquinoline, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Menthol, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Methyl acrylate, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Methyl methacrylate, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Methyl salicylate, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Methyl tert-butyl ether, water, unfiltered, recoverable, micrograms per liter	petrochemical
Methyl tert-pentyl ether, water, unfiltered, recoverable, micrograms per liter	petrochemical
Methylene blue active substances, water, unfiltered, recoverable, milligrams per liter	industrial/manufacturing
m-Xylene plus p-xylene, water, unfiltered, recoverable, micrograms per liter	petrochemical
Naphthalene, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Naphthalene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
n-Butyl methyl ketone, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
n-Butylbenzene, water, unfiltered, recoverable, micrograms per liter	petrochemical
n-Propylbenzene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
o-Xylene, water, unfiltered, recoverable, micrograms per liter	petrochemical
p,p'-DDE, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
p-Cresol, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Pentachlorophenol, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Perchlorate, water, unfiltered, micrograms per liter	industrial/manufacturing
Phenanthrene, water, filtered, recoverable, micrograms per liter	petrochemical
Phenol, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Pyrene, water, filtered, recoverable, micrograms per liter	petrochemical
sec-Butylbenzene, water, unfiltered, recoverable, micrograms per liter	petrochemical
Styrene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
tert-Butyl ethyl ether, water, unfiltered, recoverable, micrograms per liter	petrochemical
tert-Butylbenzene, water, unfiltered, recoverable, micrograms per liter	petrochemical
Tetrachloroethene, water, filtered, recoverable, micrograms per liter	dry cleaning
Tetrachloroethene, water, unfiltered, recoverable, micrograms per liter	dry cleaning
Tetrachloromethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing

Table C-23 *(continued)*

Parameter Name	Primary Use
Tetrahydrofuran, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Toluene, water, unfiltered, recoverable, micrograms per liter	petrochemical
Toluene-d8, surrogate, Schedule 2090, water, unfiltered, percent recovery	petrochemical
trans-1,2-Dichloroethene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
trans-1,4-Dichloro-2-butene, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Tributyl phosphate, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Trichloroethene, water, unfiltered, recoverable, micrograms per liter	dry cleaning
Trichlorofluoromethane, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Trichlorofluoromethane, water, unfiltered, under nitrogen atmosphere, recoverable, picograms per kil	industrial/manufacturing
Triclosan, water, filtered, recoverable, micrograms per liter	pharmeceuticals
Triethyl citrate, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Triphenyl phosphate, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Tris(2-butoxyethyl) phosphate, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Tris(2-chloroethyl) phosphate, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Tris(dichloroisopropyl) phosphate, water, filtered, recoverable, micrograms per liter	industrial/manufacturing
Vinyl chloride, water, unfiltered, recoverable, micrograms per liter	industrial/manufacturing
Xylene (all isomers), water, unfiltered, recoverable, micrograms per liter	petrochemical

Table C-24: Industrial Chemical Parameter Names, LASAR Database (ODEQ, 2007a).

Parameter	Primary Use
1,1,1,2-Tetrachloroethane (mg/L)	industrial/manufacturing
1,1,1,2-Tetrachloroethane (mg/L)	industrial/manufacturing
1,1,1-Trichloroethane (mg/L)	industrial/manufacturing
1,1,1-Trichloroethane (mg/L)	industrial/manufacturing
1,1,2,2-Tetrachloroethane (mg/L)	industrial/manufacturing
1,1,2,2-Tetrachloroethane (mg/L)	industrial/manufacturing
1,1,2,2-Tetrachloroethylene (mg/L)	industrial/manufacturing
1,1,2,2-Tetrachloroethylene (mg/L)	industrial/manufacturing
1,1,2-Trichloroethane (mg/L)	industrial/manufacturing
1,1,2-Trichloroethane (mg/L)	industrial/manufacturing
1,1-Dichloroethane (mg/Kg dry)	industrial/manufacturing
1,1-Dichloroethane (mg/L)	industrial/manufacturing
1,1-Dichloroethane (mg/L)	industrial/manufacturing
1,1-Dichloroethylene (mg/L)	industrial/manufacturing
1,1-Dichloroethylene (mg/L)	industrial/manufacturing
1,1-Dichloropropene (mg/L)	industrial/manufacturing
1,1-Dichloropropene (mg/L)	industrial/manufacturing
1,2,3-Trichlorobenzene (mg/L)	industrial/manufacturing
1,2,3-Trichlorobenzene (mg/L)	industrial/manufacturing
1,2,3-trichloropropane (mg/L)	industrial/manufacturing
1,2,3-trichloropropane (mg/L)	industrial/manufacturing
1,2,4-Trichlorobenzene (mg/L)	industrial/manufacturing
1,2,4-Trichlorobenzene (µg/L)	industrial/manufacturing
1,2,4-Trichlorobenzene (mg/L)	industrial/manufacturing
1,2,4-Trimethylbenzene (mg/L)	industrial/manufacturing
1,2,4-Trimethylbenzene (mg/L)	industrial/manufacturing
1,2-Dibromo-3-chloropropane (mg/L)	industrial/manufacturing
1,2-Dibromo-3-chloropropane (µg/L)	industrial/manufacturing
1,2-Dibromo-3-chloropropane (mg/L)	industrial/manufacturing
1,2-Dibromoethane (EDB) (mg/L)	industrial/manufacturing
1,2-Dibromoethane (EDB) (µg/L)	industrial/manufacturing
1,2-Dibromoethane (EDB) (mg/L)	industrial/manufacturing
1,2-Dichlorobenzene (mg/L)	industrial/manufacturing
1,2-Dichlorobenzene (µg/L)	industrial/manufacturing
1,2-Dichlorobenzene (mg/L)	industrial/manufacturing
1,2-Dichloroethane (mg/L)	industrial/manufacturing
1,2-Dichloroethane (mg/L)	industrial/manufacturing
1,2-Dichloropropane (mg/L)	industrial/manufacturing
1,2-Dichloropropane (mg/L)	industrial/manufacturing
1,2-Dimethylbenzene (mg/L)	petrochemical?
1,2-Dimethylbenzene (mg/L)	petrochemical?
1,3,5-Trimethylbenzene (mg/L)	industrial/manufacturing
1,3,5-Trimethylbenzene (mg/L)	industrial/manufacturing
1,3-Dichloropropane (mg/L)	industrial/manufacturing
1,3-Dichloropropane (mg/L)	industrial/manufacturing
1,3-Dimethylbenzene (mg/L)	petrochemical?
1,4/1,3-Dimethylbenzene (mg/L)	petrochemical?
1,4/1,3-Dimethylbenzene (mg/L)	petrochemical?

Table C-24 *(continued)*

Parameter	Primary Use
1,4-Dichlorobenzene (mg/L)	industrial/manufacturing
1,4-Dichlorobenzene (µg/L)	industrial/manufacturing
1,4-Dichlorobenzene (mg/L)	industrial/manufacturing
1,4-Dimethylbenzene (mg/L)	petrochemical?
1,4-Dimethylbenzene (mg/L)	petrochemical?
2,2-Dichloropropane (mg/L)	industrial/manufacturing
2,2-Dichloropropane (mg/L)	industrial/manufacturing
2,4-Dinitrophenol (mg/L)	industrial/manufacturing
2,4-Dinitrophenol (µg/L)	industrial/manufacturing
2,4-Dinitrophenol (mg/L)	industrial/manufacturing
2,4-Dinitrotoluene (mg/L)	industrial/manufacturing
2,4-Dinitrotoluene (µg/L)	industrial/manufacturing
2,4-Dinitrotoluene (mg/L)	industrial/manufacturing
2,6-Dichlorophenol (mg/L)	industrial/manufacturing
2,6-Dichlorophenol (µg/L)	industrial/manufacturing
2,6-Dichlorophenol (mg/L)	industrial/manufacturing
2,6-Dinitrotoluene (mg/L)	industrial/manufacturing
2,6-Dinitrotoluene (µg/L)	industrial/manufacturing
2,6-Dinitrotoluene (mg/L)	industrial/manufacturing
2-Butanone (MEK) (mg/L)	industrial/manufacturing
2-Butanone (MEK) (mg/L)	industrial/manufacturing
2-Chloronaphthalene (mg/L)	industrial/manufacturing
2-Chloronaphthalene (µg/L)	industrial/manufacturing
2-Chloronaphthalene (mg/L)	industrial/manufacturing
2-Chlorotoluene (mg/L)	industrial/manufacturing
2-Chlorotoluene (mg/L)	industrial/manufacturing
2-Nitrophenol (mg/L)	industrial/manufacturing
2-Nitrophenol (µg/L)	industrial/manufacturing
2-Nitrophenol (mg/L)	industrial/manufacturing
4,4`-Isopropylidenediphenol (ng/L)	industrial/manufacturing
4-Bromophenyl phenyl ether (mg/L)	industrial/manufacturing
4-Bromophenyl phenyl ether (µg/L)	industrial/manufacturing
4-Bromophenyl phenyl ether (mg/L)	industrial/manufacturing
4-Bromophenyl phenylether (mg/L)	industrial/manufacturing
4-Bromophenyl phenylether (mg/L)	industrial/manufacturing
4-Chlorotoluene (mg/L)	industrial/manufacturing
4-Chlorotoluene (mg/L)	industrial/manufacturing
4-isopropyltoluene (mg/L)	petrochemical
4-isopropyltoluene (mg/L)	petrochemical
4-Methyl-2-pentanone (mg/L)	industrial/manufacturing
4-Methyl-2-Pentanone (MIBK) (mg/L)	industrial/manufacturing
4-Methyl-2-Pentanone (MIBK) (mg/L)	industrial/manufacturing
4-Nitrophenol (µg/L)	industrial/manufacturing
4-Nitrophenol (µg/L)	industrial/manufacturing
4-Nitrophenol (µg/L)	industrial/manufacturing
4-Nitrophenol (mg/L)	industrial/manufacturing
Acenaphthene (mg/L)	industrial/manufacturing
Acenaphthene (µg/L)	industrial/manufacturing
Acenaphthene (mg/L)	industrial/manufacturing

Table C-24 *(continued)*

Parameter	Primary Use
Acenaphthylene (mg/L)	industrial/manufacturing
Acenaphthylene (µg/L)	industrial/manufacturing
Acenaphthylene (mg/L)	industrial/manufacturing
Acetone (mg/L)	industrial/manufacturing
Acetone (mg/L)	industrial/manufacturing
Acrolein (2-Propenal) (mg/L)	industrial/manufacturing
Acrolein (2-Propenal) (mg/L)	industrial/manufacturing
Acrolein (mg/L)	industrial/manufacturing
Anthracene (mg/L)	industrial/manufacturing
Anthracene (µg/L)	industrial/manufacturing
Anthracene (mg/L)	industrial/manufacturing
Arochlor 1221 (mg/L)	PCB
Arochlor 1221 (µg/L)	PCB
Arochlor 1221 (mg/Kg wet)	PCB
Arochlor 1221 (mg/L)	PCB
Arochlor 1232 (µg/L)	PCB
Arochlor 1232 (mg/Kg wet)	PCB
Arochlor 1232 (mg/L)	PCB
Arochlor 1242 and 1016 (µg/L)	PCB
Arochlor 1242 and 1016 (mg/Kg wet)	PCB
Arochlor 1242 and 1016 (mg/L)	PCB
Arochlor 1248 (µg/L)	PCB
Arochlor 1254 (mg/L)	PCB
Arochlor 1254 (µg/L)	PCB
Arochlor 1254 (mg/Kg wet)	PCB
Arochlor 1254 (mg/L)	PCB
Arochlor 1260 (mg/L)	PCB
Arochlor 1260 (µg/L)	PCB
Arochlor 1260 (mg/Kg wet)	PCB
Arochlor 1260 (mg/L)	PCB
Benzene (mg/L)	petrochemical
Benzene (mg/L)	petrochemical
Benzene, pentachloronitro- (mg/L)	petrochemical
Benzo(a)anthracene (mg/L)	petrochemical
Benzo(a)anthracene (mg/L)	petrochemical
Benzo(a)pyrene (mg/L)	petrochemical
Benzo(a)pyrene (mg/L)	petrochemical
Benzo(b)fluoranthene (mg/L)	petrochemical
Benzo(b)fluoranthene (mg/L)	petrochemical
Benzo(k)fluoranthene (mg/L)	petrochemical
Benzo(k)fluoranthene (mg/L)	petrochemical
Benzo[a]anthracene (mg/L)	petrochemical
Benzo[a]anthracene (µg/L)	petrochemical
Benzo[a]anthracene (mg/L)	petrochemical
Benzo[a]pyrene (mg/L)	petrochemical
Benzo[a]pyrene (µg/L)	petrochemical
Benzo[a]pyrene (mg/L)	petrochemical
Benzo[b]fluoranthene (mg/L)	petrochemical
Benzo[b]fluoranthene (µg/L)	petrochemical

Table C-24 *(continued)*

Parameter	Primary Use
Benzo[b]fluoranthene (mg/L)	petrochemical
Benzo[g,h,i]perylene (mg/L)	petrochemical
Benzo[g,h,i]perylene (µg/L)	petrochemical
Benzo[g,h,i]perylene (mg/L)	petrochemical
Benzo[gh,i]perylene (mg/L)	petrochemical
Benzo[gh,i]perylene (mg/L)	petrochemical
Benzo[k]fluoranthene (mg/L)	petrochemical
Benzo[k]fluoranthene (µg/L)	petrochemical
Benzo[k]fluoranthene (mg/L)	petrochemical
Bromobenzene (mg/L)	industrial/manufacturing
Bromobenzene (mg/L)	industrial/manufacturing
Bromochloromethane (mg/L)	industrial/manufacturing
Bromochloromethane (mg/L)	industrial/manufacturing
Bromodichloromethane (mg/L)	industrial/manufacturing
Bromodichloromethane (mg/L)	industrial/manufacturing
Bromomethane (mg/L)	industrial/manufacturing
Bromomethane (mg/L)	industrial/manufacturing
Butylbenzylphthalate (mg/L)	industrial/manufacturing
Butylbenzylphthalate (µg/L)	industrial/manufacturing
Butylbenzylphthalate (mg/L)	industrial/manufacturing
Carbon Tetrachloride (mg/L)	industrial/manufacturing
Carbon Tetrachloride (mg/L)	industrial/manufacturing
Chlorobenzene (mg/L)	industrial/manufacturing
Chlorobenzene (mg/L)	industrial/manufacturing
Chloroethane (mg/L)	industrial/manufacturing
Chloroethane (mg/L)	industrial/manufacturing
Chloromethane (mg/L)	industrial/manufacturing
Chloromethane (mg/Kg wet)	industrial/manufacturing
Chloromethane (mg/L)	industrial/manufacturing
Chrysene (mg/L)	petrochemical
Chrysene (µg/L)	petrochemical
Chrysene (mg/L)	petrochemical
cis-1,2-Dichloroethylene (mg/L)	industrial/manufacturing
cis-1,2-Dichloroethylene (mg/L)	industrial/manufacturing
Dibenz[a,h]anthracene (mg/L)	petrochemical
Dibenz[a,h]anthracene (µg/L)	petrochemical
Dibenz[a,h]anthracene (mg/L)	petrochemical
Dibenzo(a,h)anthracene (mg/L)	petrochemical
Dibenzo(a,h)anthracene (mg/L)	petrochemical
Dichlorodifluoromethane (mg/L)	industrial/manufacturing
Dichlorodifluoromethane (mg/L)	industrial/manufacturing
Diesel Range Organics (mg/L)	petrochemical
Diesel Range Organics (NA)	petrochemical
Diethylphthalate (mg/L)	industrial/manufacturing
Diethylphthalate (µg/L)	industrial/manufacturing
Diethylphthalate (mg/L)	industrial/manufacturing
Diisopropyl ether (mg/L)	industrial/manufacturing
di-n-Butylphthalate (mg/L)	industrial/manufacturing
di-n-Butylphthalate (µg/L)	industrial/manufacturing

Table C-24 *(continued)*

Parameter	Primary Use
di-n-Butylphthalate (mg/L)	industrial/manufacturing
Di-n-octylphthalate (mg/L)	industrial/manufacturing
Di-n-octylphthalate (µg/L)	industrial/manufacturing
Di-n-octylphthalate (mg/L)	industrial/manufacturing
Ethyl Benzene (mg/L)	industrial/manufacturing
Ethyl Benzene (mg/L)	industrial/manufacturing
Ethyl tert-butyl ether (ETBE) (mg/L)	petrochemical
Ethylbenzene (mg/L)	industrial/manufacturing
Fluoranthene (mg/L)	industrial/manufacturing
Fluoranthene (µg/L)	industrial/manufacturing
Fluoranthene (mg/L)	industrial/manufacturing
Fluorene (mg/L)	industrial/manufacturing
Fluorene (µg/L)	industrial/manufacturing
Fluorene (mg/L)	industrial/manufacturing
Formaldehyde (mg/L)	industrial/manufacturing
Gasoline Range Organics (mg/L)	petrochemical
Gasoline Range Organics (NA)	petrochemical
Hexachloro-1,3-Butadiene (mg/L)	industrial/manufacturing
Hexachloro-1,3-Butadiene (µg/L)	industrial/manufacturing
Hexachloro-1,3-Butadiene (mg/L)	industrial/manufacturing
Hexachlorobutadiene (mg/L)	industrial/manufacturing
Hexachlorobutadiene (mg/L)	industrial/manufacturing
Hexachloroethane (mg/L)	industrial/manufacturing
Hexachloroethane (µg/L)	industrial/manufacturing
Hexachloroethane (mg/L)	industrial/manufacturing
Indeno(1,2,3,c,d)pyrene (mg/L)	industrial/manufacturing
Indeno(1,2,3,c,d)pyrene (mg/L)	industrial/manufacturing
Indeno[1,2,3-cd]pyrene (mg/L)	industrial/manufacturing
Indeno[1,2,3-cd]pyrene (µg/L)	industrial/manufacturing
Indeno[1,2,3-cd]pyrene (mg/L)	industrial/manufacturing
Isophorone (mg/L)	industrial/manufacturing
Isophorone (µg/L)	industrial/manufacturing
Isophorone (mg/L)	industrial/manufacturing
Isopropylbenzene (Cumene) (mg/L)	petrochemical
Isopropylbenzene (Cumene) (mg/L)	petrochemical
Methylene Blue Active Substances (MBAS) (mg/L)	industrial/manufacturing
Methylene Chloride (mg/L)	industrial/manufacturing
Methylene Chloride (mg/L)	industrial/manufacturing
Methyl-tert-Butyl Ether (MTBE) (mg/L)	petrochemical
Methyl-tert-Butyl Ether (MTBE) (mg/L)	petrochemical
mXylene (mg/L)	petrochemical
m-Xylene (mg/L)	petrochemical
Naphthalene (mg/L)	industrial/manufacturing
Naphthalene (µg/L)	industrial/manufacturing
Naphthalene (mg/L)	industrial/manufacturing
n-butylbenzene (mg/L)	petrochemical
n-butylbenzene (mg/L)	petrochemical
Nitrobenzene (mg/L)	industrial/manufacturing

Table C-24 *(continued)*

Parameter	Primary Use
Nitrobenzene (µg/L)	industrial/manufacturing
Nitrobenzene (mg/L)	industrial/manufacturing
N-Nitrosodiphenylamine (mg/L)	industrial/manufacturing
N-Nitrosodiphenylamine (µg/L)	industrial/manufacturing
N-Nitrosodiphenylamine (mg/L)	industrial/manufacturing
n-Propylbenzene (mg/L)	industrial/manufacturing
n-Propylbenzene (mg/L)	industrial/manufacturing
Oil & Grease (mg/L)	petrochemical
Oil & Grease (mg/L)	petrochemical
Oil Range Hydrocarbons (mg/L)	petrochemical
Oil Range Hydrocarbons (NA)	petrochemical
o-Xylene (mg/L)	petrochemical
Pentachlorophenol (µg/L)	industrial/manufacturing
Pentachlorophenol (µg/L)	industrial/manufacturing
Pentachlorophenol (mg/L)	industrial/manufacturing
Pentachlorophenol (µg/L)	industrial/manufacturing
Pentachlorophenol (µg/L)	industrial/manufacturing
Pentachlorophenol (mg/L)	industrial/manufacturing
Perylene (mg/L)	petrochemicals
Phenanthrene (mg/L)	petrochemical
Phenanthrene (µg/L)	petrochemical
Phenanthrene (mg/L)	petrochemical
Phenol (mg/L)	industrial/manufacturing
Phenol (µg/L)	industrial/manufacturing
Phenol (mg/L)	industrial/manufacturing
p-Xylene (mg/L)	petrochemical
Pyrene (mg/L)	petrochemical
Pyrene (µg/L)	petrochemical
Pyrene (mg/L)	petrochemical
sec-Butylbenzene (mg/L)	petrochemical
sec-Butylbenzene (mg/L)	petrochemical
Styrene (mg/L)	industrial/manufacturing
Styrene (mg/L)	industrial/manufacturing
tert-Amyl ethyl ether (TAME) (mg/L)	petrochemical
tert-Butylbenzene (mg/L)	petrochemical
tert-Butylbenzene (mg/L)	petrochemical
Tetrachloroethylene (mg/L)	dry cleaning
Toluene (mg/L)	petrochemical
Toluene (mg/L)	petrochemical
trans-1,2-Dichloroethylene (mg/L)	industrial/manufacturing
trans-1,2-Dichloroethylene (mg/L)	industrial/manufacturing
trans-1,2-Dichloropropene (mg/L)	industrial/manufacturing
Trichloroethylene (mg/L)	industrial/manufacturing
Trichloroethylene (mg/L)	industrial/manufacturing
Trichlorofluoromethane (mg/L)	industrial/manufacturing
Trichlorofluoromethane (mg/L)	industrial/manufacturing
Vinyl Chloride (mg/L)	industrial/manufacturing
Vinyl Chloride (mg/L)	industrial/manufacturing

Table C-25: Parameter Names Indicating Pesticide Contamination of Groundwater, NWIS Database (USGS, 2007).

1,3-Dichlorobenzene, water, unfiltered, recoverable, micrograms per liter
1-Naphthol, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
2,4,5-T, surrogate, Schedule 9060/2060, water, filtered, percent recovery
2,4,5-T, water, filtered, recoverable, micrograms per liter
2,4-D methyl ester, water, filtered, recoverable, micrograms per liter
2,4-D, water, filtered, recoverable, micrograms per liter
2,4-DB, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
2,6-Diethylaniline, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per lit
2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine, water, filtered, recoverable, micrograms per lit
2-Methyl-4,6-dinitrophenol, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms
3-Hydroxy carbofuran, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per l
3-Ketocarbofuran, water, filtered, recoverable, micrograms per liter
Acetochlor, water, filtered, recoverable, micrograms per liter
Acifluorfen, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Alachlor, water, filtered, recoverable, micrograms per liter
Aldicarb sulfone, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Aldicarb sulfoxide, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per lit
Aldicarb, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
alpha-HCH, water, filtered, recoverable, micrograms per liter
alpha-HCH-d6, surrogate, water, filtered (0.7 micron glass fiber filter), percent recovery
Aminomethylphosphonic acid, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms
Atrazine, water, filtered, recoverable, micrograms per liter
Azinphos-methyl, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Barban, surrogate, Schedules 2060/9060, water, filtered, percent recovery
Bendiocarb, water, filtered, recoverable, micrograms per liter
Benfluralin, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Benomyl, water, filtered, recoverable, micrograms per liter
Bensulfuron-methyl, water, filtered, recoverable, micrograms per liter
Bentazon, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Bromacil, water, filtered, recoverable, micrograms per liter
Bromoxynil, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Butylate, water, filtered, recoverable, micrograms per liter
Carbaryl, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Carbaryl, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Carbofuran, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Carbofuran, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Chloramben methyl ester, water, filtered, recoverable, micrograms per liter
Chlorimuron, water, filtered, recoverable, micrograms per liter
Chlorothalonil, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Chlorpyrifos, water, filtered, recoverable, micrograms per liter
cis-1,3-Dichloropropene, water, unfiltered, recoverable, micrograms per liter
cis-Permethrin, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Clopyralid, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Cyanazine, water, filtered, recoverable, micrograms per liter
Cycloate, water, filtered, recoverable, micrograms per liter
Dacthal monoacid, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
DCPA, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Desulfinyl fipronil, water, filtered, recoverable, micrograms per liter

Table C-25 *(continued)*

Desulfinylfipronil amide, water, filtered, recoverable, micrograms per liter
Diazinon, water, filtered, recoverable, micrograms per liter
Diazinon-d10, surrogate, water, filtered (0.7 micron glass fiber filter), percent recovery
Dicamba, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Dichlobenil, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Dichlorprop, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Dichlorvos, water, filtered, recoverable, micrograms per liter
Dieldrin, water, filtered, recoverable, micrograms per liter
Dinoseb, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Diphenamid, water, filtered, recoverable, micrograms per liter
Disulfoton, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Diuron, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
EPTC, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Esfenvalerate, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Ethalfluralin, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Ethoprop, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Ethoxyoctylphenol, water, filtered, recoverable, micrograms per liter
Fenuron, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Fipronil sulfide, water, filtered, recoverable, micrograms per liter
Fipronil sulfone, water, filtered, recoverable, micrograms per liter
Fipronil, water, filtered, recoverable, micrograms per liter
Flumetsulam, water, filtered, recoverable, micrograms per liter
Fluometuron, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Fonofos, water, filtered, recoverable, micrograms per liter
Glufosinate, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Glyphosate, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Glyphosate, water, unfiltered, recoverable, micrograms per liter
Imazaquin, water, filtered, recoverable, micrograms per liter
Imazethapyr, water, filtered, recoverable, micrograms per liter
Imidacloprid, water, filtered, recoverable, micrograms per liter
Iodomethane, water, unfiltered, recoverable, micrograms per liter
Lindane, water, filtered, recoverable, micrograms per liter
Linuron, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Linuron, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Malathion, water, filtered, recoverable, micrograms per liter
MCPA, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
MCPB, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Metalaxyl, water, filtered, recoverable, micrograms per liter
Methiocarb, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Methomyl, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Methyl parathion, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Metolachlor, water, filtered, recoverable, micrograms per liter
Metribuzin, water, filtered, recoverable, micrograms per liter
Metsulfuron, water, filtered, recoverable, micrograms per liter
Molinate, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Napropamide, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Neburon, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Nicosulfuron, water, filtered, recoverable, micrograms per liter
Norflurazon, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Oryzalin, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter

Table C-25 *(continued)*

Oxamyl, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Parathion, water, filtered, recoverable, micrograms per liter
Pebulate, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Pendimethalin, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Phorate, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Picloram, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Prometon, water, filtered, recoverable, micrograms per liter
Propachlor, water, filtered, recoverable, micrograms per liter
Propanil, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Propargite, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Propham, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Propiconazole, water, filtered, recoverable, micrograms per liter
Propoxur, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Propyzamide, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Siduron, water, filtered, recoverable, micrograms per liter
Silvex, water, filtered, recoverable, micrograms per liter
Simazine, water, filtered, recoverable, micrograms per liter
Sulfometuron, water, filtered, recoverable, micrograms per liter
Tebuthiuron, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Terbacil, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Terbacil, water, filtered, recoverable, micrograms per liter
Terbufos, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Terbuthylazine, surrogate, water, filtered (0.7 micron glass fiber filter), percent recovery
Thiobencarb, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
trans-1,3-Dichloropropene, water, unfiltered, recoverable, micrograms per liter
Triallate, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Tribenuron, water, filtered, recoverable, micrograms per liter
Triclopyr, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter
Trifluralin, water, filtered (0.7 micron glass fiber filter), recoverable, micrograms per liter

Table C-26: Parameter Names Indicating Pesticide Contamination of Groundwater, LASAR Database (ODEQ, 2007a)

1,2,4,5-Tetrachlorobenzene (mg/L)
1,2,4,5-Tetrachlorobenzene (µg/L)
1,2,4,5-Tetrachlorobenzene (mg/L)
1,3-Dichlorobenzene (mg/L)
1,3-Dichlorobenzene (µg/L)
1,3-Dichlorobenzene (mg/L)
1-Naphthol (µg/L)
2,4,5-T (µg/L)
2,4,5-T (µg/L)
2,4,5-T (mg/L)
2,4,5-T (µg/L)
2,4,5-T (µg/L)
2,4,5-T (mg/L)
2,4,5-TP (Silvex) (µg/L)
2,4,5-TP (Silvex) (µg/L)
2,4,5-TP (Silvex) (µg/L)
2,4,5-TP (Silvex) (µg/L)
2,4,5-Trichlorophenol (mg/L)
2,4,5-Trichlorophenol (µg/L)
2,4,5-Trichlorophenol (mg/L)
2,4,6-Trichlorophenol (mg/L)
2,4,6-Trichlorophenol (µg/L)
2,4,6-Trichlorophenol (mg/L)
2,4`-DDE (µg/L)
2,4`-DDT (µg/L)
2,4-bis(isopropylamino)-6-methoxy-s-triazine (mg/L)
2,4-bis(isopropylamino)-6-methoxy-s-triazine (mg/L)
2,4-D (µg/L)
2,4-D (µg/L)
2,4-D (mg/L)
2,4-D (µg/L)
2,4-D (µg/L)
2,4-D (mg/L)
2,4-D (ng/L)
2,4-D (ppb)
2,4-DB (µg/L)
2,4-DB (µg/L)
2,4-DB (mg/L)
2,4-DB (µg/L)
2,4-DB (µg/L)
2,4-DB (mg/L)
2,4-DP (µg/L)
2,6-diethylanaline (µg/L)
2,6-diethylanaline (µg/L)
2,6-diethylanaline (µg/L)
2,6-diethylanaline (ng/L)
3,4-Dichloroaniline (ng/L)
3,6-Dichloro-2-methoxybenzoic acid (µg/L)
3,6-Dichloro-2-methoxybenzoic acid (µg/L)
3,6-Dichloro-2-methoxybenzoic acid (mg/L)
3,6-Dichloro-2-methoxybenzoic acid (µg/L)
3,6-Dichloro-2-methoxybenzoic acid (mg/L)
3-Hydroxycarbofuran (µg/L)
3-Hydroxycarbofuran (µg/L)
3-Hydroxycarbofuran (mg/L)
3-Hydroxycarbofuran (µg/L)
3-Hydroxycarbofuran (µg/L)
3-Hydroxycarbofuran (mg/L)
4,4`-DDD (mg/L)
4,4`-DDD (µg/L)
4,4`-DDD (mg/L)
4,4`-DDE (mg/L)
4,4`-DDE (µg/L)
4,4`-DDE (µg/L)
4,4`-DDE (mg/Kg wet)
4,4`-DDE (mg/L)
4,4`-DDT (mg/L)
4,4`-DDT (µg/L)
4,4`-DDT (mg/L)
4-Chloro-3-methylphenol (mg/L)
4-Chloro-3-methylphenol (µg/L)
4-Chloro-3-methylphenol (mg/L)
4-Methylphenol (p-Cresol) (mg/L)
4-Methylphenol (p-Cresol) (µg/L)
4-Methylphenol (p-Cresol) (mg/L)
Acifluorfen (µg/L)
Acifluorfen (µg/L)
Acifluorfen (µg/L)
Acifluorfen (mg/L)
Alachlor (µg/L)
Alachlor (µg/L)
Alachlor (µg/L)
Alachlor (µg/L)
Alachlor (mg/L)
Aldicarb (µg/L)
Aldicarb (µg/L)
Aldicarb (µg/L)
Aldicarb (µg/L)
Aldicarb (mg/L)
Aldicarb (ppb)
Aldicarb sulfone (µg/L)
Aldicarb sulfone (µg/L)
Aldicarb sulfone (µg/L)

Table C-26 *(continued)*

Aldicarb sulfone (µg/L)
Aldicarb sulfone (mg/L)
Aldicarb sulfoxide (µg/L)
Aldicarb sulfoxide (µg/L)
Aldicarb sulfoxide (µg/L)
Aldicarb sulfoxide (µg/L)
Aldicarb sulfoxide (mg/L)
Aldrin (µg/L)
Aldrin (µg/L)
Aldrin (mg/L)
Aldrin (µg/L)
Aldrin (µg/L)
Aldrin (mg/L)
alpha Chlordane (µg/L)
alpha Chlordane (µg/L)
alpha Chlordane (µg/L)
alpha Chlordane (µg/L)
alpha-BHC (µg/L)
alpha-BHC (µg/L)
alpha-BHC (mg/L)
alpha-BHC (µg/L)
alpha-BHC (µg/L)
alpha-BHC (mg/L)
AMPA (µg/L)
Atrazine (µg/L)
Atrazine (µg/L)
Atrazine (mg/L)
Atrazine (µg/L)
Atrazine (µg/L)
Atrazine (mg/L)
Atrazine (ng/L)
Atrazine (ppb)
Atrazine-desethyl (µg/L)
Atrazine-desethyl (µg/L)
Atrazine-desethyl (µg/L)
Atrazine-desethyl (ng/L)
azinphos-methyl (µg/L)
Baygon (µg/L)
Baygon (µg/L)
Baygon (mg/L)
Baygon (µg/L)
Baygon (µg/L)
Baygon (mg/L)
Benfluralin (µg/L)
Bensulide (µg/L)
bentazon (µg/L)
bentazon (µg/L)
bentazon (µg/L)
bentazon (mg/L)
Bentazone (µg/L)

Benthiocarb (µg/L)
beta-BHC (µg/L)
beta-BHC (µg/L)
beta-BHC (mg/L)
beta-BHC (µg/L)
beta-BHC (µg/L)
beta-BHC (mg/L)
Bromacil (µg/L)
Bromacil (µg/L)
Bromacil (µg/L)
Bromacil (µg/L)
Bromacil (ng/L)
Bromacil (ppb)
Butachlor (µg/L)
Butachlor (µg/L)
Butachlor (mg/L)
Butachlor (µg/L)
Butachlor (µg/L)
Butachlor (mg/L)
Butylate (mg/L)
Butylate (µg/L)
Butylate (µg/L)
Butylate (mg/L)
Carbamate Screen (µg/L)
Carbamate Screen (µg/L)
Carbamate Screen (NA)
Carbamate Screen (µg/L)
Carbamate Screen (NA)
Carbaryl (µg/L)
Carbaryl (µg/L)
Carbaryl (mg/L)
Carbaryl (µg/L)
Carbaryl (µg/L)
Carbaryl (mg/L)
Carbofuran (µg/L)
Carbofuran (µg/L)
Carbofuran (µg/L)
Carbofuran (µg/L)
Carbofuran (ppb)
Carboxin (mg/L)
Carboxin (µg/L)
Carboxin (µg/L)
Carboxin (mg/L)
Carboxin (ppb)
chloramben (mg/L)
Chlordane (µg/L)
Chlordane (mg/L)
Chlordane (technical mixture and metabolites) (µg/L)

Table C-26 *(continued)*

Chlordane (technical mixture and metabolites) (µg/L)
Chlordane (technical mixture and metabolites) (µg/L)
Chlordane-Cis Isomer (mg/L)
Chlordane-Cis Isomer (mg/L)
Chloroneb (µg/L)
Chloroneb (µg/L)
Chloroneb (µg/L)
Chlorothalonil (µg/L)
Chlorothalonil (µg/L)
Chlorothalonil (mg/L)
Chlorpropham (µg/L)
Chlorpropham (µg/L)
Chlorpropham (mg/L)
Chlorpropham (µg/L)
Chlorpropham (µg/L)
Chlorpropham (mg/L)
Chlorpyrifos (µg/L)
Chlorpyrifos (µg/L)
Chlorthalonil (µg/L)
Chlorthalonil (µg/L)
cis-1,3-Dichloropropene (mg/L)
cis-1,3-Dichloropropene (mg/L)
cis-Permethrin (mg/L)
cis-Permethrin (mg/L)
Clopyralid (ng/L)
Coumaphos (µg/L)
Coumaphos (µg/L)
Cyanazine (µg/L)
Cycloate (mg/L)
Cycloate (µg/L)
Cycloate (µg/L)
Cycloate (mg/L)
Daconil 2787 (mg/L)
Daconil 2787 (mg/L)
Dacthal (µg/L)
Dacthal (µg/L)
Dacthal (ppb)
Dacthal (µg/L)
Dacthal (µg/L)
Dacthal (ppb)
Dalapon (µg/L)
Dalapon (µg/L)
Dalapon (mg/L)
DCMU (mg/L)
DCMU (mg/L)
DCPA (Dacthal) (µg/L)
DCPA (Dacthal) (µg/L)
DCPA (Dacthal) (µg/L)

DCPA (Dacthal) (ng/L)
DCPA acid metabolites(a) (µg/L)
DDE (µg/L)
delta-BHC (µg/L)
delta-BHC (µg/L)
delta-BHC (mg/L)
delta-BHC (µg/L)
delta-BHC (µg/L)
delta-BHC (mg/L)
Diazinon (µg/L)
Chlorpyrifos (µg/L)
Chlorpyrifos (mg/L)
Chlorpyrifos (ng/L)
Diazinon (mg/L)
Diazinon (ng/L)
Dicamba (µg/L)
Dicamba (µg/L)
Diazinon (µg/L)
Diazinon (mg/L)
Diazinon (µg/L)
Dicamba (ng/L)
Dicamba (µg/L)
Dicamba (µg/L)
Dicamba (mg/L)
Dicamba (ng/L)
Dicamba (ppb)
Dichloran (mg/L)
Dichloroprop (µg/L)
Dichloroprop (µg/L)
Dichloroprop (mg/L)
Dichloroprop (µg/L)
Dichloroprop (µg/L)
Dichloroprop (mg/L)
Dichlorvos (µg/L)
Dichlorvos (µg/L)
Dichlorvos (µg/L)
Diclobenil (µg/L)
Dieldrin (µg/L)
Dieldrin (µg/L)
Dieldrin (mg/L)
Dieldrin (µg/L)
Dieldrin (µg/L)
Dieldrin (mg/L)
Dieldrin (ng/L)
Dimethoate (µg/L)
Dimethyl tetrachloroterephthalate (mg/L)
Dimethyl tetrachloroterephthalate (mg/L)
Dimethylphthalate (mg/L)
Dimethylphthalate (µg/L)
Dimethylphthalate (mg/L)

Table C-26 *(continued)*

Dinoseb (µg/L)
Dinoseb (µg/L)
Dinoseb (mg/L)
Dinoseb (µg/L)
Dinoseb (µg/L)
Dinoseb (mg/L)
Dinoseb (ng/L)
Dinoseb (ppb)
Diphenamid (mg/L)
Diphenamid (µg/L)
Diphenamid (µg/L)
Diphenamid (mg/L)
Disulfoton (µg/L)
Disulfoton (Di-Syston) (µg/L)
Disulfoton (Di-Syston) (µg/L)
Disulfoton (Di-Syston) (mg/L)
Disulfoton (Di-Syston) (µg/L)
Diuron (µg/L)
Diuron (µg/L)
Diuron (µg/L)
Diuron (mg/L)
Diuron (ppb)
Endosulfan I (µg/L)
Endosulfan I (µg/L)
Endosulfan I (mg/L)
Endosulfan I (µg/L)
Endosulfan I (µg/L)
Endosulfan I (mg/L)
Endosulfan II (µg/L)
Endosulfan II (µg/L)
Endosulfan II (mg/L)
Endosulfan II (µg/L)
Endosulfan II (µg/L)
Endosulfan II (mg/L)
Endosulfan sulfate (µg/L)
Endosulfan sulfate (µg/L)
Endosulfan sulfate (mg/L)
Endosulfan sulfate (µg/L)
Endosulfan sulfate (µg/L)
Endosulfan sulfate (mg/L)
Endrin (µg/L)
Endrin (µg/L)
Endrin (mg/L)
Endrin (µg/L)
Endrin (µg/L)
Endrin (mg/L)
Endrin Aldehyde (µg/L)
Endrin Aldehyde (µg/L)
Endrin Aldehyde (µg/L)
Endrin Aldehyde (µg/L)

Endrin Ketone (µg/L)
Endrin Ketone (mg/Kg wet)
EPTC (Eptam) (µg/L)
EPTC (Eptam) (µg/L)
EPTC (Eptam) (mg/L)
EPTC (Eptam) (µg/L)
EPTC (Eptam) (µg/L)
EPTC (Eptam) (mg/L)
EPTC (Eptam) (ng/L)
Ethalfluralin (µg/L)
Ethofumesate (ng/L)
Ethoprop (µg/L)
Ethoprop (µg/L)
Ethoprop (µg/L)
Ethoprop (µg/L)
Ethoprop (ng/L)
Ethylene Dibromide (µg/L)
Fenamiphos (µg/L)
Fenamiphos (µg/L)
Fenamiphos (µg/L)
Fenamiphos (µg/L)
Fensulfothion (µg/L)
Fonofos (µg/L)
Fonofos (ng/L)
Fonophos (µg/L)
gamma-BHC (Lindane) (mg/L)
gamma-BHC (Lindane) (µg/L)
gamma-BHC (Lindane) (µg/L)
gamma-BHC (Lindane) (mg/L)
Gamma-Chlordane (µg/L)
Gamma-Chlordane (µg/L)
Gamma-Chlordane (mg/L)
Gamma-Chlordane (µg/L)
Gamma-Chlordane (µg/L)
Gamma-Chlordane (mg/L)
Garlon (µg/L)
Guthion (Azinphosmethyl) (µg/L)
Heptachlor (µg/L)
Heptachlor (µg/L)
Heptachlor (mg/L)
Heptachlor (µg/L)
Heptachlor (µg/L)
Heptachlor (mg/L)
Heptachlor epoxide (µg/L)
Heptachlor epoxide (µg/L)
Heptachlor epoxide (mg/L)
Heptachlor epoxide (µg/L)
Heptachlor epoxide (µg/L)
Heptachlor epoxide (mg/L)
Hexachlorobenzene (µg/L)

Table C-26 *(continued)*

Hexachlorobenzene (µg/L)	Metolachlor (µg/L)
Hexachlorobenzene (mg/L)	Metolachlor (mg/L)
Hexachlorobenzene (µg/L)	Metolachlor (ng/L)
Hexachlorobenzene (µg/L)	Metribuzin (µg/L)
Hexachlorobenzene (mg/L)	Metribuzin (µg/L)
Hexachlorocyclopentadiene (mg/L)	Metribuzin (µg/L)
Hexachlorocyclopentadiene (µg/L)	Metribuzin (µg/L)
Hexachlorocyclopentadiene (mg/L)	Metribuzin (ng/L)
Hexazinone (µg/L)	Metribuzin (ppb)
Hexazinone (µg/L)	Molinate (µg/L)
Hexazinone (mg/L)	Monuron (mg/L)
Hexazinone (µg/L)	Napropamide (mg/L)
Hexazinone (µg/L)	Napropamide (µg/L)
Hexazinone (mg/L)	Napropamide (µg/L)
Imidan (µg/L)	Napropamide (mg/L)
Lindane (µg/L)	Nemacur (mg/L)
Lindane (µg/L)	Nemacur (mg/L)
Lindane (µg/L)	Oxamyl (µg/L)
Lindane (µg/L)	Oxamyl (µg/L)
Linuron (µg/L)	Oxamyl (µg/L)
Malathion (µg/L)	Oxamyl (µg/L)
Malathion (µg/L)	Oxamyl (ppb)
Malathion (µg/L)	p,p`-DDD (µg/L)
Malathion (ng/L)	p,p`-DDD (µg/L)
MCPA (mg/L)	p,p`-DDD (mg/L)
MCPA (µg/L)	p,p`-DDD (µg/L)
MCPA (mg/L)	p,p`-DDD (µg/L)
MCPA (ng/L)	p,p`-DDD (mg/L)
MCPP (mg/L)	p,p`-DDD (ng/L)
Merphos (µg/L)	p,p`-DDE (µg/L)
Merphos (µg/L)	p,p`-DDE (µg/L)
Merphos (µg/L)	p,p`-DDE (mg/L)
Metalaxyl (µg/L)	p,p`-DDE (µg/L)
Metalaxyl (ng/L)	p,p`-DDE (µg/L)
Methidathion (µg/L)	p,p`-DDE (mg/L)
Methiocarb (µg/L)	p,p`-DDE (ng/L)
Methiocarb (µg/L)	p,p`-DDT (µg/L)
Methiocarb (µg/L)	p,p`-DDT (µg/L)
Methiocarb (µg/L)	p,p`-DDT (mg/L)
Methomyl (µg/L)	p,p`-DDT (µg/L)
Methomyl (µg/L)	p,p`-DDT (µg/L)
Methomyl (µg/L)	p,p`-DDT (mg/L)
Methomyl (µg/L)	p,p`-DDT (ng/L)
Methoxychlor (µg/L)	p,p`-Methoxychlor (µg/L)
Methoxychlor (µg/L)	p,p`-Methoxychlor (µg/L)
Methylparathion (µg/L)	p,p`-Methoxychlor (mg/L)
Metolachlor (µg/L)	p,p`-Methoxychlor (µg/L)
Metolachlor (µg/L)	p,p`-Methoxychlor (µg/L)
Metolachlor (mg/L)	p,p`-Methoxychlor (mg/L)
Metolachlor (µg/L)	Parathion (µg/L)

Table C-26 *(continued)*

Parathion (ethyl) (µg/L)
Parathion (methyl) (µg/L)
Pebulate (µg/L)
Pendamethalin (µg/L)
Permethrin cis- (µg/L)
Permethrin-cis (µg/L)
Permethrin-cis (µg/L)
Permethrin-cis (µg/L)
Permethrin-cis (µg/L)
Phenoxyherbicide Screen (µg/L)
Phenoxyherbicide Screen (µg/L)
Phenoxyherbicide Screen (NA)
Phenoxyherbicide Screen (µg/L)
Phenoxyherbicide Screen (NA)
Phorate (µg/L)
Phorate (Thimet) (mg/L)
Phorate (Thimet) (µg/L)
Phosdrin (Mevinphos) (µg/L)
Phosdrin (Mevinphos) (µg/L)
Phosdrin (Mevinphos) (mg/L)
Phosdrin (Mevinphos) (µg/L)
Phosdrin (Mevinphos) (µg/L)
Phosdrin (Mevinphos) (mg/L)
Phosphonodithioic acid, ethyl-, O-ethyl S-phenyl ester (mg/L)
Phosphorodithioic acid, S-(2-(ethylsulfinyl)ethyl) O,O-dimethyl ester (mg/L)
Picloram (µg/L)
Picloram (µg/L)
Picloram (mg/L)
Picloram (ng/L)
Picloram (µg/L)
Picloram (µg/L)
Picloram (mg/L)
Picloram (ng/L)
Prometon (µg/L)
Prometon (µg/L)
Prometon (µg/L)
Prometon (µg/L)
Prometryne (mg/L)
Prometryne (µg/L)
Prometryne (µg/L)
Prometryne (mg/L)
Pronamide (µg/L)
Pronamide(a) (ng/L)
Propachlor (µg/L)
Propachlor (µg/L)
Propachlor (mg/L)
Propachlor (µg/L)
Propachlor (µg/L)

Propachlor (mg/L)
Propachlor (ng/L)
Propanil (µg/L)
Propanil (ng/L)
Propargite (µg/L)
Propazine (µg/L)
Propazine (µg/L)
Propazine (mg/L)
Propazine (µg/L)
Propazine (µg/L)
Propazine (mg/L)
Prophos (mg/L)
Prophos (mg/L)
Propionaldehyde, 2-methyl-2-(methyl-thio)-, O-(methylcarbomyl) oxime (mg/L)
Propionaldehyde, 2-methyl-2-(methyl-thio)-, O-(methylcarbomyl) oxime (mg/L)
Propoxur (µg/L)
Roundup (µg/L)
Roundup (µg/L)
Roundup (µg/L)
Roundup (mg/L)
Silvex (µg/L)
Silvex (µg/L)
Silvex (mg/L)
Silvex (µg/L)
Silvex (mg/L)
Simazine (µg/L)
Simazine (µg/L)
Simazine (mg/L)
Simazine (µg/L)
Simazine (µg/L)
Simazine (mg/L)
Simazine (ng/L)
Simazine (ppb)
Tebuthiuron (mg/L)
Tebuthiuron (µg/L)
Tebuthiuron (µg/L)
Tebuthiuron (mg/L)
Terbacil (µg/L)
Terbacil (µg/L)
Terbacil (mg/L)
Terbacil (µg/L)
Terbacil (ng/L)
Terbufos (µg/L)
Toxaphene (µg/L)
Toxaphene (µg/L)
Toxaphene (µg/L)
Toxaphene (µg/L)
Toxaphene (mg/L)

Table C-26 *(continued)*

trans-1,3-Dichloropropene (mg/L)
trans-1,3-Dichloropropene (mg/L)
trans-Nonachlor (mg/L)
trans-Nonachlor (µg/L)
trans-Nonachlor (mg/L)
trans-Permethrin (µg/L)
trans-Permethrin (µg/L)
trans-Permethrin (mg/L)
trans-Permethrin (µg/L)
trans-Permethrin (µg/L)
trans-Permethrin (mg/L)
Triademefon (µg/L)
Triademefon (µg/L)
Triademefon (µg/L)
Triallate (µg/L)
Triallate (ng/L)
Triclopyr (ng/L)
Trifluralin (µg/L)
Trifluralin (µg/L)
Trifluralin (µg/L)
Trifluralin (µg/L)
Vancide-89 (mg/L)

Table C-27: Pesticides for which Spatial Data (1 km grid) of Use are Available from the USGS (Nakagaki and Wolock, 2005). Those in bold are included in the analysis of risk and were used in Oregon; those in italics do not have any recorded use in Oregon.

Pesticide	Code	Potential for groundwater contamination		
		Vogue et al, 1994	Kegley et al., 2008	USDA NRCS, 2006
2,4-D	1302	Moderate	Potential	Intermediate
Acetochlor	3000	Low	?	Intermediate
Acifluorfen	1002	Moderate	?	Intermediate
Alachlor	1863	Moderate	Yes	Intermediate
Atrazine	**1980**	**High**	**Yes**	**High**
Benomyl	5001	Low	?	Low
Bentazon	**1287**	**High**		**High**
Bromoxynil	1116	Extremely Low	?	Very low
Butylate	1839	Low	Potential	Low
Carbofuran	**6007**	**Very High**	**Potential**	**High**
Chlorimuron	*4008*	*High*	*?*	*High*
Chlorpyrifos	6009	Very Low	?	Low
Cyanazine	1369	Low	Yes	Intermediate
Diazinon	6014	Low	Potential	Low
Diuron	1991	Moderate	Yes	Intermediate
EPTC	1414	Low	Potential	Low
Ethalfluralin	9009	Very low	?	Low
Ethoprop	**6023**	**High**	**Potential**	**High**
Fluometuron	*1998*	*High*	*potential*	*High*
Fonofos	6028	Low	Potential	Low
Linuron	1993	Moderate	potential	Intermediate
Methomyl	**6038**	**High**	**Potential**	**High**
Methyl parathion	6042	Very Low	Potential	Low
Metolachlor	**1011**	**High**	**Yes**	**High**
Metribuzin	**1975**	**High**	**Potential**	**High**
Molinate	1417	Moderate	Potential	Intermediate
Nicosulfuron	**7007**	**High**	**Potential**	**High**
Norflurazon	1018	Low	Yes	Low
Oryzalin	1873	Low	Potential	Low
Oxamyl	6045	Low		Low
Pebulate	1419	Low	Potential	Low
Phorate	6050	Low	Potential	Low
Pronamide	1888	Low	Potential	Intermediate
Propachlor	1191	Low	?	Low
Propanil	1282	Very low	Potential	Low
Propargite	6055	Very Low	?	Low
Propiconazole	5020	Moderate	Potential	Intermediate
Simazine	**1981**	**High**	**Yes**	**High**
Terbacil	**1109**	**Very High**	**Potential**	**High**
Terbufos	6060	Very Low	?	Low
Thiobencarb	1903	Low	Potential	Low
Triallate	1790	Low	Potential	Low
Trifluralin	1361	Very Low	?	Low

Table C-28: Aquatic Toxicity of those Pesticides in Table C-27 Identified as High, Intermediate, or Potential Risk of Contaminating Groundwater, from PAN Database (Kegley et al., 2008) and Extoxnet (Pesticide Management Education Program, various dates).

Product	Type	Aquatic toxicity	Crops
2,4-D	herbicide	Slightly to moderately toxic to fish; slightly toxic to insects and amphibians. Immobilizes and changes growth of crustaceans; affects growth of zooplankton; bioaccumulates in phytoplankton, aquatic plants, fish, zooplankton; plus more.	
ACETOCHLOR	herbicide	Moderately to highly toxic to fish; moderately toxic to zooplankton. Intoxicates zooplankton and mollusks; bioaccumulates in amphibians; affects population and growth in amphibians, phytoplankton and aquatic plants.	
ACIFLUORFEN	herbicide	Moderately toxic to opposum shrimp; slightly toxic to rainbow trout, bluegill, and sheepshead minnow. Intoxicates/immoblizes zooplankton and mollusks; changes populations of phytoplankton.	soybeans, peanuts, peas, and rice
ALACHLOR	herbicide	Moderately toxic to amphibians, fish and mollusks; slightly toxic to crustaceans and zooplankton. Bioaccumulates in fish; affects growth and population in fish, zooplankton, phytoplankton, crustaceans, and aquatic plants.	field corn, soybeans and peanuts
ATRAZINE	herbicide	Practically non-toxic to birds; slightly toxic to fish; highly toxic to phytoplankton and aquatic plants; moderately toxic to insects; slightly toxic to zooplankton, mollusks, fish, crustaceans, annelida, amphibians; little bioaccumulation; changes growth and development in amphibians; plus more.	corn, sorghum, sugarcane, pineapple, Christmas trees and other crops, and in conifer reforestation plantings.
BENTAZON	herbicide	Slightly toxic to mollusks; not acutely toxic to fish and zooplankton; slightly toxic to birds; practically non-toxic to fish with low accumulation; slightly toxic to aquatic invertebrates. Bioaccumulates in some groups of species at lower doses.	beans, rice, corn, peanuts, and mint
CARBOFURAN	insecticide (nematicide)	Very highly toxic to zooplankton; highly toxic to insects and crustaceans; moderately toxic to annelida, fish, and mollusks; slightly toxic to amphibians.	field, fruit, vegetable, and forest crops
CHLORIMURON	herbicide	Chlorimuron ethyl is practically non-toxic to birds; slightly toxic to fish and invertebrates. It is not expected to adversely affect endangered/ threatened species because of its low toxicity and low application rate.	soybeans
CYANAZINE	herbicide	Slightly to highly toxic to fish; highly toxic to phytoplankton; slightly toxic to mollusks and zooplankton. Immobilizes and changes biochemistry and genetics of fish; immobilizes zooplankton; bioaccumulates in and changes growth of phytoplankton; changes enzyme activity of crustaceans and growth/population of aquatic plants.	corn, grain sorghum, cotton, and wheat fallow

Table C-28 *(continued)*

Product	Type	Aquatic toxicity	Crops
DIURON	herbicide	Very highly toxic to phytoplankton; moderately toxic to insects; slightly toxic to amphibians, crustaceans, fish, mollusks and zooplankton. Bioaccumulates in fish, mollusks, phytoplankton, and zooplankton; affects growth and behavior of many other groups of organisms.	fruit, cotton, sugar cane and legumes.
ETHOPROP	insecticide	Moderately toxic to fish and crustaceans, but very highly and highly toxic to some species.	
FLUOMETURON	herbicide	Slightly toxic to mollusks and fish, but highly toxic in some cases; moderately toxic to opposum shrimp. Bioaccumulates in mollusks and aquatic plants; immobilizes zooplankton and insects; has physiological affects on phytoplankton	cotton
LINURON	herbicide	Highly toxic to duckweed; moderately toxic to channel catfish, rainbow trout, guppies, tilapia, swordtail fish; slightly toxic to insects, mollusks, nematodes/flatworms, annelids, goldfish, and other fish. Bioaccumulates in phytoplankton and aquatic plants; changes primary productivity of ecosystems; affects populations, growth, mobility, physiology, and other characteristics of other groups of species.	soybean, cotton, potato, corn, bean, pea, winter wheat, asparagus, carrot, and fruit
METHOMYL	insecticide	Highly toxic to birds; moderately to highly toxic to fish; highly toxic to invertebrates; very highly toxic to insects; highly toxic to zooplankton and crustaceans; slightly toxic to mollusks and amphibians; toxic to bees; may be toxic to mammals such as deer. Affects growth and enzyme activity of some species; is unlikely to bioaccumulate.	vegetable, fruit and field crops, cotton, commercial ornamentals, and in and around poultry houses and dairies
METOLACHLOR	herbicide	Practically non-toxic to slightly toxic to birds; moderately toxic to fish; slightly to moderately toxic to zooplankton. Affects growth of amphibians; affects growth of algae.	field corn, soybeans, peanuts, grain sorghum, potatoes, pod crops, cotton, safflower, stone fruits, nut trees, highway right-of-ways, and woody ornamentals.
METRIBUZIN	herbicide	Slightly to moderately toxic to birds; slightly toxic to fish; toxic to plants; slightly toxic to crustaceans and zooplankton. Affects growth of plants and amphibians at low doses and affects abundance of phytoplankton,	field and vegetable crops, in turfgrass, and fallow lands.
MOLINATE	herbicide	Highly toxic to insects and some crustaceans; moderately toxic to zooplankton and fish; slightly toxic to amphibians. Causes behavioral changes in crustaceans and fish; bioaccumulates in fish and mollusks; affects reproduction in crustaceans and zooplankton; other effects.	rice paddies

Table C-28 *(continued)*

Product	Type	Aquatic toxicity	Crops
PRONAMIDE	herbicide	Moderately toxic to zooplankton; slightly toxic to amphibians; not very toxic to fish. Intoxicates zooplankton and mollusks; changes the abundance of aquatic plants and phytoplankton.	lettuce and alfalfa crops, blueberries, ornamentals, fruit trees, forage legumes, and fallow lands
PROPICONAZOLE	fungicide	Moderately toxic to fish, mollusks, insects, and zooplankton on average (highly toxic in some cases). Intoxicates and affects populations of crustaceans, aquatic plants, insects, mollusks, nematodes/flatworms, phytoplankton and zooplankton; has genetic or reproductive effects on fish and crustaceans.	grasses grown for seed, mushrooms, corn, wild rice, peanuts, almonds, sorghum, oats, pecans, apricots, peaches, nectarines, plums, and prunes
SIMAZINE	herbicide	Practically non-toxic to birds; slightly toxic to aquatic organisms (but more toxic to daphnia and stoneflies); Highly toxic to phytoplankton; slighty toxic to zooplankton, fish, insects, and crustaceans; not acutely toxic to amphibians.	Field, berry, vegetable, and ornamental crops, turfgrass, and in orchards and vineyards
TERBACIL	herbicide	Slightly toxic to birds; non-toxic to slightly toxic for aquatic life; slightly toxic to fish and zooplankton; not accutely toxic to crustaceans (though some studies have found effects on marine crustaceans).	sugarcane, apples, alfalfa, peaches, pecans, and mints

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