The Health of Oregon Waters

Water Quality Status and Action Plan: Deschutes Basin

September 2011

State of Oregon
Department of Environmental Quality

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EXECUTIVE SUMMARY

The Department of Environmental Quality (DEQ) is undertaking a Watershed Approach (WA) to assist in managing water quality in the State of Oregon. This new approach will provide a broad assessment of the status of water quality and other environmental indicators within a basin, greater opportunities for stakeholder involvement and interagency cooperation, and will also address some of the limitations of the Total Maximum Daily Load (TMDL) process. It is intended that the WA process will eventually be implemented state-wide. We hope that this broad-based approach will allow greater flexibility in the assessment process and more assurance that the WA will be iterative in nature. It is currently envisioned that each DEQ region (Eastern, Western and Northwest Oregon) will complete a WA for one basin each year. There are approximately 15 basins within the state. This would allow the findings of the WA to be revisited and updated every 5 years.

The Deschutes Watershed Approach Plan consists of an Introduction, a Status Report and an Action Plan. The Introduction describes the development of the Watershed Approach in the Deschutes Basin. The Status Report and Action Plan summarize the important water quality problems and the strategies needing to be implemented. Together these sections will allow for the adaptive management of water quality in the Deschutes Basin.

The Deschutes Basin Watershed Approach is a work in progress. This Status Report and Action Plan are not the final products of the Deschutes Basin WA process and will be revised and updated through continuing input and interaction from DEQ staff and stakeholder input. This plan is a first version only and should not be viewed as a static document.

Stakeholder Interaction

The Deschutes Basin WA is being developed with broad public input, and stakeholder interaction will continue to be a substantial component of the process until completion and will act to inform the ongoing, iterative nature of the WA in the years to come. DEQ is coordinating efforts with many stakeholders within the Basin and welcomes the participation of all parties who are interested in being a part of the WA process. It is expected that the process will change and grow as we learn more about the basin and the needs of local stakeholders.

To date, DEQ has hosted four separate stakeholder meetings within the basin to help inform the WA process. These meetings were designed to focus on the needs and concerns specific to each of the subbasins and were held in each of the four geographic areas as follows:

Deschutes Basin Watershed Approach Stakeholders Meetings		
Area	Location	Date
Lower Deschutes Subbasin	Community Building, Maupin, Oregon	February 17, 2010
Trout and Willow Subbasins	Central Oregon Agricultural Research Center, Agency Plains, OR (north of Madras)	February 23, 2010
Crooked River Subbasins	City Hall, Prineville, Oregon	April 22, 2010
Upper and Little Deschutes Subbasins	DEQ Eastern Region Office, Bend, OR	May 10, 2010

Attendees at these subbasin meetings included representatives from Central Oregon Flyfishers, City of Bend, City of Prineville, Confederated Tribes of Warm Springs, Crooked River Watershed Council, Deschutes River Conservancy, Friends of the Metolius, Jefferson County SWCD, Middle Deschutes Watershed Council, Native Fish Society, North Unit Irrigation District, Ochoco Irrigation District, ODA, ODFW, OSU Extension Service, OWEB, OWRD, PGE, private citizens, Sherman County SWCD, the Central Oregon Irrigation District, The Nature Conservancy, Trout Unlimited, Upper Deschutes River Coalition, Upper Deschutes Watershed Council, US Bureau of Reclamation, USFS, USFWS, Wasco County SWCD, Wasco County Watershed Councils, and the Watershed Professionals Network. Numerous smaller meetings and one-on-one discussions were also held and more are planned to occur as the process moves forward.

What is the Status of Resource Conditions in the Deschutes Basin?

The Deschutes Basin Status Report is a summary of specific findings on resource status in the Deschutes Basin and is designed to answer the question "How are things doing and why are they in that condition?" The findings in this report are generally broader in scope and less rigorous in nature than for a TMDL and are based on available information and known concerns expressed by stakeholders rather than on computer modeling. The bulleted items and tables below summarize the status of conditions in the Basin. Refer to the Status Report for more detailed information.

- ***General surface water quality conditions*** as measured by DEQ's Oregon Water Quality Index are considered to be "excellent" in most of the Upper and Little Deschutes Subbasins, "good – fair" in the Lower Deschutes Subbasin, and "poor" in the Crooked Subbasins.

- DEQ's assessment of ***biological communities*** in Deschutes Basin streams as compared to reference conditions indicates that 27% of sites were in most disturbed conditions, 33% were moderately disturbed, and 40% were least disturbed. Both temperature and fine sediment were identified as stressors contributing to the observed biological impairment, with 67% of sites in poor condition for temperature stress and 56% in poor condition for sediment stress.
- ***Temperature, sedimentation, altered hydrology and habitat modification*** were identified as widespread surface water concerns in the Basin. Fish and aquatic life is the beneficial use most impacted by these factors. Stakeholders around the Basin recognize these concerns and have embarked on implementation activities, to varying degrees. Implementation activities include: stream flow restoration, channel restoration, bank stabilization, riparian plantings, changes in livestock management, riparian fencing, and upland conservation practices. TMDLs will be developed to address temperature impairments throughout the Basin and at a limited number of locations for sedimentation. Improvement of resource conditions for these parameters may largely occur outside of the TMDL arena.
- ***Harmful algal blooms of cyanobacteria*** were identified as a significant resource concern in lakes and reservoirs in some parts of the Basin. There are multiple beneficial uses affected by harmful algal blooms, including: aesthetics, livestock watering, fishing, water contact recreation, and drinking water supply. Seven lakes/reservoirs have had health advisories posted since 2004 and 11 more have been identified has being of potential concern. There may be additional lakes/reservoirs of concern, but data collection has been limited because of the cost of data analysis. Data and modeling has been done in support of TMDL development on Odell Lake and Lava Lake, although additional work is still needed on these lakes. Additional work is also needed to increase our monitoring capabilities and determine causes of algal impairments.
- ***Toxics*** have been identified as a potential pollutant to both surface waters and groundwater in the Deschutes Basin. However, very little data has been collected and/or assessed. ***Arsenic*** and ***mercury*** are two metals which have been identified as potentially affecting human health either through contamination of drinking water (arsenic) or fish consumption (mercury).
- ***Bacterial contamination*** is found in both surface waters and groundwater in the Deschutes Basin. For ***surface waters***, data indicates that there are issues with bacteria in lower Trout Creek/Willow Creek and in the lower Crooked. A TMDL for bacteria is being developed for the lower Crooked River and Jefferson County SWCD and ODA are already working with landowners to reduce bacteria loading in Trout and Willow Creeks. The need for additional sampling was identified as a need, particularly in the White River watershed and the Upper Crooked. For ***groundwater***, well testing indicates relatively widespread detections of bacteria, although to the best of our knowledge, source assessments have not been conducted.
- Elevated ***total dissolved gas levels*** (greater than 110% saturation) have been observed below Prineville Reservoir on the Crooked River and Wickiup Reservoir on the Deschutes River. Bubble gas disease has been observed in fish on the Crooked River below the dam, and has been identified by some stakeholders as a significant fisheries issue. DEQ will coordinate with USBR through the TMDL process to address this issue.
- ***Nitrate contamination of groundwater*** has been identified as one of the most widespread groundwater issues in the Deschutes Basin. Well testing indicates elevated nitrate concentrations throughout the Basin, with hot spots specifically identified in southern Deschutes County/northern Klamath County (La Pine area), the central portion of the Basin around Prineville and Redmond,

lower Trout Creek, Willow Creek, and Sherman County. DEQ has initiated a groundwater protection program for southern Deschutes County/northern Klamath County. Additional monitoring and analysis is needed to further refine and understand contamination in the rest of the Basin.

- ***Groundwater/surface water interactions*** have been identified as a resource concern in the Deschutes Basin. The basin's surface water resources have been fully appropriated for many years, and stream flows are locally below legally set minimums at certain times of the year. Because surface water rights are no longer available, virtually all new development relies on groundwater. OWRD has developed the Deschutes Groundwater Mitigation Program to provide for new groundwater uses while maintaining scenic waterway and instream water right flows. Because of the strong linkage between groundwater and surface water flows, concerns have been raised about the cumulative effects that groundwater pumping and/or lining of canals in the Upper Deschutes Subbasin will have/is having on stream flows.
- Due to resource and time constraints, DEQ was not able to coordinate assessment efforts very effectively with the ***Confederated Tribes of the Warm Springs Reservation***. CTWS have water quality standards separate from the State of Oregon that apply to resource conditions on Tribal lands. As resource assessment and resource-related concerns are most effectively addressed at the basin scale, DEQ looks forward to continued communication and coordination with CTWS on future iterations of the WA process.
- Due to resource and time constraints, DEQ was also not able to adequately evaluate all available data. Additional assessment of data is still needed in the WA process, particularly in regards to groundwater contamination and conditions.

The following flags summarize the status of surface and ground water related resources by geographic area in the Deschutes Basin as identified through existing data or information, knowledge of DEQ staff or stakeholders. They should not be construed as a prioritization of concerns or focus areas and will be updated as the stakeholder process continues.

STATUS SUMMARY FOR SURFACE AND GROUND WATER RELATED RESOURCES IN THE DESCHUTES BASIN

Surface Water	Bacteria	Harmful Algae Blooms	Temperature	Total Dissolved Gas	Nutrients, DO, pH Chlorophyll a	Altered Hydrology	Habitat Modification	Sediment / Turbidity	Toxics: Emerging Contaminants Pharmaceuticals PCPs	Toxics: Metals	Toxics: Arsenic	Toxics: Mercury	Toxics: Pesticides
Little Deschutes													
Upper Deschutes													
Beaver-South Fork													
Lower Crooked													
Upper Crooked													
Trout Creek													
Willow Creek													

Lower Deschutes						tribs	tribs	tribs					

Ground Water	**General Quality**	**Quantity**	**Nitrate**	**Bacteria**	**Pesticides**	**Volatile and Synthetic Organic Compounds**	**Arsenic**	**Nickel**	**Lead**	**Fluoride**
Little Deschutes										
Upper Deschutes										
Beaver-South Fork										
Lower Crooked										
Upper Crooked										
Trout Creek										
Willow Creek										
Lower Deschutes										

	Generally poor condition, substantial concern for water quality
	Deteriorating condition, moderate concern for water quality
	Generally good condition, not an urgent concern for water quality
	Unknown condition or lack of data

What Key Actions are Recommended for the Deschutes Basin?

The Deschutes Basin Action Plan is a summary of recommended actions necessary to assess, protect and enhance environmental resources in the Deschutes Basin. The recommended actions include both on-the-ground implementation efforts, necessary monitoring and data assessment, and education, outreach and coordination needs. Recommended actions have been identified in four focus areas: permitted point sources, surface water quality, ground water quality, and DEQ outreach, coordination and agency resources.

- Recommended actions specific to ***Permitted point sources*** *include*:
    - *UIC program assessment, revisions and updates*: Assess the number, magnitude and potential threat to groundwater from existing UICs; update existing DEQ databases to reflect recent changes in DEQ's UIC program
    - *Evaluation of water quality impacts of permits*: Assess the impact on water quality represented by permit violations; In-depth evaluation of CAFO permits to assess potential for effects on water quality; Evaluation of WPCF/NPDES permits to identify expired permits and assess known or potential groundwater or surface water contamination from point sources

- Recommended actions specific to ***Surface water quality*** include:
    - *Temperature*: Improve riparian vegetation to more closely mimic natural potential vegetation; Increase summer time instream flows (quantity and timing) to more closely mimic the natural hydrograph; Reduce stream temperatures, and the influence of pollutants, and sedimentation through conservation measures
    - *Flow (Altered Hydrology)*: Assess available flow information to achieve a better understanding of where flow impaired reaches exist; Implement water conservation strategies, water rights transfer, improved delivery efficiency; Encourage measuring devices on all irrigation and/or diversions where public funds are expended
    - *Sediment and Turbidity*: Identify causes and initiate appropriate implementation measures for sediment loading from livestock, road run-off and slope failures, irrigation, uplands, unstable stream banks, wildfires, and altered flow regimes; Minimize erosion through conservation cropping techniques and pasture management, Minimize nutrient loss by aligning fertilizer amount, type and application methodology to the physiological requirements of the crop
    - *Habitat*: Improve channel sinuosity, complexity and function; Improve riparian vegetation to more closely mimic natural potential vegetation; Increase summer time instream flows (quantity and timing) to more closely mimic the natural hydrograph,
    - *Harmful Algae Blooms*: Adopt an agency strategy for identifying/responding to harmful algal blooms; More comprehensive collection of blue-green algae data to identify areas of concern; Data collection to identify causes of harmful algal blooms and associated impairment.
    - *Toxics (Mercury/Arsenic)*: Assessment/evaluation of mercury concentrations and probable sources in East Lake; Assessment/evaluation of arsenic in both groundwater and surface waters to determine probable sources and if the concentrations observed represent human health/fish issues; Assess the arsenic survey that was done in the Prineville area.

- Recommended actions specific to ***Groundwater quality*** include:
    - *Nitrate*: Assess the distribution and cause of elevated nitrate in scattered locations throughout Deschutes Basin; Special locations of interest in La Pine, Prineville, Redmond, Sherman County, Lower Deschutes/Warm Springs
    - *Groundwater/surface water interactions and withdrawals*: Develop tools/relationships to assess the cumulative effects that groundwater pumping and/or the lining of canals in the Upper

  Deschutes Subbasin will have/is having on stream flows in the Deschutes River between Bend and Lake Billy Chinook (middle Deschutes), the lower Crooked River, and lower Whychus Creek
  - Update the _Deschutes Groundwater report_
  - Perform a _source assessment for bacteria_ found in groundwater wells (identify causes and extent and magnitude of the concern)

- Recommended actions for ***DEQ-specific coordination, outreach and data-related resources*** include:
  - _DEQ Sub-program coordination_: Obtain commitment for inter-program staff support to directly participate in ongoing WA processes; Develop an accessible, user friendly database for compilation and analysis of data from all subprograms of DEQ and stakeholders
  - _Interagency and Stakeholder Coordination_: Establish and maintain a strong working relationship with CTWS, sister agencies (ODA, ODF, DSL, OWRD, ODFW, ODOT) and local and federal agencies that allows effective communication and support; Work specifically to improve DEQ's relationship with CTWS to better understand and reflect each other's objectives and goals in coordinated efforts and to allow more effective sharing of resources and information specific to resource needs in the Deschutes Basin
  - _Public Education and Outreach_: Continue existing stakeholder outreach and involvement in the on-going WA process; Develop and maintain an interactive web tool for data and information sharing Basin-wide; Develop and oversee a Basin-wide Monitoring Council to help coordinate monitoring, funding and data analysis on a holistic scale

- It is expected that implementation of the actions outlined will, cumulatively, help to improve the overall status of environmental resources in the Deschutes River Basin, and will improve environmental and water quality on a broad scale.

- It is recognized that while some of the recommended measures may result in a very rapid response from the natural system, many of the measures recommended for resource support and restoration will require longer periods to realize results, perhaps much longer than the iteration sequence of the WA. It is expected that even with full availability of funding and project partners, full implementation of the priority elements listed in the preceding tables will extend beyond the projected 5-year sequence of the WA process. However, incremental benefits will occur within the Basin with ongoing implementation activities and will result in a positive trend in resource status over time.

- The responsibility for the monitoring identified by this plan rests with all stakeholders within the Basin including State, Federal, Local and Tribal governments, private entities such as watershed councils, environmental groups, and permitted dischargers and volunteer monitoring efforts. All of these efforts can help to fill the monitoring needs outlined below for the Deschutes Basin. Specific monitoring needs have been identified associated with the focus areas and priority actions for the Deschutes Basin.

- As part of on-going efforts coordinated with this WA, it is recommended that a comprehensive data analysis report for the Deschutes Basin be prepared at five-year intervals (coinciding with the iterative WA process). An initial report summarizing and collectively analyzing all appropriate data collected to date would provide information critical to the implementation of this Action Plan. Such a data analysis is strongly recommended in order to inform prioritization of monitoring strategies, focus and timing; to inform on-going and future implementation projects and areas of focus, and to identify existing data gaps.

INTRODUCTION

WATERSHED APPROACH (WA) PROCESS EXPLANATION

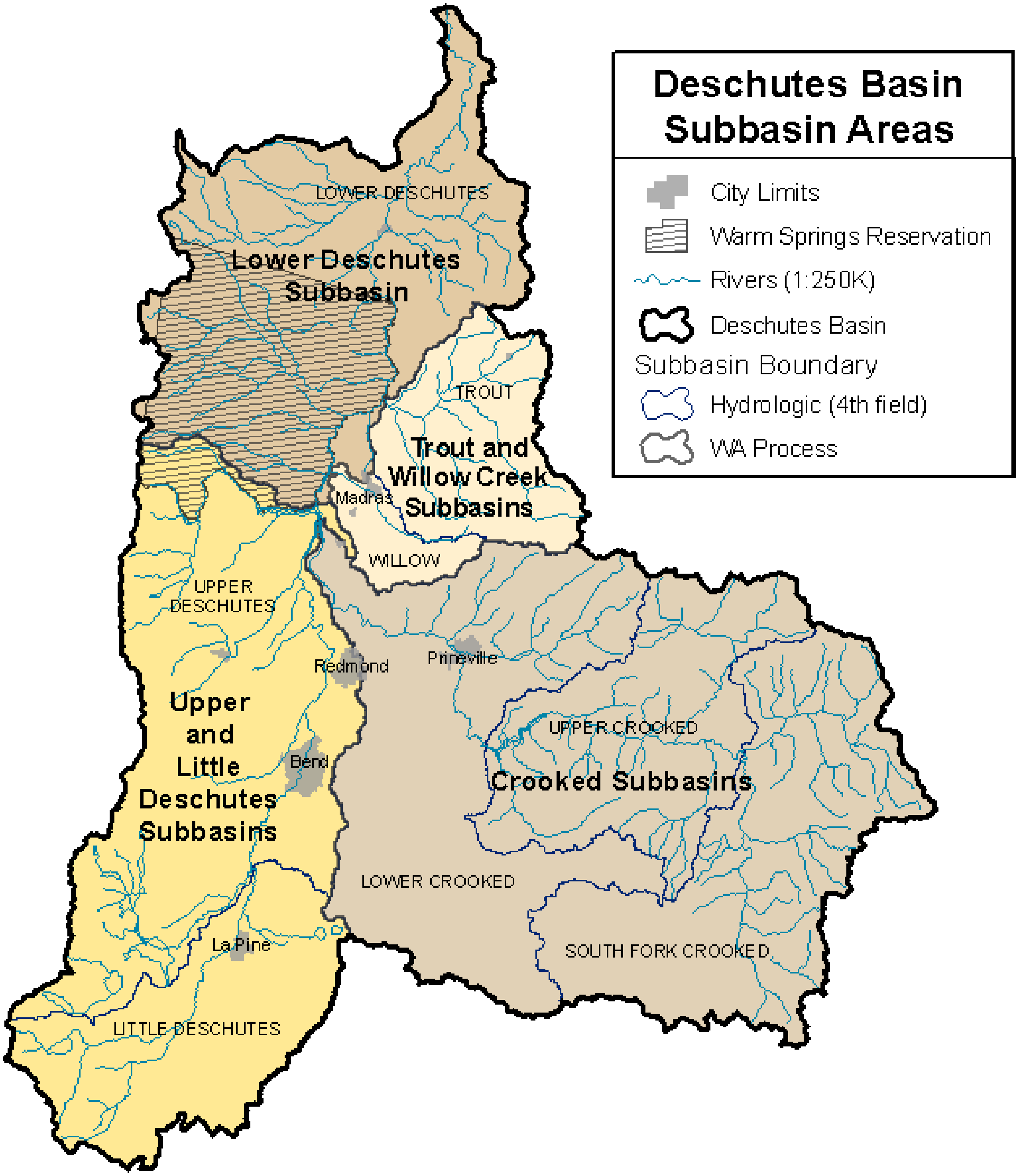
The Deschutes Basin WA is intended to provide a basin-scale resource assessment process with much greater opportunities for direct, interactive feedback from local stakeholders than the Total maximum Daily Load (TMDL) process. Unlike a TMDL, the WA process is not limited to addressing 303(d) listings using available water quality data. It addresses surface water status for both 303(d) listings and other surface water related concerns, groundwater and upland conditions, and provides an evaluation of the environmental status of the basin as a whole. While the WA process is being designed to address some of the limitations of the TMDL process, it will not replace TMDLs. The TMDL process will continue within the state and the WA process for the Deschutes Basin will inform and assist the Deschutes Basin TMDL process. It is envisioned that the Deschutes Basin WA will allow directed implementation to proceed prior to completion of the formal TMDL.

The Deschutes Basin WA does not have the regulatory authority of a TMDL and should be viewed more as a guidance document than a regulatory requirement. The WA does not identify waste load allocations for point sources or load allocations for nonpoint sources. It will however, potentially inform load and waste load allocations in the Deschutes Basin TMDL where the level of data available to the WA process is appropriate, and may inform other regulatory processes.

Tribal lands of the Confederated Tribes of Warm Springs Reservation (CTWS) represent a substantial portion of the Deschutes Basin. CTWS have water quality standards separate from the State of Oregon that apply to resource conditions on Tribal lands. As resource assessment and resource-related concerns are most effectively addressed at a watershed scale, DEQ appreciates the opportunity to work with CTWS in this process. DEQ also looks forward to continued communication and coordination with CTWS on future iterations of the WA process.

The Deschutes Basin is very large and encompasses a wide range of environmental, social and cultural conditions. In order to better assess and describe the conditions in the Basin, and to more effectively communicate with stakeholders during the WA process, the Basin has been divided into four separate subsections: the Crooked River Subbasins, the Upper and Little Deschutes Subbasins, the Lower Deschutes Subbasin and the Trout and Willow Subbasins. Public interaction, pollutant and resource assessments and priorities were developed separately for each of these four areas. A map showing the area boundaries is located on the following page. The definition of subbasin in this context is not necessarily the hydrologic definition of a subbasin (which are also indicated on the referenced map), but rather is meant to indicate that these four areas each represent a portion of the larger, Deschutes Basin (e.g. a sub-set). The term "subbasin" will be used in this context to describe these four areas throughout the Basin Status Report and Action Plan to refer to these four geographic areas. In most cases, our use of "subbasin" corresponds to the hydrologic subbasins, with the exception of the Trout and Willow Subbasins. For our purposes, this area refers to the Trout and Willow Creek watersheds along with the surrounding area of Agency Plains.

The Deschutes Basin WA consists of two primary elements: a basin status report and a basin action plan. Each of these elements is described below. Stakeholder involvement is also a critical component of the Deschutes WA. A discussion of our stakeholder involvement process for the Deschutes Basin WA is included at the end of this introductory section.


Deschutes Basin Subbasin Areas
City Limits
Warm Springs Reservation
Rivers (1:250K)
Deschutes Basin
Subbasin Boundary
Hydrologic (4th field)
WA Process
LOWER DESCHUTES
Lower Deschutes Subbasin
TROUT
Trout and Willow Creek Subbasins
Madras
WILLOW
UPPER DESCHUTES
Redmond
Prineville
UPPER CROOKED
Upper and Little Deschutes Subbasins
Bend
Crooked Subbasins
LOWER CROOKED
La Pine
SOUTH FORK CROOKED
LITTLE DESCHUTES

STATUS REPORT

The Deschutes Basin Status Report is a summary of specific findings on resource status in the Deschutes Basin and is designed to answer the question "How are things doing and why are they in that condition?" The findings in this report are somewhat broader in scope and less rigorous in nature than for a TMDL and are based on available information and known concerns rather than on computer modeling. The findings are not arbitrary or unfounded, but may not require the same level of data density as required by a TMDL. This will allow implementation work to proceed in a more timely fashion and will result in a more timely iterative process than is allowed by the TMDL process. In some cases the WA Status Report shows that insufficient information is available for some issues, this may be due to an incomplete understanding of the current status or lack of sufficient data for an assessment to be made. In the latter case, the Action Plan will identify recommended future monitoring work.

The Deschutes Basin Status Report is divided into four primary sections: Basin Description, Pollutant Sources, Water Quality Status and Trends, and Summary of Implementation Efforts in the Basin.

Basin Description

This section gives a brief description of the physical and cultural features of the Deschutes Basin, a discussion of the beneficial uses that have been identified for the Basin and other, similar information that provides context for the reader.

Pollutant Sources

This section gives a brief description of the general categories of point and nonpoint source pollution. Where information is available, there this is followed by a discussion of specific pollution sources and their water quality impacts in the Deschutes Basin.

Water Quality Status and Trends

The water quality section contains information on both surface water and groundwater within the Basin.

Surface Water

The surface water section contains information on both point and nonpoint pollutant sources that may affect the quality of surface waters in the Basin. It also contains an extensive discussion of pollutant parameters of concern in the Basin and identifies resource status specific to these parameters for different areas of the Basin. The status of surface water quality in the Basin is discussed by parameter/pollutant for each of the four subbasin areas.

Groundwater

The section on groundwater includes information on pollutants and pollutant sources, a general assessment of groundwater quality and some information on concerns relative to groundwater withdrawals in the Basin. The status of groundwater quality in the Basin is discussed by issue/pollutant for the Basin as a whole or (where appropriate) for specific locations in the Basin (e.g. the La Pine area).

Summary of Implementation Efforts in the Basin

A discussion of some of the project work relative to improving water quality and resource status is outlined in this section. While it strives to capture the work proceeding in the Basin, it is not an exhaustive listing of all implementation projects.

DESCHUTES BASIN ACTION PLAN

The Deschutes Basin Action Plan is divided into three sections: Priority Pollutants and Critical Areas, Recommended Actions and a Monitoring Plan.

Priority Pollutants and Critical Areas

This section identifies the priority pollutants of concern and specific geographic areas of focus throughout the Basin. Priority pollutants are those that have been identified to be of primary and urgent concern in the Basin and should be addressed first. Specific geographic areas of focus are those areas where it has been determined that immediate action could provide a substantial benefit to water quality or habitat, or offset an acknowledged and immediate risk. Priority rankings are based on available data and on specific concerns identified through DEQ or stakeholder assessment of conditions in the Basin.

Recommended Actions

This section identifies specific implementation measures and actions (things that we know need to be done) and specific geographic areas of focus where those actions should be implemented. As stated earlier, in some cases these recommended actions will be based on known fixes to problems identified by the WA assessment (that would act to reduce the problems identified or prevent problems from getting worse) rather than computer modeling or exhaustive data analysis. For example, if an area is identified to have both elevated water temperatures and reduced riparian vegetation, recommended actions may include projects to improve riparian vegetation even though temperature modeling has not been done to determine the exact magnitude of change in vegetation that is necessary. (Essentially, if we recognize that we need to improve shading in a stream reach, we can start moving forward with vegetation-related projects knowing that they will result in temperature and habitat benefits. We do not need to wait until there is modeling in place to tell us we need 1.1 ^{o}C of temperature reduction in order to start planting willows and alders.)

All of the identified actions will not necessarily focus directly on water quality. Upland management actions, changes in water volume or flow scenarios and public education programs are some possible recommendations that the Action Plan may contain. The Action Plan identifies items requiring additional study for next WA iteration, things we suspect need to be addressed but are not sure of, and/or things where we need additional data in order to determine an appropriate magnitude of concern.

Monitoring Plan

The Deschutes Basin Monitoring Plan contains recommendations for future monitoring that include status monitoring (water quality, biological, morphological), effectiveness monitoring (project-related changes in water quality), resource quality trend monitoring (are conditions changing over time?), and ongoing ambient monitoring (currently sponsored by DEQ, United States Forest Service (USFS), Bureau of Land Management (BLM) and other entities within the Basin). The monitoring plan also includes recommendations for setup and maintenance of a database (or databases) for collection of information (spatial, water quality, project-related and other) that provides access to stakeholders throughout the Basin.

STAKEHOLDER INTERACTION

The Deschutes Basin WA is being developed with broad public input, and stakeholder interaction will continue to be a substantial component of the process until completion and will act to inform the ongoing, iterative nature of the WA in the years to come. DEQ is coordinating efforts with many stakeholders within the Basin and welcomes the participation of all parties who are interested in being a part of the WA process. It is expected that the process will change and grow as we learn more about the basin and the needs of local stakeholders.

Throughout the Deschutes Basin WA process, local experience and participation will be invaluable in the identification of water-quality issues and reduction strategies appropriate on a local scale. Because of the impact of the WA process on the local community and the dependence of any implementation plan on local participation, public involvement is viewed as critical for the entire process. To date, DEQ has hosted four separate stakeholder meetings within the basin to help inform the WA process. These meetings were designed to focus on the needs and concerns specific to each of the subbasins and were held in each of the four geographic areas as follows:

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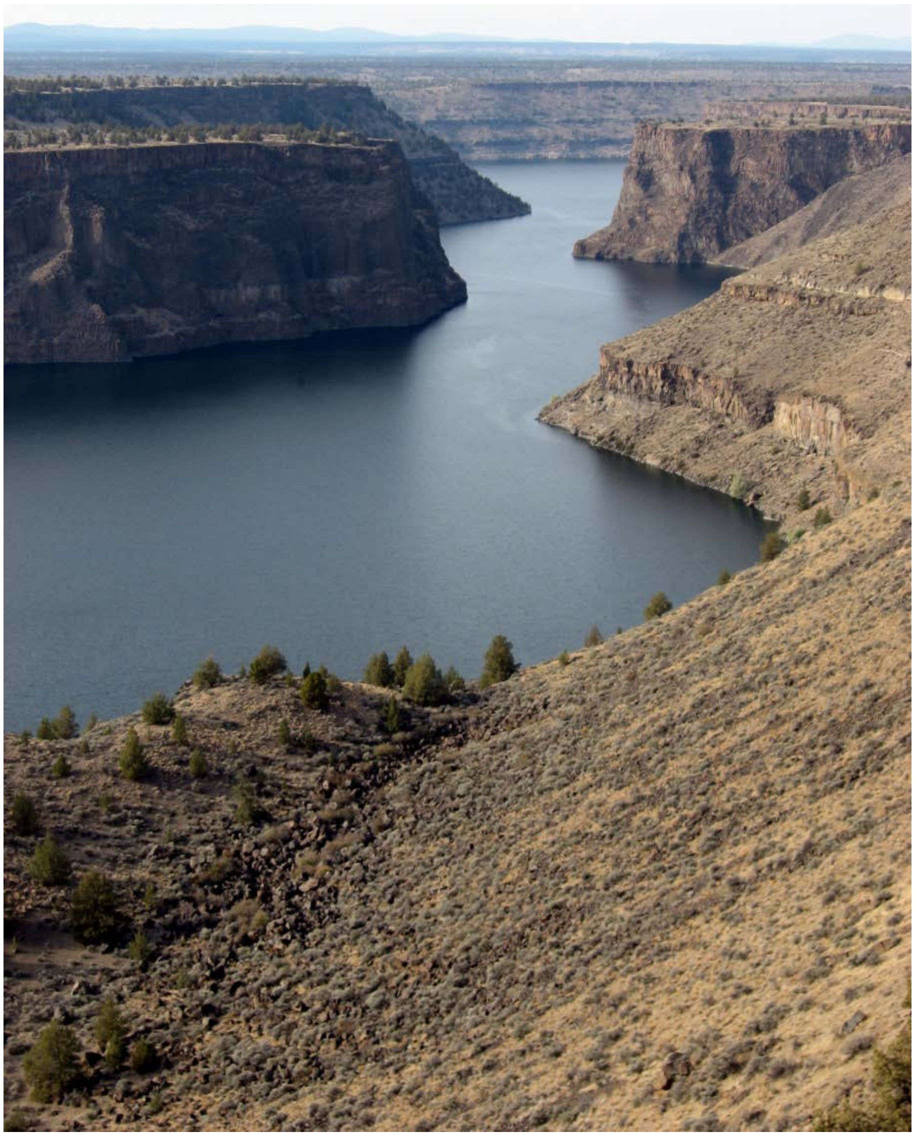
DESCHUTES BASIN STATUS REPORT



BASIN DESCRIPTION

Physical Landscape

(Note: most of this section is from Deschutes Subbasin Plan, NPCC 2005)
The Deschutes Basin is the second largest watershed in Oregon, covering 10,759 square miles (6,886,142 acres) in the north-central part of the state. The basin extends west to the crest of the Cascade Mountains, south to lava plateaus, east into the Ochoco Mountains and to the plateau between the Deschutes and John Day Rivers, and north to its confluence with the Columbia River. Much of the geography of the basin has been shaped by volcanism, from the young cinder cones and pumice deposits of the Cascades to the massive Columbia River basalts in the canyons of the lower river.

The headwaters of the Deschutes River and most major tributaries receive large amounts of precipitation, but much of the subbasin lies in the rain shadow of the Cascade Mountains and is sheltered from western Oregon's heavy rainfall. Average annual precipitation amounts to more than 100 inches on the eastern slopes of the Cascades, mostly as snow, but drops to only 40 inches in the Ochoco Mountains and 10 inches at lower central locations. Consequently, while the Metolius drainage receives up to 50 inches of precipitation annually, the Bakeoven drainage receives only 10-12 inches.

The climate in much of the basin is considered continental, with low precipitation and humidity, large daily temperature fluctuations throughout the year, and high evaporation rates. Cold winters and hot, dry summers are common. Temperatures in the Crooked River watershed, for example, can exceed 100^{o}F in summer and drop below -30^{o}F in winter. The City of The Dalles, located near the basin's mouth on the Columbia River, is often the warmest location in the state.

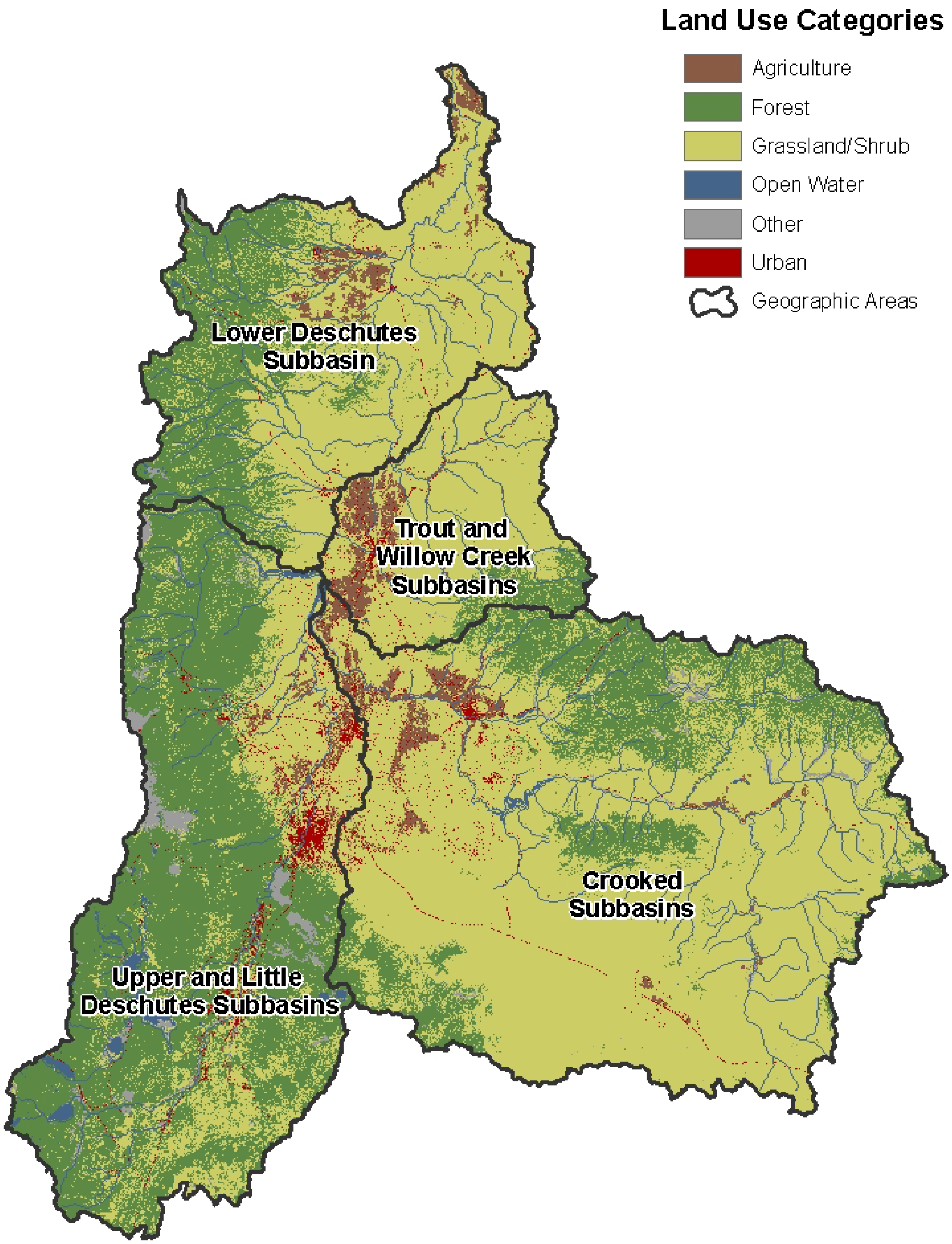
Human Landscape

All or portions of nine Oregon counties are situated in the Deschutes watershed. These counties include Crook, Deschutes, Harney, Hood River, Jefferson, Klamath, Lake, Sherman and Wasco. Five of these counties — Crook, Deschutes, Jefferson, Sherman and Wasco — comprise most of the watershed. Larger population centers in the subbasin include Bend, Redmond, Madras and Prineville.

Land ownership in the Deschutes Basin is about 51% public, 7% Tribal, and 42% private (NPCC 2005). The federal government owns and manages most public land in the basin, including three national forests, one National Grassland and one Bureau of Land Management District. Lands of the Warm Springs Tribal Reservation extend over approximately 641,000 acres and lie mostly in the Lower Deschutes Subbasin. Land use (NLCD 2001, Anderson et.al. 1976) in the Deschutes Basin is approximately 59% grassland/shrub, 34% forested, 3% agriculture, 2% urban and 2% other (see map on the following page).

Water Resources

(Note: much of this section is from Deschutes Subbasin Plan, NPCC 2005; Cole 2006; and the OWRD website)
In a natural state, the Deschutes River displayed a unique flow regime that sets it apart from other eastern Oregon rivers. The steady flows through the length of the Deschutes River were primarily due to the volcanic geology of the upper subbasin and substantial groundwater storage. Porous volcanic soils and lava formations absorb much of the snow and rain that falls on the Cascade Basin, creating a large underground aquifer. Much of this groundwater surfaces as springs in the upper and middle watershed.



Natural flows in tributaries are often more variable than those in the mainstem Deschutes River. Annual, and sometimes daily, stream flows are particularly changeable in eastside tributaries draining semi-arid lands in the Cascade rain shadow that do not receive abundant groundwater discharges. Stream flows in Westside tributaries that drain the wetter, cooler slopes of the Cascades and benefit from groundwater and surface water are generally less variable. For example, flows in the Crooked River are highly variable, while those in the Metolius River fluctuate little.

Today, water regulation by upstream reservoirs and irrigation diversion systems alters the Deschutes River's stable natural flow pattern and impacts stream/river water quality. Two main water projects on the upper Deschutes River, Crane Prairie and Wickiup Dam, regulate flows in the upper and middle Deschutes River. Water storage and releases create very low flows in the upper Deschutes River above the City of Bend during the winter, when reservoirs are being filled, and very high flows during the summer irrigation season, when water is being released from the reservoirs. Six irrigation diversion canals remove water from the Deschutes River near Bend. Consequently, water storage reduces flows in the middle Deschutes during winter months and irrigation withdrawals reduce flows during summer months. Natural flows in the Crooked River are altered through water storage and releases at Bowman and Ochoco Dams, and other smaller reservoirs, as are flows in the White River system. Flows in the Deschutes mainstem and Crooked River improve substantially near the Pelton Round Butte Complex with spring releases. Reservoirs and diversions are discussed in more detail in the Nonpoint Sources section under the discussion of Pollutant Sources.

The Oregon Water Resources Department (OWRD), in cooperation with the United States Geological Survey (USGS) and others, has conducted research on the Deschutes Basin's groundwater resources. The basin's surface water resources have been fully appropriated for many years, and stream flows are locally below legally set minimums at certain times of the year. Because surface water rights are no longer available, virtually all new development relies on groundwater. Groundwater is abundant in parts of the basin, and with the high level of development in the area, concerns exist about causing seasonal and long-term aquifer water level declines. This could cause further stream flow depletion. A secondary issue is the potential effect of lining irrigation canals. Hundreds of miles of leaking irrigation canals traverse the basin. Lining these canals to prevent leakage is being considered to conserve water. Leakage from these canals may be providing significant recharge to the groundwater system, so the overall effects of eliminating this recharge are unknown. The study resulted in numerous USGS reports and abstracts, which are available from the USGS website:
http://or.water.usgs.gov/projs_dir/deschutes_gw/index.html.

In 2002, the Oregon Water Resources commission adopted the Deschutes Groundwater Mitigation Program to provide for new groundwater uses while maintaining scenic waterway and instream water right flows in the Deschutes Basin. The goals of the program are to:

- Maintain flows for Scenic Waterways and senior water rights, including instream water rights;
- Facilitate restoration of flows in the middle reach of the Deschutes River and related tributaries; and
- Sustain existing water uses and accommodate growth through new groundwater development.

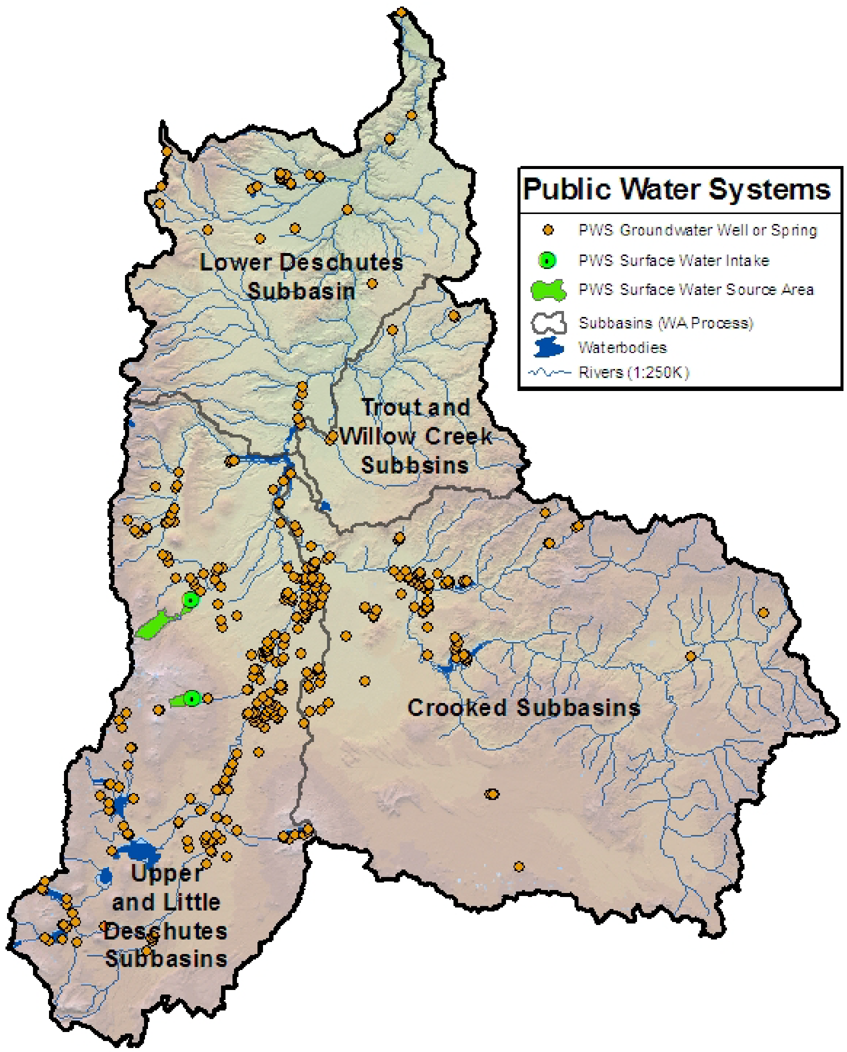
More information about the program is available from the OWRD website, including the results of a five-year evaluation in 2008: http://www.oregon.gov/OWRD/Deschutes_five_year_eval.shtml.

Beneficial Uses

Water quality standards have been developed to protect the following beneficial uses in the Deschutes Basin (OAR 340-41-0130, Table 130A): public and private domestic water supply, industrial water supply, irrigation, livestock watering, fish and aquatic life, wildlife and hunting, fishing, boating, water contact recreation, and aesthetic quality. In addition, hydropower is identified as a beneficial use for the Deschutes River from the Pelton Regulating Dam upstream to the Bend diversion dam and for the Crooked River. In practice, water quality standards are set at a level to protect the most sensitive beneficial uses.

The beneficial uses which are most sensitive to water quality impairment are typically fish and aquatic life, public and private drinking water supply (both groundwater and surface water), and water contact recreation. Temperature, dissolved oxygen, pH, sediment and pesticides are examples of pollutants which directly affect fish and aquatic life. Bacteria, toxics, turbidity and toxics are examples of pollutants which directly affect human health. These affects of these pollutants on beneficial uses will be discussed in more detail in the section on Water Quality Status and Trends.

Drinking Water Supply



Oregon implements public drinking water protection through a partnership of DEQ and the Office of Environmental Public Health at the Department of Human Services (DHS). Public drinking water systems can either rely on surface water, groundwater or a combination of both. The public water supply systems in the Deschutes Basin are described below and shown in the adjacent map. There are also private water systems. A recent query of OWRD's water rights database for private domestic points of surface water diversion (using a threshold of 0.005 cubic feet per second (cfs) for domestic water rights that are household use only, not irrigation) identified 121 private domestic surface water rights in the Deschutes Basin. There are also numerous private groundwater wells for domestic use. More information about Oregon's drinking water protection program is available at http://www.deq.state.or.us/wq/dwp/dwp.htm.

Public Surface Water Systems. There are two public drinking water systems within the Deschutes Basin that utilize rivers or streams as a water source: the City of Bend diverts water from Tumalo Creek and Bridge Creek and the City of Sisters can divert water from Pole Creek. More information about source water assessments done for these systems is available at http://www.deq.state.or.us/wq/dwp/swrpts.asp.

City of Bend. Surface water from Bridge Creek and Tumalo Creek provides about half of the City of Bend's drinking water supplies. The City collects water from source springs above upper Tumalo Creek; a portion of this water is diverted through two steel pipes into a short canal that discharges into the top of Bridge Creek. The City then diverts water out of Bridge Creek at an intake facility seven miles downstream (near the mouth of Bridge Creek) and transfers this water approximately 11 miles down to the City of Bend in a pipeline. Water that is not used by the City for drinking water is returned to Tumalo Creek in Shevlin Park. There have been turbidity problems associated with this returned water due to erosion which occurs between the City's reservoir and Tumalo Creek. The percentage of water used by the City from the City's surface water source varies from year to year depending on weather, snowpack, maintenance activities, spring storm events and community demands. The remaining water supply is provided by groundwater wells. The City of Bend has currently embarked on a surface water improvement project designed to upgrade the treatment capability of the system to comply with new United States Environmental Protection Agency (EPA) drinking water regulations which require compliance by 2012.

The source watershed is owned and managed by the Deschutes National Forest to provide high quality drinking water under a 1926 agreement and subsequent 1991 Memorandum of Understanding between the Deschutes National Forest and the City of Bend. Annual watershed inspections are conducted every September with City and Deschutes National Forest staff to evaluate forest health, fire protection, control of human activity and projects for improving water quality.

City of Sisters. The City of Sisters has a drinking water intake on Pole Creek in the Whychus Creek watershed. This surface water source is currently inactive and is listed as an emergency source, with groundwater providing the City's primary source of drinking water. The delineated drinking water protection area for this source is primarily dominated by forest lands. No potential sources of contamination to the drinking water were identified within the surface water portion of Sisters' drinking water protection area.

Because of the protections afforded by various levels of legal and administrative actions there are no anthropogenic sources of contaminants in the Bridge Creek Watershed. The delineated drinking water protection area for Sisters is also primarily dominated by forest lands and no potential sources of contamination to the drinking water were identified in the Source Water Assessment. Contaminants of concern for the Bridge Creek and Pole Creek sources are naturally occurring sources of microbial contaminants attributed to warm blooded wildlife species and several bird species. The Bridge Creek and Pole Creek Watersheds have consistently complied with all applicable state and federal regulations for source water under the Safe Drinking Water Act.

Public Groundwater Systems. In the Deschutes Basin there are 253 public water systems relying on in whole or in part on groundwater serving a total population of over 196,000 residents. Of these systems, 101 have experienced groundwater contamination problems, which are described further in the section on Water Quality Status and Trends for groundwater. Contaminants of concern include volatile organic compounds (3 systems), synthetic organic chemicals (5 systems), metals (nickel and fluoride in 3 systems), arsenic (17 systems), nitrate (20 systems), and bacteria (72 water systems).

POLLUTANT SOURCES

Pollution is the presence of a substance which causes harm or degradation where it would not normally be found, or causes harm or degradation if it is present in quantities greater than those found naturally. Man's use of water can result in pollution both because of the substances we put into the water directly or indirectly and because of water withdrawals that result in lower flows, increased temperatures and lack of dilution of substances entering the water.

Pollution can have both direct and indirect effects. An example of direct effects may be an accidental oil spill into a river that results in a fish kill. An indirect effect may be a fish kill that results from depleted dissolved oxygen caused by algal growth due to nutrient enrichment from improperly applied fertilizer.

Pollution is often described as point source or non-point source pollution.

Point Sources

Point source pollution typically enters a water body at a specific site (like through a pipe) that is easy to identify. A point source is simply described as a discrete discharge of pollutants as through a pipe or similar conveyance. A technical definition exists in federal regulation at 40 CFR 122.2. Point sources of pollution include effluent discharges from waste water treatment plants and industrial discharges, most of which are permitted and required to comply with certain discharge limits.

Municipal and industrial wastewater, and stormwater discharges to surface waters (lakes, rivers and streams) are permitted under the National Pollutant Discharge Elimination System (NPDES). NPDES permits are required under the federal Clean Water Act (CWA), and are issued and monitored in Oregon by DEQ. Limits included in these permits are designed to ensure approved water quality standards are not violated by the discharge. Water Pollution Control Facility (WPCF) permits are issued to sources of wastewater that discharge to the land surface or allow infiltration to the ground. WPCF permits do not allow direct discharge to surface waters. These latter permits are issued under rules adopted by the Environmental Quality Commission, which oversees and directs the activities of DEQ.

Some permits are issued to the wastewater or stormwater source with specific or “individual” requirements for monitoring and effluent limits. These limits are determined by DEQ staff through analysis of the characteristics (flow rates, pollutant types) of the wastewater source. Others contain “general” requirements that are applicable to all sources that operate in a particular way. These permits are issued to cover relevant activities throughout the state, but require individual facilities or businesses to be registered under the permit. Permits are divided this way into “individual” and “general” permits.

Under a Memorandum of Understanding, ODA and DEQ jointly issue NPDES individual and general permits for the Confined Animal Feeding Operation (CAFO) permit program. ODA assigns the permits and conducts the compliance and monitoring under this agreement. These permits are discussed further below.

DEQ plans permit issuance on a basin schedule. The intent is to consider all sources within a basin at once, and to be able to make connections among observed water quality issues and these sources. Through the prioritization of water quality issues, we will be able to ensure that permitted sources are appropriately regulated where they have potential to add to these problems. Although DEQ plans for permit issuance on a basin schedule, we do not have sufficient resources to fulfill these plans in every year. Often the need to address priority or new permits outweighs the need to issue permits on schedule. As a result, there are some permits that are expired awaiting staff resources. These expired permits remain in effect with the same treatment, monitoring and reporting requirements as long as the permittee has applied for a renewal of their permit.

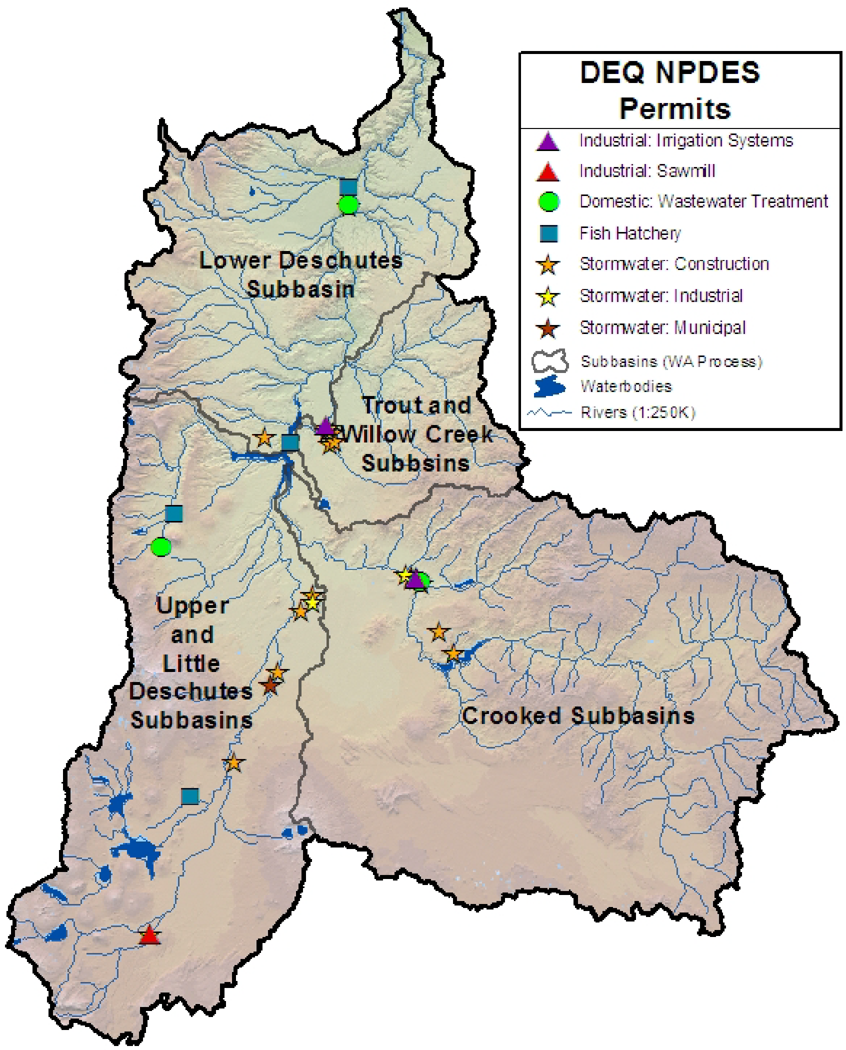
To learn more about the wastewater permitting program go to the DEQ website at:

http://www.deq.state.or.us/wq/wqpermit/permits.htm#wwp. To view permits for specific facilities, go to: http://www.deq.state.or.us/wqpermitsearch/. For more information on general permits or to view the requirements of these permits, go to: http://www.deq.state.or.us/wq/wqpermit/genpermits.htm Specific information about Deschutes Basin permits is provided below. It should be noted that the location of the facilities (as shown in the maps in this section) is based on information in DEQ"s permit database. When compiling permit information for the WA process, it was noted that the latitude/longitude information in the database was incorrect for some of the facilities. Where noticed, this information was corrected in the maps for this report. A more comprehensive review of the permit database needs to occur to correct this problem, both for the Deschutes Basin as well as for the whole state.

In addition to NPDES/WPCF permitted facilities, there are number of other hazardous waste or solid waste sources permitted or regulated by DEQ which have the potential to impact groundwater or surface water quality.

NPDES Permits

The adjacent map shows the location of NPDES permits regulated by DEQ, including both individual and general permits. These are described further below.

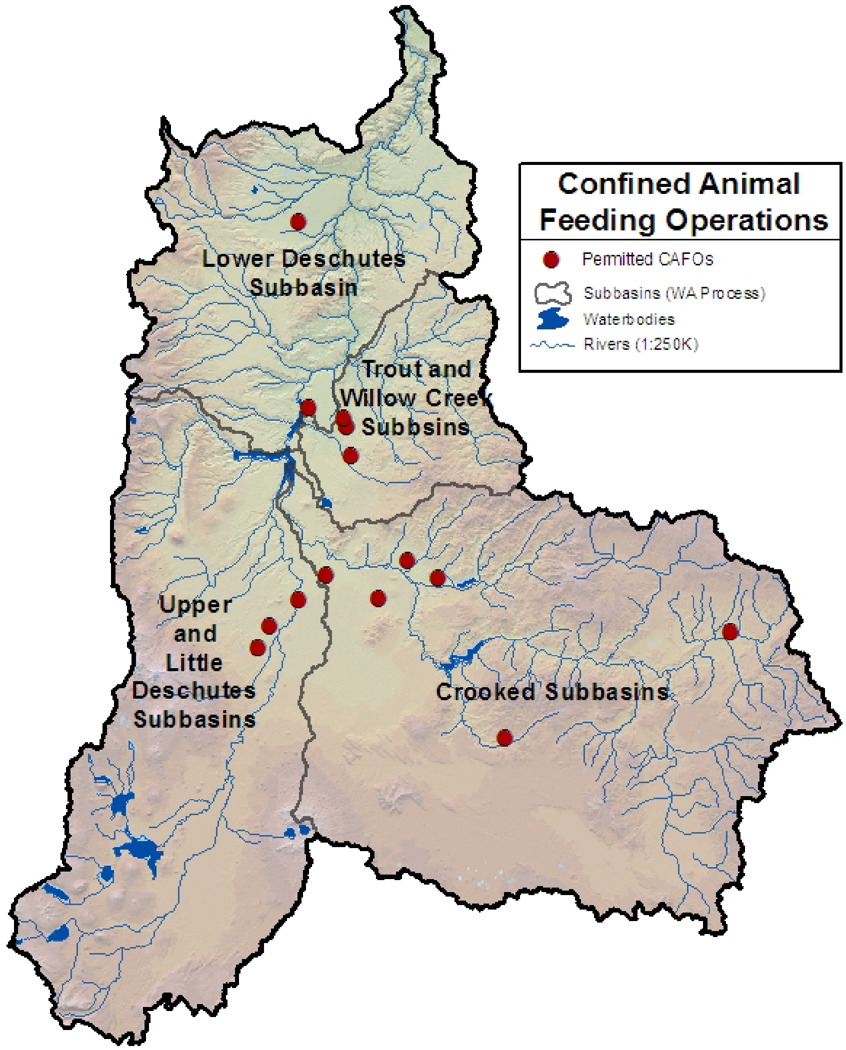


Individual Permits administered by DEQ. There are currently (as of 2/18/11) seven individual NPDES permits issued to sources in the Deschutes Basin (see table on following page). Three of these permits are issued for domestic wastewater treatment: The City of Prineville, the City of Maupin, and Black Butte Ranch. Most other municipal wastewater sources in the Deschutes Basin beneficially reuse wastewater through land irrigation to vegetation or slow infiltration to groundwater and have WPCF permits (see below). The City of Bend has a permit for its municipal separate stormwater system (MS4). Two irrigation districts maintain permits for application of specific herbicides to irrigation canals during the irrigation season. Interfor Pacific, Inc. operates a sawmill in Gilchrist, OR that discharges cooling water from its facilities. More information about each permit is provided in the figure on the previous page and in the table below. Of the seven individual NPDES permits in the Basin, five permits are currently expired and are in the process of revision and renewal. These are the two irrigation system permits, the permits for domestic wastewater treatment for the City of Prineville and Black Butte Ranch, and the cooling water permit for Interfor Pacific. The permits remain in force while they await renewal.

PERMITTED DISCHARGES TO SURFACE WATERS IN THE DESCHUTES BASIN: INDIVIDUAL NPDES PERMITS				
Common Name	Discharge Location	Permit Type (as shown in figure)	Permit Number	Benchmark or Effluent Limits
Prineville WWTP	Crooked River	NPDES-DOM-C2b (Domestic wastewater treatment)	101433	CBOD, TSS, total coliform bacteria, pH, total chlorine residual
Maupin WWTP	Deschutes River	NPDES-DOM-Da (Domestic wastewater treatment)	102274	BOD, TSS, E. coli bacteria, pH, total chlorine residual, temperature
Black Butte Ranch	Indian Ford Creek	NPDES-DOM-Da (Domestic wastewater treatment)	102218	BOD, TSS, E. coli bacteria, pH, total chlorine residual, ammonia-nitrogen
Bend Municipal Stormwater	Municipal Stormwater Area	NPDES-DOM-MS4-2 (Stormwater: municipal)	102901	None
North Unit Irrigation District	District canals, Deschutes River, Crooked River	NPDES-IW-B15 (Industrial: irrigation system)	102628	acrolein, xylene,
Ochoco Irrigation District	District canals, Crooked River, McKay Creek	NPDES-IW-B15 (Industrial: irrigation system)	102627	acrolein, xylene,
Interfor Pacific, Inc.	Little Deschutes River	NPDES-IW-B19 (Industrial: sawmill)	100660	inorganic arsenic, total recoverable lead, total recoverable copper, pH, temperature, oil and grease, debris

General Permits administered by DEQ. These permits in the Deschutes Basin most often cover stormwater discharges from industrial or construction sites. There currently (as of 2/18/11) are 11 construction stormwater permits (GEN12C) and 10 industrial stormwater permits (GEN12Z) in the basin (see map on previous page). Of the construction stormwater permits, four are located in the Upper Deschutes and Little Deschutes Subbasins, two are located in the Crooked Subbasins, four are in the Trout and Willow Creek Subbasins and one in the Lower Deschutes Subbasin. The industrial stormwater permits are located as follows: two in the Upper and Little Deschutes Subbasins (Interfor Pacific and Fosters Auto Parts), six in the Crooked Subbasins (3 millworks – Consolidated Pine, Contact Industries, Woodgrain Millwork; 1 Trucking – Les Schwab; 2 Sawmills and Planing Mills – Pioneer Cut Stock, Prineville Sawmill Co.), one in the Trout and Willow Creek Subbasins (Brightwood millwork in Madras), and one in the Lower Deschutes Subbasin (Millcraft sawmill in Maupin). There are also 5 permitted fish hatcheries (GEN03): Fall River and Wizard Falls hatcheries in the Upper and Little Deschutes Subbasins, and Oak Springs, Pelton Ladder and Round Butte hatcheries in the Lower Deschutes Subbasin. The fish hatchery general permit expired on 9/30/07. The permits remain in force while they await renewal.

Confined Animal Feeding Operation Permits. Confined Animal Feeding Operations (CAFOs) are the confined feeding or holding of animals in buildings, pens or lots where the surface is prepared to support animals in wet weather or where there are wastewater treatment facilities. Typical CAFOs in Oregon include dairies, beef feedlots, poultry, swine, horse and other animal farms that land apply their wastewater and manure at rates to meet crop needs while avoiding over applications that could lead to water quality impairment. CAFOs generate manure, silage pit drainage, wash down waters, contaminated runoff and milk wastewater.



The Oregon Department of Agriculture and DEQ have had agreements to address CAFO regulation since the late 1980s. In 2001, the Oregon Legislature authorized and directed the transfer of the federal Clean Water Act NPDES permit program for CAFOs from DEQ to the Oregon Department of Agriculture, subject to approval from EPA. In the interim period, DEQ and ODA operate under a Memorandum of Agreement describing the regulatory responsibilities of the agencies.

Livestock activities are common and have a long history in the Deschutes Basin. Currently (as of 11/15/10) there are 15 animal feeding operations (see adjacent map) under either state or federal permit. For more information regarding animal feeding operations, see: http://oregon.gov/ODA/NRD/cafo_front.shtml.

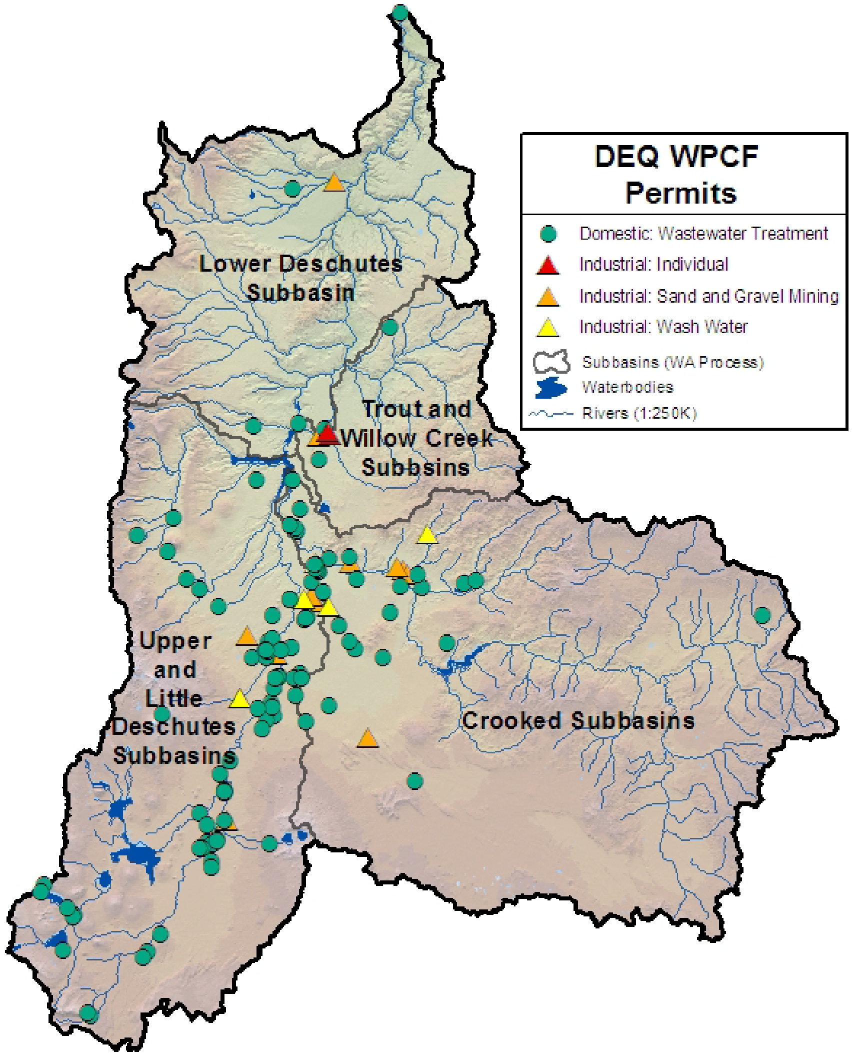
Water Pollution Control Facility Permits

There are both “individual” and “general” WPCF permits in the Deschutes Basin. The individual WPCF permits are mostly for large onsite wastewater treatment and disposal systems. These are similar to individual onsite wastewater systems used by residences where sewer service is not available, though these permits are for advanced treatment systems or those with daily flows exceeding 2500 gallons per day, and they often require significantly more treatment than required for an individual homeowner. A map showing the locations of the WPCF permits in the Deschutes Basin, both general and individual, is shown on the following page.

Underground Injection and Control (UIC) permits are a special case of Water Pollution Control Facility permits. UICs are used to discharge water below ground surface and have the potential to impact groundwater that is a source of drinking water. UICs are regulated under the federal Safe Drinking

Water Act, rather than the CWA, but state registrations or permits are required to ensure these "wells" do not violate drinking water standards. UIC permits are discussed further below.

Individual Permits. There are currently (as of 12/18/11) 109 individual WPCF permits for facilities of various sizes and complexities within the Deschutes Basin. The vast majority of these systems treat and dispose of domestic wastewater from resorts, mobile home parks, and other communities. The two largest cities in the basin, Bend and Redmond, are both regulated under this type of permit and discharge highly treated wastewater through a combination of infiltration and application to hay crops and golf courses. In addition to the domestic wastewater permits, there are two industrial sources that discharge non process water to a drainfield or dispose of wastewater by evaporation from a water tight lagoon.



General Permits. There are currently (as of 12/18/11) 20 general WPCF Permits in the basin: 15 permits for industrial sand and gravel mining (GEN10), and 5 permits for disposal of wash water (GEN17B). The mining permit covers sand, gravel and other non-metallic mineral quarrying and mining operations that dispose of all process wastewater and storm water by recirculation, evaporation, and/or controlled seepage with no discharge to surface waters. The wash water permit covers vehicle, equipment, building, and pavement cleaning activities that discharge wash water by means of evaporation, seepage and/or irrigation.

Underground Injection and Control Permits. Underground injection systems are any man-made design, structure or activity which discharges below the ground or subsurface. Common uses include: stormwater discharge, industrial/commercial and process waste water disposal, large domestic onsite systems and cesspools, sewage drill holes, aquifer remediation systems, motor vehicle waste disposal, agricultural drainage, geothermal systems and aquifer storage and recovery. Common designs include drywells, trench drains, sumps, perforated piping, floor drains, drainfields and drill holes.

The intent of the program is to protect groundwater resources, primarily used for drinking water, from contamination. All groundwater aquifers in Oregon are considered suitable as drinking water. The program is implemented from DEQ headquarters and serves the entire state. There are numerous federal classes and types of injection systems. All classes and types are required to be registered with DEQ and approved either through rule authorization (in lieu of a permit), under a state permit or closed.

There are over 12,000 registered UIC wells in the Deschutes basin and there are likely many unregistered wells. Many of the known UICs are within the boundaries of cities and provide stormwater disposal. Within the larger cities of the Deschutes Basin, these systems will soon be regulated under permit. Of the undetermined UICs, many serve agricultural lands and dispose of irrigation return flows, particularly for flood irrigation systems. The number of these wells and their impact is unknown at this time. Sewage drillholes discharge minimally treated sewage directly into a drilled well exposing groundwater to pollutants.

Though sewage drillholes were once in common use for sewage disposal, the vast majority of these have been decommissioned as a result of sewer extensions in urban areas and replacement with more modern systems upon failure (Nichols, internal DEQ memo, 1999). Still, there are many of these wells in service within and outside of sanitary sewer district boundaries.

Hazardous and Solid Waste Sources

Environmental cleanup sites, underground storage tanks, and solid waste facilities (landfills) are sources of pollution which are regulated by the Land Quality Program at DEQ. These sources of pollution are discussed further in this report under the section on Groundwater Quality.

DEQ maintains a list of known hazardous substance release site in the Environmental Cleanup Site Information (ECSI) database. Information on specific sites is available through on-line queries at: http://www.deq.state.or.us/lq/ecsi/ecsi.htm.

The DEQ Underground Storage Tank (UST) program regulates tanks storing petroleum or certain hazardous substances, and regulates tank release cleanups. The program maintains a list of regulated underground storage tank facilities in the state, which is available at: http://www.deq.state.or.us/lq/tanks/ust/index.htm. The UST program also maintains a database of Leaking Underground Storage Tanks where releases from tanks have been reported. This database is available at: http://www.deq.state.or.us/lq/tanks/LUST/.

Landfills are another source of potential groundwater contamination. Four landfills have operated in Deschutes County in recent years: Crook County Landfill near Prineville, Knott Pit Landfill in Bend, Southwest Landfill between Sunriver and La Pine, and Box Canyon Landfill in Jefferson County. As of 2010, only the Crook County Landfill and Knott Landfill were currently active. More information about active permitted solid waste facilities is available at: http://www.deq.state.or.us/lq/sw/disposal/permittedfacilities.htm.

Nonpoint Sources

Nonpoint source pollution is generally associated with spatially disperse land-use activities such as urban development, agriculture, forestry and transportation. It is often difficult to identify specific sources of nonpoint source pollution as they are linked to land use and management practices.

Examples of nonpoint source pollution include nutrients, bacteria, sediments and pesticides generated from agriculture and forestry land management, bacteria and petroleum products associated with urban runoff, leaking underground storage tanks, improperly operating septic systems, sediment runoff from construction sites, stream channel alteration, and damage to wetland and riparian areas.

There are many, varied, nonpoint sources of pollution in the Deschutes Basin. Major sources include:

- Agricultural practices
- Forestry practices
- Urban/suburban management practices (including stormwater and construction)
- Recreation activities
- Reservoirs and diversions
- Transportation corridors
- Invasive species
- Mining activities (legacy and current)

The occurrence and input of each of these sources varies throughout the basin relative to the distribution of land-use and management practices in place in each of the subbasins. The table below shows the break-down of broad land-use categories within the whole basin and within each of the subbasins. This information is discussed further in the rest of this section on nonpoint sources of pollution.

LAND-USE IN THE DESCHUTES BASIN

Area	Total Land	Agricultural Land	Range/ Grassland[a]	Forested Land	Urban/ Suburban Land	Other
Deschutes Basin	6,886,142 acres 100%[b]	222,704 acres 3%	4,056,960 acres 59%	2,314,642 acres 34%	124,400 acres 2%	167,441 acres 2%
Lower Deschutes Subbasin	1,316,164 acres 100%	54,593 acres 4%	817,830 acres 62%	415,477 acres 32%	11,495 acres 1%	16,769 acres 1%
Trout Creek and Willow Creek Subbasins	604,833 acres 100%	53,393 acres 9%	472,111 acres 78%	62,704 acres 10%	14,747 acres 2%	1,879 acres <1%
Crooked Subbasins	2,922,651 acres 100%	81,133 acres 3%	2,228,507 acres 76%	542,897 acres 19%	36,805 acres 1%	33,309 acres 1%
Upper and Little Deschutes Subbasins	2,042,496 acres 100%	33,585 acres 2%	538,512 acres 26%	1,293,564 acres 63%	61,352 acres 3%	115,483 acres 6%

[a] Range/grassland entry above represents a mixture of grazed and ungrazed lands.
[b] Percentages add across each row, representing the percent of each land use in each area identified in the first column of the table.

Agriculture/Agricultural Management Sources

A total of 222,704 acres were identified under agricultural land-use within the basin. Non-irrigated rangeland accounts for the majority of the agricultural land-use acres. Irrigated crop and pasture land makes up 3% of agricultural acres. Primary sources of pollutants associated with agriculture are bacteria, sediment and nutrients (present in both dissolved and sediment-bound forms). Related impacts are alteration of stream flows and temperatures. The generation and transport of pollutants from agricultural nonpoint sources are influenced by the health of riparian areas through which water is transported to streams, lakes and reservoirs, overland flow from runoff and snow-melt, irrigation practices, pasture and grazing management and fertilizer application (Deschutes Basin Agricultural

Water Quality Management Area Plans [2006, 2007, 2009, 2010] available from ODA online at: http://www.oregon.gov/ODA/NRD/water_agplans.shtml).

Bacteria, sediment, temperature and nutrient concerns associated with agricultural/grazing lands in these areas are discussed in detail in the parameter-specific sections. Potential impacts from agricultural management practices are listed in the following table.

POTENTIAL SOURCES OF POLLUTION FROM AGRICULTURAL PRACTICES	
Pollutant Source	**Resulting Status of Pollutant Loads**
Riparian grazing and in-stream stock watering	Increased sediment loads Increased nutrient loads Increased bacteria loads Increased erosion Vegetation reduction/removal Higher stream temps
Over-utilization of pasture	Increased erosion-sheet and rill Increased transport of sediment Decreased stubble height Soil compaction leading to reduced water infiltration Increased nutrient load from animal waste deposition Increased bacteria loads
Irrigation	Decreased stream flows from diversion resulting in increased temperature and degraded instream habitat Irrigation return flows can contribute pollutants, including heat, to surface waters Removal of soil fines from surface and subsurface (flood) Increased bank erosion from subsurface drainage and recharge Subsurface saturation, decreased permeability and increased erosion from surface runoff Removal of soil fines decrease surface area of soils and decreases available capacity for phosphorus sorption (flood)
Ranchettes	Increased sediment transport from high road and livestock density Increased nutrient loads from increased animal waste deposition and transport Increased bacterial levels Increased storm- water pollutants

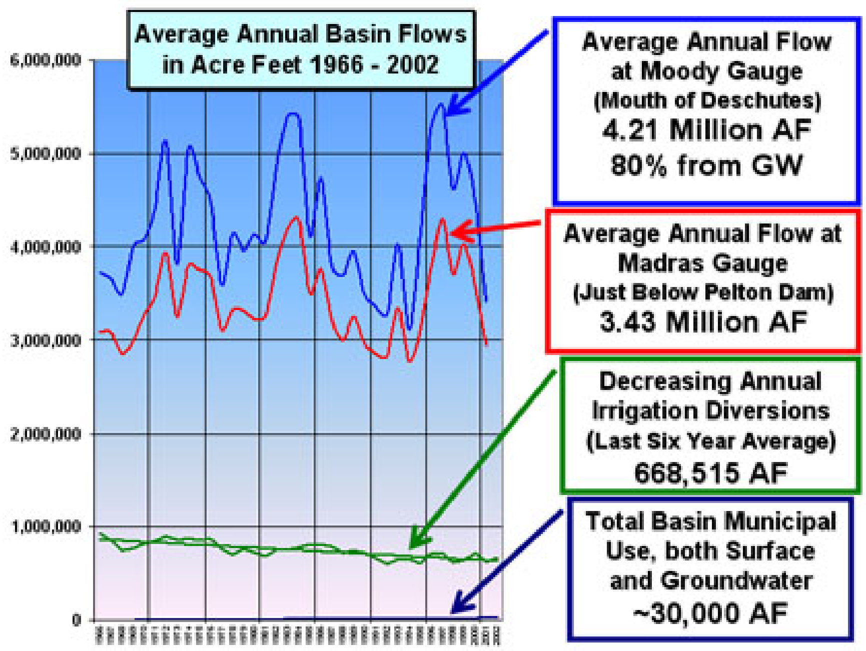
Grazing. Grazing in the late 1800s by high numbers of sheep, cows and horses depleted grasslands in the subbasin and resulted in encroaching sage and juniper communities, and more recently by noxious weeds. This change in vegetation contributed to higher soil erosion and runoff on uplands. The dry climate causes livestock to concentrate near streams where they alter riparian vegetative communities. The grazing pressure and variable climate (dry summers and intense winter storms) causes streams to erode vertically and laterally, and contributes to the loss of riparian vegetation (Platts and Nelson 1995). Related impacts of improper grazing management include increased water temperatures, increased sediment transport to streams and channels, greater dissolution of adsorbed phosphorus and other nutrients from sediment-bound forms, and higher levels of bacterial loading. In addition to stream-channel degradation, vegetation in over-utilized pasture areas is commonly insufficient to retain sediment within overland flow and deposited manure is easily transported directly into or downstream within existing stream and irrigation channels (Omernik et al., 1981). Historical trends in grazing have shown a gradual decrease in total stock counts within the basin, but livestock still tend to be concentrated near and within flood plains and stream channels. Grazing practices are being revised to encourage early season use, better livestock distribution, and alter duration, timing, and intensity of use. Improved practices are allowing vegetation to reestablish and streambanks to stabilize in some areas and trees and shrubs in these areas are gradually recolonizing degraded streambanks.

Cropping. Cropping in the Deschutes Basin began in the mid 1800s and early management practices resulted in changes in floodplain and vegetations patterns, accelerated runoff and erosion rates, and altering the timing and amount of water and sediment delivered to streams in some parts of the Basin. Impacts from agricultural practices were particularly damaging in those areas of the lower subbasin where soils are more susceptible to erosion. Natural Resource Conservation Service (NRCS) technicians have measured soil loss on steeper fields up to 300 tons per acre per year (Omernik et al., 1981).

Impacts from cropping within the watershed are relatively minor due to the small acreages dedicated to crop production. These impacts include those detailed for sub-flood irrigation in the section above and the impacts of fertilizers applied in the production of grains and to establish growth in newly seeded pastures. Fertilizer is reportedly not applied to pastures routinely once growth is established.

Farming and tillage practices in the Deschutes Subbasin are currently improving and erosion has been reduced through the Conservation Reserve Program (CRP) and other efforts.

Irrigation. Irrigation in the basin began in the 1850's when farms and orchards were established by European settlers. Water diversions have been occurring since that time, supported by local ditch companies, irrigation districts and municipal improvement districts formed to supply water to farms via storage reservoirs and canals. Seven major irrigation districts operate within the Deschutes Basin: Arnold Irrigation District (Bend), Central Oregon Irrigation District (Redmond), North Unit Irrigation District (Madras), Ochoco Irrigation District (Prineville), Swalley Irrigation District (Bend), Three Sisters Irrigation District (Sisters), and



Numbers and graphic from Swalley Irrigation website at: http://www.swalley.com/deschutes.htm

Tumalo Irrigation District (Bend). These irrigation districts collectively divert approximately 700,000 acre-feet per year (average 1996-2002). Irrigation water comes from both instream diversions and storage rights supplied by three large reservoirs in the upper Deschutes and two large reservoirs in the Crooked River drainage. Smaller storage reservoirs and irrigation diversions also exist on many tributary streams. Irrigation recharge and surface runoff often created flood irrigation practices are diverted to local streams or returns as tail water or shallow groundwater. These waters generally contain high concentrations of phosphorus and nitrogen compared to ambient concentrations of local streams (Omernik et al. 1981; Shewmaker 1997). These same irrigation systems funnel and accelerate delivery of runoff from snow-melt during spring thaw. In addition, inefficient irrigation water management practices can reduce stream flows unnecessarily, resulting in increased water temperatures. Irrigation withdrawals affect anadromous salmonids in several ways. Low summer flows and high water temperatures in diverted stream reaches limit habitat for rearing juveniles. They also restrict fish passage to other areas and connectivity between fish populations. The effects of reduced streamflows are particularly damaging to salmonid populations in degraded stream reaches, which may be wider than they were historically and lack deep pools and other structure that could provide refuge for fish during low flow periods. The altering of the natural stream flow cycles also affect riparian communities, leaving streambanks and channels unstable, reducing aquatic vegetation and habitat, and seasonally displacing or eliminating some vertebrates and invertebrates. Flow restrictions also contribute to stream channel constriction and simplification.

Today, irrigation districts and other water users in the Deschutes River Subbasin are concentrating on increasing water conservation and efficiency and implementing projects to put water back into streams and augment depleted summer flows. Recent projects include canal lining and piping, changes to source water and point of diversion, instream transfers, instream deliveries and water leasing. Through these efforts, summer instream flows in the Deschutes River below Bend have increased by over 30 cfs. Flows in Wychus Creek will have a permanent flow of 7 cfs (near Sisters), an area where the creek has historically been dry during summer months since the late 1800s.

Ranchettes and Hobby Farms. These properties, occurring throughout the basin and commonly associated with destination resort properties, are a potential source of high nutrient loading and bacteria from hobby livestock such as horses, mules, llamas and other domestics. Because Best Management Practices (BMPs) are not regularly implemented on hobby farms in many cases, animal densities (particularly of horses) are often greater than the available land can support, causing over utilization of existing vegetation and problems with waste management, leading to increased erosion and nutrient transport. However, in addition to contributing common agricultural pollutants, these properties represent a significant source of urban pollutants as well. Increased road density is observed with such development.

Subbasin Summaries. The following provides subbasin-specific information for agricultural activities, where available. Much of this information comes from the NRCS Subbasin profiles (2005), the land use summary provided earlier in this section of this report, and from information from stakeholders.

Lower Deschutes Subbasin. Range land (potential grazing land) represents a substantial portion of the Lower Deschutes Subbasin (62%). Agricultural activities in the subbasin are divided between rangelands, grass/pasture/hay and a small amount of grain crops. Much of the agricultural land along Buckhollow and Bakeoven Creeks is currently enrolled in the Conservation Reserve Enhancement Program (CREP) and so represents a lower risk for direct sediment, nutrient and bacterial contamination of surface waters from livestock. There is a total of 1,578 acres enrolled in the CREP in this subbasin (which includes the Willow Creek watershed in this summary), and 51,190 acres enrolled in the Conservation Reserve Program (CRP).

Trout Creek and Willow Creek Subbasins. Range land (potential grazing land) represents a very substantial portion of the Trout and Willow Creek Subbasins (78%). Agricultural activities in these subbasins are divided between rangelands, grass/pasture/hay and grain crops. The grain crops are primarily located in the Willow Creek watershed, which has approximately 3,200 acres of irrigated row crops (corn, vegetables, etc.). There are 2,746 acres in the Trout Creek watershed enrolled in the CRP program and 120 acres enrolled in CREP. This information for the Willow Creek watershed is included in the summary information for the Lower Deschutes Subbasin.

Crooked Subbasins. Agricultural activities in these subbasins are divided between rangeland and grass/pasture/hay. Range land (potential grazing land) represents a very substantial portion of the Crooked River Subbasins (76%). Livestock grazed are primarily cattle with some sheep, some horses and a small number of dairy cattle. Land associated with riparian areas enrolled in conservation programs that exclude grazing is increasing but still represents only a very small portion of total agricultural land in the basin. In the Lower Crooked watershed 218 acres are enrolled in CRP, in the Upper Crooked watershed 100 acres are enrolled in CRP, and in Beaver South Fork watershed 478 acres are enrolled in CRP (NRCS 2005b, 2005d, 2005f). There is no enrollment in CREP reported in these subbasins, as of 2005.

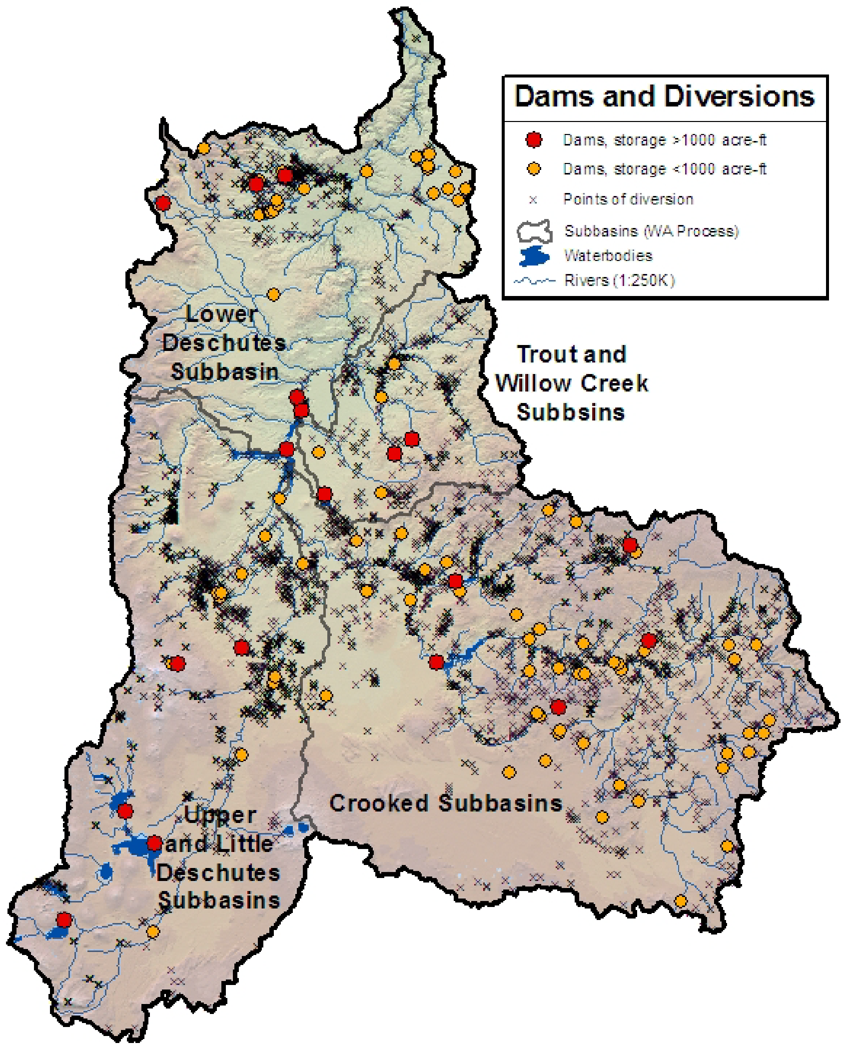
Upper and Little Deschutes Subbasins. Agricultural activities in these subbasins are divided between rangelands and grass/pasture/hay. Range land (potential grazing land) represents a smaller portion of land use in the Upper and Little Deschutes Subbasins (26%) as compared to the other subbasins, in part because so much more of the land here is forested. Livestock grazed are primarily cattle with some sheep, some horses and a small number of goats. Grazing in the Little Deschutes may be more focused in riparian areas and have the potential to affect water quality if not carefully management. Grazing in the Upper Deschutes probably has little effect on water quality, however, as it occurs more commonly in the uplands and generally not along streams. There is no reported enrollment in CREP or CRP in the Upper Deschutes Subbasin; 108 acres are enrolled in CRP in the Little Deschutes Subbasin.

Reservoirs and Diversions

Reservoirs. Reservoirs are man-made lakes formed by the construction of one or more dams. Water quality conditions in reservoirs are often different from those occurring in the river above the impoundment. Water quality problems commonly associated with reservoirs include temperature (water is too hot or cold), dissolved gases (too little oxygen or too much nitrogen), nutrients or algae blooms, bacteria, sediment and persistent and toxic contaminants. Dams vary widely in their size, purpose and operation. These differences influence their impact on river ecosystems. Dams can affect the river environment below the impoundment through changes in flow, sediment, temperature, and water quality.

Dams generally act to smooth out the natural hydrograph, reducing peak flow events and limiting the benefit of flushing flows within the system. They can alter the natural hydrograph completely. Dams constructed for irrigation often fill in the winter and spring and release in the summer and fall, leading to higher late summer baseflows and reduced winter and spring flow volumes. Hydroelectric dams are often operated for peak power production and releases may fluctuate widely over the course of a day or season. Changing water levels may create unstable habitat conditions downstream of the dam that can be disruptive to juvenile fish and limit spawning opportunities. Bottom sediments are a natural "sink" for many toxic and persistent pollutants that are hard to detect in the water column. The presence of these compounds creates an increased risk of bioaccumulation in benthic organisms, especially if anoxic conditions occur in the waters behind the dam, and can be transmitted up the food chain. Because sediment tends to fall out of the slowly moving water behind a dam, stream reaches immediately downstream of a dam are often sediment limited which reduces spawning habitat and can lead to substantial channel and bank erosion and down-cutting. Large reservoirs with deep releases can dramatically alter water temperatures in the river immediately around the dam and often for some length downstream. Water temperatures from deep releases are generally much cooler and more consistent than the temperatures in an un-impounded river would be. This can have a negative effect on fish and macroinvertebrate species. Water clarity is also generally higher immediately below dams (sediments fall out in the slack water behind the dam) and can lead to increased growth of algae and periphyton than would be present naturally.

The following section provides subbasin-specific information, where available. Much of the information provided here came from the Oregon Lakes Atlas (Johnson et.al., 1985), the Reservoir Management Report written by the Deschutes Water Alliance (Fitzpatrick et.al., 2006) and from a GIS data layer compiled by OWRD for large dams in Oregon (http://spatialdata.oregonexplorer.info/GPT9/catalog/main/home.page). The GIS layer was used to distinguish the dams with a storage capacity of greater than 1000 acre-feet which are described further in this subbasin section and shown in the adjacent map. The map also shows all of the points of diversion included in OWRD's diversion database (downloaded on 2/16/11 from: http://www.wrd.state.or.us/OWRD/MAPS/index.shtml#Water_Right_Data_GIS_Themes). Diversions are discussed further in the next section.



In addition to the large impoundments described below, there are many smaller dams and impoundments in the Basin that are not specifically identified in this section but that contribute to changes in the hydrology and (potentially) to the water quality of the Basin. Most of these structures are operated to support agriculture activities.

Lower Deschutes Subbasin. Lake Billy Chinook and Lake Simtustus are the two largest reservoirs in the Subbasin, with Lake Billy Chinook also being the largest in the whole Basin. There are three dams associated with this complex (Pelton Dam, Round Butte Dam and Pelton Reregulating Dam), which is operated for hydroelectric power by the CTWS and PGE. A selective withdrawal structure built at the outlet to the Round Butte Dam enables the dam to release water from a particular depth in Lake Billy Chinook. This structure was designed in order to improve water temperature and water quality conditions downstream of the dam and in within the reservoir and to improve conditions for out-migrating juvenile fish. This new structure began operation in January, 2010. Clear Lake, Rock Creek Reservoir, and Pine Hollow Reservoir are the three other reservoirs in the Subbasin with a storage capacity greater than 1000 acre-feet. These three reservoirs are largely used for irrigation and are all located in the White River watershed.

Trout Creek and Willow Creek Subbasins. Haystack Reservoir is the largest reservoir in these Subbasins. Haystack Reservoir is an irrigation storage facility for North Unit Irrigation District and is a component of USBR's Deschutes Project. Flow from Haystack Creek is stored in the reservoir created by Haystack Dam. However, most of the stored water in the reservoir is supplied by feeder canals bringing water from the Crooked River and Wickiup Reservoir on the Deschutes River (Johnson et.al., 1985). Brewer Reservoir and Little Willow Creek reservoir are the two other reservoirs in these Subbasins with a storage capacity greater than 1000 acre-feet. Brewer Reservoir is an impoundment on Hay Creek and Little Willow Creek Reservoir is on Little Willow Creek. These two reservoirs are largely used for irrigation.

Crooked Subbasins. Prineville and Ochoco Reservoirs are the two largest reservoirs in the Crooked Subbasins. Both reservoirs are part of USBR's Deschutes Project and are primarily used for irrigation water storage. Ochoco Reservoir is fully allocated for irrigation to the Ochoco Irrigation District. Prineville Reservoir serves as a supplemental water supply for the Ochoco Irrigation District around Prineville, and provides primary and supplemental water for other private storage accounts. Both reservoirs also provide for flood control and recreational use and the upper end of Prineville Reservoir has been designated as a wildlife management area. Several different companies, including PGE, USBR and Symbiotics, are considering installation of a hydroelectric facility on Bowman Dam at the base of Prineville Reservoir. There are three additional reservoirs in the Crooked Subbasins with a storage capacity of greater than 1000 acre-feet: Antelope Flat Reservoir (Bear and Faught Creeks), Watson Reservoir (also called Merwin Reservoir, located on Watson Creek), and Allen Creek Reservoir (Allen Creek). These three reservoirs are largely used for irrigation and are located above either Ochoco or Prineville Reservoirs

Upper and Little Deschutes Subbasins. Wickiup Reservoir, Crane Prairie Reservoir, and Crescent Lake are the three biggest reservoirs in these subbasins. All three are part of USBR's Deschutes Project and are primarily used for irrigation water storage. Crane Prairie Reservoir is situated a few river miles downstream from the headwaters of the Deschutes River. Crook County Improvement District #1 (Lone Pine), Central Oregon Irrigation District (COID) and Arnold Irrigation District hold water rights in Crane Prairie. Although USBR holds the title to the reservoir, the reservoir has been paid off and COID is the operator, and the primary name on the water right certificate. The reservoir was authorized for multiple purposes by the State of Oregon in 2000, including instream flows for fish and wildlife. Wickiup Reservoir is located two miles downstream of Crane Prairie and is the primary supplemental storage facility for North Unit Irrigation District (NUID). USBR holds the title to Wickiup, and NUID is the operator. In contrast to Crane Prairie, Wickiup is only authorized for irrigation water uses. Crescent Lake Reservoir is a moderate sized reservoir located on Crescent Lake, headwaters of Crescent Creek and tributary of the Little Deschutes River. Unlike Wickiup and Crane Prairie, Crescent Lake is a storage facility built on an existing natural lake. The reservoir provides a supplemental source of irrigation water for the Tumalo Irrigation District (TID), and is privately owned and operated by TID.

There are two additional reservoirs in the Upper Deschutes Subbasin with a storage capacity of greater than 1000 acre-feet. These are Three Creek Lake and Upper Tumalo Reservoir. Three Creek

Lake is a natural lake which is controlled by a small dam for irrigation use. Upper Tumalo Reservoir impounds water which is diverted from Tumalo Creek and the Deschutes River by TID and is used for irrigation.

Diversions. Diverting water from the stream channel for other uses can also have a tremendous effect on both local hydrology and habitat. Irrigation diversions often create substantial changes in instream flow volume, timing and magnitude of high and low flow events, and quality, diversions often decrease summer base-flows instream. Decreased summer flows can lead to elevated stream temperatures, reduced dissolved oxygen, increased algal growth and loss of habitat. Lower flows decrease the streams ability to effectively process pollutant loads which can lead to detrimental water quality effects from both natural and man-made sources.

Generally a portion of the water diverted from streams and rivers for agricultural use is returned to the stream as drain water or irrigation runoff. This water often carries greater sediment and nutrient loads and is higher temperatures than the water that was initially diverted. Drain water can also carry pesticides, salts and bacteria off the irrigated fields and lawns and transport it to streams and rivers.

POTENTIAL SOURCES OF POLLUTION FROM DAMS AND DIVERSIONS	
Pollutant Source	**Resulting Status of Pollutant Loads**
Dams	Increased pollutant loading in sediments and attached pollutants deposited behind the dam Increased risk of bioaccumulation of toxics in benthic and other aquatic organisms, especially if anoxic conditions occur in the waters behind the dam Hydrologic alterations – changes in flow volume, timing and quality (agricultural impoundments often increase late summer base-flows and reduce winter and spring flows, hydropower impoundments can cause highly variable flows that reduce usable habitat and are disruptive to fish) Changes in gravel, sediment and large wood recruitment within the stream channel downstream of the structure Lack of bank storage below the project Loss of habitat and species diversity within the impoundment and downstream
Diversions	Hydrologic alterations – changes in flow volume, timing and quality, diversions often decrease summer base-flows instream Decreased flow in the natural stream leading to elevated temperatures and loss of habitat Decreased ability for the stream to process/dilute pollutant loads leading to more acute site-specific effects from both natural and man-made sources
Return flows	Increased nutrient and sediment enrichment in tail waters Increased pollutant loading (pesticides, salts, bacteria, etc.)

Forestry/Forestry Management Sources

A total of 2,341,288 acres are included in the forestry land-use designation of the Basin. Principal ownership is with the USFS (Deschutes, Ochoco and Mt. Hood National Forests) and BLM lands. Forestry management practices include timber harvest and related activities such as road construction and use, timber removal, replanting and livestock grazing on forested allotments.

Most forested lands in the Basin have sustained some level of harvest and road building. Historic forest management practices resulted in damage to many stream systems. Riparian harvest reduced shade and led to higher water temperatures, depleted future large woody debris and led to loss of pools and decreased channel complexity, increased sedimentation due to soil disturbance, and altered stream hydrology. Road building on forest lands delayed or prevented upstream fish migration.

The major pollutant associated with forestry management practices is sediment which may contain phosphates and carry adsorbed nutrients. The geology of forested lands within the Deschutes Basin is conducive to erosion and sediment production. Predominant lithology is basaltic rocks that are decomposing to unstable, easily transportable sediments.

Bacteria, sediment, temperature and nutrient concerns associated with agricultural/grazing lands in these areas are discussed in detail in the parameter-specific sections following.

Potential impacts from forest management practices are listed in the following table.

POTENTIAL SOURCES OF POLLUTION FROM FORESTRY PRACTICES	
Pollutant Source	**Resulting Status of Pollutant Loads**
Road Building & Use	Increased sediment load Increased nutrient load from sediment-bound phosphorus Decreased dissolved oxygen resulting from nutrient enriched algal growth
Timber Harvest	Destabilization of slopes Increased sediment transport in storm events and runoff Increased nutrient load from sediment-bound phosphorus
Landslides	Increased sediment loads Increased nutrient load from sediment-bound phosphorus
Flow Alterations	Increased velocity resulting in increased erosion and sediment transport Increased nutrient load from sediment-bound phosphorus
Grazing	See grazing in Agricultural Source table above

Local lithology also contributes to landslides. Most slides are due to natural causes but some are management induced (i.e. from a destabilized road cut and fill). Traditional timber harvest activities can result in increased sediment loads within the watershed due to construction of roads, erosion of road surfaces, landslides on destabilized slopes and erosion of harvest areas. Nearly all forested areas within the Basin have an extensive network of roads which increases sediment yields. The construction and use of roadways represent the major source of sediment from timber harvest activities, with erosion from streambanks and landslides caused by management activities representing more minor sources. The recommended practices outlined by the Forest Practices Act (FPA) minimize non-road related sediment transport. The FPA also prohibits removal of timber within riparian areas near the stream channel. When these practices are adhered to impacts associated with removal of overhanging vegetation (i.e. increased water temperatures in the tributaries resulting in greater dissolution of adsorbed phosphorus and other nutrients from sediment-bound forms) should not occur.

Positive steps taken in recent years on public and some private forestlands are helping reverse the impacts of timber harvest on fish and wildlife habitat. Efforts are allowing stream recovery and providing shade, streambank stability, and future large woody debris. Inadequate road culverts for fish passage are also being replaced with bridges or open arch culverts where possible, and reconstructed to pass 50-year flood events.

Grazing. Grazing occurs on public forest lands within grazing allotments. All grazing on USFS and BLM lands is governed by approved grazing management plans designed to protect both upland and riparian resources. Impacts from improper grazing practices on forest lands are similar to those discussed in the Agricultural Sources section.

Urban/Suburban Sources

Urban/suburban land-use totals 124,400 acres within the watershed. The largest portion of this acreage is within the cities of Bend and Redmond, although the area has experienced a recent increase in resorts and subdividing of private land for construction of new homes. Developments are occurring with greater frequency near rivers and streams, resulting in loss and fragmentation of wildlife habitats, loss of riparian structure and habitat vegetation, loss of instream structure from construction of retaining walls and boat docks (such as along the upper Deschutes River), and degradation of water quality from fertilizers, pesticides, and failed septic systems.

Potential impacts from urban/suburban management practices are listed in the following Table.

POTENTIAL SOURCES OF POLLUTION FROM URBAN/SUBURBAN PRACTICES	
Pollutant Source	**Resulting Status of Pollutant Loads**
Construction	Increased sediment loads from improperly maintained construction sites
Failing Septic Systems	Increased nutrient load in highly bioavailable form from failing septic systems Increased bacterial levels from failing septic systems
Auto and Yard Chemicals	Increases loading of petroleum products, metals and road/home/ lawn care chemicals transported to ground and surface waters in storm events, improper application and overwatering
Stormwater Runoff	Increased sediment from roadways and other impervious surfaces Increased sediment-bound nutrients from runoff and construction Altered hydrographs and long-term storage from increased impervious surfaces

Construction Sites.
Improper construction site erosion and sediment control practices can cause loss of topsoil, increased susceptibility of erosion prone areas, elevated sediment and nutrient loads to nearby water bodies, and impaired water quality. Runoff from construction sites can be a substantial contributor of sediment in urban areas under development. Sediment-loading rates from construction sites are 5 to 500 times greater than those from undeveloped land (USEPA, 1977).

Deschutes and Crook County and their communities have been experiencing and will most likely to continue to experience a high level of growth. With this growth comes the conversion of land from rural/agricultural use to urban use (residential, commercial, roads, etc.). During construction activities, land is very vulnerable to erosion and/or sedimentation especially when erosion and sediment control practices are not installed and maintained properly.

Erosion control consists of practices that are designed to intercept precipitation and prevent soil particles from moving. Products designed for this use include straw, mulch, ground covers, fiber blankets, hydro-seeding, etc. Sediment control consists of practices that are designed to capture soil particles after they have been dislodged and have begun to be carried away from leaving the site. Products designed for this include silt fences, straw bale check dams, sedimentation ponds, etc.

Septic Systems. Several areas in the Basin with developed subdivision parcels were identified as potential nutrient source locations due to inadequate retention time and treatment of septic tank effluent. Failing septic systems were also identified as an issue for bacteria in surface waters in the White River drainage, and possible sources of both nutrients and bacteria to surface waters in subdivision/resort areas (Camp Sherman, Odell Lake, etc.). It was previously recognized that these locations were dominated by high ground-water tables, evidence of ground-water contamination, high septic tank density and poor soil types. These are discussed in greater detail in the Groundwater Section.

Stormwater Runoff. Stormwater is rain and snow melt that runs off impervious surfaces such as rooftops, streets and parking lots, often carrying substantial loads of oil, fertilizers, pesticides, soil, trash, and bacteria-laden animal waste directly into streams and rivers. Stormwater runoff from large impervious surfaces increases the peak flow of runoff, which can result in sedimentation, streambed scouring and loss of habitat. Untreated stormwater is not safe for people to drink and can trigger toxic algal blooms. Alterations to the watershed leading to problems with stormwater runoff include building high density structures and clearing away vegetation.

The largest urban/suburban centers in the Deschutes Basin are the incorporated cities of Bend, Redmond and Prineville. The Deschutes and Crooked Rivers flow directly through the cities of Bend and Prineville (respectively) and have the potential to receive stormwater discharges directly. The city impact area of Redmond includes the Redmond Airport, which serves a small commercial fleet and private planes. The City of Bend also maintains a small airport which serves primarily private planes. Pollutant sources of concern associated with urban runoff include nutrients, sediment from erosion of conveyance systems, oils, pesticides and bacteria.

Today, efforts are being made to reduce residential and municipal impacts on the environment. For example, while experiencing heavy growth, the City of Bend has become a leader in water conservation and stewardship. Through an aggressive program of water metering, conservation incentives and partnerships, and public education, the city maintained the same peak summer demand in 2003 as compared to 2002 despite 1,000 new service connections (Prowell 2004). The City of Prineville was recently awarded a federal grant to complete a stormwater management plan. The final plan will include more complete information about location, type and condition of stormwater conveyance systems within the City, identify stormwater discharge points, and will prioritize needed upgrade, outreach and long-term sustainable maintenance options. Other municipalities in the subbasin are also adopting water conservation programs to use available water supplies more efficiently.

Recreation Sources

A variety of recreational opportunities are available within the Deschutes Basin including boating, fishing, camping, hiking and other activities. Water-based recreational activities peak in the season between Memorial Day weekend and Labor Day Weekend, when the rivers are utilized by boaters, swimmers, campers and fishermen. Water-side campgrounds throughout the basin are heavily utilized during the summer season.

Potential impacts from recreational uses are varied, ranging from increased erosion potential caused by irresponsible forest road and off-road vehicle use, to direct contamination of surface water by personal water craft or accidental fuel spills. Pollutants of concern generated by recreational use of the watershed include (but are not limited to) hydrocarbons from outboard motors, organic material from fish cleaning, potential bacterial contamination from human waste (improper sanitary disposal) and addition of nutrients, grease and oils from parking lot runoff at camp grounds and boat ramps/developed put ins. Sediments are also contributed by erosion of banks around popular beach areas and camping sites, and heavy use of forested roads, particularly during the wet season.

Concentrated recreational use, commonly associated with campgrounds or day use sites has resulted in the loss or some reduction in riparian vegetation and stream bank stability. Dispersed camping and recreation in localized areas also has contributed to loss of riparian vegetation and trampling and compaction of streamside soils.

POTENTIAL SOURCES OF POLLUTION FROM RECREATION PRACTICES	
Pollutant Sources	**Resulting Status of Pollutant Loads**
Camping	Increased nutrient load from improperly disposed wastes Increased bacterial levels from improperly disposed human, fishing, and hunting wastes Loss of riparian vegetation and trampling and compaction of streamside soils addition of grease and oils from parking lot runoff at camp grounds
Boating	Increased petroleum products in water column from motorized boats and/or personal watercraft use and maintenance and/or fueling practices Addition of grease and oils from parking lot runoff at boat ramps/developed put ins
Swimming	
OHV	Increased sediment from off-road and irresponsible camping vehicle use
Hiking	
Fishing	organic material from fish cleaning

Transportation

Roads, drives and car parks are large runoff-producing areas in the urban environment. This runoff is often contaminated with sediment, litter, oil and petrol, and with toxic metals from motor vehicles. Water carrying these contaminants is washed off into drains and directly into nearby watercourses. Most surface water drains are connected directly to watercourses and not sewage treatment works, hence any spillage of chemicals will tend to be washed into streams and rivers.

Transportation in the Deschutes Basin includes state, county and local roadways and streets, and railroads. Highways and railways follow along stream and river channels throughout the Basin. Railways parallel the Deschutes River (often on both sides) from the mouth to Warm Springs. These highways and railways constrain the natural meanders of the river and affect riparian and aquatic habitat. In addition, culverts installed at tributary stream crossings form barriers to upstream fish migration in many areas.

Development of the transportation network in the basin also had some negative impacts on the watershed and water quality. Road construction commonly occurred in stream bottoms and frequently resulted in the loss of riparian vegetation, changes in the channel configuration, filling of the stream channel, and constriction of flow at bridge sites. Road corridors frequently are a source of erosion that culminates in turbidity and sedimentation in adjacent streams. This can be a significant problem when the road is located in close proximity to the stream. Road surfaces have also reduced natural infiltration of water into the soil, which is important for groundwater and spring recharge. Roads have acted to divert and concentrate surface water flow, which can exacerbate erosion and stream sedimentation problems. Maintenance of roads and railways often involves weed treatments. These are often sprayed along right-of-ways. When roads and railways are located along rivers and streams, herbicide drift, overspray and improper application can result in contamination of surface waters. Railways are directly adjacent to most of the lower Deschutes River.

POTENTIAL SOURCES OF POLLUTION FROM TRANSPORTATION CORRIDORS	
Pollutant Source	**Resulting Status of Pollutant Loads**
Roadways	Increased sediment from improperly maintained road construction practices Increased petroleum-based products and automotive chemicals from storm events Lack of channel complexity from constrained stream movement Potential for herbicide contamination in waters from right-of-way weed spraying

POTENTIAL SOURCES OF POLLUTION FROM TRANSPORTATION CORRIDORS	
Pollutant Source	**Resulting Status of Pollutant Loads**
Railways	Increased sediment from improperly maintained road construction practices Increased petroleum-based products and haul chemicals Leaching of chemical preservatives from track and improperly disposed waste ties Lack of channel complexity from constrained stream movement Potential for herbicide contamination in waters from right-of-way weed spraying

Invasive Species

Invasive species are those plants, animals, and other life forms not native to a region that, when introduced, can come to dominate local and regional ecosystems. Once introduced into a new area, invasive species can proliferate in an area because their natural predators and/or competitors are not present. They are often difficult to control and have the potential to out-compete native species.

The impacts of invasive species can affect agriculture, rangeland, forests, food chains, fishing and boating, outdoor recreation, water and wastewater treatment and other areas. They can indirectly affect water quality through decreased bank and soil stability and the related pollution runoff, fluctuating water tables, fire frequency, water temperature (through loss of shading), greater pesticide and herbicide use and over-application.

Within the Deschutes Basin:

- Threatening invasive aquatic species include New Zealand Mud Snails and Eurasian Watermilfoil. These species are listed as threatening because, while the risk of invasion is high, they have not been specifically identified as present in the Basin.
- Invasive wildlife species include feral swine and (potentially) nutria.
- Invasive weed species include Reed Canarygrass, Canada and Scotch thistle, Perennial pepperweed, Diffuse and Spotted knapweed, Poison hemlock, Whitetop, Purple loosestrife, Dalmation toadflax, Leafy spurge, Medusahead rye, Rush skeletonweed, Tamarix, Yellow starthistle, Kochia, Yellow flag iris and many others.

Invasive weed species, Canada geese and nutria are found in all geographic areas of the Deschutes Basin.

Mining

Many abandoned/legacy mine sites exist in the Deschutes Basin. Many of them discharge mine drainage to surface waters within the basin. When mines are abandoned, they often flood with groundwater and discharge at a mine adit (a horizontal shaft to an underground mine used for ventilation and to drain the mine of water) or seep into groundwater sources. The discharges are often acidic and can contain dissolved metals. High metal concentrations in water can be toxic to plants and wildlife and can bioaccumulate in fish tissues, passing on to humans and other animals through the food chain. Contemporary mining operations use pumps to deal with the large quantities of water that infiltrate the mine cavities and need a permit to discharge the water. Concerns stemming from legacy sites include Acid Mine Drainage (AMD) which can dissolve metals like arsenic, cadmium, chromium, and lead and carry them into streams or groundwater, and kill vegetation, fish and other aquatic organisms; and erosion of tailings piles which can wash fine particles into a stream, changing the light, temperature, and oxygen conditions of a waterway, covering fish eggs or young, impairing the growth of other aquatic organisms and filling pools.

Additional information on pollutants from mining activities in the basin is provided in the Toxics section.

WATER QUALITY STATUS AND TRENDS

Given the large expanse and varied nature of the landscape and water quality issues in the Deschutes Basin, it was difficult to determine the most appropriate and user-friendly manner in which to display the findings of the assessment. We ultimately hope to have an electronic report where the details of this assessment can either be investigated by geographic area or by resource concern (water quality pollutant or parameter).

In the following sections we will discuss the status of water quality conditions, both surface water and groundwater. Within each section, information is organized by pollutant, including a discussion of the impacted beneficial use(s). Where there is specific information about a geographic area, that information is provided. We have also included a summary table at the end of this report which highlights the most significant water quality concerns by geographic area. This will enable the reader to quickly locate issues in a given area, and then turn to the parameter section for more detailed information.

The information used in this assessment came from a variety of sources, including both data and "best professional judgment" from resource professionals. We compiled and synthesized monitoring data which have been collected by DEQ and other stakeholders, using our stakeholder meetings as a format for soliciting data which we may not have known about. We also used the stakeholder meetings and a review of watershed/basin assessments to gather information about water quality issues/concerns for which there may not be much data. It should be noted that, for the most part, Tribal data are not included in this assessment. There is some mention of conditions on Tribal lands, as referred to in the Deschutes Subbasin Plan (NPCC 2005); however we did not do an assessment of conditions beyond that. Staff from CTWS participated in several of the stakeholder meetings and we look forward to continued coordination with CTWS on future iterations of the WA process in order to accurately assess the resource status and coordinate effective, successful implementation efforts in the future.

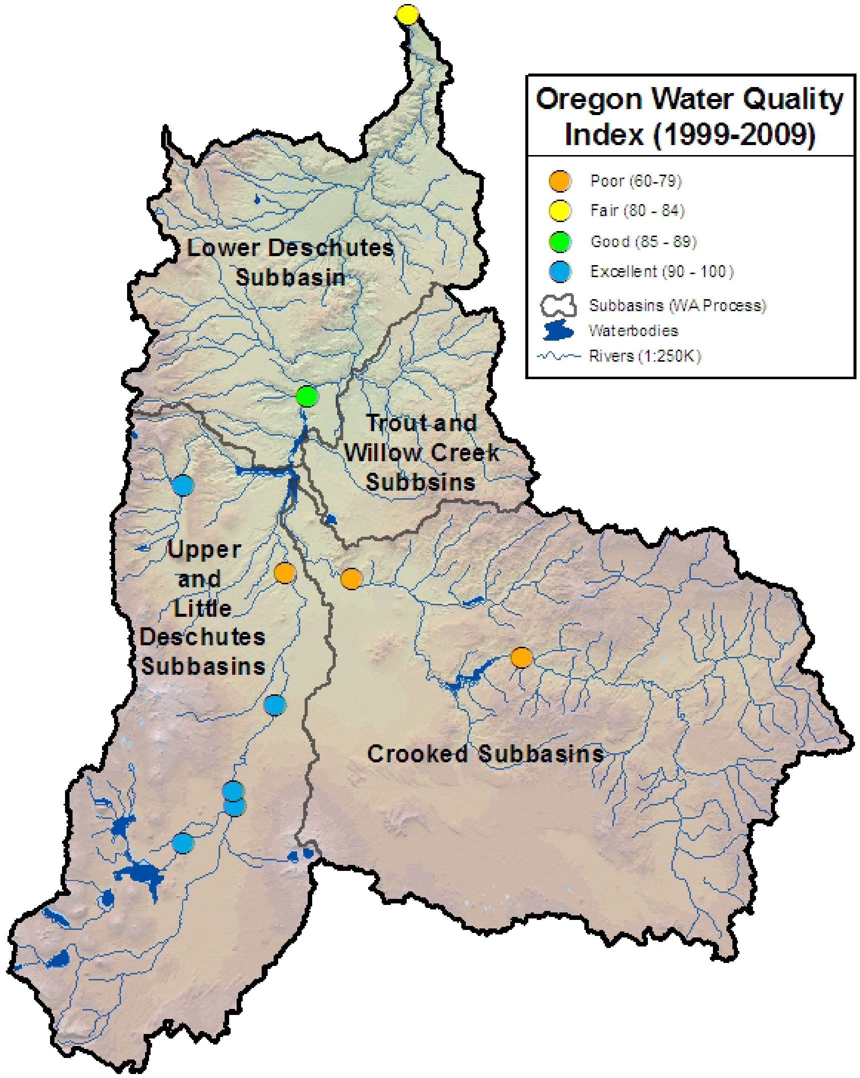
General Surface Water Quality Conditions

DEQ has two different tools which can be used to assess the general watershed health and surface water quality conditions in a geographic area. These two tools, the Oregon Water Quality Index and macroinvertebrate models, were used to assess general water quality conditions within the Deschutes Basin.

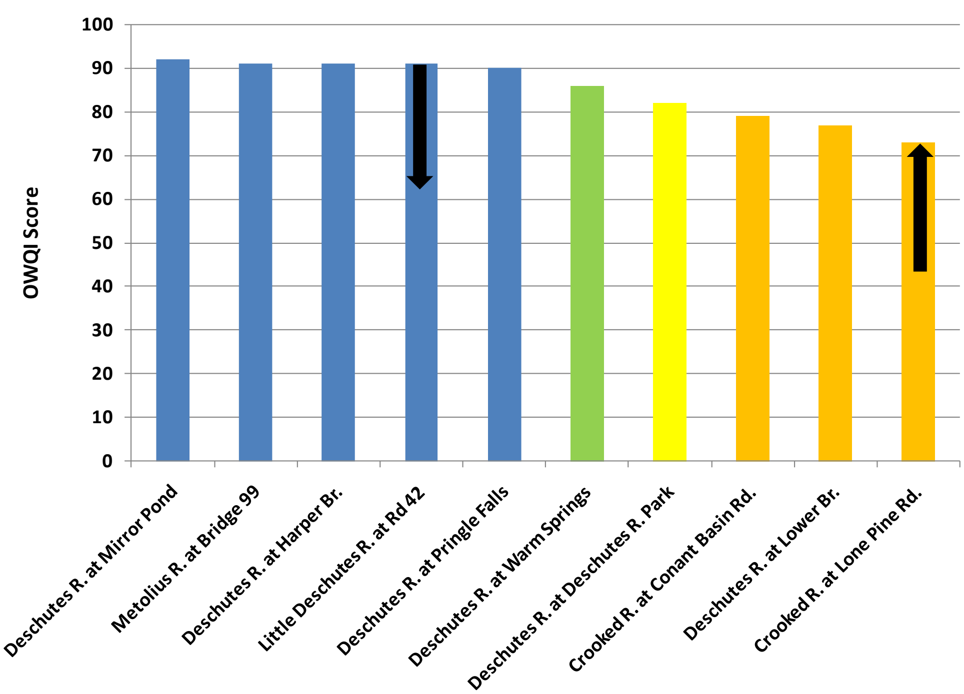
Oregon Water Quality Index – Status 1999 to 2009

The Oregon Water Quality Index (OWQI) analyzes a defined set of water quality variables and produces a score describing general water quality. The index was designed to allow comparison of water quality among different stretches of the same river of between different watersheds. The index provides a general assessment of water quality at a site by combining information from eight different sub-indexes. Sub-indexes report on conditions of temperature, dissolved oxygen, pH, BOD, total solids, nitrogen, phosphorus, and bacteria. A classification scheme was derived from application of the OWQI to describe general water quality conditions. OWQI scores that are less than 60 are considered very poor; 60-79 poor; 80-84 fair; 85-89 good; and 90-100 excellent. For more information on use of OWQI and assessments visit DEQ Water Quality Index web site at: http://www.deq.state.or.us/lab/wqm/wqimain.htm.

Water quality conditions in the Deschutes Basin were examined using DEQ's OWQI (see adjacent map). Ten monitoring stations in the Deschutes Basin are included in DEQ's long-term ambient water quality monitoring program and for which OWQI scores have been calculated. Five sites were in excellent condition (coded as blue), one site was in good condition (green), one site was in fair condition (yellow), and three sites were in poor condition (orange). There were no sites in the Deschutes Basin which scored as very poor.



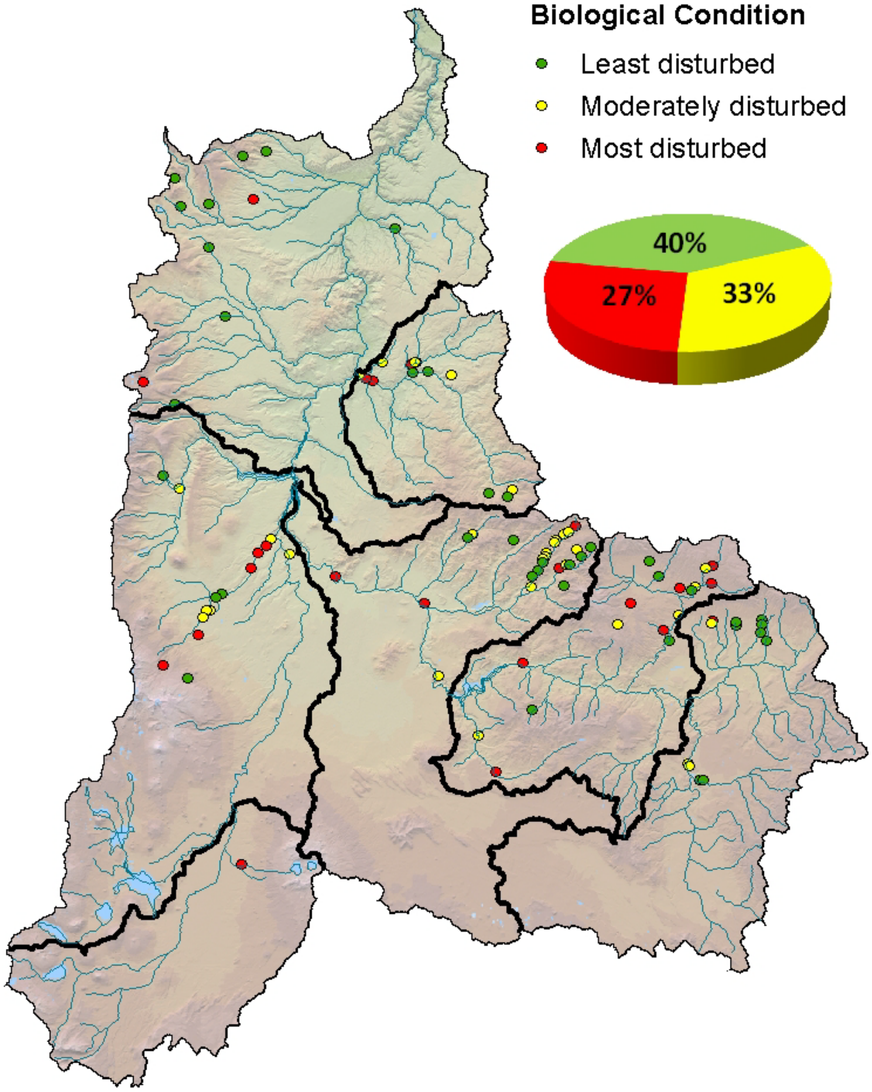
OWQI Trending. Water quality trends at these sites were assessed between 1999 and 2009 (see adjacent graph). Only two sites showed any significant trends during this time. The station on the Crooked River at Lone Pine Road showed a slight improvement in OWQI scores, with an increase of approximately 2.0 OWQI points. Several sub-indices (dissolved oxygen, nitrogen, and total solids) showed significantly improving trends across this time period. Slightly decreasing trends in water quality were observed at the station on the Little Deschutes at Rd 42, with OWQI scores



decreasing by approximately 3.0 OWQI points. Although water quality at this site is still rated as excellent, the site appears to be moving from excellent to good water quality conditions. The BOD and dissolved oxygen sub-indices showed significantly decreasing trends at the Little Deschutes site.

Macroinvertebrate Health

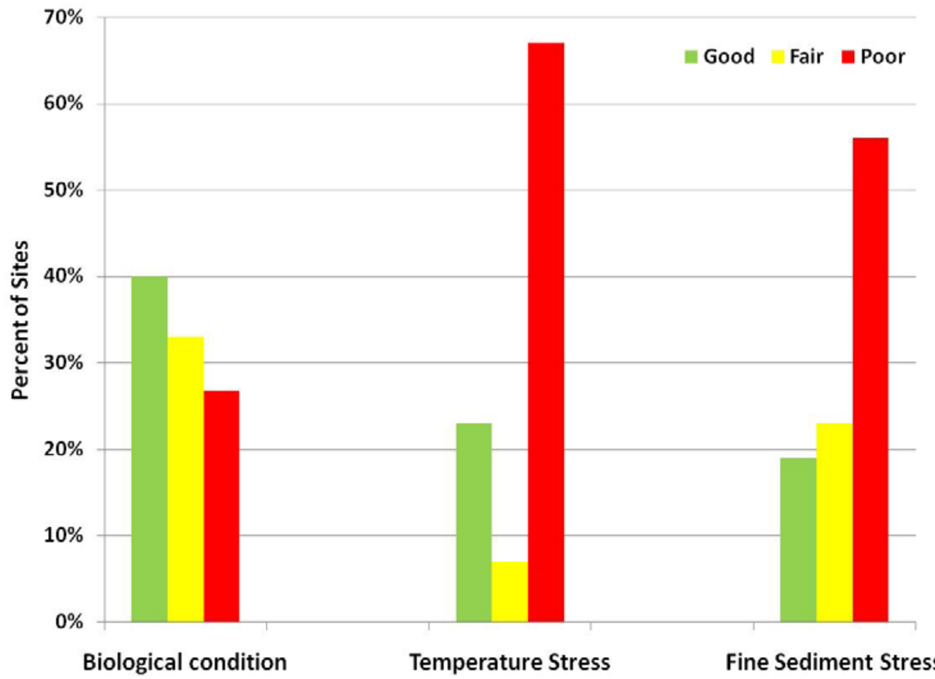
Because aquatic insects and other freshwater invertebrates are sensitive to changes in water temperature, sediment, habitat conditions and other factors, macroinvertebrate populations provide good information about the health of a water body. Macroinvertebrates are the most commonly used aquatic assemblage for assessing stream biological health. DEQ uses several models to assess the biological condition of a given aquatic community and the potential stressor causing the impairment.



In the Deschutes Basin macroinvertebrate samples have been collected by a number of agencies and individuals over the years. To be used in DEQ's models, data have to be collected by a specific protocol. Data that met these criteria were collected by DEQ and Xerces Society at 97 sites from 2000 – 2009 (see adjacent map). Some of these data were collected as part of subbasin-specific macoinvertebrate studies: DEQ collected data in the Cooked Subbasins in 2005 and in the Trout Subbasins in 2006 and the Xerces Society and Upper Deschutes Watershed Council collected data in the Whychus Creek watershed in 2005 and 2009 (Mazzacano 2010).

Biological Condition. Using DEQ's predictive model to assess biological condition (PREDATOR model), we observed 40% of sites to be in least disturbed conditions. Thirty-three percent of sites were in moderately disturbed conditions, and 27% of sites were in most disturbed conditions.

Nonpoint Source Stressors. We used information on optimal conditions for macroinvertebrate taxa to model the potential causes of stress to macroinvertebrate assemblages. Using macroinvertebrates alone, we inferred seasonal maximum temperature and percent fine sediments at a site. We then made comparisons of inferred conditions at a site to inferred conditions observed at a group of reference sites in the same ecoregion. Sites on Whychus Creek sampled by the Xerces Society were not included in this stressor analysis because the raw data was not available at the time of the analysis.



Temperature stress*:* About one-quarter of sites (23%) in the Deschutes showed good condition for temperature stress, with few sites in fair condition (7%). The majority of sites in the Deschutes (67%) were in poor condition for temperature stress.

Fine sediment stress*:* Nineteen percent of Deschutes sites were in good condition for fine sediment stress and 23% of sites were in fair condition. More than half (56%) of sites were in poor condition for fine sediment stress.

Other Macroinvertebrate Studies. In addition to the sites shown on the map, other macroinvertebrate studies have been done which have not been assessed using DEQ's models. These other studies include: (1) the Regional Environmental Monitoring and Assessment Program (REMAP), where DEQ collected macroinvertebrate, chemistry and vertebrate data in the Upper Deschutes, Little Deschutes and Crooked Subbasins in 1997 and 1998; (2) comprehensive Wild & Scenic River studies conducted by BLM of the lower Crooked and middle Deschutes River BLM in 2004-2006 and of springs to those rivers in 2008; and (3) surveys in the Crooked River below Bowman Dam conducted by local stakeholders in 2004-2005. At stakeholder meetings, the USFS was also identified as a possible source for additional macroinvertebrate and/or mollusk data. Data has been collected under PIBO (Pacfish Infish Biological Opinion Effectiveness Monitoring Program) and AREMP **(**Aquatic and Riparian Effectiveness Monitoring Program)**.** Stakeholders felt that a review of all biological data collected in the Basin would be useful for better understanding the biological condition in the Basin rather than just relying on DEQ's models.

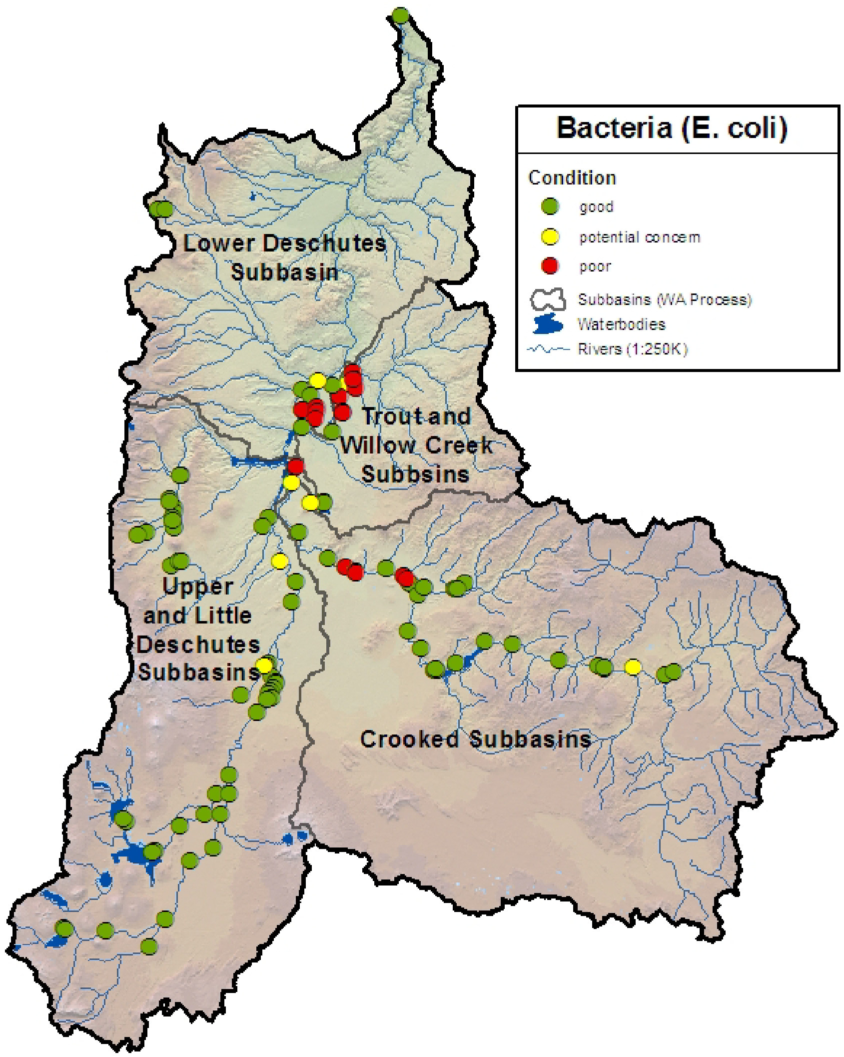
Pollutant-specific Surface Water Quality Conditions

Bacteria

Water contact recreation and public and private drinking water supply are the beneficial uses most sensitive to pathogenic organisms, including bacteria. In Oregon, *Escherichia coli* (*E.coli*) bacteria are used as the indicator organism for assessing impairment in surface waters*.* DEQ's bacteria standard

(OAR 340-041-0009) is available at:
http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_041.html.

Water Quality Status. There are presently no 303(d) listings of impairment for bacteria in the Deschutes Basin. However, there is evidence that bacteria may be an issue in some parts of the Basin, in both surface waters and groundwater, as described below and as seen in the map. The following criteria were used in this assessment to define the condition classes shown on the adjacent map:



Good – Meets water quality criteria, no exceedances of the 406 organisms/ml criterion

Potential concern - At least one exceedance of 406 organisms/ml criterion but does not meet listing criteria; geometric mean or average of data (if only 1 or 2 data points) exceeds 126 organisms/ml

Poor - Does not meet water quality criteria: exceeds listing criterion (10% of samples >406 with a minimum of 2 samples or 30-day log mean >126)

Lower Deschutes Subbasin. Although DEQ does not have much data indicating that there are bacteria issues here, stakeholders provided additional information in terms of potential sources and monitoring needs. Stakeholders identified a number of areas which have a history of problems with failing septic systems, particularly in the White River watershed. Homes in the Sportsman's Park area are all on septic systems and stakeholders felt they should be evaluated for risk of contributing to water quality concerns to Rock Creek Reservoir and lower Rock Creek. Similar concerns exist in the rural areas near Wamic and Three Mile Creek where local knowledge suggests there is a potential problem with failing septic systems. To in part address this issue, the Wasco County SWCD helped to get a community system in place in the Wamic area. Stakeholders recommended that repeat monitoring be conducted in this area to identify if there is a noticeable trend in water quality specific to pH, DO, nutrients and bacteria. There is also local concern that there might be bacteria issues in Clear Creek as it passes through the community of Pine Grove. The regulation of small, domestic septic systems in Wasco County falls under the jurisdiction of the County, which larger systems are regulated by DEQ.

Stakeholders reported that much of the agricultural land along Buckhollow and Bakeoven Creeks is currently enrolled in CREP and so represents a lower risk for direct bacterial contamination of surface waters from livestock.

Trout Creek and Willow Creek Subbasins. Data have been collected by the Jefferson County SWCD and ODA which indicates that there are some issues with bacteria in the Willow Creek and Trout Creek watersheds (Hammond and Roofener, 2007; Hammond and Roofener, 2008; Hammond and Roofener, 2010). Many of the sites with high bacteria counts appear to be associated with agricultural lands, including irrigation drains. Stakeholders have reported concerns about the water quality impacts (both bacteria and nutrients) of agricultural irrigation return flows on the Deschutes River and other tributaries. Sites with high bacteria counts (exceeding the single sample criterion of 406 organisms/ml) include: multiple sites on Mud Springs Creek and Campbell Creek, a tributary to Mud Springs Creek, Sagebrush Springs, and multiple irrigation drains in the Agency Plains area. ODA and the SWCD are trying to determine sources of the bacterial problems and will then work with agricultural landowners to address the problems.

Crooked Subbasins. Data collected by DEQ and the Crooked River Watershed Council indicate that there are some bacteria issues in the Crooked River subbasins, particularly the Lower Crooked Subbasin. Water quality criteria for *E. coli* bacteria were exceeded sufficient to warrant a 303(d) listing on the next 303(d) list at sites on the Crooked River at Lone Pine Rd, McKay Creek at mouth, Ochoco Creek at mouth and Dry Canyon at mouth. There were multiple sites in both the Lower Crooked and Upper Crooked Subbasins where the E. coli criterion of 406 organisms/ml was exceeded, but there were not enough data collected to result in a 303(d) listing. DEQ has begun work on developing a TMDL for bacteria in the Lower Crooked Subbasin. Further assessment of conditions in the Upper Crooked and Beaver-South Fork Crooked Subbasins is needed.

Upper and Little Deschutes Subbasins. Of all of the data evaluated in the Upper and Lower Deschutes Subbasins (data collected by DEQ, City of Bend and the Upper Deschutes Watershed Council), only two sites exceeded water quality criteria for *E. coli* bacteria – Deschutes River at Lower Bridge and Tumalo Creek at mouth. Neither of these sites had enough exceedances to result in a 303(d) listing: the site at Lower Bridge exceeded the single sample criterion of 406 organisms/ml on three out of 93 sampling dates (1996-2009) and the site at the mouth of Tumalo Creek exceeded the 406 criterion on 1 out of 23 sampling dates (2006-2008). Based on data that have been collected, in general, bacteria do not appear to be an issue in surface waters in the Upper and Little Deschutes Subbasins.

There is some local concern about potential bacteria and nutrient contamination of both surface waters and groundwater in areas with a large number of old, potentially failing onsite septic systems. One of the areas where this issue has been raised as a concern is in the Camp Sherman area near the Metolius River. Jefferson County and Friends of the Metolius have proposed the need for a comprehensive monitoring program to evaluate water quality in this area, both for bacteria and nutrients. Old, failing onsite systems have also been raised as a potential water quality issue around Odell Lake and Crescent Lake and along the Deschutes and Little Deschutes Rivers.

Harmful Algal Blooms

Some species of algae, such as cyanobacteria or blue-green algae, can produce toxins or poisons that can cause serious illness or death in pets, livestock, wildlife and humans. There are multiple beneficial uses affected by harmful algal blooms. These include: aesthetics, livestock watering, fishing, water contact recreation, and drinking water supply.

The Oregon Department of Health Services runs the Harmful Algae Bloom Surveillance (HABS) program which tracks blue-green algae health advisories: http://www.oregon.gov/DHS/ph/hab/. Health advisories are generally posted if the cell density of blue-green algae equals or exceeds 100,000 cells/ml (DHS, 2009 http://www.oregon.gov/DHS/ph/hab/docs/DHS_GUIDANCE_on_HAB.pdf; Stone and Bress, 2007). At this time, cell density limits adopted by Oregon are based on recommendations by the World Health Organization (WHO): http://www.who.int/water_sanitation_health/bathing/srwe1execsum/en/index7.html. To protect people from irritation and allergies related to cyanobacteria, WHO also suggests a guideline level of 20,000 cells/ml. For the purposes of this Deschutes assessment, DEQ adopted this intermediate guidance level as one of the triggers to indicate a potential concern.

Water Quality Status. The lakes in the following table have had health advisories posted since the HABS program began in 2004. It should be noted that the posting criterion used in 2004 was 15,000 cells/ml. Lava Lake and Suttle Lake were both posted that year, but neither lake had a density exceeding 100,000 cells/ml. The table also indicates the proposed impairment listing designations in the draft 2010 Water Quality Assessment.

Health Advisories and Impairment Status of Lakes in the Deschutes Basin						
Lake	**Proposed listing of impairment**	**Years with Health Advisories**				
Odell Lake	Category 5 (303d list)	2009	2008	2007	2005	2004
Wickiup Reservoir	Category 5 (303d list)	2009	2008	2004		
Crane Prairie Reservoir	Category 5 (303d list)	2009	2005	2004		
Paulina Lake	Category 5 (303d list)	2009	2006	2004		
Haystack Reservoir	Category 5 (303d list)	2010	2009			
Lava Lake	Needs data	2004				
Suttle Lake	Needs data	2004				

Historically, algae data have been collected on numerous lakes around the state. Data collected prior to 1985 is summarized in two reports (Sweet 1985; Johnson et.al., 1985). More recent data (2004-present) have been collected in the Deschutes Basin, primarily by the Deschutes National Forest with a focus on the high Cascades lakes. Limited data on only one or two sampling dates in 2005 and 2006 have also been collected by DEQ in Lake Billy Chinook, Lake Simtustus, Prineville Reservoir and Ochoco Reservoir.

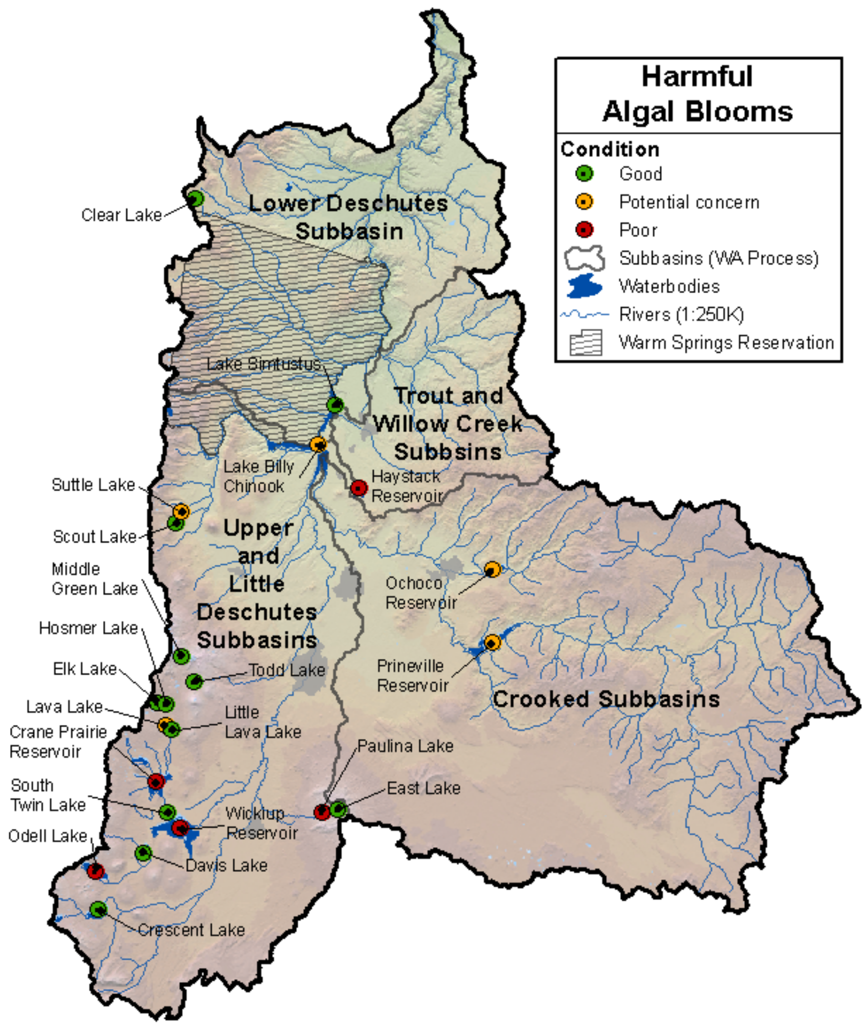
The map on the following page shows the condition class for lakes where blue-green algae has been monitored in the Deschutes Basin, including sites where HABS advisories have been posted. The following criteria were used in this assessment to define the condition classes shown on the map:

Good – lake has been monitored since 2004 and has had BGA cell densities of <20,000 cells/ml

Potential concern - (1) algae data collected since 2004 indicated a BGA cell density between 20,000 and 100,000 cells/ml; (2) lake was identified in the 1985 phytoplankton report (Sweet 1985) as having cyanobacteria as a dominant algae species; (3) lake was identified in the Oregon Atlas of Lakes (Johnson et.al., 1985) as having water quality issues related to algae, chlorophyll *a*, pH, D.O.

or nutrients; or (4) a remote sensing report (Turner 2010) assessed chlorophyll *a* concentrations in the lake

Poor - HABS advisory has been posted on the lake



During stakeholder discussions, it was recognized that there might be additional lakes of concern where data have not been collected. It was suggested that continued monitoring of this parameter was important. Lake Billy Chinook was identified as one place where additional monitoring was specifically warranted given the high level of recreational use on that reservoir.

For the lakes with identified concerns for BGA, detailed source assessment and analysis work has been done to date on Odell and Lava Lakes as part of TMDL development. These lakes had been listed as impaired for pH and/or dissolved oxygen impairments and data for developing TMDLs was collected in 2004. The impairments on these lakes are believed to be caused by BGA blooms. Based on preliminary TMDL analysis, the blooms on Lava Lake are believed to be caused by natural conditions, while those on Odell Lake have been attributed to increased internal loads of nutrients caused by introduced fisheries. An interagency team has been meeting to discuss the next steps to take on Odell Lake, which will likely include additional monitoring and analysis.

DEQ is currently working with others to develop a statewide HABS Program. At the time this report was written, a grant for funding had been submitted to OWEB in conjunction with the Portland State University (PSU) Center for Lakes and Reservoirs. The USFS, DHS and the United States Army Corps of Engineers (USACOE) were also supporters of this proposal. The idea for the statewide strategy is based on that developed in Washington State: (http://www.ecy.wa.gov/programs/wq/plants/algae/index.html).

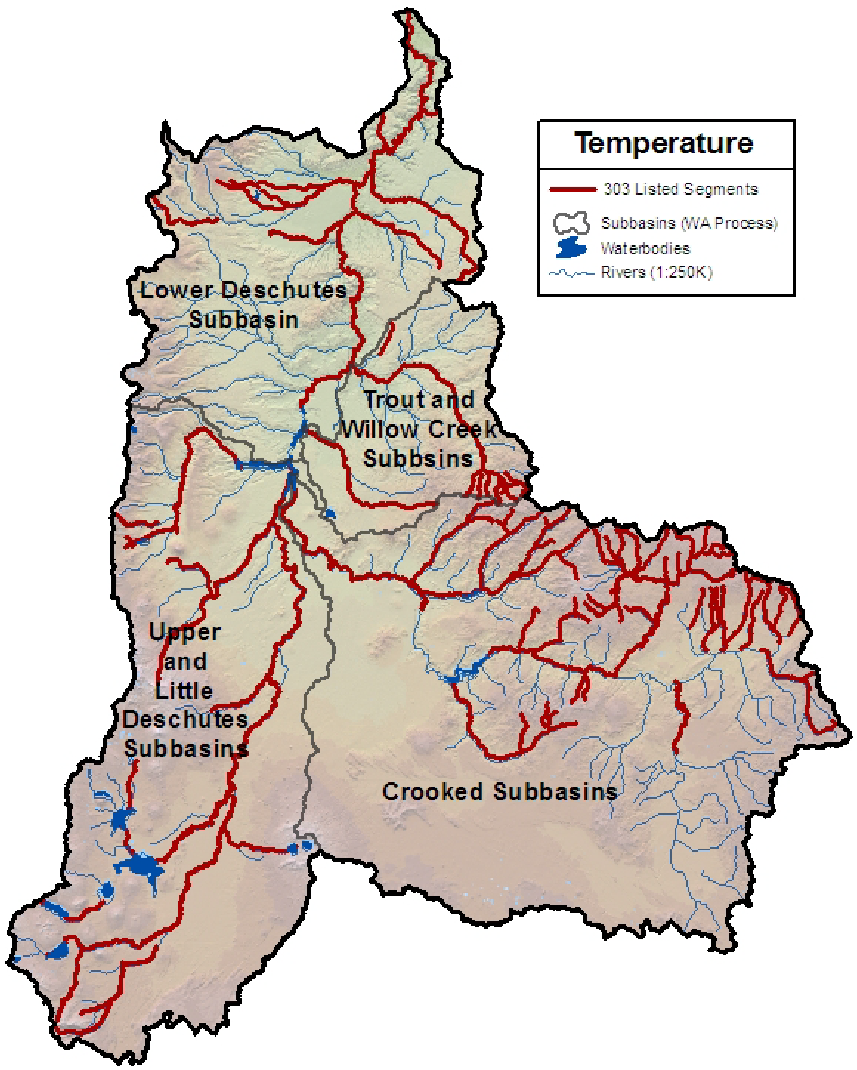
Harmful algal blooms have been identified as a Priority Focus Area in this iteration of the Deschutes WA. See the Action Plan for more information.

Temperature

Fish and aquatic life is the designated beneficial use most sensitive to temperature. Oregon's water temperature criteria employ a logic that relies on using salmon and trout (salmonid) life cycles as the indicator. If temperatures are protective of these indicator species, other species will share in this protection. More information about DEQ"s temperature standard (OAR 340-041-0028) is available from: http://www.deq.state.or.us/wq/standards/temperature.htm.

Excessive water temperatures reduce the quality of rearing and spawning habitat. Potential thermal pollutants include human-caused increases in solar radiation due to riparian vegetation disturbance or removal, channel modifications and widening, reduction of summer time stream flows though diversions, warm discharges from NPDES permitted sources, and irrigation district management.

Water Quality Status. Temperature is a wide-spread issue of concern throughout the Deschutes Basin. There are impairment listings for temperature on 86 streams in the Deschutes Basin [2004/2006 303(d) list, see adjacent map]. In addition, the analysis of macroinvertebrate data collected around the basin indicate that temperature is a significant stressor on the macroinvertebrate community, with the majority of sites sample (67%) being in poor condition for temperature stress.



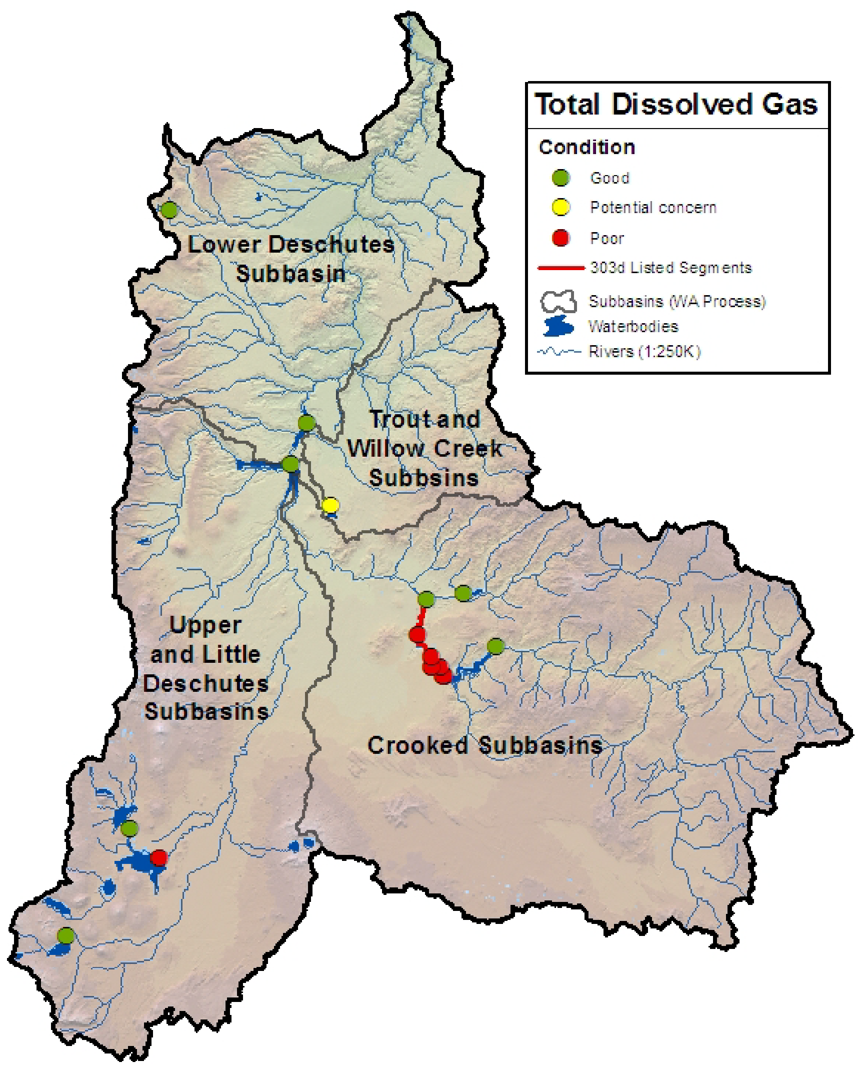
DEQ will be developing TMDLs to address temperature throughout the Basin. For subbasins and stream located above Lake Billy Chinook, TMDL development as already started and completion is expected by 2012. TMDLs for the streams in the Lower Deschutes and Trout Subbasins are not yet scheduled.

DEQ coordinates with key partners to reduce thermal loading. During the stakeholder meetings, it was identified that many restoration projects are already being implemented which will improve stream temperatures. For more information about implementation actions to improve stream temperatures, please see the section below, *Summary of Implementation Efforts*. Temperature has been identified as a Priority Focus Area in this iteration of the Deschutes WA. See the Action Plan for more information.

Total Dissolved Gas

Dissolved gas supersaturation (measured as total dissolved gas or TDG) is a condition that results from natural and human-caused processes. Supersaturation can result in gas bubble trauma, a condition that affects aquatic animals residing in fresh or marine waters that are supersaturated with atmospheric gases. Fish and aquatic life is the beneficial use most affected by this parameter. DEQ has developed a water quality standard to protect this use. The numeric portion of the standard states that the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation. DEQ's TDG standard (OAR 340-041-0031) is available at: http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_041.html.

The effects of dam operation on gas supersaturation have been well documented (Weitkamp et al., 2003). Gas supersaturation below dams occurs when air becomes entrained in the water column and is forced into solution. This typically occurs when excess water is spilled over the face of a dam, with air becoming entrained as the water plunges to a stilling basin or plunge pool at the base of the dam. As the water plunges below the surface, hydrostatic pressures are increased, driving the entrained gases into solution and causing supersaturation of dissolved gases. Although this entrainment typically occurs when water is spilled over the top of a dam, it can also occur anytime water leaving the dam plunges below the water surface in the receiving waters.



Water Quality Status. There are a number of dams in the Deschutes Basin. Gas supersaturation has been identified as an issue below Bowman Dam on the Crooked River and Wickiup Reservoir on the Deschutes River. Limited data collected by USBR suggest that there could also be a problem below Haystack Reservoir. USBR data discussed in this section were obtained from the agency in October, 2009 for the period 1995-2009. In the adjacent map, the following criteria were used in this assessment to define the condition class:

Good – Meets water quality criteria, gas levels do not exceed 110%
Potential concern - At least one exceedance of 110% but does not meet listing criteria
Poor - Does not meet water quality criteria: exceeds listing criterion (10% of samples >110% with a minimum of 2 samples >110%)

Lower Deschutes Subbasin. Gas supersaturation was evaluated for the Pelton Round Butte Project on the Deschutes River during Federal Agency Regulatory Agency (FERC) relicensing. It was determined that supersaturation was not an issue for this dam complex because the conditions normally required for the development of excess total dissolved gas are not present at the Project. There are no deep or plunging water discharges from the dams at any time (ODEQ 2002, Section 9.7). TDG will be measured below the Reregulating Dam during the first two years following implementation of the selective withdrawal structure as part of the FERC license requirements (CTWS & PGE 2002). Sampling will take place during significant spill events at the dam and development of a plan will be required if noncompliance with the TDG standard is observed.

There is one other major dam in the Lower Deschutes Subbasin on Clear Lake in Wasco County. Limited data collected by USBR indicate that gas supersaturation is not an issue below this dam. USBR has collected data once every two to four years at this site since 1997 and gas levels have ranged between 93% and 102%.

Trout Creek and Willow Creek Subbasins. There is a dam on Haystack Reservoir in the Willow Creek watershed. Water from Haystack Reservoir drains into the North Unit Irrigation District canal system. Limited data collected by BOR on four dates in the summer between 1995 and 2007 suggest that TDG may be an issue in the canal below this dam. Measured gas levels were 104% to 111% saturation, with one value exceeding the criterion of 110%. Because the water released from the reservoir enters the irrigation system, fish should not be present in the canal.

Crooked Subbasins. The only 303(d) listing of impairment for TDG in the Deschutes Basin is on the Crooked River below Bowman Dam. Listings were originally based on the presence of bubble gas disease in fish (ODFW data from 1989). More recent TDG data collected by USBR and ODFW (2006-2009) indicate that the TDG criterion of 110% saturation is regularly exceeded below Bowman Dam when flows are greater than 500-800 cfs. Electrofishing by ODFW in 2006 also still revealed the presence of bubble gas disease in mountain whitefish and redband trout. A TMDL will be required for TDG on the Crooked River, which will likely require a change in management of the water is released from Bowman Dam. DEQ will work with USBR to address this issue. Stakeholders believe this to be a very important issue to get resolved for fish in the river.

Limited TDG data have been collected by USBR on Ochoco Creek below Ochoco Dam. Data were collected three times in the summer between 1995 and 2001. TDG levels ranged between 102% and 104% on these three different sampling dates.

Upper and Little Deschutes Subbasins. Nitrogen supersaturation has been observed on the Deschutes River below Wickiup Reservoir. USBR collects TDG data below the reservoir in July. Data were collected in 1995, 2001, 2004 and 2007. TDG levels exceeded 110 percent saturation on three of these four sampling dates, with data ranging from 109% to 115%. In addition, Symbiotics, LLC collected monthly TDG data below the reservoir in 2009. Data were collected once in April and then twice monthly from May to September. In a draft report (dated December, 2009); Symbiotics reports that the 100 percent saturation level was frequently exceeded in all samples except those in early May and early June. Maximum concentrations approached 120 percent saturation. There appeared to be a relationship between reservoir outflow and TDG saturation, with the threshold for exceeding 110 percent saturation around 1,000 cfs. Stakeholders were surprised by these results and questioned whether these higher TDG levels were having an impact on the fishery in the river. There has been no sign of bubble gas disease in fish here.

Although the Deschutes River below Wickiup Reservoir is not currently listed as impaired in the State's Water Quality Assessment, it is likely to be in the future based on these data. As with Bowman Dam, a change in management of how water is released from Wickiup Dam will probably be required to address this impairment. DEQ will work with USBR to address this issue.

Limited TDG data have been collected by USBR below the dams on Crane Prairie Reservoir and Crescent Lake. TDG levels below Crane Prairie Reservoir have ranged between 101% and 105% from 1995-2007. TDG levels below Crescent Lake were 102% on one date in July, 2001.

Dissolved Oxygen, pH, Nutrients, and Chlorophyll *a*

DEQ has water quality standards for dissolved oxygen, pH and chlorophyll *a* to protect beneficial uses in the Deschutes Basin. DEQ's standards for DO (OAR 340-041-0016), pH (OAR 340-041-0021), and chlorophyll a (OAR 340-041-0019) are available at: http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_041.html. The most sensitive beneficial uses for pH and DO are fish and aquatic life (dissolved oxygen and pH) and water contact recreation (pH). The beneficial uses affected by chlorophyll *a* are water supply, water contact recreation, fishing, aesthetics and livestock watering.

At the moment, DEQ does not have any standards for nutrients. The nutrients of concern for surface water quality are typically nitrogen and phosphorus. Nutrients are discussed in this section because elevated nutrient levels can be one of the causes of pH and/or dissolved oxygen problems in lakes or streams. Elevated nutrients can also cause increased plant and algal growth, which can be reflected in elevated chlorophyll *a* (nuisance phytoplankton growth) concentrations.

Water Quality Status. The waterbodies in the following table are identified as impaired for one of these related parameters in the 2004/2006 Water Quality Assessment. In addition, a number of streams are listed as "potential concern" for phosphorus: Deschutes River, Crystal Creek, Fall River, Metolius River, Odell Creek/Lake, Rosary Creek, Trapper Creek, Little Deschutes River, and Crooked River. The upper Crooked River is also listed as "potential concern" for ammonia.

WATERBODIES 303(D) LISTED FOR PH, DISSOLVED OXYGEN AND CHLOROPHYLL			
Name	**River Miles**	**Parameter**	**Season**
Crooked River	0 to 51	pH	Fall/Winter/Spring
Crooked River	0 to 51	pH	Summer
Crooked River	82.6 to 109.2	pH	Fall/Winter/Spring
Crooked River	82.6 to 109.2	pH	Summer
Deschutes River	0 to 46.4	pH	Summer
Deschutes River	46.4 to 99.8	pH	Fall/Winter/Spring
Lake Simtustus	102.3 to 106.3*	Chlorophyll *a*	Summer
Lake Simtustus	102.3 to 106.3*	pH	Summer
Lake Billy Chinook	110.1 to 116*	Chlorophyll *a*	Summer
Lake Billy Chinook	110.1 to 116*	pH	Summer
Deschutes River	116 to 222.2	Dissolved Oxygen	January 1 - May 15

WATERBODIES 303(D) LISTED FOR pH, DISSOLVED OXYGEN AND CHLOROPHYLL			
Name	**River Miles**	**Parameter**	**Season**
Deschutes River	126.4 to 162.6	pH	Fall/Winter/Spring
Deschutes River	126.4 to 162.6	pH	Summer
Deschutes River	162.6 to 168.2	pH	Summer
Deschutes River	168.2 to 189.4	Chlorophyll *a*	Summer
Deschutes River	171.7 to 223.3	Dissolved Oxygen	Year Around (Non- spawning)
Little Deschutes River	0 to 68.8	Dissolved Oxygen	January 1 - May 15
Odell Creek/Odell Lake	0 to 16.3	Chlorophyll *a*	Summer
Odell Creek/Odell Lake	0 to 16.3	pH	Summer
Lava Lake		Dissolved Oxygen	Summer

*River miles are for the Deschutes River

Lower Deschutes Subbasin. The lower Deschutes River, Lake Simtustus and Lake Billy Chinook do not meet water quality standards for pH and/or chlorophyll *a*. A new selective withdrawal structure was activated at the base of Lake Billy Chinook in January, 2010. Based on modeling done in conjunction with the new FERC license for the Pelton Round Butte Project, the new withdrawal structure is expected to greatly improve water quality conditions both in the reservoirs as well as downstream in the river. Stakeholders felt it was very important to monitor changes in water quality specific to this new operation, looking at both pH and dissolved oxygen, and impacts on fisheries. PGE and CTWS (the joint owners and licensees of the project) are responsible for doing some monitoring, which will likely be supplemented by DEQ monitoring as part of the TMDL process in the future.

Stakeholders also believed that monitoring was needed in the tributaries to the Deschutes River because very little data have been collected in the past. The Wamic area was identified as one area of particular concern (see Section on Bacteria for further discussion). A preliminary assessment of data collected by USBR also indicates that there could be dissolved oxygen problems in Clear Lake and Clear Creek below the dam, although further study is needed. There might be opportunities to work with the school in Maupin and the Mt. Hood National Forest to do some monitoring in the White River watershed. It should also be noted that stakeholders indicated that agricultural irrigation return flows could enter either the lower Deschutes River and/or tributaries in the Trout Creek and Willow Creek areas which may pose water quality concerns for both nutrients and bacteria.

Trout Creek and Willow Creek Subbasins. There are presently no 303(d) listings of impairment for pH, dissolved oxygen or chlorophyll *a* in either of these subbasins. Data collected by the Jefferson County SWCD and ODA (2006-2008) indicate that there are some issues for either or both parameters in these areas, however. Although data have not been collected, stakeholders believed that low dissolved oxygen is also an issue for fish in upper Trout Creek. Data collected by USBR show that there have been violations of one or both standards in some years on Haystack Reservoir.

The data collection effort by the Jefferson SWCD and ODA is part of a long-term study being conducted to assess water quality in the area around Agency Plains. The impetus for the study came from monitoring conducted by PGE beginning in the 1990s which documented high nitrate levels in surface waters and springs associated with Willow Creek, Campbell Creek and Mud Springs Creek (Lewis 2003). In an attempt to understand the sources of this nitrate (legacy or current practices), the SWCD and ODA embarked on a more comprehensive study to assess nutrient and bacterial sources and distribution in the Agency Plains area (Hammond and Roofener 2007; Hammond & Roofener 2008; Hammond & Roofener 2010). The work done to date indicates that nitrate concentrations are higher in groundwater of agricultural areas (1-8 mg/L nitrate-N) than in non-agricultural areas. Agriculture appears to contribute nitrates to streams in the area primarily by leaching to groundwater (which surfaces as springs) rather than via surface runoff from crop fields. Nitrate sources may be either fertilizer or livestock manure. Phosphorus naturally appears to be 0.1-0.3 mg/L in groundwater, depending on location, but also appears to be contributed to local streams via surface runoff from crop fields and pastures.

The Jefferson SWCD and ODA are continuing their work on two fronts. They are planning additional sampling and analysis to better understand nutrient sources and timing in the Agency Plains area in order to direct implementation measures. They also are continuing to work with landowners and the North Unit Irrigation District to pipe delivery water and improve irrigation practices. Concern has been raised by stakeholders about the quality of water in irrigation return flows in this area entering the Deschutes River. DEQ is a cooperator in these on-going monitoring efforts.

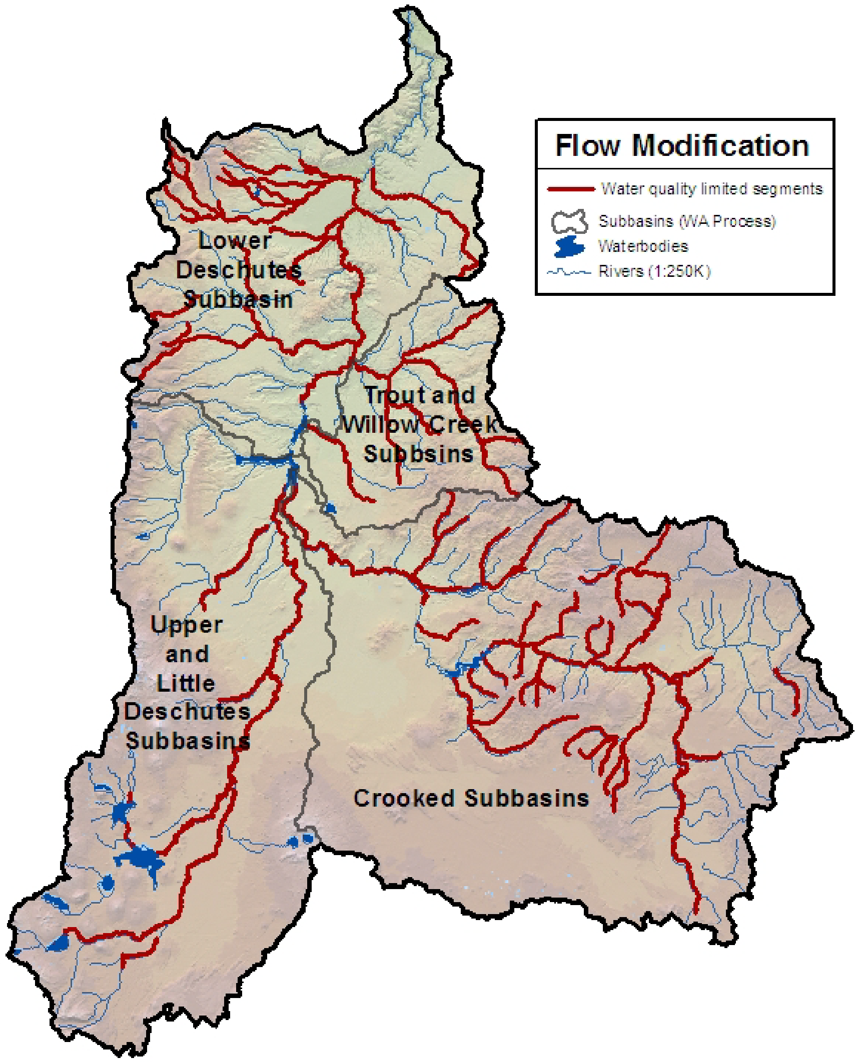
Crooked Subbasins. The Crooked River (in both the Upper and Lower Crooked Subbasins) has been identified as not meeting water quality standards for pH. In a preliminary assessment of data collected by DEQ and/or USBR since the last 303(d) assessment, there appear to be additional sites in all three Crooked River hydrologic subbasins where either pH, dissolved oxygen or both appear to be an issue. These include sites on Prineville Reservoir, Dry Canyon, Marks Creek, McKay Creek, Ochoco Creek, Ochoco Reservoir, North Fork Crooked River, South Fork Crooked River, Beaver Creek, Sanford Creek, Dry Paulina Creek and Camp Creek. DEQ will be working on developing TMDLs for dissolved oxygen, pH and nutrients in the Crooked River Subbasins beginning in 2011. The TMDLs will at least address listings on the Crooked River, although it is unclear at this point whether sufficient data exist to address the potential concerns on the other tributaries. Additional data might be needed to adequately address these tributaries.

Upper and Little Deschutes Subbasins. As indicated above, there are water quality impairments on the Deschutes River, Little Deschutes River, Odell Lake/Odell Creek and Lava Lake. In a preliminary assessment of data collected by DEQ and/or BOR since the last 303(d) assessment, there appear to be additional sites in all both subbasins where either pH, dissolved oxygen or both appear to be an issue. These include sites on Whychus Creek, Indian Ford Creek, Spring River, Fall River, Crescent Creek, Hemlock Creek, Metolius River, Wickiup Reservoir, Crane Prairie Reservoir, Deschutes River between Crane Prairie and Wickiup Reservoirs. DEQ has begun work on developing TMDLs for dissolved, pH, nutrients and chlorophyll *a* in the Upper and Little Deschutes Subbasins. The TMDLs will at least address listings on the Deschutes River, Little Deschutes River, Odell Lake/Creek and Lava Lake. It is unclear at this point whether sufficient data exist to address the potential concerns on the other tributaries. Additional data might be needed to adequately address these tributaries, which will be determined during the TMDL process.

As was discussed under the section on bacteria, there is some local concern about potential bacteria and nutrient contamination of both surface waters and groundwater in areas with a large number of old, potentially failing onsite septic systems. This has been identified as a potential issue in the Camp Sherman area near the Metolius, in developed areas around some of the Cascade lakes, and along the Deschutes and Little Deschutes Rivers. A preliminary analysis of data from DEQ's ambient monitoring station on the Metolius River at Bridge 99 indicates that there is potentially a gradually increasing trend at this site in pH values. Further analysis of this data is needed.

Altered Hydrology

Altered hydrology refers to decreased summer flows due to diversions, changes in flow magnitude and timing from dam operations, flashier flow regimes due to altered uplands conditions, returning excess flow to a different reach or watershed, and groundwater withdrawal impacts. Flow alterations can directly impact instream water quality and fish and aquatic life habitat.



Water Quality Status. There are 75 303(d) listings of impairment for flow modification (altered hydrology) in the Deschutes Basin (see adjacent map). These impairments were originally identified in the 1994/1996 Water Quality Assessment, with much of the source information for the listings coming from a Nonpoint Source Assessment done by DEQ in 1988 (ODEQ 1988). In 2002 EPA determined that flow modification was not a pollutant. Although the water bodies are considered water quality limited, TMDLs are not required to address the problem.

Based on stakeholder input, there appeared to be general consensus that altered hydrology is a significant resource issue around the whole Basin, although there were some questions about whether all the impaired reaches identified on the map were still impaired. Some more specific concerns by geographic area are summarized below. Much of this information comes from the Deschutes Subbasin Plan (NPPC, 2005) and input from stakeholders. The Deschutes Subbasin Plan and local watershed assessments can be referred to for more specific details about this resource concern and suggested priority areas for future work.

Lower Deschutes Subbasin. There are very few diversions in the Bakeoven and Buck Hollow watersheds. Low summer stream flow in these systems is rather a result of the effects of generally rapid runoff from upland dry land fields and rangeland, loss of natural floodplain and riparian function and severe channel scour and incision. These systems are also characterized as being flashier than they were historically due to upland watershed conditions: the invasion of grassland areas by juniper and shrub habitats, conversion of grasslands to agricultural uses, and loss of near-stream vegetation buffer zones. Enrollment of uplands in CRP in these drainages was identified as an important strategy for helping to buffer high (damaging) flows. There is local concern that if lands currently enrolled in these programs are removed from conservation reserve, stream flows will respond with increased variability (flashy flows) due to changes in soil permeability and storage from resumption of cropping and grazing. This was of particular concern in the Buck Hollow watershed.

In the watersheds of the White River, low stream flow is attributed to the cumulative effect of multiple irrigation diversions and/or water storage behind reservoirs. The Deschutes Subbasin Plan (NPPC, 2005) identifies a habitat objective of increasing minimum stream flows by 25% throughout the White River watershed, with a long-term goal of meeting instream water right flows. The Plan generally calls for the need to increase stream flow throughout most of the Subbasin.

Trout Creek and Willow Creek Subbasins. Diversions and pumping have been identified as contributing to low or intermittent stream flows in both watersheds, although stakeholders expressed some concern with the identification of segments experiencing flow modification on the 303(d) list. Some stakeholders felt that altered hydrology was one of the greatest resource concerns for the Trout Creek watershed due to land management activities and changes in upland communities. Both watersheds have also lost their ability to absorb high flows because of changes in upland plant communities, loss of floodplain connectivity (through channel straightening, and berms) and wetlands, and reduction in channel complexity. Stream flow is augmented by springs in the lower portions of both watersheds, particularly in lower Willow Creek where springs in the lower section of the creek from Madras to the mouth at Lake Simtustus provide a substantial base stream flow. The Deschutes Subbasin Plan (NPPC, 2005) identifies restoring and maintaining perennial flows as a management strategy for both creeks.

Crooked Subbasins. Altered stream flow in the Crooked Subbasins has been identified as a significant and widespread resource concern. Above Prineville Reservoir, the concerns largely focus on low summer-time flows. Stream flow is over-appropriated in many locations. Upstream water storage, water withdrawal for irrigation and lowered stream valley water tables result in low or intermittent flow and associated high water temperatures in many streams. Degraded watershed conditions also contribute to flashy stream flow regimes. Increased perennial stream flows is identified as a management strategy in all watersheds above the reservoirs in the Deschutes Subbasin Plan (NPPC, 2005).

In the Lower Crooked Subbasin, water storage in both Prineville and Ochoco Reservoirs and downstream flow regulation below the dams has reversed the historic hydrograph. Diversions below both dams result in low or intermittent summer stream flows in both the Crooked River and lower Ochoco Creek. Irrigation withdrawals from Ochoco Creek above the reservoir, Mill Creek, Marks Creek and McKay Creek also result in low or intermittent summer stream flows. Flows improve in the lower Crooked River due to a large number of springs between Highway 97 and Lake Billy Chinook which add more than 1,000 cfs of high quality water to the lower Crooked River. It is theorized that a portion of this spring flow is due to leakage from canals in the Upper Deschutes Subbasin, so that these spring flows would be reduced under unregulated flows.

Upper and Little Deschutes Subbasins. Altered stream flow has been identified as a significant and widespread resource concern throughout most of the Upper and Little Deschutes Subbasins. There are some mostly unregulated streams, such as the Metolius River, Fall River, and Spring River, but most of the streams in this area have altered stream flow because of dams and/or water withdrawals.

The Deschutes River has a series of dams which alter flows due to water storage and seasonal releases of water. These dams include Crane Prairie Reservoir, Wickiup Reservoir and the dams associated with the Pelton-Round Butte hydroelectric project. Water storage in Crane Prairie and Wickiup Reservoirs for irrigation has reversed the historic hydrograph. Between Wickiup and Bend, low winter flows reduce fish habitat quality and contribute to increased river bank erosion. Downstream of Bend, low summer flows (from irrigation diversions) reduce water quality and aquatic habitat conditions in the Deschutes River down to the area around Big Falls. Below this, the river gains a substantial amount of flow from groundwater releases (springs) before entering Lake Billy Chinook. A similar pattern of a reversed hydrograph is also seen on Crescent Creek and lower Little Deschutes River due to irrigation water storage in Crescent Lake.

Diversions from Tumalo Creek, Whychus Creek, the Little Deschutes River and tributaries to these water bodies contribute to reduced stream flows. Most of these diversions are for irrigation water, although the City of Bend diverts water from Bridge Creek and Tumalo Creek for municipal water and the City of Sisters diverts from Pole Creek.

DEQ's current process to promote flow protection and restoration relies on voluntary measures and community initiative. The direct regulation of flow is not under the jurisdiction of DEQ but is addressed through Oregon Water Resources Department. Restoration of more natural stream flows is typically identified as a component of improved stream temperatures in Oregon’s temperature TMDLs. For subbasins and streams located above Lake Billy Chinook, TMDL development as already started and completion is expected by 2012. In the past, DEQ has applied for in-stream water rights in some basins, as has the Oregon Department of Fish and Wildlife, and this is a possibility in the Deschutes Basin as well.

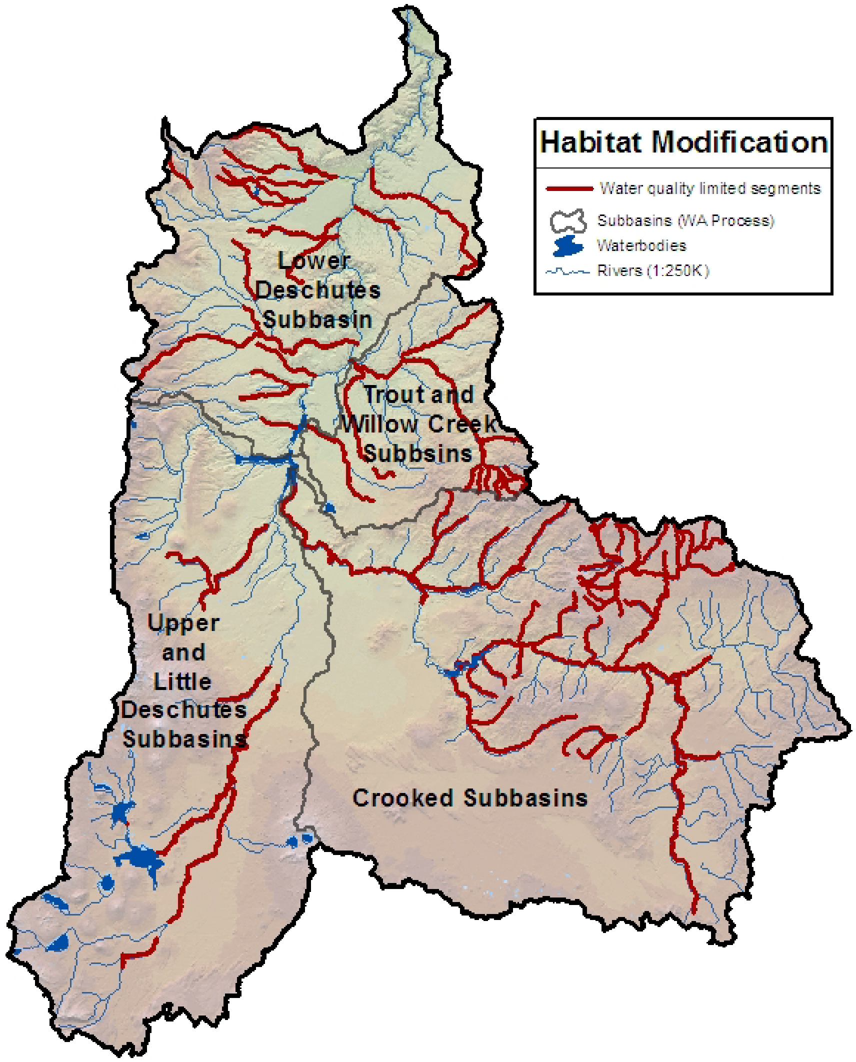
Altered hydrology has been identified as a Priority Focus Area in this iteration of the Deschutes WA. See the Action Plan for more information.

Habitat Modification

<u>Water Quality Status</u>. There are 85 303(d) listings of impairment for habitat modification in the Deschutes Basin (see map on following page). These impairments were originally identified in the 1994/1996 Water Quality Assessment, with much of the source information for the listings coming from a Nonpoint Source Assessment done by DEQ in 1988 (ODEQ 1988). In 2002 EPA determined that habitat modification was not a pollutant. Although the water bodies are considered water quality limited, TMDLs are not required to address the problem.

Based on stakeholder input, there appeared to be general consensus that habitat modification was a significant resource issue around the whole Basin. Some more specific concerns by geographic area are summarized below. Much of this information comes from the Deschutes Subbasin Plan (NPPC, 2005) and input from stakeholders. The Deschutes Subbasin Plan and local watershed assessments can be referred to for more specific details about this resource concern and suggested priority areas for future work.

Lower Deschutes Subbasin. Although the specific causes of habitat degradation varied somewhat by watershed, in general, riparian habitat degradation was attributed to channel alteration, agricultural practices and/or livestock grazing. Degraded riparian conditions along Shitike Creek have also been attributed to urban and industrial development. In some areas, road and railroad construction along stream corridors was also identified as a cause of channel straightening. Beaver habitat degradation was also identified due to loss of riparian vegetation, reduced stream flow, loss of riparian vegetation, and loss of oxbow sloughs and backwaters in lower gradient stream reaches. Riparian restoration projects, changes in livestock management and other efforts have improved habitat conditions, including bank stabilization and channel narrowing along some stream reaches.



Trout Creek and Willow Creek Subbasins. In the Willow Creek watershed, riparian habitat degradation has been attributed to flooding, channel scour, channel alteration and livestock grazing. In the Trout Creek watershed, loss of channel structure, increased stream gradient, loss of sinuosity, reductions in wetland habitats, and reductions in pool habitat have all been identified as types of habitat modification. Beaver habitat degradation was also indicated for these watersheds, as described for the Lower Deschutes Subbasin. In some areas, stream restoration projects have increased instream structure and stream bank stability and riparian fencing projects and management have significantly improved riparian conditions in some areas.

Crooked Subbasins. Degraded habitat has been identified as an issue throughout the Crooked Subbasins, with instream structure and riparian habitat generally lacking on many stream reaches. Poor riparian conditions are attributed to livestock grazing, agricultural practices, forest management, channel alteration, and road building practices. In the Lower Crooked Subbasin, urbanization and the loss of instream habitat complexity due to upstream dams are also identified as sources of poor riparian habitat conditions. All of these management practices have altered riparian and instream conditions, resulting in channel incision or erosion, and reduced quality and quantity of habitat and stream flow.

Upper and Little Deschutes Subbasins. Habitat degradation has been identified along reaches of the Little Deschutes River, Whychus Creek, and the Deschutes River. For the Little Deschutes River, the combination of an altered flow regime, historic grazing practices, and more recently urbanization of the river corridor are credited with having the greatest impact on aquatic habitat conditions. On Whychus Creek, historically there was extensive channel alteration along the length of the stream channel, as well as past livestock grazing and development. Recent restoration projects have been targeted at restoring the natural stream channel in many places. On the Deschutes River, degraded riparian/wetland habitat on the reaches between Wickiup Reservoir and Big Falls and between Crane Prairie and Wickiup Reservoirs has been attributed to the altered hydrograph. Below Big Falls, riparian habitat is generally considered to be in good condition, with excellent streambank stability and a non-erodible substrate in this section. Habitat conditions along the Metolius River and Tumalo Creek are also generally considered to be in good condition. In the Metolius watershed, there has been some degradation based on past forest fires, forest management and livestock and recreational use and along tributaries to the Metolius. Habitat impairments along Tumalo Creek are largely attributed to the area burned in the Bridge Creek fire. This area has recently undergone extensive restoration.

Sedimentation and Turbidity

DEQ has standards for both sedimentation (OAR 340-041-0007(12)) and turbidity (OAR 340-041-0036), which are available at: http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_041.html. The standard addressing sedimentation is a narrative criterion for the formation of bottom or sludge deposits. Both pollutants affect the beneficial use of fish and aquatic life. In addition, turbidity in surface waters can also be an issue for drinking water supply and aesthetics.

Turbidity – Public Drinking Water Supply

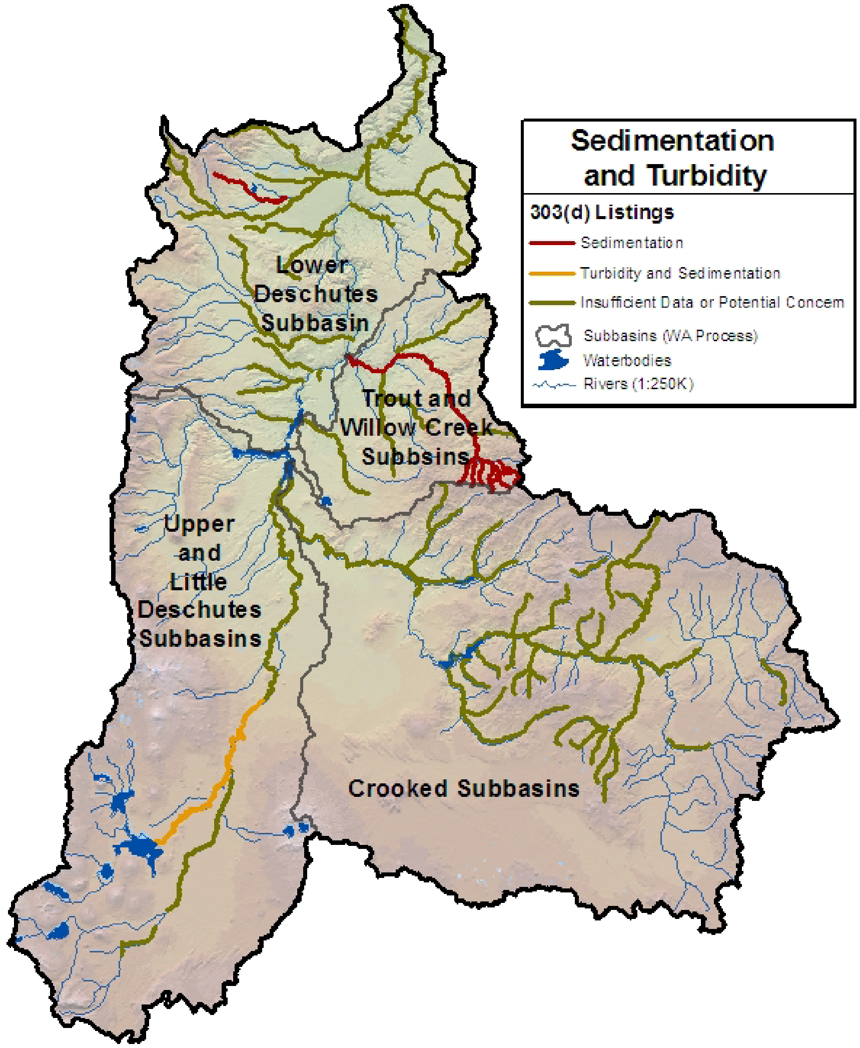
In the Deschutes Basin there are only two public water supply systems which rely on surface water as a drinking water source: the City of Bend which diverts water from Bridge Creek (Tumalo Creek watershed) and the City of Sisters which diverts water from Pole Creek (Whychus Creek watershed). Turbidity has not been identified as a significant issue for either surface water source. When natural turbidity levels become elevated in Bridge Creek, the City of Bend does not use its surface water source and instead switches to groundwater wells during these times. The City of Sisters only uses its surface water system as an emergency water source.

Sedimentation and Turbidity – Fish and Aquatic Life

Water Quality Status. There are a handful of water quality impairment listings for turbidity and/or sedimentation scattered throughout the Deschutes Basin according to the 2004/2006 Water Quality Assessment (see map on following page). Most of these listings are for sedimentation.

In our meetings with stakeholders and in a review of existing watershed/basin assessments, it appears that sedimentation is a bigger issue in the basin than is represented by these few 303(d) listings of impairment. This conclusion is supported by our analysis of macroinvertebrate data collected around the basin which indicate that sediment is a significant stressor on the macroinvertebrate community, with the majority of sites sample (56%) being in poor condition for sediment stress. In addition, a number of segments were identified in DEQ's 1988 Nonpoint Source Assessment as "insufficient data" or "potential concern" for sedimentation or turbidity (ODEQ 1988). The NPS Assessment established that there were moderate or severe observed impairments, but that supporting data needed to be collected or obtained from partners.

The lack of 303d listings for sedimentation may also be in part because DEQ currently has a narrative standard for sedimentation which is difficult to interpret. DEQ is currently working on developing a new standard for sedimentation, although effort has not yet been completed. The following discussion highlights some of the concerns and needs that we heard voiced in the different geographic regions of the basin.



Sedimentation has been identified as a Priority Focus Area in this iteration of the Deschutes WA. See the Action Plan for more information.

Lower Deschutes Subbasin. The only sedimentation 303(d) listings in the Lower Deschutes Subbasin are on Gate Creek in the White River watershed. This listing was based on data for fine sediments collected by the Mt. Hood National Forest back in the early 1990s. Previously, Rock Creek was also listed for sedimentation impairment, but was de-listed in 2004/06 based on recent Wolman pebble count (surface fines) data collected by the Mt. Hood National Forest.

Conversations with stakeholders and a review of the Deschutes Subbasin Plan (NPPC, 2005) and other watershed assessments for this area all identified stream turbidity and sedimentation as a resource issue in the watersheds of the lower Deschutes River. Although the sources of sedimentation and magnitude of the issue varied a bit by watershed, in general, stream sediment loading was attributed to: livestock, road run-off and slope failures, ditch failures, erosion from cropland, stream bank erosion, road density, past forest fires, and/or altered flow regimes. In addition, some tributaries are incised into highly erodible soils. Sedimentation was also identified as an issue for the mainstem Deschutes River, with stream turbidity and sedimentation usually associated with high intensity rain on snow storms with frozen ground, or summer convection storms. The White River naturally contributes glacial silt, sediment and turbidity to the Deschutes River below river mile 46.

Stakeholders generally felt that there were limited data available to assess these pollutants. They felt that stream surveys and relative bed stability (RBS) data might be useful to look at and indicated that they thought would be a useful thing to have done. The CTWR has collected sediment cores and sampled sediment boxes in some locations, and felt that was also worthwhile data. Sediment and turbidity were identified as issues in reservation waters. Stakeholders also pointed out that conservation practices implemented in recent years on some cropland and upland range have increased water retention and reduced upland erosion throughout the Subbasin.

DEQ will conduct a further assessment of sedimentation in the Lower Deschutes as part of future TMDL efforts. A TMDL schedule for the Lower Deschutes Subbasin has not yet been established.

Trout Creek and Willow Creek Subbasins. There are multiple 303(d) listings for sedimentation in the Trout Creek Subbasin. The listings are based on cobble embeddedness data collected by the Ochoco National Forest in the early 1990s. Although not currently included as part of 303(d) listing determinations, macroinvertebrate sampling and analysis conducted by DEQ in 2006 indicated that sediment was a significant stressor to the biological community, with conditions generally decreasing in the downstream direction (refer back to section on *Macroinvertebrate Health* for more information).

Conversations with stakeholders and a review of the Deschutes Subbasin Plan (NPPC, 2005) and other watershed assessments for this area identified sedimentation as a resource issue in both the Trout and Willow Creek watersheds. In the Trout Creek watershed, sedimentation is largely attributed to erosion from uplands, including cropland and roads, and to streambank erosion. Sedimentation in the lower part of Trout Creek (below the confluence with Mud Springs Creek) in the past appeared to be related to ditch cleanout and over-irrigated pasture with head cuts. Turbidity monitoring conducted by ODA and the Jefferson SWCD was helpful in tracking down and solving some of these issues. In many places, sediment appears to be contributing phosphorus to streams. For Willow Creek, the NPPC Subbasin Plan indicated that stream sediment loading originates from highly erodible soils (60% of cropland is classified this way), unstable stream banks, agricultural and forest management practices and drainage from the watershed road system. Irrigation tailwater occasionally discharges over the canyon rim and erodes sediment into lower Willow Creek.

Stakeholders recommended that it was important to track sediment concentrations and cobble embeddedness specific to projects in the Trout and Willow Creek area. It was generally acknowledged that monitoring has shown improvements in water quality over time and that monitoring should continue. ODFW conducted sediment surveys from the 1990s. Stakeholders suggested that these surveys be used as a baseline for identifying trends in water quality if surveys are repeated in the future.

DEQ will conduct a further assessment of sedimentation in the Trout Creek watershed as part of future TMDL efforts. A TMDL schedule for this effort has not yet been established.

Crooked Subbasins. There are no 303(d) listings for turbidity or sedimentation in the Crooked River subbasins, although Prineville Reservoir is listed as “potential concern” for both parameters. Sedimentation and turbidity in these subbasins has been identified as a concern by stakeholders and in watershed assessments (NPCC, 2005; NRCS, 2005b; Whitman, 2002; Nielsen-Pincus, 2008). In the Lower Crooked Subbasin, channel alterations, soil disturbance from livestock, tillage of cropland, low stream gradient, degraded riparian vegetation and eroding stream banks have been identified as contributing to high sediment loading. Uplands in the area are degraded with reduced ability to collect and store runoff and maintain soil stability. In the Upper Crooked Subbasin, some stream reaches are incised in drainages with highly erodible soils susceptible to annual erosion and stream substrate frequently contains high concentrations of fine sediment. Stakeholders have noted that water coming out of Bowman Dam is highly turbid, and can affect turbidity in the entire length of the lower Crooked River until river flows are comprised predominantly of spring water in the lower portion of the river.

Macroinvertebrate monitoring conducted by DEQ in 2005 identified sediment as a source of macroinvertebrate community impairment (refer back to section on *Macroinvertebrate Health* for more information). Samples were collected at 29 randomly selected sites on public lands in the Subbasins. The PREDATOR model was used to determine whether a macroinvertebrate community at a given site was impaired relative to reference communities. The majority of the sites scored as either “most disturbed” or “moderately disturbed”, with the “least disturbed” sites typically located in the headwater portions of the streams. Stressor ID models indicated that both temperature and sediment scores were pollutants are affecting the biological community. Sediment impairments were actually more wide-spread the temperature except in head-water sites.

Upper and Little Deschutes Subbasins. The Deschutes River between Wickiup Reservoir and Bend has 303(d) impairment listings for both sedimentation and turbidity. Both listings are based on USFS data from the mid 1990s. The turbidity data indicating a 30 fold increase in turbidity when irrigation water was released from Wickiup Reservoir in the early spring. The Upper Deschutes River Instream Flow Assessment (USFS, 1994) determined that spawning gravels contain a high percent of fines that limit embryo survival rates for trout.

The turbidity in the Deschutes River appears to be related to suspended sediment concentrations. The sediment appears to be generated from eroding banks. The bank erosion is likely caused by a combination of alteration of flow regime, boat wake, development along river and natural processes. The Upper Deschutes Watershed Council's Upper Deschutes Subbasin Assessment (Yake 2003) concludes that in spring, high water releases out of Wickiup can scour sediment from stream banks that have been dewatered in the winter. The assessment identified 47 of 130 reaches that had high to extreme bank erosion. DEQ and the USFS collected turbidity and total suspended solids (TSS) data in the reach between Wickiup Reservoir and Bend during 2001. The results of this study appear to indicate a relationship between increased stream flows and higher TSS levels during the period March-May when stream flows were being increased for irrigation. Data collected during the summer and fall had much lower TSS levels. Upper Deschutes River Strategy (DRC, UDWC, ODFW 2008) calls for the restoration of the channel dimension, pattern and profile of the Deschutes River and altering the existing hydrograph towards a desired future hydrograph. DEQ will begin work on developing a TMDL for turbidity and sedimentation in 2011.

There are little data available to evaluate turbidity and/or sedimentation conditions in other parts of this geographic area. Information from stakeholders indicates that there are sedimentation issues along the Little Deschutes due to streambank erosion. Some stakeholders suggest that the problem could be the result of changes in geomorphology over time but it was generally acknowledged that there was not a single clear driver for the current condition. It was suggested that grazing intensity is heavier here than in other parts of the Subbasins but that bank instability may stem from past impacts. Other areas where sedimentation was identified as a potential concern were tributaries to the Metolius River (Lake Creek and Brush Creek) and lower Whychus Creek. It was noted that the lower half of Whychus Creek has high percentages of fine sediment associated with erosion of unstable stream banks. Livestock grazing was identified as a past problem, but current management was greatly improved.

The need for consistent assessment protocols for streambank erosion, channel stability and general sedimentation condition was noted by stakeholders and a desire that the Watershed Approach further delve into this issue. Stakeholders also voiced concerns about the status of the state’s turbidity and sedimentation standards.

Toxics

The water quality criteria discussed in this section and elsewhere in this report reflect current values as identified in OAR 340-041 (http://www.deq.state.or.us/wq/standards/standards.htm). Some of water quality criteria for toxics are based on human consumption of fish and other aquatic life. DEQ is currently planning to revise the fish consumption rate from 17.5 grams per day to 175 grams per day statewide. This revision is scheduled to go to public notice in early 2011. If this revision is approved, the current water quality criteria for mercury and many other toxics may also be revised. It is expected that some criteria may be revised downward (become more stringent) in order to be reflective of the greater risk of exposure from the higher fish consumption rate.

DEQ is currently in the process of revising water quality criteria (for human health/consumption) for more than 100 toxic compounds including copper, iron, manganese and arsenic.

DEQ does not have much toxics data, either for surface waters, groundwater, sediments or fish tissue. There are limited toxics data available in DEQ's Laboratory Analytical Storage and Retrieval (LASAR) database that were not evaluated as part of this assessment due to time constraints. As will be described further in the Action Plan, evaluation of these data and additional toxics monitoring is needed in the Deschutes Basin.

Toxics, specifically arsenic and mercury, have been identified as a Priority Focus Area in this iteration of the Deschutes WA. See the Action Plan for more information.

Emerging Contaminants, Pharmaceuticals and Personal Care Products (PCPs)

The term "emerging contaminant" represents a wide range of chemical compounds that are a perceived, potential or real threat to human health or the environment. There are not published health guidelines for many of these compounds. A large number of these compounds exist in surface and groundwater at extremely low concentrations and have only recently been detected due to the development of new analytical methods. Many emerging contaminants are chemicals associated with everyday life and commonly used products and food additives. Evidence is becoming available that shows that low concentrations of these chemicals in water and sediments may adversely affect wildlife and aquatic life, and interfere with the hormone systems of humans, wildlife and aquatic organisms. Not all of the effects on humans and other species are known at this time. While no direct effects on humans have been identified, the presence of these compounds in waters designated for drinking water supply is of concern.

These emerging contaminants originate from a multitude of anthropogenic sources and most commonly are released into surface waters through municipal, agricultural, and industrial wastewater sources. Many come from commonly used consumer products such as personal care products (shampoos, soaps, toothpastes, cosmetics, lotions, fragrances, antimicrobial agents from antibacterial soap), pharmaceuticals (hormones, antibiotics, antidepressants), food additives (caffeine, dyes, preservatives, linings of food cans), fabric treatments (laundry detergents, flame retardants, stain resistors, anti-wrinkle and anti-static agents, dyes), automotive products (catalytic converter components, fuel additives, anti-icing agents), lawn and garden treatments (herbicides, insecticides, paints, stains, waterproofing agents), industrial by-products, and a myriad of others.

As stated above, water quality targets or guidance are not available for the vast majority of these contaminants at either a state or federal level. The State of Oregon is actively working to address this concern. Senate Bill 737, passed in 2007, requires DEQ to develop a list of persistent pollutants that have a documented effect on human health, wildlife and aquatic life ("P3 List") (http://www.deq.state.or.us/wq/SB737/index.htm) Oregon's 52 largest municipal wastewater treatment facilities are monitoring their effluent and developing reduction plans. In the Deschutes Basin, the cities of Bend, Redmond and Sunriver are monitoring their effluent for persistent pollutants.

While this will provide some information on the occurrence of some emerging contaminants in the Deschutes Basin, it will not account for the potential pollutant loads from septic systems (discharge to groundwater) and those treatment facilities that are not required to monitor at this time.

Water Quality Status. There are presently no 303(d) listings of impairment for emerging contaminants in the Deschutes Basin.

Metals (General)

The most common metal pollutants are iron, arsenic, chromium, copper, nickel, lead, zinc, cobalt, antimony and mercury.

Many fish species are very sensitive to low concentrations of metals in the water. Direct effects of metals contamination on aquatic life include changes in behavior like cough rate, predator avoidance, feeding behavior, learning, social interactions, and others. In humans, long-term exposure to metals in drinking water can result in reduced growth and development, cancer, nervous system damage, development of autoimmunity, and other problems. Childhood exposure to some metals can result in learning difficulties, memory impairment, damage to the nervous system, and behavioral problems such as aggressiveness and hyperactivity. Toxicity levels depend on the type of metal, its biological role, and the type of organisms that are exposed to it.

Metals can enter aquatic systems as a result of the weathering of soils and rocks, from volcanic eruptions, and from a variety of human activities involving the mining, processing, or use of metals and/or substances that contain metal pollutants. In the Deschutes Basin, natural geologic processes liberate like weathering and the action of geothermal springs can liberate metals from rock and soil. Manmade sources include air emissions from smelters (legacy), and other industrial facilities; process wastes from mining and industry; improper disposal of wastes. Streams coming from draining mining areas are often very acidic and contain high concentrations of dissolved metals with little aquatic life. Unlike some organic pesticides, metals cannot be broken down into less harmful components in the environment.

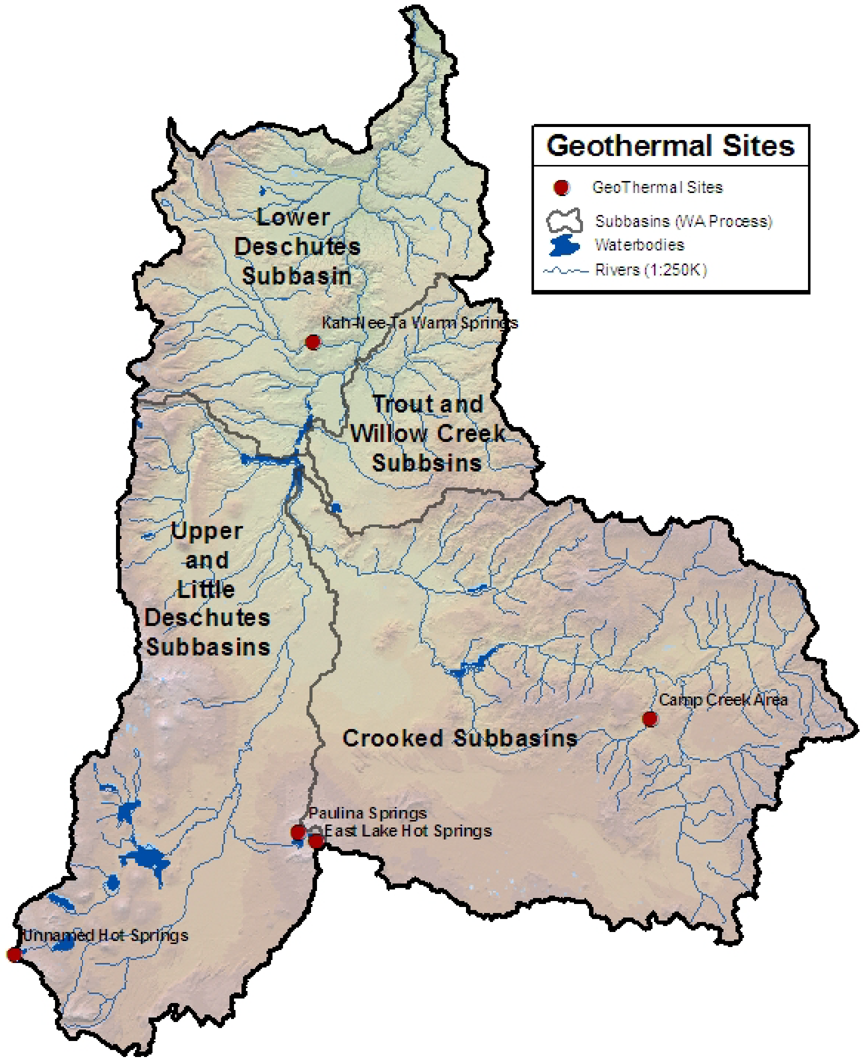
Many mines are present in the Deschutes Basin. The majority of these (outside of gravel extraction operations) are closed or abandoned sites, many of which were associated with historical mercury, gold and silver extraction activities. Soil and rock at several of the mines in the Ochoco Mountains have been assessed and found to contain concentrations of antimony, arsenic, chromium, copper, cobalt, iron, lead, mercury, nickel and zinc that exceed State-screening values for ecological receptors.

Metals concentrations of concern to the direct health of aquatic life are identified in the US EPA toxics rule and DEQ Table 20 (http://www.deq.state.or.us/wq/rules/div041/table20.pdf).

Water Quality Status. There are presently no 303(d) listings of impairment for metals in the Deschutes Basin, although Crescent Creek, Hemlock Creek, Little Deschutes River, Canyon Creek, Cultus Creek, Jefferson Creek, North Fork Tumalo Creek, Odell Creek, Soda Creek, Wychus Creek and Tumalo Creek (mainstem) all carry a listing of potential concern for alkalinity relative to metals concentrations. East Lake is listed as impaired for mercury in the draft 2010 Water Quality Assessment (see further discussion below).

Arsenic

Long-term exposure to high concentrations of arsenic in drinking water has been linked to cancer and to cardiovascular, pulmonary, immunological, neurological, and endocrine (e.g., diabetes) effects in humans.



Arsenic is found in the atmosphere, soils and rocks, natural waters and some aquatic organisms. Naturally occurring arsenic can be mobilized through weathering of soils and rocks, biological and metabolic activity, and volcanic emissions. Most arsenic in eastern Oregon is the result of natural geologic arsenic occurring in rocks and geothermal waters (see adjacent map) but some arsenic may be the result of mining activities, combustion of fossil fuels, arsenical pesticides, herbicides and crop desiccants, and commercially available wood preservatives. Elevated levels of arsenic in drinking water are fairly common throughout Eastern Oregon.

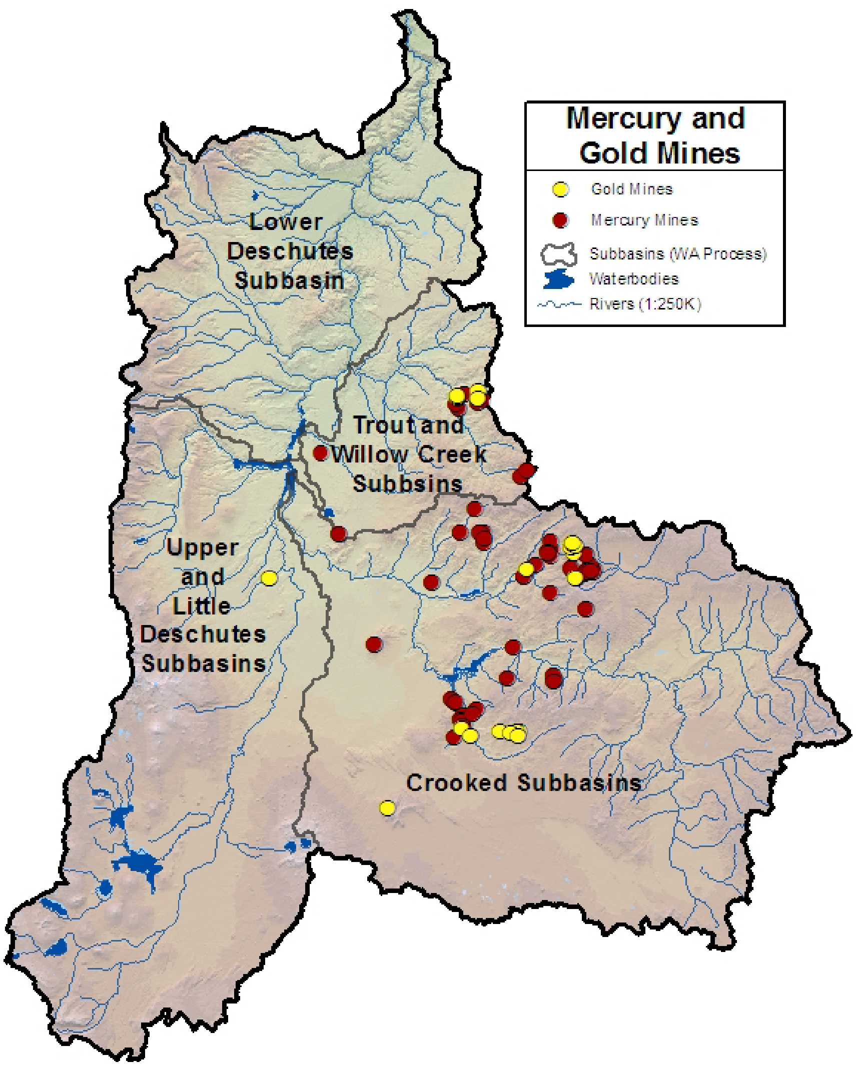
Arsenic concentrations of concern to the direct health of aquatic life are identified in the US EPA toxics rule and DEQ Table 20. Currently, Oregon does not have water quality targets for arsenic for the protection of aquatic life. Oregon State standards for the protection of human health are as follows: for water and fish ingestion, not to exceed 2.2 ng/L; for fish consumption only, not to exceed 17.5 ng/L; maximum concentration allowed in drinking water 0.05 mg/L. EPA has identified 0.01 mg/L as the maximum concentration of arsenic allowed in drinking water. The State of Oregon is currently in the process of revising their water quality criteria for arsenic, and is proposing to change the maximum concentration of arsenic allowed in drinking water to 0.01 mg/L. Information on this proposed criteria change can be found at: http://www.deq.state.or.us/wq/standards/toxics.htm.

Water Quality Status. There are presently no 303(d) listings of impairment for arsenic in the Deschutes Basin, although there is a listing of potential concern for Paulina Lake/Creek. However, there is evidence that arsenic may be an issue in some parts of the Basin in groundwater. This will be further explored in the groundwater section. The Interfor-Pacific Mill (sawmill) at Gilchrist is operating under an industrial discharge permit that identifies concentration requirements for arsenic in their discharge. At renewal, this permit will be revised to reflect the new water quality criteria and ensure that discharge concentrations are protective of human health, fish and other aquatic life.

Mercury

The presence of mercury in surface waters can be a water quality concern, especially when it occurs in mobile and easily accumulated forms such as methylated mercury. In rare cases, when concentrations are extremely high, mercury can result directly in the death of aquatic biota. More commonly, bioaccumulation and concentration affect designated beneficial uses (fishing and wildlife habitat) by building up concentrations within the food chain to levels where consumers (human or other predators) can be adversely affected.

Mercury is a toxic substance released to the environment through many natural and manmade sources, including mining of mercury ore and the processing of gold ore using mercury. Bacteria and chemical reactions in lakes and wetlands can change mercury into its most toxic form- methyl mercury. Fish become contaminated with methyl mercury by eating plankton and smaller fish. Mercury accumulates in older fish at increasing concentrations as it moves through the food chain. Most people are directly exposed to mercury through eating fish.



The primary sources of mercury in the Deschutes Basin are legacy mining activities and natural geologic materials. Substantial gold and mercury mining is known to have occurred in the Upper Trout Creek, Lower Crooked, and Upper Crooked watersheds. Much of this mining activity is undocumented and little or no data exist on mercury concentration in surface water or waste rock in the majority of the Deschutes Basin. Air deposition of mercury in the basin is known to occur but has not been effectively quantified. Historical agricultural chemicals, industrial and municipal source inputs of mercury are generally considered to be relatively minor compared to the legacy mining and natural geologic inputs. The Deschutes Basin has been the site of a number of mining activities mostly for gold, silver and mercury ores (see adjacent map). In addition to extraction of the naturally occurring mercury ores (cinnabar), mercury was used to amalgamate gold and silver at mining sites throughout the region, and is still present in mining tailings and around old mining sites.

Bioaccumulation of mercury to dangerous levels in fish tissues is the basis for the current human fish consumption advisory at East Lake (1994), issued by the state of Oregon DHS. Mercury concentrations of concern to the direct health of aquatic life are identified in the US EPA toxics rule and DEQ Table 20. It should be noted that this water column target is only one of the factors that determine fish tissue mercury levels. It is the fish tissue mercury levels that determine whether a fish consumption advisory is necessary and the lack of full support of fishing as a designated use.

Water Quality Status. There are presently no 303(d) listings of impairment for mercury in the Deschutes Basin, although there is a listing of potential concern for Paulina Lake/Creek. East Lake is listed as impaired for mercury in the draft 2010 Water Quality Assessment. There is evidence that mercury may be an issue in some parts of the Basin, as described below. Specific subbasin information is only provided for those areas where data have been collected and evaluated.

Crooked Subbasins. Ochoco Creek, a tributary to the Crooked River located near Prineville, was the site of intensive mercury mining between the 1930s and 1960s. Most mines were located upstream of the present day Ochoco Reservoir. The reservoir was included in a DEQ study of mercury in lakes conducted in 1993-1994 (Mercury in Oregon Lakes, 1993-1994, DEQ 1996). Collected data showed elevated levels of mercury in rainbow trout tissue samples. While these data did not meet the Oregon Health Division's criteria for mercury advisory, some samples had concentrations exceeding the EPA screening level, which resulted in a listing of "potential concern" for Ochoco Creek/Reservoir. Fish tissue mercury concentrations in Ochoco Reservoir ranged from 0.23 mg/kg to 0.79 mg/kg (median = 0.34 mg/kg). Sediment mercury concentrations ranged from 0.13 mg/kg to 0.20 mg/kg (Mercury in Oregon Lakes, 1993-1994, DEQ 1996).

In Prineville Reservoir, located in an area of known cinnabar deposits but not in close proximity to known legacy mercury mining sites, fish tissue mercury concentrations ranged from 0.06 mg/kg to 0.15 mg/kg (median = 0.34 mg/kg).

Other studies by the USFS have also documented elevated mercury levels in stream sediment from the upper reaches of Canyon Creek, a tributary of Ochoco Creek, and in sediments located in the ore processing areas of the Mother Lode Mine (located on Canyon Creek). The USFS is currently addressing these findings through a cleanup action at the Mother Lode Mine.

DEQ, EPA and USFS collaborated on a project to assess historic mines to determine if they are a source of mercury contamination in Ochoco Reservoir and Ochoco Creek, part of a statewide effort to identify, characterize and reduce inactive mines and other mercury contamination sources which may be contributing to water quality problems. The project included collecting soil and water samples from a variety of inactive mines located on public and private lands in the Ochoco Creek watershed.

One of the mines where samples were taken is the Motherlode Mine located on Canyon Creek, a tributary to Ochoco Creek. Mercury concentration data are available for water (less than 0.2 ug/L), soils (22.1 ug/g to 380 ug/g [mean = 163 ug/g]), macroinvertebrates (115.7 ng/g to 8064 ng/g [mean = 2881 ng/g]), plants (47.9 ng/g to 307.6 ng/g [mean = 130.6 ng/g]) and fish (0.323 mg/kg to 0.660 mg/kg [mean = 0.468 mg/kg]). All show measurable levels of total mercury, all but fish tissue analyses show very low levels of methylated mercury (generally less than 2% of total). In the fish tissue analyses, methylated mercury accounted for more than 80% of the total mercury present. Similar fish tissue data collected in Ochoco Creek, downstream of Canyon Creek, showed much lower mercury concentrations ranging from 0.054 mg/kg to 0.65 mg/kg (mean = 0.059 mg/kg). Sediment sampling indicated that mercury concentrations are approximately 20 times higher in samples collected at and downstream from the mine site than in the upstream samples collected near the source of Canyon Creek (Ecological Risk Assessment, Motherlode Mine).

DEQ used mercury data collected at mining and other locations in the Ochoco basin to evaluate potential environmental impacts on local and basin-wide scales. The results of the bioassessment indicated that the presence of abandoned mine lands in the Ochoco basin did not appreciably impair the biotic community in Ochoco creek. This project is ongoing. Future work is centered on factors that may influence mercury bioaccumulation within specific mining sub-basins.

Upper and Little Deschutes Subbasins. Fish tissue from Paulina and East Lakes, natural lakes located near Newberry Crater in the Little Deschutes Subbasin, was analyzed for mercury by the USFS in 1994. Fish tissue from East Lake showed elevated levels of mercury which led to a fish consumption advisory in 1994. This fish consumption advisory is the basis for the recommendation to include East Lake on the 2010 draft list of impaired water bodies in Oregon. There is also a listing of "potential concern" for aquatic life and human health in East Lake and Paulina Lake/Creek based on Table 20 values. Waters in both lakes is most likely influenced by natural geothermal sources which may be the source of the elevated mercury concentrations. Fish tissue mercury concentrations from East Lake ranged from 0.13 mg/kg to 2.84 mg/kg (median = 0.5 mg/kg). Older brown trout from the lake average mercury concentrations of 2.5 mg/kg (Mercury in Oregon Lakes, 1993-1994, DEQ 1996).

Fish tissue collected from Paulina Lake during 1994 did not show elevated levels of mercury. Observed concentrations ranged from 0.03 mg/kg to 0.06 mg/kg (Mercury in Oregon Lakes, 1993-1994, DEQ 1996).

Pesticides

Fish containing high concentrations of pesticides pose a health threat to humans and predatory wildlife that ingest fish tissue. Predatory wildlife most at risk are those predators of older, larger fish such as bald and golden eagles, both of which inhabit the Deschutes Basin.

Basin-Wide Pesticide Use (ODA PURS) in 2008 shows 333,055 lbs of pesticides applied in the Deschutes Basin including xylene (aquatic) 48,551 lbs (15%), glyphosate (herbicide) 35,931 lbs (11%), boric acid (insecticide) 35,097 lbs (11%), 2,4-D (herbicide) 41,457 lbs (12%), diuron (herbicide) 20,092 lbs (6%), and others 151,927 lbs (46%). While total pesticide usage in 2008 was somewhat lower than that recorded in 2007, the primary formulations used were similar year to year.

These compounds entered surface water systems primarily from agricultural nonpoint source runoff and atmospheric deposition. Currently, the primary sources of these compounds in surface waters are legacy deposition and continued agricultural runoff from previously treated areas.

Data are available to DEQ for surface water, groundwater, fish tissue, sediment and effluent for a variety of pesticides including DDT, carbamates, chlorinated cyclodienes and camphenes, diuron, organophosphates, and triazines. The majority of samples analyzed showed no pesticide concentrations over the detection limits. Some fish tissue samples showed measureable concentrations of DDT and its metabolites and some of the chlorinated cyclodiene insecticides.

Neither DDT nor its metabolites occur naturally to any appreciable extent in the environment (Harrison, 2001). All sources of these compounds are anthropogenic. DDT was used extensively in the United States prior to the 1970's. Its use was discontinued due to their potential negative effects on humans and wildlife. DDT is considered probable carcinogens in humans (US EPA, 1991a, 1992c, 1994c). The use of DDT in the US has been banned since 1972. Chlorinated cyclodienes are also man-made, chlorinated insecticides; popular for crops like corn and cotton from 1950 to 1970. Because of concerns about damage to the environment and the potential harm to human health, use of chlorinated cyclodiene insecticides were restricted during the 1970's (ATSDR, 2001; NTP, 2001).

Neither t-DDT nor chlorinated cyclodienes are highly water-soluble. However, these compounds commonly adsorb onto suspended particles within the water system where they can be deposited on stream, lake and reservoir bottoms and then become re-suspended and transported in a cyclic fashion dependant on flow volume and velocity. Aquatic organisms, especially bottom-feeding species such as suckers, are vulnerable to the bioaccumulation of these compounds.

Organochlorine pesticide transport and deposition are, in most cases, directly correlated with the transport and deposition of sediment and organic matter (Clark and Maret, 1998; Maret, 1995a and 1995b; Maret and Ott, 1997; Rinella et al., 1994). As these compounds are no longer in use today, the transport and delivery of pesticides adsorbed to entrained sediment and organic material in the Deschutes Basin is the most likely source of continued loading to surface waters within the Basin.

Water quality targets or guidance are not available for the vast majority of commonly used pesticides at either a state or federal level. The State of Oregon is actively working to address this concern. Where water quality criteria are available, they are identified in the US EPA toxics rule and DEQ Table 20 (http://www.deq.state.or.us/wq/rules/div041/table20.pdf). The US EPA action level for fish tissue DDT (1.0 mg/kg) was established to address the combination of DDT and its metabolites (known as total or t-DDT). The US EPA action level for fish tissue chlorinated cyclodienes has been established at 0.1 mg/kg (chlordane, endrin, and dieldrin). The water quality targets established for these pesticides by the State of Oregon are based on US EPA guidance values (National Toxics Rule and Table 20) (EPA FRL-OW-6186-6a) (Water Quality Criteria 1972 (National Academy of Sciences and National Academy of Engineering, 1973)).

Water Quality Status. There are presently no 303(d) listings of impairment for pesticides in the Deschutes Basin, although the Deschutes River, Dry Creek, Shitike Creek, and Trout Creek all carry a listing of insufficient data relative to pesticide concentrations in the assessment database. No fish consumption advisories for pesticides are currently in place.

Groundwater Conditions

There are fewer data available to assess groundwater conditions than there are for surface water. For this status report, we tried to identify conditions or activities that could change either: (1) the amount or timing of groundwater flow, or (2) groundwater quality (i.e., chemistry or temperature) that could adversely affect human health or the environment. For example, groundwater withdrawals can decrease the amount or alter the timing of water available to other wells, springs, or surface water bodies. Similarly, waste disposal or chemical application can degrade groundwater quality.

Threats to groundwater *quantity* include:

- High capacity wells for municipalities, agriculture, and industry.
- High density of small capacity wells
- Diversion of surface water and consumptive use for irrigation

Threats to groundwater *quality* include:

- Large volume or high density of septic systems, especially in areas with shallow water table
- Use of fertilizer and pesticides
- Land application of wastes (biosolids, food processing wastewater, pulp and paper waste, animal rendering waste)
- Wastewater treatment facilities
- Landfills
- Chemical spills from gas stations, dry cleaners, airports, military bases
- Mines and smelting/refining waste (heavy metals)
- Underground injection of stormwater or wastewater
- Dairies and feedlots (nutrients)
- Leaking underground storage tanks (petrochemicals)

Groundwater Quantity

Groundwater issues in the Deschutes Basin were introduced in the Water Resources section of the Basin Description in this Status Report. As was mentioned, the USGS conducted a study of the groundwater system of the upper Deschutes Basin to develop a quantitative understanding of the regional hydrology and provide tools to allow resource managers and basin residents to evaluate the possible effects of various development scenarios. The study was conducted in cooperation with OWRD; the Cities of Bend, Redmond, and Sisters; Deschutes and Jefferson Counties; and CTWS. The study resulted in five USGS publications as well as several abstracts and other miscellaneous publications. The following website provides a summary of the project and links reports and abstracts that came out of the study: http://or.water.usgs.gov/projs_dir/deschutes_gw/index.html

Concerns have been raised about the cumulative effects that groundwater pumping and/or lining of canals in the Upper Deschutes Subbasin will have/is having on spring/stream flows in the Deschutes River between Bend and Lake Billy Chinook (middle Deschutes), the lower Crooked River, and lower Whychus Creek. Increased pumping or lining of canals could affect the lower portions of these rivers by decreasing the amount of groundwater appearing as springs, which could affect both water quantity and quality in the rivers. An interagency (DEQ, ODFW, BLM, OWRD) group had several meetings over the last couple of years trying figure out how to assess the value of these spring complexes. A draft needs assessment was written by this group, although the document has not been finalized or implemented.

In response to proposed destination resorts, private consultants have utilized existing models to evaluate the impact of increased groundwater withdrawals on springs along the Middle Deschutes River and Whychus Creek (Yinger and Salminen 2009; Yinger and Strauss 2008). These evaluations have included an assessment of the impacts on stream temperatures with the reduction in spring flow, based on the USGS groundwater models and the Heat Source temperature models developed for the Deschutes River and Whychus Creek.

Additional concerns have been raised about the interaction of surface water and groundwater in the Deschutes Basin. Based on the studies which have been done, we know that there is a strong relationship between the two. However little work has been done to assess the degree to which groundwater can contaminate surface waters or vice versa.

The cumulative effects of increased groundwater withdrawals and groundwater/surface water interactions have been identified as a Priority Focus Area in this iteration of the Deschutes WA. See the Action Plan for more information.

Groundwater Quality

Public and private drinking water supply are the beneficial uses most sensitive to contamination of groundwater. However in some situations where groundwater has the potential to reach surface waters, groundwater contamination can also affect other beneficial uses as described above for each parameter in the surface water section.

DEQ published a report (referred to in this section as the Groundwater Quality Report) in 2006 summarizing groundwater quality information for the Deschutes Basin (Cole 2006 http://www.deq.state.or.us/lab/techrpts/groundwater/DeschutesBasinGW.htm). The report evaluated data through 2005 obtained from: the Real Estate Transaction Domestic Well Testing program (http://www.oregon.gov/DHS/ph/dwp/dwt.shtml), the Oregon DHS Drinking Water Program database (data for public systems which can be accessed on-line at http://170.104.63.9/), DEQ groundwater studies in the Prineville and La Pine areas, DEQ groundwater studies adjacent to four landfills in the Basin, and information from DEQ's Environmental Cleanup Sites Information (ECSI) database and Leaking Underground Storage Tanks (LUST) database. The groundwater studies are described below.

Prineville Groundwater Study (1993). As part of its ambient groundwater quality monitoring program, DEQ collected water quality samples from 17 private, domestic wells around Prineville in the summer of 1993. The samples were analyzed for a full suite of constituents, including Volatile Organic Compounds (VOCs), pesticides, metals, common ions, nutrients, and physical parameters.

The Lower Crooked River Watershed Assessment (Nielsen-Pincus 2008) identifies the area around Prineville as being particularly susceptible to groundwater contamination because high water tables exist in the most populated portions of the watershed around Prineville, Lone Pine and along valley bottoms in general. The Assessment suggests that a more thorough investigation of groundwater in the Lower Crooked River assessment area is needed to better understand the human health risks.

Southern Deschutes County/Northern Klamath County Groundwater Studies (1978-present). A shallow alluvial aquifer provides drinking water for an area in southern Deschutes County and northern Klamath County near La Pine. The majority of the residents get their drinking water from wells less than 100 ft deep. Most homes in the area also use on-site wastewater disposal systems. Ground-water sampling in studies done in 1978-1979 and 1993 revealed elevated concentrations of nitrate in some private domestic wells, raising concern for the vulnerability of the ground-water resource. In response to the need for a better scientific understanding of the movement, fate, and transport of nitrogen in groundwater in this area, DEQ and Deschutes County contracted with the USGS to conduct additional monitoring and modeling studies in this area. Copies of the USGS reports are available from their website: http://or.water.usgs.gov/projs_dir/or186/. More information about the groundwater protection program in this area is provided below in the Section on Nitrates.

Landfill Studies. Groundwater and leachate monitoring data have been collected from four landfills in the Deschutes Basin: Crook County Landfill near Prineville, Knott Pit Landfill in Bend, Southwest Landfill between Sunriver and La Pine, and Box Canyon Landfill in Jefferson County. DEQ's Groundwater Quality Report and recent information from DEQ staff (Lee Huckins, personal communication) provides a following summary of contamination issues:

- Crook County Landfill. Monitoring wells and leachate had detectable levels of nitrates, barium, beryllium, chromium and cooper. All detections were below drinking water standards.

- Knott Pit Landfill. Monitoring wells (five) had detectable levels of nitrates, barium, chromium, cadmium, cooper, and lead. One well had chromium and lead levels over drinking water standards and one well had chromium levels over the standard.
- Southwest Landfill. Groundwater samples have been analyzed since 1976 and the following detections were observed: antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nitrates, VOCs. One well had arsenic levels over the drinking water standard and one had antimony levels over the standard. The DEQ Solid Waste Program referred the landfill to the DEQ Cleanup Program to evaluate the nature and extent of groundwater contamination. As a result of this study, the landfill was closed in 2006. Monitoring continues at the site.
- Box Canyon Landfill. This landfill was reported as closed in the Groundwater Report. Contaminants of concern at the site include perchloroethylene, trichloroethane, and their degradation products. Monitoring continues at this site.

Environmental Cleanup Site Information and Leaking Underground Storage Tanks. The information presented in the Groundwater Quality Report for these two programs includes data through 2001-2004. These data need to be updated to provide a picture of current groundwater contamination in the basin. One area of ongoing concern is leaking underground storage tanks in the Prineville area. DEQ began an area-wide investigation of petroleum sources in 1997, identifying several leaking tanks of concern. The groundwater report identifies that both DEQ and Prineville have been involved with remediation activities for this area. Benzene was the primary contaminant of concern.

It should be noted that the Groundwater Quality Report includes a small portion of land near Biggs and Rufus which does not drain to the Deschutes Basin, but rather drains to the Columbia. This area is not included in the WA, so some of the summary statistics may not be accurate for the WA, but should be fairly close. It should also be noted that the Groundwater Quality Report summarized data for 373 public water systems in the Deschutes Basin which rely on groundwater, whereas recent data (2000-2009) from the Oregon Public Drinking Water Protection Program indicate that there are 253 public water systems. Further research is needed to investigate this discrepancy. The most recent data from 2000-2009 are summarized in this Status Report.

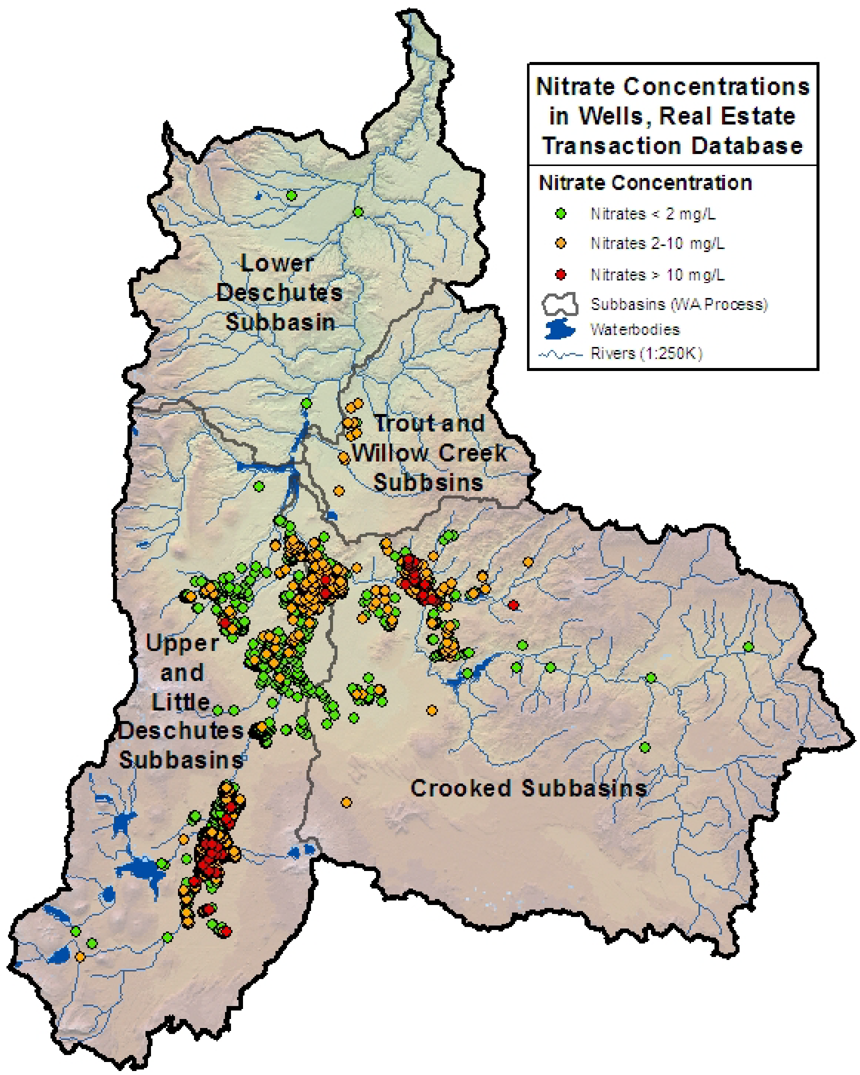
The following summary of groundwater conditions in the Deschutes Basin evaluates data from the DEQ Groundwater Report, the more recent data from the Public Drinking Water database (2000-2009), more recent data from the Real Estate Transaction database (1989-2009), and information from stakeholders. This summary provides a limited update of the 2006 Groundwater Report. A more comprehensive update, particularly as related to toxics is still needed. Groundwater contaminants which have been identified in Deschutes Basin groundwater are: nitrates, bacteria, fluoride, arsenic, nickel, antimony, chromium, lead, thallium, tetrachloroethylene, dichloromethane, xylenes, hexachlorobenzene, pentachlorophenol, di(2-ethylhexyl) phthalate, 1,2-dichloroehtane and glyphosate.

Four public water systems served by groundwater have closed or modified a well due to contamination. These include Ochoco West Water District, Idleway Improvement District, and Arts Place in Prineville due to arsenic; and Redmond Tallow in Redmond due to nitrate. Ochoco West Water District also had issues with coliform. All four systems are located in the Crooked Subbasins in the vicinity of Prineville or Prineville Reservoir. DEQ's Drinking Water Source Monitoring Project includes collecting groundwater and surface water samples from high-risk drinking water sources. As part of this project, DEQ Laboratory staff have collected groundwater samples for Avion Water System (Bend) in 2008 and 2009. The list of analytes includes Oregon-specific herbicides, insecticides, pharmaceuticals, volatile organic compounds, fire retardants, PAHs, and plasticizers. There were no confirmed detections in Avion's source water.

Nitrates

The drinking water criterion (also called the maximum contaminant level, or MCL) for nitrate-nitrogen is 10 mg/L, although nitrate levels above 2 mg/L usually indicate anthropogenic activities (ODHS 2001, http://oregon.gov/DHS/ph/dwp/docs/fact/nitrate.pdf), and have adversely affected the groundwater. Area-wide concentrations of greater than 7 mg/L can trigger the declaration of a Groundwater Management Area (GWMA). There have been no declarations of GWMAs in the Deschutes Basin. Nitrate sources include dispersed non-point sources such as agricultural activities and on-site septic systems, and point sources generating nutrient rich waste products.

Water Quality Status. Nitrate contamination of groundwater is found in the Deschutes Basin. Elevated nitrate levels have been found at scattered locations around the Deschutes Basin, particularly in the Prineville and La Pine areas. The area around Redmond was also identified as an area of potential concern in the DEQ Groundwater Report. The adjacent map shows the distribution of nitrate data in wells from the Real Estate Transaction database (1989-2009), which highlights these geographic areas of concern. In addition, stakeholders have indicated elevated nitrate levels in wells in Sherman County and in springs in Jefferson County.



Nitrate contamination of groundwater been identified as a Priority Focus Area in this iteration of the Deschutes WA. See the Action Plan for more information. The following list provides a summary of what is currently known about nitrate contamination of groundwater in the Deschutes Basin.

- The public drinking water database reported 20 systems (7.9%) with concentrations above the "action level" (defined as ½ of the MCL), with four of these systems (1.6%) at or exceeding the MCL of 10 mg/L. The public drinking water system at Redmond Tallow (Lower Crooked Subbasin) was closed because of high nitrate levels. The high nitrate levels in the groundwater at this site are due to contamination from a now closed WPCF permit for the Redmond Tallow facility. Although the facility is closed, there is apparently still groundwater contamination at the site.

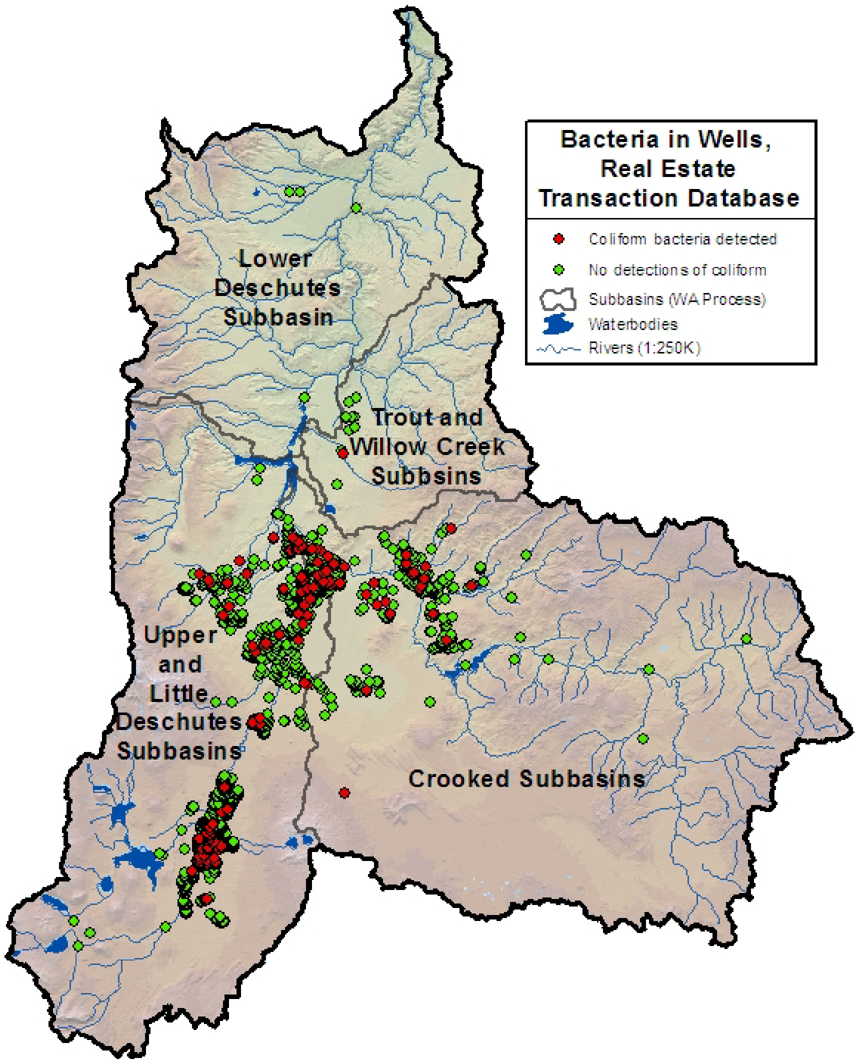
- The Real Estate Transaction database reported 59 samples (1.7%) with concentrations greater than 10 mg/L and 817 samples (22.9%) with concentrations between 2-10 mg/L. (It should be noted that the Real Estate Transaction database summary reports number of samples, some of which could represent multiple samples taken from the same well).
- There has been nitrate contamination of groundwater associated with several WPCF-permitted facilities in the Basin. Although a comprehensive investigation of this issue has not yet been done, DEQ permit staff have identified groundwater nitrate contamination associated with two known facilities in the Deschutes Basin: the Redmond Tallow facility (GEN 14B permit for disposing of wastewaters associated with food/animal processing) near Redmond (which is now closed) and the City of Gilchrist individual WPCF permit for domestic wastewater treatment.
- ***Lower Deschutes Subbasin***. The OSU Extension Service in Sherman County conducted well water testing in Sherman County in 1993 (46 wells) and 1999 (41 wells). In both years, concentrations above the action level of 10 mg/L were observed: Sixteen wells (35%) exceeded 10 mg/L in 1993 and 18 wells (44%) exceeded this limit in 1999. In both years, the maximum concentration observed was greater than 40 mg/L. The Extension Service has been interested in repeating this study again, but has been unable to secure funding. Note: the well testing by Sherman County was county-wide and was broader than just the Lower Deschutes Subbasin.
- ***Trout Creek and Willow Creek Subbasins***. Sampling conducted by PGE around the Pelton Round-Butte Project during the 1990s indicated elevated levels of nitrate at the mouth of Willow Creek. Further study revealed that the source of the elevated nitrates came from springs in lower Willow Creek (Lewis 2003). Elevated nitrates were also seen in springs feeding to Campbell Creek and Mud Springs Creek. In an attempt to understand the sources of this nitrate (legacy or current practices), the Jefferson SWCD and ODA embarked on a more comprehensive study to assess nutrient and bacterial sources and distribution in the Agency Plains area (Hammond and Roofener 2007; Hammond & Roofener 2008; Hammond & Roofener 2010). The work done to date indicates that nitrate concentrations are higher in groundwater of agricultural areas (1-8 mg/L nitrate-N) than in non-agricultural areas. Nitrate sources may be either fertilizer or livestock manure. The SWCD and ODA are interested in continuing their studies in this area, with one of their goals being to better determine the age and source of nitrates in the groundwater around Agency Plains through further analysis of water samples and modeling of groundwater flow paths.
- ***Crooked Subbasins***. As described above, a groundwater study was done in the Prineville area in 1993. Nitrate concentrations were greater than 10 mg/L in five of the 17 wells (29%) sampled. Sixty-five percent of the wells had nitrate levels at or above 2 mg/L. Elevated nitrate levels are also found in domestic wells from the Real Estate Transaction database in the area around Prineville. The DEQ Groundwater Report does not indicate whether source assessments were done to determine the cause of the elevated nitrate in groundwater in this area. Stakeholders have indicated a concern about nitrate contamination around Prineville because of high water tables in this area. This is especially a concern where residents are not serviced by public water and sewer systems. Many residents in this area have shallow wells and septic systems. The Lower Crooked River Watershed Assessment (Nielsen-Pincus 2008) also identified high nitrogen fertilizers used in crop and livestock production as another potential source of nitrate contamination.
- ***Upper and Little Deschutes Subbasins***. Based on groundwater studies done in southern Deschutes and north Klamath Counties, DEQ, the USGS and Deschutes County have determined

that the safety of the groundwater in this area is threatened by nitrate contamination from traditional onsite septic wastewater treatment systems. To protect the quality of the drinking water in the aquifer, Deschutes County passed an ordinance in 2008 requiring upgrades on all septic systems; voters overturned the ordinance in a special election in March 2009. Deschutes County has asked DEQ to take the lead to resolve the issue. In July 2010, DEQ assembled a steering committee of community members to discuss and make recommendations to improve groundwater protection in South Deschutes and North Klamath counties. More information about this groundwater protection program is available from the DEQ website: http://www.deq.state.or.us/wq/onsite/sdesch-nklam.htm.

There are also concerns about the possible effects of groundwater nitrate on surface waters. USGS did some studies looking at redox potential along the riparian zone (Hinkle et. al. 2007). DEQ will be evaluating the groundwater-surface water relationships in this area during TMDL development.

Bacteria

For surface waters, *E. coli* bacteria (a type of fecal coliform bacteria) are used as the indicator organisms for assessing impairment. For drinking water sources, the presence of any type of coliform bacteria is considered indicative of possible impairment. The presence of coliforms in drinking water suggests microbiological contamination of the source water or contamination from the water distribution system. Positive groundwater bacteria detections may indicate contamination from non-point sources, including on-site septic systems, or point sources, including facilities handling or disposing of septage or manure.



Bacteria from well water can also be due to poor well construction and maintenance practices. ODHS has prepared a fact sheet which provides more information about bacterial contamination of drinking water (ODHS 2002b, http://oregon.gov/DHS/ph/dwp/docs/fact/colibact.pdf.)

Water Quality Status. Bacterial contamination of groundwater is found in the Deschutes Basin. The adjacent map shows the distribution of coliform bacteria data in wells from the Real Estate Transaction database (1989-2009). The following provides a summary of what is currently know about bacterial contamination of groundwater in the Deschutes Basin:

- The public drinking water database reported 75 systems (29.6%) with detectable concentrations of total coliform bacteria. If total coliform is detected in a sample, the sample is re-run for either fecal coliform or E. coli. All of the follow-up samples since 2003 have been for *E. coli*. If a system continues to have positive test for total coliform, even if *E. coli* is not present, this indicates a problem with the treatment or distribution system and requires action to remedy it. Of the 75 systems which re-sampled, eight systems (3.2%) had detections for *E. coli* bacteria. The Ochoco West Water System (Lower Crooked Subbasin) has had water quality issues with both arsenic and coliform, which has caused them to modify their system. Due to the presence of arsenic in one of their wells, they switched over to suing a spring water source in 2009. Since that switch, there have been some coliform detections, causing them to evaluate additional treatment options.
- The Real Estate Transaction database reported 215 samples (3.8%) with detectable concentrations of fecal coliform, total coliform or *E. coli*. (It should be noted that the Real Estate Transaction database summary reports number of samples, some of which could represent multiple samples taken from the same well).
- Bacteria were also sampled in the well testing done by OSU Extension in Sherman County in 1993 and 1999 (see discussion above under the section on groundwater nitrate). There were no detections of E. coli found in either sampling event, although there were detections of coliform bacteria. The Extension Service reported that the coliform issue was solved by moving livestock further away from the well head.

To the best of our knowledge, source assessments for the causes of these bacteria detections have not been conducted, with the exception of the Sherman County surveys.

Pesticides

Elevated levels of pesticides in groundwater can pose human health risks. General information about pesticides in drinking water can be found on the Oregon State University Website: http://www.npic.orst.edu/factsheets/drinkingwater.pdf. There is very little information available about pesticides in groundwater in the Deschutes Basin. A more comprehensive evaluation of data in the DEQ LASAR database might provide additional information, but generally not much sampling of pesticides in groundwater has been conducted to date.

Water Quality Status. The following provides a summary of what is currently known about pesticide contamination of groundwater in the Deschutes Basin:

- The public drinking water database reported one (0.4%) system with detections of glyphosate which exceed the program's level of concern, which is defined as any detection. The MCL for this pesticide is 0.7 mg/L and the sample did not exceed the MCL. The system is located in the Upper Deschutes Subbasin.

Volatile Organic Compounds (VOCs) and Synthetic Organic Compounds (SOCs)

The presence of VOCs and SOCs in groundwater can pose human health risks. Fact sheets about the health risks of some of these are contaminants are available from the Oregon DHS website: http://oregon.gov/DHS/ph/dwp/tools.shtml. There is very little information available about the presence of these contaminants in groundwater in the Deschutes Basin; however a more comprehensive evaluation of data from DEQ's LASAR database and from DEQ's Solid Waste, Hazardous Waste and Cleanup Programs is needed.

Water Quality Status. The following provides a summary of what is currently known about VOC and SOC contamination of groundwater in the Deschutes Basin:

- The public drinking water database reported six (2.4%) systems with detections of VOCs or SOCs which exceed the program's level of concern, which is defined as any detection of the compound. The compounds which have been detected are:
    - Dichloromethane (one system),
    - Tetrachloroethylene (two systems),
    - Xylenes (one system),
    - Hexachlorobenzene (one system),
    - Pentachlorophenol (one system),
    - Di(2-Ethylhexyl) Phthalate (two systems)

  MCLs do not exist for all of these compounds, but where they do exist, the concentrations measured did not exceed the MCLs. Of the six systems, five are located in the Upper Deschutes Subbasin and one is located in the Lower Crooked Subbasin.

- VOCs and or SOCs have been detected in groundwater near the Southwest and Box Canyon landfills and in association with leaking underground storage tanks. Summaries of this information are provided earlier in this section and in the Deschutes Groundwater Quality Report.

Arsenic

Elevated levels of arsenic in drinking water are fairly common throughout Eastern Oregon as the result of natural geologic arsenic occurring in rocks and geothermal waters. More information about arsenic and its effects on human health are available from ODHS (2002a, http://oregon.gov/DHS/ph/dwp/docs/fact/arsenic.pdf).

The drinking water criterion (also called the MCL) for arsenic is identified in Oregon State Standards as 0.05 mg/L. EPA has identified 0.01 mg/L as the maximum concentration of arsenic allowed in drinking water. The State of Oregon is currently in the process of revising their water quality criteria for arsenic and is proposing to change the MCL to 0.01 mg/L. Information on this proposed criteria change can be found at: http://www.deq.state.or.us/wq/standards/toxics.htm.

Long-term exposure to high concentrations of arsenic in drinking water has been linked to cancer and to cardiovascular, pulmonary, immunological, neurological, and endocrine (e.g., diabetes) effects in humans.

Water Quality Status. Arsenic is found in Deschutes Basin groundwater at concentrations higher than the drinking water criterion. The following provides a summary of what is currently known about arsenic contamination of groundwater in the Deschutes Basin:

- The public drinking water database reported 17 systems (6.7%) with detections of arsenic which exceed the program's level of concern, which is defined as ½ of the MCL identified by EPQ for drinking water (0.01 mg/L) for this metal. Of these 17 systems, four of them were at or above the

MCL. All four of these systems were in the Crooked Subbasins (two in the Upper Crooked Subbasin and two in the Lower Crooked Subbasin). Of these four, two of the systems with the most frequent exceedances of the criterion (Ochoco West Water District and Idleway Improvement) have made modifications to their systems. One other system, Arts Place in Prineville, has been closed due to arsenic concerns.

- Two systems in the real Estate Transaction database were reported as having detectable levels of arsenic. Only one of the detections (0.1% of samples collected) was above the MCL. This system was located south of Bend.
- Drinking water from wells in the Simnasho area of the Warm Springs Reservation has exceeded drinking water criteria for arsenic since 2006. Since May, 2007, residents have been drinking bottled water while the tribes worked to lower the arsenic levels (Dake 2010). In the past year, officials have identified an arsenic-free water source about five miles from the Simnasho area. The Tribe is working with EPA on the finding a new water source for this community system.

Nickel

The primary source of nickel in drinking water is leaching from metals in contact with drinking water, such as pipes and fittings. However, nickel may also be present in some groundwater as a consequence of dissolution from nickel ore-bearing rocks. Nickel is used principally in its metallic form combined with other metals and nonmetals as alloys. According to EPA, nickel has not been found to cause health effects from acute exposures at levels above the MCL, although nickel does have the potential to cause the following health effects from long-term exposures at levels above the MCL: decreased body weight; heart and liver damage; dermatitis. More information about nickel is available from EPA: http://www.epa.gov/safewater/pdfs/factsheets/ioc/tech/nickel.pdf.

Water Quality Status. The following provides a summary of what is currently known about nickel contamination of groundwater in the Deschutes Basin:

- The public drinking water database reported one (0.4%) system with detections of nickel which exceed the program's level of concern, which is defined as ½ of the MCL (0.1 mg/L) for this metal. This sample did not exceed the MCL. The system is located in the Lower Crooked Subbasin.
- Nickel is not a routine analysis for sampling done through the Real Estate Transaction monitoring program. This metal was sampled in four wells during the time period 1989-2009, with all samples collected between 2000 and 2002. Two of the samples exceeded the MCL. Both wells were located in the greater La Pine area of the Little Deschutes Subbasin.

Lead

Lead is a naturally occurring element that is found in the earth as a trace constituent in soil, rocks and minerals. Lead is seldom found in natural waters, but it frequently enters drinking water supplies by dissolving from piping, fittings, joining materials, and fixtures in water supply systems. Usually the only source of lead in a drinking water system is household plumbing. In its dissolved state (ionic form) lead is invisible, odorless and without taste in water. More information about lead and its effects on human health are available from ODHS (1993, http://oregon.gov/DHS/ph/dwp/docs/fact/lead.pdf).

The US EPA has adopted an action level for lead in public water systems. This national "action level" is 0.015 mg/L. This is a very protective standard and is aimed at protecting pregnant women and small children, the most susceptible people in our population.

Water Quality Status. The following provides a summary of what is currently known about arsenic contamination of groundwater in the Deschutes Basin:

- Lead was not detected in any systems in the public drinking water database for the period 2000-2009.
- Lead is not a routine analysis for sampling done through the Real Estate Transaction monitoring program. This metal was sampled in three wells during the time period 1989-2009. None of the samples exceeded the MCL (0.015 mg/L).

Fluoride

Fluoride compounds are salts that form when the element, fluorine, combines with minerals in soil or rocks. Many communities add fluoride to their drinking water to promote dental health; however exposure to excessive consumption of fluoride over a lifetime could lead to health issues. Some people who drink water containing fluoride in excess of the MCL (4.0 mg/l) over many years could get bone disease, including pain and tenderness of the bones. Fluoride in drinking water at half the MCL (2.0mg/l) or more may cause mottling of children's teeth, usually in children less than nine years old. Mottling, also known as dental fluorosis, may include brown staining and/or pitting of the teeth, and occurs only in developing teeth before they erupt from the gums. More information about fluoride in drinking water is available from EPA: (http://water.epa.gov/drink/contaminants/basicinformation/fluoride.cfm).

Water Quality Status. The following provides a summary of what is currently known about presence of fluoride in groundwater in the Deschutes Basin:

- The public drinking water database reported two (0.8%) systems with detections of fluoride which exceed the program’s level of concern, which is defined as ½ of the MCL (4 mg/L) for this metal. These samples did not exceed the MCL. Both systems were located in the Crooked Subbasins (one in the Upper Crooked Subbasin and one in the Lower Crooked Subbasin).

SUMMARY OF WATER QUALITY RESOURCE CONCERNS BY GEOGRAPHIC AREA

The following flags summarize the status of surface and ground water related resources in the Deschutes Basin as identified through existing data or information, knowledge of DEQ staff or stakeholders. They should not be construed as a prioritization of concerns or focus areas and will be updated as the stakeholder process continues.

Status Summary for Surface and Ground Water Related Resources in the Deschutes Basin

Surface Water	**Bacteria**	**Harmful Algae Blooms**	**Temperature**	**Total Dissolved Gas**	**Nutrients, DO, pH Chlorophyll *a***	**Altered Hydrology**	**Habitat Modification**	**Sediment / Turbidity**	**Toxics: Emerging Contaminants Pharmaceuticals PCPs**	**Toxics: Metals**	**Toxics: Arsenic**	**Toxics: Mercury**	**Toxics: Pesticides**
Little Deschutes													
Upper Deschutes													
Beaver-South Fork													
Lower Crooked													
Upper Crooked													
Trout Creek													
Willow Creek													
Lower Deschutes						tribs	tribs	tribs					

Ground Water	**General Quality**	**Quantity**	**Nitrate**	**Bacteria**	**Pesticides**	**Volatile and Synthetic Organic Compounds**	**Arsenic**	**Nickel**	**Lead**	**Fluoride**
Little Deschutes										
Upper Deschutes										
Beaver-South Fork										
Lower Crooked										
Upper Crooked										
Trout Creek										
Willow Creek										
Lower Deschutes										

	Generally poor condition, substantial concern for water quality
	Deteriorating condition, moderate concern for water quality
	Generally good condition, not an urgent concern for water quality
	Unknown condition or lack of data

SUMMARY OF IMPLEMENTATION EFFORTS IN THE BASIN

Point Source Efforts

There are currently 172 NPDES and WPCF permits in the Deschutes Basin. The majority of these are administered by DEQ, although 15 of these are CAFO permits administered by ODA. DEQ Regional permitting staff issue permits on a Basin schedule and will continue to do so. DEQ permitting staff are also coordinating a stakeholder process of community members to discuss and make recommendations to improve groundwater protection in South Deschutes and North Klamath counties. Further information about point source activities is provided in the Action Plan.

Nonpoint Source Efforts

Restoration and pollutant reduction projects within the Deschutes Basin have been undertaken by a variety of agencies, entities and stakeholders. While the following is not an exhaustive list, individual projects include the following practices:

- Irrigation system/delivery upgrades
- Flood to sprinkle conversions
- Field/ditch erosion control measures
- Forest practices act measures/practices
- Irrigation management upgrades
- Irrigation pumpback systems
- River channel/streambank/shoreline erosion controls and restoration
- Riparian fencing
- Sediment pond settling and removal of sediments
- Nutrient and grazing management plans
- Stormwater management and treatment
- Surface erosion controls
- Flow augmentation measures
- Water conservation measures
- Water development
- Fish passage
- Large wood placement
- Wetland construction/enhancement
- Weed management and control

Many resource-related implementation and restoration activities have been completed in the Deschutes Basin and many more are in progress or planned. Project work is proceeding in all categories of nonpoint source management and land use activities. Specific goals are being set to reduce nitrate and bacterial contamination of ground-water sources. Many of these efforts will have immediate beneficial results; others will several years after completion before they are able to operate at full efficiency.

Improved grazing, cropping and water management practices have been combined with approved BMP to reduce pollutant loading to surface waters within the Basin. Nutrient management plans are in place or in progress in many areas. Several irrigation districts and canal companies have made a commitment to meeting water quality standards in irrigation waters discharged to basin streams. Created wetlands and riparian fencing have been constructed to reduce nutrient loadings and the associated algal growth and decreased dissolved oxygen. Many local producers are working with NRCS and ODA to improve cropping and stock management practices and to enroll lands in conservation programs.

The management practices outlined in the Forest Practices Act (FPA) actively reduce the impact of logging and other use practices in riparian corridors and similarly sensitive areas. Application of these practices on both public and private forested lands has resulted in reduced sediment, nutrient and other pollutant loads being generated and transported within forested systems. Additionally, these practices act to preserve and enhance riparian areas that act as buffers for stream channels in degraded areas, further reducing the potential for pollutant transport to surface waters in the Deschutes Basin.

Stormwater management plans are in place or pending in the cities of Bend, Madras, Prineville and other municipalities that discharge directly or indirectly to surface waters. These plans target specific projects and practices to reduce stormwater-based pollutant loads. In several cases substantial progress has been made and positive trends have been documented in overall loading. Septic and wastewater treatment upgrades have been completed, are in progress, or are planned in many areas of the watershed.

Recreational facilities have been upgraded or are planned for upgrades in several areas of the Upper Deschutes River. Restroom facilities have been improved in high use campground and boat ramp areas and have been installed in other less-used areas that previously did not offer facilities. Pumpout and dump facilities are provided in areas of high use, and public participation in proper disposal of waste materials has increased.

There are also other basin-wide efforts underway to improve both low summer stream flows and low winter flows below dams. Much of this work in the upper basin (above Lake Billy Chinook) has been coordinated through the Deschutes River Conservancy (DRC) in cooperation with the irrigation districts. The Deschutes Water Alliance (DWA) was formed in 2004 to plan for long term water resource management in the Deschutes Basin. The vision of the DWA is that uses of water resources in the Deschutes Basin are balanced to serve and sustain agriculture, urban and ecosystem needs. The Deschutes Water Alliance is comprised of the following stakeholders:

- **The Deschutes Basin Board of Control (DBBC):** an association of irrigation districts that includes North Unit, Central Oregon, Swalley, Tumalo, Three Sisters, Arnold, and Ochoco.
- **The Confederated Tribes of Warm Springs (CTWS):** focused on managing resources as sustainable assets available for cultural, subsistence, economic and social purposes
- **Deschutes River Conservancy (DRC):** a non-profit organization with a mission to restore streamflow and improve water quality in the Deschutes Basin
- **Central Oregon Cities Organization (COCO):** includes representatives from the cities of Bend, Culver, Madras, Maupin, Metolius, Prineville, Redmond, and Sisters

In 2006, the DWA published a series of six reports, outlining key water resource findings. This information was presented at a Deschutes Basin Water Summit, held in May, 2006. The reports are available at the following web location:
http://www.deschutesriver.org/News_and_Reports/Water_Summit/default.aspx

It should be recognized that current data may not reflect the full extent of the water quality improvements that may be realized through these projects. Data collection and evaluation must therefore be an integral part of the overall WA process for water quality improvements within the mainstem and/or tributary systems.

It is envisioned that in the final version of the Deschutes WA, a comprehensive listing of implementation efforts (including both on-the-ground project activities and assessment activities) will be compiled. This listing will used to identify the monitoring that is occurring in the Basin relative to implementation and assessment activities AND to provide contact and monitoring content information so that those needing access to the these data will have information on where to go and who to contact. This list will be updated with each iteration of the WA until such a time as a central clearing house for data is available.

DESCHUTES BASIN ACTION PLAN

INTRODUCTION

The actions and priorities described in this document were drawn together through input from DEQ and other agency staff and from stakeholders and citizens of the Deschutes Basin. This stakeholder process is not complete and additional communication and exchange will be required to finalize this document. Every citizen and interested party in the Basin is encouraged to become involved in implementing the Action Plan to help restore the health of the streams. Initial stakeholder meetings were conducted to distribute information, gain feedback, and solicit participation in smaller forums. The stakeholder meeting groups were comprised of local stakeholders and representatives from each of the subbasin areas (as discussed in the Introduction). Varied opinions were voiced throughout the stakeholder meetings regarding the WA process. Additional stakeholder interaction is desired. These initial meetings were envisioned as a first step in the WA process which would be extended to a much broader group of stakeholders. Due to time and resource constraints, these further meetings have not yet been held.

Input from the stakeholder meetings, together with available data and information and the expertise and knowledge of the Basin furnished by DEQ staff, provided the basis for preliminary decisions about prioritization.

The cornerstone of a successful action plan in the Deschutes Basin is cultivating public involvement and education as well as encouraging commitment and partnerships between the citizens in the watershed and government agencies in order to attain the water quality goals. To this end, throughout the final prioritization process, major emphasis should be placed on discussing best management practices (BMPs), BMP specifications, locations of control measures, education, technical assistance, and funding.

Priority focus areas have been identified for permitted point sources, surface water quality, groundwater quality, and DEQ sub-program resources which encompass the most significant resource concerns in the Deschutes Basin, for which urgent action is required. The priorities in each of these four focus areas are listed in the following table.

FOCUS AREAS AND PRIORITY ACTIONS FOR THE DESCHUTES BASIN	
Focus Area	Priority Issues and Concerns
Permitted point sources	UIC program assessment, revisions and updates Further evaluation of water quality impacts of permits
Surface water quality	Temperature Flow (altered hydrology) Sediment Habitat Harmful Algae Blooms Toxics (mercury and arsenic)
Groundwater quality	Nitrate Groundwater/surface water interactions and withdrawals
DEQ-specific coordination, outreach and data-related resources actions	DEQ Sub-program coordination DEQ database management Interagency Coordination Public Education and Stakeholder Outreach

The priorities identified here are preliminary in nature and do not represent the full level of stakeholder input that this WA process will have at completion. DEQ continues to welcome comment on what it should consider the highest priority basin-wide and localized issues in each focus area, and also on how to address these issues to maximize results.

The actions detailed by this plan reflect a start to the process of restoring natural resources to full support in the Deschutes Basin but are by no means an exhaustive list. DEQ will continue to encourage new ideas and possible remedies to known resource concerns. DEQ also looks forward to continuing its existing relationships with federal and local agencies, as well as forming unique public-private partnerships with citizen groups and landowners throughout the Deschutes Basin to implement both the actions outlined herein and any further appropriate actions in an effort to protect, restore and maintain this valuable shared resource.

High Priority Basin-Wide and Localized Issues

Within these four focus areas, it is DEQ's intent to work directly with local stakeholders to target specific measures that will improve resource status and maximize results. DEQ believes that targeted, cooperative efforts are necessary to ensure meaningful progress on resource issues facing the Deschutes Basin. The focus areas identified are of concern at both the basin-wide scale and on more localized levels. Within the WA process, DEQ feels that basin stakeholders have an unprecedented opportunity to address these issues in a coordinated, directed and meaningful manner.

Each focus area in this Action Plan includes a identification of limiting factors, the extent to which these limiting factors occur in the Basin and some identification of locations of specific concern, the primary resource threat perceived for the specific focus area, a strategy for addressing this threat, specific measures to be taken and an identification of the party/parties responsible or most able to implement the specific measures and goals.

Prioritizing Concerns

A general listing of concerns relative to resource status in the Deschutes Basin was compiled by DEQ staff, acting on available data and stakeholder input, and informed (to the extent possible) by existing resource assessments that had been completed for several different areas within the Deschutes Basin by a variety of agencies and other entities. Due to the accelerated schedule for completing both the Resource Status Report and the Action Plan for the Deschutes Basin, there has not been the opportunity for broad stakeholder comment and interaction, and many additional documents and data assessments exist that have not been thoroughly examined and incorporated. As the Deschutes WA process continues, additional stakeholder comment and available data will be used to better identify and refine both resource concerns in the basin and those measures necessary and appropriate to address them.

Priority Areas

The listing of priorities identified for this iteration of the Deschutes WA represents triage of known concerns and a complex assessment of opportunities and the interface with other watershed and regulatory processes. It is our intent that these priorities will be the focus of activities in the basin for this iteration of the WA process and that, with the next iteration of this process, the status of implementation achieved relative to these priorities be re-evaluated in the context of the larger list of concerns.

It is expected that in future iterations of the WA process, implementation successes will allow some issues to be removed from the priority list or reduced in priority as they are no longer represent a substantial concern or have been adequately addressed by implementation and land management changes. It is also expected that with additional data collection, better understanding of watershed function, TMDL completion and other efforts, new concerns will be identified and existing concerns not addressed directly in this Action Plan will rise in priority. In this manner, we expect that, over time, the consistent iterative prioritization of resource needs will enable all critical needs within the watershed to be adequately addressed.

PROCESS DISCUSSION

Each focus area in this Action Plan includes a identification of limiting factors, the extent to which these limiting factors occur in the Basin and some identification of locations of specific concern, the primary resource threat perceived for the specific focus area, a strategy for addressing this threat, specific measures to be taken and an identification of the party/parties responsible or most able to implement the specific measures and goals. These factors are summarized in table format for each focus area in the tables on the following pages.

Limiting Factors

A limiting factor commonly refers to any condition that controls a process, or species population, size, or distribution. This generally refers to conditions that are beneficial to an ecosystem. In the case of this Action Plan, DEQ has defined limiting factors as those conditions that are contributing to the degradation of natural resources in the Basin (for example, lack of riparian vegetation that contributes to increased water temperature), or to conditions that influence the effectiveness or functionality of necessary processes in the Basin (for example, lack of an effective public education and outreach program that results in management practices that are unsustainable). Often, more than one limiting factor was identified as contributing to resource concerns in the Basin.

Extent/Location

The extent of a resource concern is critical in determining the solution and area of implementation. In some cases the Action Plan identifies resource concerns that exist throughout the Basin; where appropriate, specific areas within the Basin have been identified. The identification of these areas will allow DEQ and other stakeholders to focus restoration and enhancement efforts in those areas where the need is greatest and where coordinated efforts will have the most immediate effect.

Primary Threat

Primary threats have been identified for each of the limiting factors. These attempt to describe the specific concern most associated with the limiting factors identified. By identifying the specific threat to the resource, effective strategies and measures for recovery can be developed which can act to guide actions at the subbasin level to mitigate the threats and return the basin to more sustainable conditions.

Strategy

The strategies identified in the tables below attempt to define the goal and procedure that will guide implementation decisions and assist in allocating resources to basin needs.

Measures

The measures identified are intended to guide selection of specific projects and programs that will improve resource status in those are identified by this plan. Specific measures were selected based on their ability to strategically achieve measurable environmental improvements linked to the highest priority issues. Other factors considered included opportunity for prompt/immediate cost effective implementation, performance record and effectiveness of similar projects, best available science, experience and ability of stakeholders and responsible entities, reasonable/sustainable project costs, ability to track specific success.

Responsible Parties

This is a listing of agencies, stakeholders and other entities best suited to help implement the identified measures. In many cases these entities will have the role of outreach and education as well as implementation. It is our goal to work closely with all stakeholders and support all of those listed as responsible parties in the implementation of the measures outlined by the Action Plan.

In order to conserve space, abbreviations for related groups of responsible parties are used in the tables on the following pages. These include *Municipalities, Counties, SWCDs, Irrigation Districts,* and *Watershed Councils*. A complete listing of all the separate entities represented by these abbreviations is provided in the table below. A listing of all abbreviations and acronyms used in the priority action tables is available at the end of this document (pages 132 through 136).

MEMBER ORGANIZATIONS LISTED AS GROUPS IN THE PRIORITY FOCUS AREA TABLES				
Municipalities	Counties	Soil and Water Conservation Districts (SWCDs)	Irrigation Districts/Ditch Companies	Watershed Councils (WC)
Bend	Deschutes	Deschutes SWCD	Arnold Irrigation District	Upper Deschutes WC
Redmond	Crook	Crook County SWCD	Central Oregon Irrigation District	Crooked River WC
Prineville	Sherman	Sherman County SWCD	North Unit Irrigation District	Willow Creek WC
Madras	Wasco	Wasco County SWCD	Swalley Irrigation District	Trout Creek WC
Sisters	Jefferson	Jefferson County SWCD	Three Sisters Irrigation District	Buck Hollow WC
Maupin	Klamath	Klamath SWCD	Tumalo Irrigation District	Bakeoven WC
La Pine			Ochoco Irrigation District	White River WC
Culver			Lone Pine Irrigation District	
Metolius			Crooked River Central Irrigation District	
Antelope			People's Irrigation District	
			Lowline Ditch Company	
			Juniper Flat District Improvement Company	
			Lost & Boulder Ditch Improvement District	
			Rock Creek District Improvement Company	
			Badger Improvement District	

The responsible Parties listings are intended to be informational only and should not be interpreted as assigning the responsibility to design, fund or implement projects at a designated site in the future. The table should be updated over time and additional entities that are participating in implementation activities at priority sites or to address priority components in the Basin should be added as appropriate.

SPECIFIC ACTION/IMPLEMENTATION TARGETS

The current WA Status Report identified many areas and issues of concern in the Deschutes Basin. The areas and issues identified were prioritized based on available data and information, stakeholder input and the experience and knowledge of DEQ staff. The tables below represent *Priority Focus Areas* and *Priority Actions* recommended under this iteration of the WA for point source discharges, surface water, groundwater and DEQ actions within the Deschutes Basin. For those areas and issues of concern identified by this iteration of the WA but not ranked as immediate priorities, additional information and recommended actions are included in the sections following the priority tables.

Priority Point Source-Related Resource Actions

UIC Program

Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Number and status of UICs in the Basin is unknown	Basin-wide Special concern in urban areas	Unknown level of risk to groundwater quality	Assess the number and status of UICs to estimate projected risk to groundwater quality	Assess the number and status of UICs in the Deschutes Basin Update existing DEQ databases to reflect recent changes in DEQ's UIC program	DEQ (See Appendix A for DEQ Subprogram information) CTWS, Municipalities, COIC
Effect of discharge on groundwater quality in the Basin is unknown	Basin-wide Special concern in urban areas	Groundwater contamination and potential for communication to surface waters	Assess the potential magnitude of effect on groundwater quality from UICs	Assess the magnitude and potential threat to groundwater quality from existing UICs Update existing DEQ databases to reflect recent changes in DEQ's UIC program	DEQ (See Appendix A for DEQ Subprogram information) CTWS
Use/permitting of UICs when other (more sustainable) treatment/ disposal methods are available	Basin-wide Special concern in urban areas	Groundwater contamination and potential for communication to surface waters	Prepare and provide guidance and actively support appropriate alternatives to UICs for public education	Develop and consistently support adequate public education and outreach Standards for stormwater discharge from developments and management activities to watercourses should be established and enforced	DEQ (See Appendix A for DEQ Subprogram information) Municipalities COIC CTWS

Further Evaluation of Water Quality Impacts of Permits

Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Status and potential effect on surface and groundwaters of permitted discharges in	Basin-wide	Unknown level of risk to surface and groundwater quality	Assess the status and potential effect of permitted discharges (UIC, NPDES, WPCF, CAFO) to	Assess the impact on water quality represented by permit violations Evaluation of CAFO permits to assess potential for effects on water quality Evaluation of WPCF/NPDES permits to identify expired permits	DEQ (See Appendix A for DEQ Subprogram information) ODA NRCS EPA

Further Evaluation of Water Quality Impacts of Permits					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
the Basin has not been assessed			estimate projected risk to surface and groundwater quality	and assess known or potential groundwater or surface water contamination from point sources Prepare and provide guidance and actively support education and outreach to permitted dischargers Ensure that new permits include the appropriate environmental impact assessment and approval processes. Environmental assessments should address potential impacts on water quality. Permits should contain conditions to ensure that activities are carried out in a manner that protects and, as necessary, improves current surface and groundwater quality.	CTWS COIC Municipalities

Priority Surface Water Resource Actions

Temperature					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Lack of adequate riparian vegetation	Basin-wide	Increased solar radiation resulting in elevated water temperatures Current land use practices degrades water quality by increasing temperatures, pollutants, and sedimentation	Improve riparian vegetation to more closely mimic natural potential vegetation Reduce stream temperatures through changes in land management and implementation of conservation measures	Encourage land owners and managers to fence riparian areas and adhere to responsible riparian grazing practices/plans Require a minimum distance from stream for all publically funded agricultural fencing projects (dependent on stream size and flow characteristics Make riparian restoration a priority project type in the NPS 319 program Encourage and support applications for funding for riparian restoration projects Environmental management plans should be promoted for agricultural activities. These plans should promote farming practices that minimize instream and downstream impacts	DEQ (See Appendix A for DEQ Subprogram information) ODA ODF ODFW OWRD NRCS SWCDs CTWS BLM USFS OWEB EPA Irrigation Districts Watershed Councils

Temperature					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
				including (as appropriate) Livestock Exclusion, Riparian Fencing, Riparian Grazing Plans, Hardened Crossing Systems, Producer Education Programs, Permanent Vegetative Cover on Cropland, Improved Pasture Management, Enhanced Erosion & Sediment Control, Vegetated Stream Buffers, CREP Encourage land owners and managers to utilize best management practices that do not increase temperatures, and cause nonpoint source pollution issues Develop, initiate and implement public education programs about the connectivity between land use and the impacts on basin resources	Municipalities COIC
Decreased (summer time) flows	Basin-wide	Elevated water temperatures from decreased flow volume and lack of thermal buffering capacity	Increase (summer time) instream flows (quantity and timing) to more closely mimic the natural hydrograph	Implementation of water conservation strategies on-farm Encourage water rights transfer to instream flows in cases where property management is changing or public funds are being spent	DEQ (See Appendix A for DEQ Subprogram information) OWRD ODA USBR Irrigation Districts NRCS DRC OWEB CTWS SWCDs Watershed Councils

Flow (Altered Hydrology)					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Decreased water quantity in-	Basin wide	Agricultural and municipal diversions	Implementation of water conservation	Implementation of water conservation strategies on-farm Encourage consideration of water rights transfer to instream	DEQ (See Appendix A for DEQ Subprogram

Flow (Altered Hydrology)					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
stream (substantial in-stream flow is being diverted under existing water rights and irrigation practices)		decrease stream flow and alter the natural hydrograph	strategies, water rights transfer, improved delivery efficiency	flows in cases where property management is changing or public funds are being spent Encourage the use of measuring devices on all irrigation diversions Require measuring devices on all irrigation and/or diversions where public finds are expended Prioritize funding of water conservation and efficiency projects to those that specifically and permanently reduce stream water withdrawals and upland conservation measures, and are designed to improve instream flows to more closely replicate the natural hydrograph	information) ODA USBR Irrigation Districts OWEB NRCS City of Bend DRC OWRD SWCDs CTWS

Sediment and Turbidity					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
No formal DEQ strategy for assessing, addressing or responding to sediment concerns	State wide	Inability to successfully identify and implement TMDL and WA objectives for water quality due to lack of sediment assessment tools and standards	Initiate an agency strategy for identifying and responding to sediment impairment concerns	Identify funding for support of sediment assessment tools and strategies Develop, adopt and implement a better way to assess sedimentation and determine impairment Develop and implement consistent assessment protocols for streambank erosion, channel stability and general sedimentation condition Evaluate RBS and other available/accepted methodologies for stream condition assessment as potential models for agency use Work with other programs and stakeholders to determine potential causes and treatments of sediment impairments	DEQ (See Appendix A for DEQ Subprogram information) ODA USBR Irrigation Districts OWEB NRCS EPA USFS ODF BLM ODFW

Sediment and Turbidity					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
				Develop and implement more effective sedimentation and turbidity standards	
Elevated deposition and concentration of fine sediments	Basin wide	Deposition of fine sediments resulting in impaired spawning gravels and hypoxia Elevated concentrations of suspended sediments that interfere with aquatic life	Minimize erosion through targeted streambank stabilization, improved land management and conservation cropping techniques	Identify causes and initiate appropriate implementation measures for sediment loading from livestock, road run-off and slope failures, irrigation, uplands, unstable stream banks, wildfires, and altered flow regimes Minimize erosion through conservation cropping techniques and pasture management	DEQ (See Appendix A for DEQ Subprogram information) ODFW USFWS NMFS/NOAA Watershed Councils USFS ODF BLM CTWS BPA ODA NRCS SWCDs
Transport and deposition of pollutants carried by excess sediments	Basin wide	Elevated nutrient and potentially pesticide loading potentially leading to elevated pH, decreased DO and other water quality concerns		Minimize nutrient loss by aligning fertilizer amount, type and application methodology to the physiological requirements of the crop Minimize pesticide loss by ensuring appropriate application methodology; encourage use of “softer” pesticides as they are available Minimize erosion through conservation cropping techniques and pasture management	DEQ (See Appendix A for DEQ Subprogram information) ODA NRCS SWCDs Watershed Councils

Habitat					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Lack of aquatic habitat; decreased channel complexity and function	Basin wide	Loss of spawning and rearing capacity, loss of essential food web components, elevated pollutant loading (sediment, temperature, dissolved oxygen and pH)	Encourage projects and practices that will result in increased channel complexity and function, increased sinuosity and more natural flow volumes and regimes	Improve channel sinuosity, complexity and function Improve riparian vegetation to more closely mimic natural potential vegetation Increase summer time instream flows (quantity and timing) to more closely mimic the natural hydrograph	DEQ (See Appendix A for DEQ Subprogram information) ODFW USFWS NMFS/NOAA Watershed Councils USFS ODF CTWS BLM ODA NRCS SWCDs Irrigation districts OWEB DSL USACOE
Decrease in or lack of native vegetation; decrease in or lack of riparian vegetation diversity	Basin wide	Introduced weed species: White top, medusa head, etc.	Encourage practices and programs that will result in increased incidence and diversity of native vegetation	Encourage land owners and managers to utilize best management practices that allow for and promote restoration of native vegetation Require all publically-funded projects to use approved native seed mixes for restoration activities Encourage and support programs that promote responsible grazing practices Support public education programs	DEQ (See Appendix A for DEQ Subprogram information) ODA NRCS CTWS SWCDs OWEB ODOT Watershed Councils OSU Extension Counties
Spread of invasive	Basin wide	Introduced weed species:	Prevent further introduction and	Encourage land owners and managers to utilize best management practices that do not encourage the spread of	DEQ (See Appendix A for DEQ

Habitat					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
weeds(white top, medusa head, others)		White top, medusa head, etc. Juniper encroachment	spread of introduced species	introduced weed species Encourage basin-wide cooperation (and efforts outside the Basin but adjacent to Basin lands) in invasive weed identification and eradication or control Encourage development and use of effective, environmentally responsible herbicides and biocontrols Implementing integrated pest management techniques. Support public education programs.	Subprogram information) ODA NRCS SWCDs OWEB Counties ODOT Watershed Councils OSU Extension CTWS USFS BLM ODF
Juniper encroachment	Basin wide	Reduction in native herbaceous and shrubby species	Reduce existing footprint of juniper encroachment to more closely approximate historic levels Prevent further encroachment of juniper into new areas	Support juniper felling projects as appropriate Support reintroducing natural fire regimes into the basin Support and encourage sustainable grazing practices in rangelands	DEQ (See Appendix A for DEQ Subprogram information) ODA ODF OWEB BLM USFS ODF OSU Extension SWCDs Watershed Councils

Harmful Algae Blooms					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Very limited data available for identifying areas of concern and determining causes of algal impairments	High mountain lakes and reservoirs throughout the Basin	Generation of toxic by-products that can cause serious illness or death in pets, livestock, wildlife and humans Decrease in support status of beneficial uses including aesthetics, livestock watering, fishing, water contact recreation, and drinking water supply	Identify and assess the occurrence, extent, and potential causes of harmful algal blooms in the Basin	Design and implement a more comprehensive collection of blue-green algae data to identify areas of concern Design and support a monitoring program to collect data to help identify causes of harmful algal blooms and associated impairment	DEQ (See Appendix A for DEQ Subprogram information) USFS ODF PGE USBR DHS USFWS ODFW USGS Irrigation Districts PSU – Center for Lakes and Reservoirs
No formal DEQ strategy for assessing, addressing or responding to HABs concerns	State wide	Inability to identify and effectively respond to harmful algae blooms	Initiate an agency strategy for identifying and responding to harmful algal blooms	Identify funding for support of HABs data collection and analysis Develop, adopt and implement a statewide strategy for identifying and responding to harmful algal blooms Work with other programs and stakeholders to determine potential causes of impairments	DEQ (See Appendix A for DEQ Subprogram information) USFS ODF USBR USGS DHS PSU – Center for Lakes and Reservoirs

Toxics (Mercury/Arsenic)					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties

Toxics (Mercury/Arsenic)					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Very limited data available for identifying specific locations of concern, sources of mercury, and potential treatments	Geological and mining sources in Upper Trout, Lower Crooked, Upper Crooked, Little Deschutes Air deposition basin wide	Unidentified locations with elevated mercury concentrations in surface waters (aquatic life) and in fish tissue (human consumption)	Identify and assess sources of mercury in the Basin and existing water column and fish tissue concentrations	Assess and evaluate mercury concentrations and probable sources of mercury in East Lake Design and implement a monitoring program(s) to provide a robust data set for fish tissue mercury (methylmercury) in the basin – special emphasis on the Crooked and Little Deschutes Subbasins Detailed evaluation of available USGS data for mercury (all forms, all media) Coordinate with Oregon State-Wide Mercury TMDL process to share data and loading/deposition assessments Revision of Oregon water quality and human health criteria for mercury specific to proposed increase in fish consumption rate and toxics rule revisions	DEQ (See Appendix A for DEQ Subprogram information) DOGAMI USFS ODF EPA USGS CTWS ODFW USFWS NMFS/NOAA
Very limited data for identifying areas of concern and sources of arsenic	Basin wide	Elevated concentrations of arsenic in drinking water that may lead to human health concerns	Identification of sources and existing water column concentrations	Assess and evaluate arsenic in both groundwater and surface waters to determine probable sources and if the concentrations observed represent human health/fish issues Assess the arsenic survey that was done in the Prineville area Revision of Oregon water quality and human health criteria for arsenic specific to proposed toxics rule revisions	DEQ (See Appendix A for DEQ Subprogram information) DOGAMI EPA USGS CTWS

Priority Groundwater Resource Actions

Nitrate					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Limited data for identifying areas of concern and sources of nitrate in groundwater	Basin wide Areas of special concern in southern Deschutes County, northern Klamath County Prineville, Redmond, lower Trout Creek, Willow Creek, Sherman County	Elevated concentrations of nitrate in drinking water that may lead to human health concerns	Identify sources and extent of nitrate contamination of groundwater throughout the basin, including the need for additional monitoring, data analysis and public outreach	Develop and implement additional monitoring and analysis to further refine and understand contamination in groundwater in the Basin Assess and evaluate nitrate contamination in groundwater basin wide to determine probable sources and if the concentrations observed represent human health concerns and if designation of a Groundwater Management Area is warranted anywhere Better assessment of nitrate contamination of groundwater in identified areas of concern (Prineville area, Redmond area, lower Trout Creek, Willow Creek, and Sherman County) Continue to support and participate in the groundwater protection program for southern Deschutes County/northern Klamath County (La Pine area) Provide appropriate staff support for outreach and education activities specific to nitrate contamination of groundwater from human activities	DEQ (See Appendix A for DEQ Subprogram information) USGS Municipalities Counties COIC SWCDs CTWS
Known nitrate contamination of groundwater from human activities	Basin wide Special concern in the southern Deschutes County/ northern Klamath County	Elevated concentrations of nitrate in drinking water that may lead to human health concerns	Minimize nitrate transport to groundwater	Minimize nitrate transport to groundwater from septic systems Actively assist and encourage septic upgrades, conversion to sewer Assess and (if necessary) revise standards for sewage, wastewater and stormwater discharge from developments and management activities to watercourses Work to establish nutrient management plans and programs that will minimize nutrient loss to groundwater by aligning	DEQ (See Appendix A for DEQ Subprogram information) EPA USGS Municipalities Counties COIC SWCDs CTWS

Nitrate					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
	Prineville, Redmond, lower Trout Creek, Willow Creek, Sherman			fertilizer amount, type and application methodology to the physiological requirements of the crop	ODA NRCS

Groundwater/Surface Water Interactions and Withdrawals					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
Little data on groundwater to surface water connectivity and groundwater quality	Basin wide	Potential for contamination of groundwater		Update the Deschutes Groundwater report (particularly as related to toxics) Perform a source assessment for bacteria found in groundwater wells (identify causes and extent and magnitude of the concern)	DEQ (See Appendix A for DEQ Subprogram information) OWRD ODA USBR USGS Municipalities Counties COIC
Substantial and increasing groundwater withdrawals	Basin wide	Loss of surface water volumes (from reduced spring flows and seepage) and related water quality and habitat degradation	Understand and assess the connection between groundwater and surface water in the Basin. Use this information to guide policy and projects.	Develop tools/relationships to assess the cumulative effects that groundwater pumping and/or the lining of canals in the Upper Deschutes Subbasin will have/is having on spring/stream flows and water quality in the Deschutes River between Bend and Lake Billy Chinook (middle Deschutes), the lower Crooked River, and lower Whychus Creek Recognize that the basin's surface water resources have been fully appropriated for many years, and stream flows are locally below legally set minimums at certain times of the year, and that virtually all new development will rely on groundwater. Use this information to guide projects and policy in future	DEQ (See Appendix A for DEQ Subprogram information) OWRD USBR USGS Municipalities Counties COIC BLM USFS

Groundwater/Surface Water Interactions and Withdrawals					
Limiting Factors	Extent/ Location	Primary Threat	Strategy	Measures	Responsible Parties
				regulatory and funding decisions. Recognize, support and enhance OWRD's Deschutes Groundwater Mitigation Program	ODF ODFW Irrigation Districts

Priority DEQ-Specific Coordination, Outreach and Data-Related Resource Actions

DEQ-Specific Coordination, Outreach and data-related Resource Actions				
Limiting Factors	Primary Threat	Strategy	Measures	Partners
Use of DEQ data is limited with the current LASAR application; this application does not support access to and correlated analysis of DEQ subprogram and other data, and does not provide a reliable mechanism for importing non-DEQ data in a timely and effective fashion; some data types are not supported at all by LASAR	Inaccurate and/or incomplete assessment of existing resource conditions and concerns, lack of inter-program data coordination, lack of effective, timely access to available data Duplication of effort, ineffective use of limited funding	Consciously act to improve DEQ's capability for data accessibility, analysis, import and sharing	Identify funding and staff support for developing, maintaining and routinely updating a more accessible, user friendly database for compilation, display, access and analysis of all appropriate forms of data from DEQ (all subprograms) and stakeholders	(Initial actions will be the responsibility of DEQ Administration and all subprograms, See Appendix A) ODA ODF OWRD ODFW CTWS USFS BLM EPA NRCS Irrigation Districts Watershed Councils SWCDs Municipalities Counties COIC
Interagency coordination is limited	Loss of benefit from other experience and program	Actively promote and encourage	Establish and maintain a strong, interactive, working relationship with CTWS, sister agencies (ODA, ODF, DSL,	(Initial actions will be the responsibility

DEQ-Specific Coordination, Outreach and data-related Resource Actions				
Limiting Factors	Primary Threat	Strategy	Measures	Partners
due to resource constraints	opportunities Inability to effectively leverage funding and available information Unnecessary duplication in monitoring and restoration efforts	interaction with other natural resource agencies and entities	OWRD, ODFW) and local and federal agencies and entities that allows effective communication and support Work with CTWS to compile and assess water quality data on tribal lands – and their data off tribal lands as well. Work specifically to improve DEQ's relationship with CTWS to better understand and reflect each other's objectives and goals in coordinated efforts and to allow more effective sharing of resources and information specific to resource needs in the Deschutes Basin Develop and oversee a Basin-wide Monitoring Council to help coordinate monitoring, funding, project implementation and data analysis on a holistic scale	of DEQ Administration and all subprograms, See Appendix A) ODA ODF OWRD ODFW DSL CTWS USFS BLM EPA NRCS Irrigation Districts Watershed Councils SWCDs Municipalities Counties
Outreach opportunities in Water Quality programs are limited, resulting in minimal education and outreach efforts to increase public awareness of natural resource-related issues	Decreases ability to effectively engage stakeholders resulting in less than successful TMDL implementation, WAs and other resource-related processes (nonpoint source pollution commonly represents the majority of pollutant loading but implementation is primarily voluntary and dependant on stakeholder engagement)	Consciously identify and support strong public education and outreach programs as essential components of resource-related processes (adopt outreach programs similar to those in the North Coast statewide)	Continue and enhance existing stakeholder outreach and involvement in the on-going WA and TMDL processes Identify funding and staff support for developing and maintaining an interactive web tool for data and information and sharing; web tool should be developed in a fashion that it can support efforts and processes on a state-wide scale with Basin or smaller specificity; develop and maintain an interactive web tool for data and information sharing with Deschutes Basin-specific information Update and revise the existing DEQ website so that it provides effective, interactive information, and staff	(Initial actions will be the responsibility of DEQ Administration and all subprograms, See Appendix A) ODA ODF OWRD ODFW CTWS USFS BLM EPA

DEQ-Specific Coordination, Outreach and data-related Resource Actions				
Limiting Factors	Primary Threat	Strategy	Measures	Partners
			and stakeholder support Develop and implement public and management specific education programs about the connectivity between land use and the impacts on natural resources	NRCS Irrigation Districts Watershed Councils SWCDs Municipalities Counties COIC

Lower Priority Actions

The following sections detail actions recommended for those areas and issues of concern identified by this iteration of the WA not included in the preceding priority tables.

Drinking Water Supply

Public drinking water systems can either rely on surface water, groundwater or a combination of both. There are also private water systems and numerous private groundwater wells in the Basin that are for domestic use. Safe and secure drinking water is a high priority for DEQ in the Deschutes Basin, and actions and assessments for public drinking water systems will be overseen by DEQ and the Office of Environmental Public Health at DHS using applicable state and federal regulations for source water under the Safe Drinking Water Act.

Point Sources

This Action Plan identifies UICs and further assessment of the potential affect of permitted discharges on water quality in the Basin as Priority Focus Areas with specific recommended actions under the WA. Additional actions identified relative to point sources include:

- Regional permitting staff will continue to issue permits consistent with a basin schedule. This may require issuing permits for shorter periods for one cycle. Maintaining a basin schedule will continue be challenge the permitting program statewide. Renewal of permits will include outreach to stakeholder groups to ensure all relevant information is available to permit writers.
- Renewal of land application permits will continue to consider possible impacts to surface waters and groundwater. Information for these permits will be available to permit writers for discharging (NPDES) permits to ensure possible cumulative impacts are understood.
- Sewage drill holes should be located, decommissioned and replaced with appropriate waste treatment systems. Where these wells are located within existing sewer districts/city limits, their connection to sewer systems should become priorities within these districts.
- DEQ staff will continue to pursue solutions to existing ground water contamination from known sources (Redmond Tallow former site) and ongoing system failures (Gilchrist WWTP). DEQ will also continue working for a comprehensive solution to vulnerable groundwater in Southern Deschutes and Northern Klamath Counties.
- Water quality permit database needs to be updated with accurate latitude/longitude information.

NPDES Permits

Both Individual and General NPDES Permits are administered by the Permit Section of DEQ. There is an established schedule and protocol for assessing, renewing and revising NPDES permits. This process will be informed by the WA and the ongoing TMDL process. DEQ will work together with ODA to better assess the potential effects of confined animal feeding operations on surface and groundwater quality

Water Pollution Control Facility Permits

Both Individual and General WPCF Permits are administered by the Permit Section of DEQ. There is an established schedule and protocol for assessing, renewing and revising WPCF permits. This process will be informed by the WA and the ongoing TMDL process.

General Surface Water Quality Conditions

This Action Plan identifies temperature, flow (altered hydrology), sediment, habitat, hazardous algae blooms, and toxics (mercury and arsenic) as Priority Focus Areas with specific recommended actions under the WA. Additional surface water quality concerns include:

Macroinvertebrate Health and Biological Condition

Aquatic insect and other freshwater invertebrate data collected in the Deschutes Basin indicate that nearly one third of all monitored sites are representative of most disturbed conditions for water temperature, sediment, habitat conditions and other factors. However, these types of data have only been collected in a small portion of the surface waters in the Basin. Stakeholders felt that a review of all biological data collected in the Basin would be useful for better understanding the biological condition in the Basin rather than just relying on DEQ's models. Both DEQ staff and stakeholder recommendations include the collection of additional data as a recommended task for future efforts. It is also recommended that data collection in the future be focused on those methodologies that are widely accepted and can be accurately assessed as part of the larger data pool. These efforts (as appropriate) should be included as priorities in future iterations of the WA.

Bacteria

Stakeholders identified a number of areas of concern for bacterial contamination and need for monitoring (or repeat monitoring) in the Lower Deschutes and Trout Creek areas (White River, Sportsman's Park, Rock Creek Reservoir, lower Rock Creek, Wamic, Three Mile Creek). Further assessment of conditions in these areas, as well as the Upper Crooked and Beaver-South Fork Crooked Subbasins is needed. DEQ has begun work on developing a TMDL for bacteria in the Lower Crooked Subbasin. Additional data collection and assessment concerns specific to the water quality impacts (both bacteria and nutrients) of agricultural irrigation return flows on the Deschutes River and other tributaries, and the contribution of failing septic systems (Metolius area of the Upper Deschutes, Camp Sherman, Odell Lake, Crescent Lake, Little Deschutes) should be identified as a priority in future versions of the WA. DEQ will continue to work with ODA, SWCDs and local rural communities to determine sources of the bacterial problems and will then work with agricultural and other rural landowners to address the problems.

Total Dissolved Gas (TDG)

DEQ has developed a water quality standard for TDG that is protective of aquatic life. Activities with the potential to result in elevated TDG concentrations are generally dams or impoundments. If hydropower is produced by these structures, they are regulated by DEQ under the 401 Water Quality Certification process, part of the Federal Energy Regulatory Commission (FERC) licensing process. TDG concentrations are specifically assessed under the 401 Water Quality Certification process. For the Pelton-Round Butte dams, this process specifies that TDG will be measured below the Reregulating Dam during significant spill events at the dam and development of a plan will be required if noncompliance with the TDG standard is observed.

Bowman Dam and the dam on Wickiup Reservoir do not produce hydropower and are therefore not subject to 401 water quality certification, although hydropower facilities are currently proposed to be added to both dams. The Crooked River below Bowman Dam is 303(d) listed for TDG impairment and gas bubble disease has been observed in fish in this location. A TMDL will be required for TDG on the Crooked River, which will likely require a change in management of the water is released from Bowman Dam. Although the Deschutes River below Wickiup Reservoir is not currently listed as impaired in the State's Water Quality Assessment, it is likely to be in the future based on these data. As with Bowman

Dam, a change in management of how water is released from Wickiup Dam will probably be required to address this impairment. DEQ will work with USBR (who owns and operates these two dams) to address TDG issues.

Dissolved Oxygen, pH, Nutrients, and Chlorophyll *a*

DEQ has water quality standards for dissolved oxygen, pH and chlorophyll *a* that are protective of beneficial uses in the Deschutes Basin. Elevated nutrient levels can be one of the causes of pH and/or dissolved oxygen problems in lakes or streams. DEQ has begun work on developing TMDLs for dissolved, pH, nutrients and chlorophyll *a* in the Upper and Little Deschutes Subbasins, and the Crooked River Subbasins. The TMDLs will address listings on the Deschutes River, Little Deschutes River, Odell Lake/Creek and Lava Lake, and the Crooked River. It is unclear at this point whether sufficient data exist to address the potential concerns on the other tributaries. Additional data might be needed to adequately address these tributaries and will be identified through the TMDL process.

Further assessment of these parameters has also been identified as a priority data analysis need (see table below) in resort/developed areas in the Upper and Little Deschutes Subbasins. This includes areas along the Metolius and along developed lakes such as Odell Lake.

Additional data collection and assessment concerns specific to the water quality (pH and dissolved oxygen) and impacts on fisheries have been identified as needs in the Lower Deschutes and Trout and Willow Creek Subbasins. The collection of data in the White River watershed, irrigation return flows/tributaries to the lower Deschutes, and upper Trout Creek are identified as monitoring needs in this iteration of the WA (see Priority Monitoring Needs Table below). Collection and assessment of data in the lower Deschutes River, Lake Simtustus and Lake Billy Chinook should be identified as a priority in future versions of the WA following the change in operations resulting from the activation of the selective withdrawal structure. PGE and CTWS (the joint owners and co-licensees of the project) are responsible for doing some monitoring, which will likely be supplemented by DEQ monitoring as part of the TMDL process in the future.

While TMDL activities may not directly address or assess water quality concerns specific to dissolved oxygen, pH, nutrients, and chlorophyll *a* in all areas of the Basin, implementation of recommended actions identified for temperature and sediment (preceding priority tables) will have beneficial effects on water quality relative to these concerns.

Toxics

This Action Plan identifies specific recommended actions for mercury and arsenic in surface waters. Additional toxics-related concerns include:

Emerging Contaminants, Pharmaceuticals and Personal Care Products.. In the Deschutes Basin, the cities of Bend, Redmond and Sunriver are monitoring their effluent for persistent pollutants. Additional information should be collected to account for the potential pollutant loads from septic systems (discharge to groundwater) and those treatment faciliti

Metals (General). Additional information should be collected as opportunities for monitoring become available to better assess metals concentrations in surface waters in the Deschutes Basin. Priority for metals monitoring is recommended for Crescent Creek, Hemlock Creek, Little Deschutes River, Canyon Creek, Cultus Creek, Jefferson Creek, North Fork Tumalo Creek, Odell Creek, Soda Creek, Wychus Creek and Tumalo Creek (mainstem) as all carry a listing of potential concern for alkalinity relative to metals concentrations.

Pesticides. DEQ has developed water quality standards that are protective of aquatic life for many of the pesticides known to have been used and that are currently in use in the Deschutes Basin. Additional information should be collected as opportunities for monitoring become available to better assess pesticide concentrations in surface waters in the Deschutes Basin. Priority for pesticide monitoring

Groundwater Conditions

This Action Plan identifies specific recommended actions for nitrate and groundwater/surface water interactions and groundwater withdrawals. Additional groundwater-related concerns include:

Groundwater Quality (General)

Additional information should be collected to better assess groundwater contamination in the Lower Crooked River (Prineville, Lone Pine and along valley bottoms). A more thorough investigation of groundwater in the Lower Crooked River assessment area is needed to better understand the human health risks. The collection and analysis of these data should be identified as a priority in future versions of the WA. Specific concerns for monitoring include arsenic, nitrate and coliform.

Bacteria

The primary reasons for concern about bacteria in groundwater are specific to drinking water systems that rely on groundwater where bacterial contamination represents a human health concern, and the presence of bacteria as an indication of a contamination source that may contain other constituents. Safe and secure drinking water is a high priority for DEQ in the Deschutes Basin, and actions and assessments for public drinking water systems will be overseen by DEQ and the Office of Environmental Public Health at DHS using applicable state and federal regulations for source water under the Safe Drinking Water Act. Source assessments for bacterial contamination of private well water as identified by the Sherman County surveys, indicates a reason for concern and source assessments for the causes of these bacteria detections should be conducted in Sherman County and other areas with similar risk factors for well contamination. It is recommended that surveys and follow-up source assessments be coordinated with the work recommended for bacterial contamination of surface waters specific to failing septic systems (Metolius area of the Upper Deschutes, Camp Sherman, Odell Lake, Crescent Lake, Little Deschutes), and should be identified as a priority in future versions of the WA. DEQ will continue to work with local rural communities to determine sources of the bacterial problems and will then work with rural landowners to address the problems.

Pesticides

Safe and secure drinking water is a high priority for DEQ in the Deschutes Basin, and actions and assessments for public drinking water systems will be overseen by DEQ and the Office of Environmental Public Health at DHS using applicable state and federal regulations for source water under the Safe Drinking Water Act. Source assessments for pesticide contamination of private well water should be conducted in areas of the Basin with high risk factors (high pesticide use rates, high permeability rates). It is recommended that these types of surveys and follow-up source assessments be coordinated with existing Pesticide Stewardship Partnership activities. DEQ will continue to work with local rural communities to determine sources of identified pesticide problems and will then work with rural landowners to address the problems. There is very little information available about pesticides in groundwater in the Deschutes Basin. A more comprehensive evaluation of data in the DEQ LASAR database is also recommended to be identified as a priority action in future versions of the WA

Volatile Organic Compounds (VOCs) and Synthetic Organic Compounds (SOCs)

There is very little information available about the presence of these contaminants in groundwater in the Deschutes Basin. A more comprehensive evaluation of data in the DEQ LASAR database is also recommended to be identified as a priority action in future versions of the WA.

Arsenic

The primary reason for concern about arsenic in groundwater is specific to drinking water systems that rely on groundwater where elevated arsenic concentrations can represent a human health concern. Safe and secure drinking water is a high priority for DEQ in the Deschutes Basin, and actions and assessments for public drinking water systems will be overseen by DEQ and the Office of Environmental Public Health at DHS using applicable state and federal regulations for source water under the Safe Drinking Water Act. Source assessments for elevated levels of arsenic in public and private well water indicate particular areas of concern in the Crooked and Lower Deschutes Subbasins, with several public water supplies in these areas being closed in order to protect public health. It is recommended that surveys and follow-up source assessments be identified as a priority in future versions of the WA. DEQ will continue to work with local rural communities to identify areas with elevated arsenic concentrations in drinking water and will then work with rural landowners to address the problems.

Nickel, Lead and Fluoride

Elevated nickel, lead and fluoride concentrations represent a concern in groundwater when it is the source of drinking water for public or private systems. Public drinking water systems in the Deschutes Basin are overseen by DEQ and the Office of Environmental Public Health at DHS using applicable state and federal regulations for source water under the Safe Drinking Water Act. If nickel, lead or fluoride concentrations are identified above the MCL in private drinking water systems, DEQ will work with local rural communities to identify areas at risk and will then work with rural landowners and partner agencies to address the problems.

EXPECTED/DESIRED RESPONSES

It is expected that implementation of the actions outlined in the preceding tables will, cumulatively, help to improve the overall status of environmental resources in the Deschutes River Basin, and will improve environmental and water quality on a broad scale.

Timelines

It is recognized that while some of the recommended measures may result in a very rapid response from the natural system, many of the measures recommended for resource support and restoration will require longer periods to realize results, perhaps much longer than the iteration sequence of the WA. Project specific timelines can be affected by outreach, funding, permitting, design constraints, level of staff experience and many other factors. Benefit realization timelines can be constrained by weather and flow variability, precipitation levels, vegetation maturation timeframes, wildfire, flood events and many other elements out of the control of the stakeholders in the Basin. This response variability needs to be considered in the determination of implementation success on a project by project and area by area basis.

It is expected that even with full availability of funding and project partners, full implementation of the priority elements listed in the preceding tables will extend beyond the projected 5-year sequence of the WA process. Full realization of benefits from the implemented actions may take decades. However, incremental benefits will occur within the Basin with ongoing implementation activities and will result in a positive trend in resource status over time.

Milestones

The ongoing stakeholder outreach for the Deschutes Basin WA process must establish milestones and appropriate implementation periods along the path toward improving resource status in the Basin and, eventually, meeting water quality criteria and TMDL load allocations and water quality objectives. (Implementation periods are the intervals between milestones in which a level of effort is focused on effectively implementing the recommended actions.) The milestones may be used to guide implementation project prioritization, funding and permitting decisions as the WA process moves forward. Implementation periods may be used to judge the pace of implementation and justify the need for additional outreach, funding and staff support.

While the actions identified in this document will act cumulatively to improve resource status within the Basin, additional planning and strategy adjustments will be necessary with time. A comprehensive review of milestones, implementation planning and trend analysis should be incorporated in each iteration of the WA process so that implementers will be able to effectively target priority projects before the current planning horizon ends.

MONITORING PROGRAMS

Data are needed to build the assessments we need to make better resource-related decisions. Without data, we simply cannot know where resource problems exist, where we need to focus our efforts or where we've made progress. Effective implementation of this Action Plan and those that follow will be dependent on the development of a monitoring program that will allow DEQ and other stakeholders to reliably measure progress of implementation, effectiveness of implemented actions, validity of original assumptions made, trends and status of water and resource quality within the Basin and fill the data gaps identified in the status report.

Implementation Monitoring

This category includes monitoring that is designed to answer the question “Did we accomplish what we said we would in the manner, time, and budget proposed?”, and is generally directed toward specific management changes or implementation activities. It may involve tracking less direct measures of success such as landowners contacted, workshops held, or acres under conservation tillage rather than a monitored change in stream temperature or reduction in sediment entering a stream. These indicators, while not as straightforward as instream data, are indicative of success in implementation and represent progress toward the objectives outlined in the tables above.

Monitoring activities and the observed changes may be subdivided into those specific to water quality improvements (e.g. the reduction of water temperature due to increased shade from fencing riparian areas) and those specific to management actions or the accomplishment of implementation goals (e.g. the change to no-till practices on a defined number of acres of crop-land). This type of monitoring can be complicated by a wide variety of environmental factors and timing of contributing activities. This type of monitoring should be the primary driver for implementation of the Action Plan as implementation measures to reduce degradation or pollutant loading may also bring about other habitat improvements beneficial to aquatic life.

Effectiveness Monitoring

While implementation monitoring (described above) provides a measure of projects that were implemented, effectiveness monitoring is designed to determine how well the projects implemented performed, answering the question "Did it work?" Did the project (or group of projects) achieve the objective?". Often there are several different ways of working toward a certain goal, some of which will achieve greater improvement than others. For example, water temperature in a stream may be reduced by increased instream flow, increased shading, increased bank-storage or a number of other measures. Effectiveness monitoring is designed to look at how much improvement comes from a single practice or project, or a certain type of project. In the example of stream temperature, effectiveness monitoring might be used to determine if increased flow had a greater temperature benefit than increased shading. Project-scale effectiveness monitoring on management changes can be used to determine the biotic and abiotic changes resulting on, and adjacent to, the treatment area; to determine if treatment and restoration actions were effective in meeting the project objective; and to learn from mistakes and oversights and to incorporate new knowledge in future treatment design (OWEB 2006). In order to provide effective and informative information, effectiveness monitoring must follow established protocols, generate quantifiable data, and produce repeatable results. Again, it should be kept in mind that this type of monitoring is rarely straightforward and can be complicated by a wide variety of environmental factors and timing of contributing activities.

Validation Monitoring

This category of monitoring is designed to answer the question "Were the original assumptions we made correct?" During an assessment process like the WA, assumptions about how a watershed functions are often made based on available data and best professional judgment. Collection of additional data helps to increase our understanding of environmental processes and can be used to better inform the original assumptions. For example, if it is assumed that groundwater seeps into a stream segment at a certain rate, validation monitoring may include some analysis of gaining and losing reaches of the stream during low surface flows to determine if the rates assumed are accurate.

Trend and Water Quality Monitoring

In correlation with the collective, rigorous analysis of existing data, on-going and future water quality condition monitoring in the Deschutes Basin is strongly recommended. In some locations this type of monitoring is needed to establish baseline conditions and/or to better understand environmental problems to inform implementation actions.

Water quality condition monitoring is performed to help better characterize existing resource status and to help identify trends in resource conditions. Water quality monitoring is generally based on examining data collected from a water body to see if it meets established standards or reference conditions. This type of monitoring helps to identify where waters do not meet standards and need restoration; and helps to better assess which waters are in good condition and in need of further protection to prevent impairment. Over time, this type of monitoring can also identify trends in water quality. This helps determine whether water quality conditions are improving or worsening, and identifies how changes in management and other implementation actions are improving resource conditions overall.

Water quality condition monitoring can also be used to fill in areas where data are not available either because no data have been collected, or the data that have been collected are not sufficient for analysis. This condition may occur due to funding constraints, access difficulties, changing priorities, emerging issues, and many other circumstances. Monitoring efforts that can be coordinated to focus data collection efforts where data gaps have been identified and to supplement work already being done by others in the Basin are strongly encouraged.

Coordinated Monitoring Responsibilities

In the Deschutes Basin, resource-related monitoring will be performed by many different entities for many different reasons. Some types of monitoring activities will be able to meet several of the purposes described above at once; others will be specifically designed for one reason.

The responsibility for the monitoring identified by this plan rests with many different agencies. DEQ has monitoring responsibilities and conducts rigorous monitoring programs associated with ambient water quality assessments and TMDLs. The CTWS and local governments such as cities and counties also conduct water quality monitoring within their boundaries. The EPA and other federal agencies (USFWS, USGS, NOAA, USACOE, and others) also conduct extensive monitoring to identify trends in water, sediment, and biota in the Deschutes Basin. Additionally, private entities such as watershed councils, environmental groups, and permitted dischargers also collect water quality data for their own purposes which they often share with government decision makers. Many volunteer monitoring efforts by private citizens who are trained in monitoring methods, regularly collect and analyze water samples, conduct visual assessments of physical conditions, and measure the biological health of waters. All of these efforts can help to fill the monitoring needs outlined below for the Deschutes Basin. If a basin-wide monitoring council (or something similar) is created, they will logically play a lead role coordinated monitoring in the basin.

The coordinating entities listed in the table below are generally those entities that have collected data of the type or at a location similar to or adjacent to the areas listed; or are those entities most likely to have a direct role in interpreting the data collected or implementing resource related projects based on data analysis. The coordinating entities listings are intended to be informational only and should not be interpreted as assigning the responsibility to collect data at a designated site in the future. The table should be updated over time and additional entities that are conducting ongoing monitoring at priority sites or for priority components in the Basin should be added as appropriate.

Priority Monitoring Needs Identified in the Deschutes Basin			
Location	Media	Constituents	Coordinating Entities
White River watershed	Surface water and groundwater	Bacteria, DO/pH/nutrients	DEQ ODA Wasco SWCD Mt Hood National Forest/Maupin school BLM ODFW
Upper Crooked/Beaver-South Fork	Surface water	Bacteria, nutrients	DEQ Crooked River Watershed Council ODA
Metolius/Camp Sherman and other resort areas	Surface water and groundwater	Nutrients and bacteria (associated with septic systems), pH	DEQ Friends of the Metolius Deschutes National Forest Jefferson County USGS
Deschutes/Little Deschutes Rivers	Surface water and groundwater	Nutrients and bacteria (associated with septic systems) Correlate data collection with specific	DEQ USGS Upper Deschutes WC

Priority Monitoring Needs Identified in the Deschutes Basin			
Location	Media	Constituents	Coordinating Entities
		actions identified in the Priority Focus Area for groundwater nitrate	
Basin-wide Lake Billy Chinook (specifically identified as one needed locale)	Surface water	More comprehensive collection of blue-green algae data to identify areas of concern, both on and off forest Data collection to identify causes of hazardous algal blooms and associated impairment Correlate data collection with specific actions identified in the Priority Focus Area for harmful algae blooms	DEQ PGE CTWS Deschutes, Ochoco and Mt. Hood National Forests BLM USBR
Deschutes River below Pelton-Round Butte project	Surface water	Water quality conditions (monitoring beginning in 2012 in order to allow system to equilibrate with changes in operation at the dam)	PGE DEQ data collection during TMDL development
Irrigation return flows/tributaries to lower Deschutes, Trout Creek (upper)	Surface water and groundwater	DO/pH/nutrients Further studies/evaluations in conjunction with Jefferson SWCD and ODA to assess nitrate sources in groundwater	DEQ Jefferson SWCD ODA CTWS
Basin-wide	Surface water and groundwater Fish tissue (mercury)	Toxics (mercury, arsenic, emerging contaminants) Little data currently exists for either groundwater or surface water. Monitoring to determine source (natural or man-made) Correlate data collection with data analysis identified in the following table	DEQ coordination with USGS monitoring ODFW CTWS
Basin-wide La Pine area (better characterization of plume movement and concentration) Prineville area Redmond area Sherman County Other areas in the Lower Deschutes Warm Springs Tribal lands	Groundwater	Nitrate Correlate data collection with specific actions identified in the Priority Focus Area for groundwater nitrate	DEQ USGS La Pine Prineville Redmond Sherman County CTWS

ANALYSIS OF COLLECTED DATA

Water quality and resource data have been collected in the Deschutes Basin for well over 30 years. A portion of this data was analyzed as part of the Deschutes Basin WA process. The findings of these analyses are presented in the preceding sections of this document. A very substantial amount of data have been collected by many different stakeholders in the basin. These data have not been collectively reviewed or analyzed relative to (1) statistical trend analysis of water quality data at fixed sites, (2) regression and other types of analysis linking spatial data and water quality data, and/or (3) statistical and manual comparisons of land management information, spatial data and water quality data.

As part of on-going efforts coordinated with this WA, it is recommended that a comprehensive data analysis report for the Deschutes Basin be prepared at five-year intervals (coinciding with the iterative WA process). An initial report summarizing and collectively analyzing all appropriate data collected to date would provide information critical to the implementation of this Action Plan.

Such a data analysis is strongly recommended in order to inform prioritization of monitoring strategies, focus and timing; to inform on-going and future implementation projects and areas of focus, and to identify existing data gaps.

PRIORITY DATA ANALYSIS NEEDS IDENTIFIED IN THE DESCHUTES BASIN	
Analysis needs	Coordinating Entities
Gather all macroinvertebrate data (REMAP, BLM, AREMP, PIBO, J. Anderson, Xerces) and analyze data for conditions - Need methodology to integrate DEQ data with other methods	DEQ USFS ODF USFWS EPA Crooked and Upper Deschutes Watershed Councils BLM
Perform OWQI trend analysis for different time periods - DEQ currently uses a 10-year moving trend. Need to opportunity to assess longer time periods to provide additional insight into resource status changes over time	DEQ
Analysis of collected Metolius data (USFS and others) to identify water quality trends - Identify additional data collection needs - Better characterize issues around Camp Sherman and/or the hatchery - Gradual increase in pH at ambient site - Coordinate with Friends of the Metolius for database	DEQ Deschutes National Forest Friends of the Metolius Jefferson County
Track and assess changes in land use and land management in the Deschutes Basin (these changes have the potential to effect resources status and function to a substantial degree) - Future iterations of the WA need to assess land use changes and revise the findings of the previous assessment accordingly	DEQ NRCS ODA DLCD Counties OWRD
Assess available flow information to achieve a better understanding of where flow impaired reaches exist - Need information to better determine/project what natural flows would be in different areas of the Basin - Need to better coordinate with other entities currently working on flow assessment (Habitat Conservation Plan, irrigation districts, etc)	DEQ OWRD ODFW Irrigation Districts
Assessment of toxics data in LASAR – groundwater, surface water, fish and sediments. - Determine where problems are indicated - Determine where data gaps exist and prioritize filling them - Evaluate available data	DEQ

PRIORITY DATA ANALYSIS NEEDS IDENTIFIED IN THE DESCHUTES BASIN	
Analysis needs	**Coordinating Entities**
Assessment/evaluation of mercury concentrations in East Lake - Assess probable source(s)	DEQ EPA USGS USFWS
Assessment/evaluation of arsenic in both groundwater and surface waters - Determine if the concentrations observed represent human health/fish issues - Determine the source(s) - Secure/prioritize additional studies arsenic - Coordinate with other stakeholders on this issue - Assess the arsenic survey that was done in the Prineville area	DEQ ODFW CTWS Prineville
Assessment/evaluation of changes in groundwater-surface water interactions specific to spring/stream flows and water quality - Develop tools/relationships to assess the cumulative effects of groundwater pumping - Develop tools/relationships to assess the cumulative effects of lining of canals - Areas needing assessment include ° Deschutes River between Bend and Lake Billy Chinook (middle Deschutes) ° Lower Crooked River ° Lower Whychus Creek.	DEQ OWRD USBR Irrigation Districts USGS ODFW BLM The Nature Conservancy CTWS
Update the Deschutes Groundwater report - Combine information from public drinking water supply database and RET databases - Update info on landfill monitoring, environmental cleanup/underground storage tanks - Perform a source assessment for bacteria found in groundwater wells (identify causes and extent and magnitude of the concern)	DEQ OWRD ODA USBR USGS Municipalities Counties COIC
Evaluation of CAFO permits - Determine/assess potential for effects on water quality - Identify any violations of permit conditions	DEQ ODA NRCS
Further evaluation of WPCF/NPDES permits - Identify expired permits - Identify/assess known or potential groundwater or surface water contamination from point sources	DEQ EPA

REPORTING

It is recognized that at this time there is no structure in place that allows multi-stakeholder data to be submitted to a central clearing house for the Deschutes Basin. In the absence of such a structure, the Action Plan and Summary of Implementation Efforts in the Status Report will function as an unofficial clearing house and coordination mechanism for monitoring efforts in the Basin. It is envisioned that in future versions of the Deschutes WA, a comprehensive listing of implementation efforts (including both on-the-ground project activities and assessment activities) will be compiled.

This listing will used to identify the activities and monitoring that are occurring in the Basin relative to implementation and assessment activities AND to provide contact and monitoring content information so that those needing access to the data will have somewhere to go to get it.

This listing will contain (at minimum) information on project name, project type, project sponsor [including specific contact information for agency/entity with project oversight responsibility], project partners, project status [completed, in-progress, designed, planned], funding source(s), monitoring associated with the project [type of monitoring, parameters recorded, measured or analyzed, scope, frequency and timescale of monitoring], and a brief description of the project work and expected outcomes. This listing will be updated with each iteration of the WA until such a time as a central clearing house for data is available.

BIBLIOGRAPHY

Anderson, J.R., E.H. Hardy, J.T. Roach and R.E. Witmer. 1976, digital conversion 2001. A Land Use and Land Cover Classification System For Use With Remote Sensor Data. Geological Survey Professional Paper 964. U.S. Department of Interior, U.S. Geological Survey.

ATSDR. 2001. Public Health Statement for DDT, DDE, and DDD, May 1994. Public Health Statement for Dieldrin, April 1993. http://www.atsdr.cdc.gov/toxprofiles/phs35.html

Aylward, B. 2006. Growth, Urbanization and Land Use Change: Impacts on Agriculture and Irrigation Districts in Central Oregon. Deschutes Water Alliance Final Report. Bend, OR.

Aylward, B. and D. Newton. 2006. Long-Range Water Resources Management in Central Oregon: Balancing Supply and Demand in the Deschutes Basin. Deschutes Water Alliance Final Report. Bend and Redmond, OR.

Clark, J.S. and K. Lamson. 2005. Bakeoven Watershed Assessment and Action Plan. Wasco County Soil and Water Conservation District.

Clark, G.M. and T.R. Maret. 1998. Organochlorine compounds and trace elements in fish tissue and bed sediments in the Lower Snake River basin, Idaho and Oregon. United States Geological Survey Water Resources Investigations Report 98-4103. 35 p.

Cole, D.L. 2006. Groundwater Quality Report for the Deschutes Basin, Oregon. Prepared for the Oregon Department of Environmental Quality. Portland, OR.

CTWS and PGE. 2002. Pelton Round Butte Project Water Quality Management and Monitoring Plan. 29 pp.

Dake, L. 2010. "EPA, Warm Springs work to ensure pure water." In: News from Indian Country, accessed on-line 1/10/11 http://indiancountrynews.net/index.php?option=com_content&task=view&id=10388&Itemid=1

Deschutes River Conservancy, Upper Deschutes Watershed Council, Oregon Department of Fish and Wildlife. 2008. Upper Deschutes River Restoration Strategy.

Fitzpatrick, K, K. Gorman and B. Aylward. 2006. Reservoir Management. Deschutes Water Alliance Final Report. Bend, OR.

Fry, J.A., Coan, M.J., Homer, C.G., Meyer, D.K., and Wickham, J.D., 2009, Completion of the National Land Cover Database (NLCD) 1992–2001 Land Cover Change Retrofit product: U.S. Geological Survey Open-File Report 2008–1379, 18 p.

Golden, B. and B. Aylward. 2006. Instream Flow in the Deschutes Basin: Monitoring, Status and Restoration Needs. Deschutes Water Alliance Final Report. Bend, OR.

Hammond, E. and J. Roofener. 2007. Agency Plains WQ Sampling – 2006 – Final Report. Oregon Department of Agriculture and Jefferson County Soil and Water Conservation District. 28 pp.

Hammond, E. and J. Roofener. 2008. 2007 Agency Plains WQ Sampling – Final Report. Oregon Department of Agriculture and Jefferson County Soil and Water Conservation District. 18 pp.

Hammond, E. and J. Roofener. 2010. 2008 Agency Plains WQ Sampling – Final Report. Oregon Department of Agriculture and Jefferson County Soil and Water Conservation District. 13 pp.

Hinkle, S.R., D.S. Morgan, L.L. Orzol, and D.J. Polette. 2007. Ground Water Redox Zonation near La Pine, Oregon: Relation to River Position within the Aquifer–Riparian Zone Continuum. U.S. Geological Survey Scientific Investigations Report 2007–5239.

Johnson, Daniel, R. Petersen, D. Lycan, J. Sweet, M. Newhaus and A. Schaedel. 1985. Atlas of Oregon Lakes. OSU Press, 319 pp

Lamson, K. and J.S. Clark. 2004. White River Watershed Assessment. Wasco County Soil and Water Conservation District.

Lee Huckins, DEQ, personal communication, December 2010.

Lewis, S.E. 2003. Nitrate Concentrations in Willow Creek and the Agency Plains Aquifer, Jefferson County, Oregon. Portland General Electric. Madras, OR. 20 pp.

Maret, T.R. 1995a. Mercury in Streambed Sediment and Aquatic Biota in the Upper Snake River Basin, Idaho and Western Wyoming, 1992. U.S. Geological Survey, 1995. FS-089-95.

Maret, T. R. 1995b. Water-Quality Assessment of the Upper Snake River Basin, Idaho and Western Wyoming-Summary of Aquatic Biological Data for Surface Water through 1992. United States Geological Survey Water-Resources Investigations Report 95-4006, Vol. 4006. 59 p.

Maret, T. R. and D.S. Ott. 1997. Organochlorine Compounds in Fish Tissue and Bed Sediment in the Upper Snake River Basin, Idaho and Western Wyoming. United States Geological Survey Water-Resources Investigations Report 95-4006, Vol. 4080, Boise, Idaho. 23 p.

Mazzacano, C. 2010. "Whychus Creek Restoration: Project Effectiveness Monitoring Using Benthic Macroinvertebrates". Pages 100-119 in Golden B and Houston R, Editors. 2009 Whychus Creek Monitoring Report. Upper Deschtues Watershed Council, Bend, OR. 134 pp. Pages 100-119

National Academy of Sciences (NAS) and National Academy of Engineering (NAE). 1973. Water Quality Criteria 1972. United States Environmental Protection Agency Ecological Research Series Report R3-73-003, Washington, DC.

National Pesticide Telecommunications Network. 2000. Pesticides in Drinking Water. Oregon State University. http://www.npic.orst.edu/factsheets/drinkingwater.pdf

National Toxicology Program (NTP). 2001. National Institutes of Health (NIHS). Research Triangle Park, North Carolina.

Natural Resources Conservation Service. 1994. Buck Hollow Watershed Plan and Environmental Assessment. Sherman and Wasco Counties, OR.

Natural Resources Conservation Service. 2005a. Subbasin Profile: Little Deschutes Subbasin – 17070302. http://www.or.nrcs.usda.gov/technical/huc-deschutes.html

Natural Resources Conservation Service. 2005b. Subbasin Profile: Lower Crooked Subbasin – 17070305. http://www.or.nrcs.usda.gov/technical/huc-deschutes.html

Natural Resources Conservation Service. 2005c. Subbasin Profile: Lower Deschutes Subbasin – 17070306. http://www.or.nrcs.usda.gov/technical/huc-deschutes.html

Natural Resources Conservation Service. 2005d. Subbasin Profile: South Fork Crooked Subbasin – 17070303. http://www.or.nrcs.usda.gov/technical/huc-deschutes.html

Natural Resources Conservation Service. 2005e. Subbasin Profile: Trout Subbasin – 17070307. http://www.or.nrcs.usda.gov/technical/huc-deschutes.html

Natural Resources Conservation Service. 2005f. Subbasin Profile: Upper Crooked Subbasin – 17070304. http://www.or.nrcs.usda.gov/technical/huc-deschutes.html

Natural Resources Conservation Service. 2005g. Subbasin Profile: Upper Deschutes Subbasin – 17070301. http://www.or.nrcs.usda.gov/technical/huc-deschutes.html

Newton, D. and M. Pearle. 2006. Irrigation District Water Efficiency Cost Analysis and Prioritization. Deschutes Water Alliance Final Report. Redmond, OR.

Newton, D., M. Pearle, and J. Polvi. 2006. Future Ground Water Demand in the Deschutes Basin. Deschutes Water Alliance Final Report. Redmond, OR.

Nichols, D. 1999. An Update on Sewage Disposal Wells in Central Oregon. Internal DEQ memo.

Nielsen-Pincus, M. ed., 2008. Lower Crooked River Watershed Assessment. Crooked River Watershed Council. Prineville, OR.

NLCD (National Land Cover Database). 2001. http://www.mrlc.gov/nlcd.php. Multi-Resolution Land Characteristics (MRLC) Consortium

Northwest Power and Conservation Council. 2005. Deschutes Subbasin Plan. In *Columbia River Basin Fish and Wildlife Program.* Portland, Oregon. 668 pp.

ODEQ. 1988. 1988 Oregon Statewide Assessment of Nonpoint Sources of Water Pollution. Portland, OR.

ODEQ. 2002. Final Evaluation and Findings Report on the Application for Certification Pursuant to Section 401 of the Federal Clean Water Act. Submitted by Portland General Electric Company and the Confederated Tribes of the Warm Springs Reservation of Oregon for the Relicensing of the Pelton Round Butte Hydroelectric Project on the Deschutes River, Jefferson County, Oregon (FERC No. 2030). 177 pp.

ODHS. 1993. Technical Bulletin: Health Effects Information on Lead. Fact Sheet prepared by the Environmental Toxicology Section of the Oregon Department of Human Services.

ODHS. 2001. Technical Bulletin: Health Effects Information on Nitrate. Fact Sheet prepared by the Environmental Toxicology Section of the Oregon Department of Human Services.

ODHS. 2002a. Technical Bulletin: Health Effects Information on Arsenic. Fact Sheet prepared by the Environmental Toxicology Section of the Oregon Department of Human Services.

ODHS. 2002b. Technical Bulletin: Health Effects Information on Coliform Bacteria. Fact Sheet prepared by the Environmental Toxicology Section of the Oregon Department of Human Services.

Omernik, J.M.; Abernathy, A.R.; Male, L.M.; 1981 (July-August); Stream Nutrient Levels and Proximity of Agricultural and Forest Land to Streams: Some Relationships; Journal of Soil and Water Conservation; pp 227-231.

Platts, W.S.; Nelson, R.L.; 1995 (February); Streamside and Upland Vegetation Use by Cattle; Rangelands; Volume 7; Number 1; pp 5-7.

Prowell, Roger; 2004. Personal Communication. As quoted in: Deschutes Subbasin Plan, Northwest Power and Conservation Council, May 2004

Rinella, F.A., W.H. Mullins, and C.A. Schuler. 1994. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Owyhee and Vale Projects, Oregon and Idaho, 1990-1991. United States Geological Survey Water Res. Invest. Rep. 93-4156.

Shewmaker, G.E.; 1997; Livestock Grazing Effects on Phosphorus Cycling in Watersheds; Proceedings: Watershed and Riparian Workshop; LeGrand, Oregon; September 11-13; 25 p.

Stone, D. and W. Bress. 2007. Addressing Public Health Risks for Cyanobacteria in Recreational Freshwaters: The Oregon and Vermont Framework. Integrated Environmental Assessment and Management, Volume 3, Number 1. pp. 137–143.

Sweet, James W. May 1985. An Analysis of Phytoplankton of Oregon Lakes. Aquatic Analysts. Portland, OR.

Turner, Dan. June 2010. Remote sensing of chlorophyll *a* Concentrations to Support the Deschutes Basin Lake and Reservoir TMDLs. Oregon Department of Environmental Quality.

U.S. Environmental Protection Agency. 1977. Guidelines for the pollution classification of Great Lake harbor sediments. Region 5. Chicago, IL.

U.S. Forest Service. 1994. Upper Deschutes River Instream Flow Assessment. Developed in cooperation with U.S. Bureau of Reclamation, Oregon parks and Recreation Department, Dechutes County Community Development Department and Oregon Department of Fish and Wildlife.

Watershed Professionals Network. 2002. Trout Creek Watershed Assessment. Prepared for the Bonneville Power Administration and the Trout Creek Watershed Council.

Weitkamp, D.E., Sullivan, R.D., Swant, T. and J. DosSantos. 2003. Behavior of Resident Fish Relative to Total Dissolved Gas Supersaturation in the Lower Clark Fork. *Transactions of the American Fisheries Society* 132:856-864

Whitman, T. 2002. Crooked River Watershed Assessment. Crooked River Watershed Council. Prineville, OR.

Yake, K. 2003. Upper Deschutes Subbasin Assessment. Upper Deschutes Watershed Council. Bend, OR.

Yinger, M. and E. Salminen. 2009. Evaluation of the Impact of Cumulative Groundwater Withdrawals in the Upper Deschutes Basin on Water Temperatures of the Middle Deschutes River. Prepared for: Central Oregon LandWatch. 9 pages. http://www.centraloregonlandwatch.org/files/Middle%20Deschutes%20100%20cfs%20Report%202009-02-25%20FINAL.pdf

Yinger. M. and L. Strauss. 2008. Case Study: Thornburgh Resort Water Resources Impact Evaluation, Upper Deschutes Basin, Oregon. Prepared for Vulcan Power Company, Bend, OR. 59 pages plus tables and appendices. http://www.centraloregonlandwatch.org/content/hydrological-impacts-assessment-yinger

ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
AF	Acre-feet
AMD	Acid Mine Drainage
AREMP	Aquatic and Riparian Effectiveness Monitoring Program
BGA	Blue-green algae
BLM	United States Bureau of Land Management
BMPs	Best Management Practices
BOD	Biochemical oxygen demand
BPA	Bonneville Power Administration
ºC	Degrees Celsius
CAFO	Confined Animal Feeding Operation
CBOD	Carbonaceous biochemical oxygen demand
CFR	Code of Federal Regulations
cfs	Cubic feet per second
COCO	Central Oregon Cities Organization
COIC	Central Oregon Intergovernmental Council
COID	Central Oregon Irrigation District
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CTWS	Confederated Tribes of Warm Springs
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DBBC	Deschutes Basin Board of Control
DEQ	Oregon Department of Environmental Quality
DHS	Department of Human Services
DO	Dissolved oxygen
DOGAMI	Oregon Department of Geology and Mineral Industries
DRC	Deschutes River Conservancy
DSL	Oregon Department of State Lands
DWA	Deschutes Water Alliance
E. Coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
ECSI	Environmental Cleanup Site Information
FERC	Federal Agency Regulatory Agency
ft	Feet
FPA	Forest Practices Act
G	Gram
GIS	Geographic Information Systems
GW	Groundwater
GWMA	Groundwater Management Area
HABS	Harmful Algal Bloom Surveillance

Acronym or Abbreviation	Definition
kg	Kilogram
LASAR	Laboratory Analytical Storage and Retrieval Database
Lbs	Pounds
LUST	Leaking Underground Storage Tank
MCL	Maximum Contaminant Level
Mg	Milligram
mg/L	Milligrams/liter
ml	Milliliters
ng	Nanogram
NMFS/NOAA	National Marine Fisheries Service/National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NUID	North Unit Irrigation District
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
OWQI	Oregon Water Quality Index
OWRD	Oregon Department of Water Resources
PCPs	Personal Care Products
PGE	Portland General Electric
PIBO	Pacfish Infish Biological Opinion Effectiveness Monitoring Program
PSU	Portland State University
PURS	Pesticide Use Reporting System
RBS	Relative Bed Stability
REMAP	Regional Environmental Monitoring and Assessment Program
SOCs	Synthetic Organic Compounds
SWCD	Soil and Water Conservation District
TDG	Total Dissolved Gas
TID	Tumalo Irrigation District
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
UDWC	Upper Deschutes Watershed Council

Acronym or Abbreviation	Definition
ug	Microgram
UIC	Underground Injection and Control
US	United States
USACOE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds
WA	Watershed Approach
WC	Watershed Council
WHO	World Health Organization
WPCF	Water Pollution Control Facility
WWTP	Wastewater Treatment Plant

APPENDIX A: DESCHUTES BASIN WATERSHED APPROACH PRIORITIES

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	Timeline	Bio-Solids	Water Reuse	CWSRF	Drinking Water	Groundwater	On-Site	UIC	401 dredge/fill	Standard/Assess	Pretreatment	Municipal	Stormwater	319	TMDLs	Monitoring	Toxics	Data Management	Permitting	Nonpoint	401 hydro	Industrial Permits	Partner Organizations
Assess the number and status of UICs in the Deschutes Basin; Update existing DEQ databases to reflect recent changes in DEQ's UIC program	N			X				X					X					X					Municipalities, COIC, CTWS
Prepare and provide guidance for, and actively support appropriate alternatives to UICs for public education	N					X		X								X		X					Municipalities, COIC, CTWS
Require a minimum distance from stream for all publically funded agricultural fencing projects (dependent on stream size and flow characteristics)	N													X						X			ODA, ODF, ODFW, NRCS, SWCDs, CTWS, BLM, USFS, OWEB, Watershed Councils, SWCDs
Make riparian restoration a priority project type in the NPS 319 program (including	N													X						X			ODA, ODF, ODFW, NRCS, SWCDs, CTWS, BLM, USFS, OWEB,

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	Timeline	Bio-Solids	Water Reuse	CWSRF	Drinking Water	Groundwater	On-Site	UIC	401 dredge/fill	Standard/Assess	Pretreatment	Municipal	Stormwater	319	TMDLs	Monitoring	Toxics	Data Management	Permitting	Nonpoint	401 hydro	Industrial Permits	Partner Organizations
riparian fencing). Support riparian restoration as a priority in other funding programs.																							Watershed Councils, SWCDs
Support agricultural management plans that promote farming practices that minimize instream and downstream impacts (refer to Action Plan)	N			X										X						X			ODA, ODF, ODFW, NRCS, SWCDs, CTWS, BLM, USFS, OWEB, Watershed Councils, SWCDs
Develop, initiate and implement public education programs about the connectivity between land use and the impacts on basin resources	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ODA, ODF, ODFW, OWRD, NRCS, SWCDs, CTWS, BLM, USFS, OWEB, EPA, Irrigation Districts, Watershed Councils, SWCDs, Municipalities, COIC
Support implementation of	N			X										X						X			OWRD, ODA, USBR,

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	Timeline	Bio-Solids	Water Reuse	CWSRF	Drinking Water	Groundwater	On-Site	UIC	401 dredge/fill	Standard/Assess	Pretreatment	Municipal	Stormwater	319	TMDLs	Monitoring	Toxics	Data Management	Permitting	Nonpoint	401 hydro	Industrial Permits	Partner Organizations
water conservation strategies on-farm																							Irrigation Districts, NRCS, DRC, OWEB, CTWS, SWCDs, Watershed Councils
Encourage consideration of water rights transfer to instream flows in cases where property management is changing or public funds are being spent	N			X										X						X			OWRD, ODA, USBR, Irrigation Districts, NRCS, DRC, OWEB, CTWS, SWCDs, Watershed Councils
Identify funding for support of sediment assessment tools and strategies	N								X	X		X	X	X	X	X			X	X		X	ODA, USBR, Irrigation Districts, OWEB, NRCS, EPA, USFS, ODF, BLM, ODFW
Develop, adopt and implement a better way to assess sedimentation and determine	N								X	X		X	X	X	X	X			X	X		X	ODA, USBR, OWEB, NRCS, EPA, USFS, ODF, BLM, ODFW

Priority Actions																							
Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
impairment																							
Develop and implement consistent assessment protocols for streambank erosion, channel stability and general sedimentation condition	N								X	X		X	X	X	X	X			X	X		X	ODA, USBR, Irrigation Districts, OWEB, NRCS, EPA, USFS, ODF, BLM, ODFW
Evaluate RBS and other available/accepted methodologies for stream condition assessment as potential models for agency use	N								X	X		X	X	X	X	X			X	X		X	ODA, USBR, OWEB, NRCS, EPA, USFS, ODF, BLM, ODFW
Work with other programs and stakeholders to determine potential causes and treatments of sediment impairments	N								X	X		X	X	X	X	X			X	X		X	ODA, USBR, Irrigation Districts, OWEB, NRCS, EPA, USFS, ODF, BLM, ODFW

Priority Actions																							
Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
Develop and implement more effective sedimentation and turbidity standards	N								X	X		X	X	X	X	X			X	X		X	ODA, USBR, NRCS, EPA, USFS, ODF, BLM, ODFW
Minimize erosion through targeted streambank stabilization, improved land management and conservation cropping techniques	N								X	X		X	X	X	X	X			X	X		X	ODA, USBR, Irrigation Districts, OWEB, NRCS, EPA, USFS, ODF, BLM, ODFW
Encourage projects and practices that will result in increased channel complexity and function, increased sinuosity and more natural flow volumes and regimes	N													X	X					X			ODFW, USFWS, NMFS/NOAA, Watershed Councils, USFS, ODF , CTWS, BLM, ODA, NRCS, SWCDs, Irrigation districts, OWEB, DSL, USACOE
Encourage practices and programs that will result in	N													X	X					X			ODA, NRCS, CTWS, SWCDs, OWEB, ODOT,

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
increased incidence and diversity of native vegetation																							Watershed Councils, OSU Extension, Counties
Support and encourage sustainable grazing practices in rangelands	N													X	X					X			ODA, ODF, OWEB, BLM, USFS, ODF, OSU Extension, SWCDs, Watershed Councils
Detailed evaluation of available USGS data for mercury (all forms, all media)	N									X					X	X	X	X					DOGAMI, USFS, ODF, EPA, USGS, CTWS, ODFW, USFWS, NMFS/NOAA
Coordinate with Oregon State-Wide Mercury TMDL process to share data and loading/deposition assessments	N									X			X		X	X	X	X	X			X	DOGAMI, USFS, ODF, EPA, USGS, CTWS, ODFW, USFWS, NMFS/NOAA
Revision of Oregon water quality and human health criteria for toxics	N									X					X	X	X	X	X			X	DOGAMI, USFS, ODF, EPA, USGS, CTWS, ODFW,

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	Timeline	Bio-Solids	Water Reuse	CWSRF	Drinking Water	Groundwater	On-Site	UIC	401 dredge/fill	Standard/Assess	Pretreatment	Municipal	Stormwater	319	TMDLs	Monitoring	Toxics	Data Management	Permitting	Nonpoint	401 hydro	Industrial Permits	Partner Organizations
specific to proposed increase in fish consumption rate and toxics rule revisions																							USFWS, NMFS/NOAA
Assess the arsenic survey that was done in the Prineville area	N									X					X	X	X	X	X				DOGAMI, EPA, USGS, CTWS
Revision of Oregon water quality and human health criteria for arsenic specific to proposed toxics rule revisions	N									X					X	X	X	X	X			X	DOGAMI, EPA, USGS, CTWS
Minimize nitrate transport to groundwater, including from septic systems, stormwater discharge and agricultural activities.	N			X		X		X		X			X		X	X		X	X	X			EPA, USGS, Municipalities, Counties, COIC, SWCDs, CTWS, ODA, NRCS
Develop tools/relationships to assess the	N					X									X	X		X		X			OWRD, USBR, USGS, Municipalities,

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	Timeline	Bio-Solids	Water Reuse	CWSRF	Drinking Water	Groundwater	On-Site	UIC	401 dredge/fill	Standard/Assess	Pretreatment	Municipal	Stormwater	319	TMDLs	Monitoring	Toxics	Data Management	Permitting	Nonpoint	401 hydro	Industrial Permits	Partner Organizations
cumulative effects that groundwater pumping and/or the lining of canals in the Upper Deschutes Subbasin will have/is having on spring/stream flows and water quality in the Deschutes River between Bend and Lake Billy Chinook (middle Deschutes), the lower Crooked River, and lower Whychus Creek.																							Counties, COIC, LM, USFS, ODF, ODFW, Irrigation Districts
Recognize that the basin's surface water resources have been fully appropriated for many years, and stream flows are locally below legally set minimums at certain times of the year, and that virtually all new	N					X									X	X		X		X			OWRD, USBR, USGS, Municipalities, Counties, COIC, LM, USFS, ODF, ODFW, Irrigation Districts

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
development will rely on groundwater. Use this information to guide projects and policy in future regulatory and funding decisions.																							
Recognize, support and enhance OWRD's Deschutes Groundwater Mitigation Program.	N					X									X	X		X		X			OWRD, USBR, USGS, Municipalities, Counties, COIC, LM, USFS, ODF, ODFW, Irrigation Districts
Identify funding and staff support for developing, maintaining and routinely updating a more accessible, user friendly database for compilation, display, access and analysis of all appropriate forms	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Priority Actions																							
Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
of data from DEQ (all subprograms) and stakeholders																							
Establish and maintain a strong, interactive, working relationship with CTWS, sister agencies (ODA, ODF, DSL, OWRD, ODFW) and local and federal agencies and entities that allows effective communication and support	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ODA, ODF, OWRD, ODFW, DSL, CTWS, USFS, BLM, EPA, NRCS, Irrigation Districts, Watershed Councils, SWCDs, Municipalities, Counties
Work with CTWS to compile and assess water quality data on tribal lands - and their data off tribal lands as well.	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	CTWS
Work specifically to improve DEQ's relationship with CTWS to better	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	CTWS

Priority Actions																							
Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
understand and reflect each other's objectives and goals in coordinated efforts and to allow more effective sharing of resources and information specific to resource needs in the Deschutes Basin																							
Develop and oversee a Basin-wide Monitoring Council to help coordinate monitoring, funding, project implementation and data analysis on a holistic scale	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ODA, ODF, OWRD, ODFW, DSL, CTWS, USFS, BLM, EPA, NRCS, Irrigation Districts, Counties, Watershed Councils, SWCDs, Municipalities
Continue existing stakeholder outreach and involvement in the on-going WA and	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ODA, ODF, OWRD, ODFW, CTWS, USFS, BLM, EPA, NRCS,

Priority Actions																							
Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
TMDL processes																							Irrigation Districts, Watershed Councils, SWCDs, Municipalities, Counties , COIC
Identify funding and staff support for developing and maintaining an interactive web tool for data and information and sharing; web tool should be developed in a fashion that it can support efforts and processes on a state-wide scale with Basin or smaller specificity; develop and maintain an interactive web tool for data and information sharing	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ODA, ODF, OWRD, ODFW, CTWS, USFS, BLM, EPA, NRCS, Irrigation Districts, Watershed Councils, SWCDs, Municipalities, Counties , COIC

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
with Deschutes Basin-specific information																							
Update and revise the existing DEQ website so that it provides effective, interactive information, and staff and stakeholder support	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ODA, ODF, OWRD, ODFW, CTWS, USFS, BLM, EPA, NRCS, Irrigation Districts, Watershed Councils, SWCDs, Municipalities, Counties , COIC
Design and implement a more comprehensive collection of blue-green algae data to identify areas of concern	N M									X					X	X	X	X					USFS, ODF, PGE, USBR, DHS, USFWS, ODFW, USGS, Irrigation Districts, PSU – Center for Lakes and Reservoirs
Design and support a monitoring program to collect data to help	N M									X					X	X	X	X					USFS, ODF, PGE, USBR, DHS, USFWS, ODFW, USGS,

Priority Actions

Near Field = N (next 18 months) **Mid Field = M (18 months - 3 years)** **Far Field = F (3 to 5 years)**	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
identify causes of harmful algal blooms and associated impairment																							Irrigation Districts, PSU – Center for Lakes and Reservoirs
Identify funding for support of HABs data collection and analysis	N M									X					X	X	X	X					USFS, ODF, PGE, USBR, DHS, USFWS, ODFW, USGS, Irrigation Districts, PSU – Center for Lakes and Reservoirs
Develop, adopt and implement a statewide strategy for identifying and responding to harmful algal blooms	N M									X					X	X	X	X					USFS, ODF, PGE, USBR, DHS, USFWS, ODFW, USGS, Irrigation Districts, PSU – Center for Lakes and Reservoirs
Develop and implement additional monitoring and analysis to further refine and	N M			X		X		X		X			X			X		X	X	X			USGS, Municipalities, Counties, COIC, SWCDs, CTWS

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
understand contamination in groundwater in the Basin																							
Identify sources and extent of nitrate contamination of groundwater throughout the basin, including the need for additional monitoring, data analysis and public outreach; minimize nitrate transport to groundwater (refer to Action Plan)	N M			X		X		X		X			X			X		X	X	X			USGS, Municipalities, Counties, COIC, SWCDs, CTWS
Assess the status and potential effect of permitted discharges (UIC, NPDES, WPCF, CAFO) to estimate projected risk to surface and groundwater quality	M					X	X	X					X						X				ODA, NRCS, EPA, CTWS, COIC, Municipalities

Priority Actions

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
Assess and evaluate mercury concentrations and probable sources of mercury in East Lake	M									X					X	X	X	X					DOGAMI, USFS, ODF, EPA, USGS, CTWS, ODFW, USFWS, NMFS/NOAA
Design and implement a monitoring program(s) to provide a robust data set for fish tissue mercury (methylmercury) in the basin - special emphasis on the Crooked and Little Deschutes Subbasins	M									X					X	X	X	X					DOGAMI, USFS, ODF, EPA, USGS, CTWS, ODFW, USFWS, NMFS/NOAA
Assess and evaluate arsenic in both groundwater and surface waters to determine probable sources and if the concentrations observed represent	M									X					X	X	X	X	X				DOGAMI, EPA, USGS, CTWS

Priority Actions **Near Field = N (next 18 months)** **Mid Field = M (18 months - 3 years)** **Far Field = F (3 to 5 years)**	**Timeline**	**Bio-Solids**	**Water Reuse**	**CWSRF**	**Drinking Water**	**Groundwater**	**On-Site**	**UIC**	**401 dredge/fill**	**Standard/Assess**	**Pretreatment**	**Municipal**	**Stormwater**	**319**	**TMDLs**	**Monitoring**	**Toxics**	**Data Management**	**Permitting**	**Nonpoint**	**401 hydro**	**Industrial Permits**	**Partner Organizations**
human health/fish issues																							
Update the Deschutes Groundwater report (particularly as related to toxics)	M					X		X							X	X	X	X	X	X		X	OWRD, ODA, USBR, USGS, Municipalities, Counties, COIC
Perform a source assessment for bacteria found in groundwater wells (identify causes and extent and magnitude of the concern)	M					X									X	X		X		X			OWRD, ODA, USBR, USGS, Municipalities, Counties, COIC

Monitoring Needs

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	Timeline	Nonpoint	Groundwater	On-Site	319	TMDLs	Laboratory Monitoring	Volunteer Monitoring	Toxics	Partner Organizations
DEQ support for bacteria, DO, pH and nutrient monitoring in the White River Watershed	N	X		X	X	X	X	X		ODA, Wasco SWCD, Mt Hood NF, Maupin School, BLM, ODFW
DEQ support for bacteria and nutrient monitoring (as associated with possible septic system influences) in the Deschutes and Little Deschutes Rivers, Metolius River, Camp Sherman and other resort areas	N	X	X	X	X		X	X		Friends of the Metolius, Deschutes NF, Jefferson County, USGS, Upper Deschutes WC
More comprehensive collection of blue-green algae data to identify areas of concern, both on and off forest, causes of hazardous algal blooms and associated impairment. Correlate data collection with specific actions identified in the Priority Focus Area for harmful algae blooms.	N	X			X	X	X	X		PGE, CTWS, Deschutes NF, Ochoco NF, Mt. Hood NF, BLM, USBR
DEQ support for monitoring water quality conditions in the Deschutes River below Pelton-Round Butte project beginning in 2012	N					X				PGE
DEQ support for monitoring of irrigation return flows and tributaries to lower Deschutes and upper Trout Creek for DO, pH and nutrients, assesment of nitrate sources to groundwater	N	X	X		X	X	X	X		Jefferson SWCD, ODA, CTWS
DEQ support for monitoring toxics (mercury, arsenic, emerging contaminants) to determine source (natural or man-made). Correlate data collection with identified data analysis needs.	N	X	X		X		X		X	USGS, CTWS, ODFW
DEQ support for basin-wide monitoring of nitrate in groundwater with specific focus on the La Pine area (better characterization of plume movement and concentration), Prineville area, Redmond area, Sherman County, other areas in the Lower Deschutes, Warm Springs Tribal lands	N	X	X	X			X			USGS, La Pine, Prineville, Redmond, Sherman County, CTWS
DEQ support for bacteria and nutrient monitoring in the Upper Crooked and Beaver-South Fork watersheds	M	X			X		X	X		Crooked River WC, ODA
DEQ facilitate comprehensive monitoring with partners to establish monitoring plans and funding mechanisms	M	X						X		Natural Resource Agencies

Data Analysis Needs

Near Field = N (next 18 months) Mid Field = M (18 months - 3 years) Far Field = F (3 to 5 years)	Timeline	Nonpoint	Permitting	Groundwater	Laboratory	TMDLs	Ambient	Bio-monitoring	Toxics	Partner Organizations
Perform OWQI trend analysis for different time periods: DEQ currently uses a 10-year moving trend. Need to opportunity to assess longer time periods to provide additional insight into resource status changes over time	N							X		
Analysis of collected Metolius data (USFS and others) to identify water quality trends - Identify additional data collection needs - Better characterize issues around Camp Sherman and/or the hatchery - Gradual increase in pH at ambient site - Coordinate with Friends of the Metolius for database	N				X					Deschutes NF, Friends of the Metolius, Jefferson County
Assess available flow information to achieve a better understanding of where flow impaired reaches exist - Need information to better determine/project what natural flows would be in different areas of the Basin - Need to better coordinate with other entities currently working on flow assessment (Habitat Conservation Plan, irrigation districts, etc)	N				X	X	X			OWRD, ODFW, Irrigation Districts
Assessment of toxics data in LASAR – groundwater, surface water, fish and sediments. - Determine where problems are indicated - Determine where data gaps exist and prioritize filling them - Evaluate available data	N				X				X	
Assessment/evaluation of changes in groundwater-surface water interactions specific to spring/stream flows and water quality - Develop tools/relationships to assess the cumulative effects of groundwater pumping - Develop tools/relationships to assess the cumulative effects of lining of canals - Areas needing assessment include: Deschutes River between Bend and Lake Billy Chinook (middle Deschutes) Lower Crooked River Lower Whychus Creek.	N M	X		X	X					OWRD, USBR, Irrigation Districts, USGS, ODFW, BLM, The Nature Conservancy, CTWS
Gather all macroinvertebrate data (REMAP, BLM, AREMP, PIBO, J. Anderson, Xerces) and analyze data for conditions. Need methodology to integrate DEQ data with other methods	M						X	X		USFS, ODF, USFWS, EPA, Crooked WC, Upper Deschutes WC, BLM

Data Analysis Needs

Near Field = N (next 18 months) **Mid Field = M (18 months - 3 years)** **Far Field = F (3 to 5 years)**	**Timeline**	**Nonpoint**	**Permitting**	**Groundwater**	**Laboratory**	**TMDLs**	**Ambient**	**Bio-monitoring**	**Toxics**	**Partner Organizations**
Assessment/evaluation of mercury concentrations in East Lake - Assess probable source(s)	M	X			X				X	EPA, USGS, USFWS
Assessment/evaluation of arsenic in both groundwater and surface waters - Determine if the concentrations observed represent human health/fish issues- Determine the source(s)- Secure/prioritize additional studies arsenic- Coordinate with other stakeholders on this issue - Assess the arsenic survey that was done in the Prineville area	M	X		X	X				X	ODFW, CTWS, Prineville
Update the Deschutes Groundwater report - Combine information from public drinking water supply database and RET databases - Update info on landfill monitoring, environmental cleanup/underground storage tanks - Perform a source assessment for bacteria found in groundwater wells (identify causes and extent and magnitude of the concern)	M			X	X					OWRD, ODA, USBR, USGS, Municipalities, Counties, COIC
Evaluation of CAFO permits - Determine/assess potential for effects on water quality - Identify any violations of permit conditions	M									ODA, NRCS
Further evaluation of WPCF/NPDES permits - Identify expired permits - Identify/assess known or potential groundwater or surface water contamination from point sources	M		X							EPA
Track and assess changes in land use and land management in the Deschutes Basin (these changes have the potential to effect resources status and function to a substantial degree) - Future iterations of the WA need to assess land use changes and revise the findings of the previous assessment accordingly	F	X			X					NRCS, ODA, DLCD, Counties, OWRD