Crooked River Agricultural Water Quality Management Area Plan

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Developed by the

Oregon Department of Agriculture

and the

Crooked River Local Advisory Committee

with support from the

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Acronyms and Terms

Ag Water Quality Program – Agricultural Water Quality Program
Area Plan – Agricultural Water Quality Management Area Plan
Area Rules – Agricultural Water Quality Management Area Rules
CAFO – Confined Animal Feeding Operation
CRWC – Crooked River Watershed Counci
CRWMA – Crooked River Weed Management Area
CWA – Clean Water Act
DEQ – Oregon Department of Environmental Quality
GWMA – Groundwater Management Area
LAC – Local Advisory Committee
LMA – Local Management Agency
Management Area – Agricultural Water Quality Management Area
NPDES – National Pollution Discharge Elimination System
NRCS – Natural Resources Conservation Service
OAR – Oregon Administrative Rules
ODA – Oregon Department of Agriculture
ODF – Oregon Department of Forestry
ORS – Oregon Revised Statute
OWEB – Oregon Watershed Enhancement Board
OWRI – Oregon Watershed Restoration Inventory
PMP – Pesticides Management Plan
PSP – Pesticides Stewardship Partnership
SIA – Strategic Implementation Area
SWCD – Soil and Water Conservation District
TMDL – Total Maximum Daily Load
USDA – United States Department of Agriculture
US EPA – United States Environmental Protection Agency
WPCF – Water Pollution Control Facility
WQPMT – Water Quality Pesticides Management Team

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Foreword

This Agricultural Water Quality Area Plan (Area Plan) provides guidance for addressing water quality related to agricultural activities in the Agricultural Water Quality Management Area (Management Area). The Area Plan identifies strategies to prevent and control water pollution from agricultural lands.

The Area Plan is neither regulatory nor enforceable (Oregon Revised Statute (ORS) 568.912(1)). The Area Plan refers to associated Agricultural Water Quality Management Area Rules (Area Rules). The Area Rules are Oregon Administrative Rules (OARs) and are enforced by the Oregon Department of Agriculture (ODA).

Required Elements of Area Plans

Area Plans must describe a program to achieve the water quality goals and standards necessary to protect designated beneficial uses related to water quality as required by federal and state law (OAR 603-090-0030(1)).

Plan Content

Chapter 1: Agricultural Water Quality Program Purpose and Background. Presents consistent and accurate information about the Ag Water Quality Program.

Chapter 2: Local Background. Provides the local geographic, water quality, and agricultural context for the Management Area. Describes the water quality issues, Area Rules, and potential practices to address water quality issues.

Chapter 3: Implementation Strategies. Presents goal(s), measurable objectives, strategic initiatives, proposed activities, and monitoring.

Chapter 4: Progress and Adaptive Management. Describes progress toward achieving the goal of the Area Plan and summarizes results of water quality and land condition monitoring.

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Chapter 1: Agricultural Water Quality Program

1.1 Purpose of Agricultural Water Quality Program and Applicability of Area Plans

As part of Oregon's Agricultural Water Quality Program (Ag Water Quality Program), the Area Plan guides landowners and partners such as Soil and Water Conservation Districts (SWCDs) in addressing water quality issues related to agricultural activities. The Area Plan identifies strategies to prevent and control "water pollution from agricultural activities and soil erosion" (ORS 568.909(2)) on agricultural and rural lands within the boundaries of this Management Area (OAR 603-090-0000(3)) and to achieve and maintain water quality standards (ORS 561.191(2)). The Area Plan has been developed and revised by ODA and the Local Advisory Committee (LAC), with support and input from the SWCD and the Oregon Department of Environmental Quality (DEQ). The Area Plan is implemented using a combination of outreach, conservation and management activities, compliance with Area Rules, monitoring, evaluation, and adaptive management.

The provisions of the Area Plan do not establish legal requirements or prohibitions (ORS 568.912(1)).

Each Area Plan is accompanied by Area Rules that describe local agricultural water quality regulatory requirements. ODA will exercise its regulatory authority for the prevention and control of water pollution from agricultural activities under the Ag Water Quality Program's general regulations (OAR 603-090-0000 to 603-090-0120) and under the Area Rules for this Management Area (OAR 603-095-3400). The general regulations guide the Ag Water Quality Program, and the Area Rules for the Management Area are the regulations with which landowners must comply. Landowners are encouraged through outreach and education to implement conservation and management activities.

The Area Plan and Area Rules apply to all agricultural activities on non-federal and non-Tribal Trust land within this Management Area including:

- Farms and ranches,
- Rural residential properties grazing animals or raising crops,
- Agricultural lands that lay idle or on which management has been deferred,
- Agricultural activities in urban areas,
- Agricultural activities on land subject to the Forest Practices Act (ORS 527.610).

Water quality on federal land in Oregon is regulated by DEQ and on Tribal Trust land by the respective tribe, with oversight by the United States Environmental Protection Agency (US EPA).

1.2 History of the Ag Water Quality Program

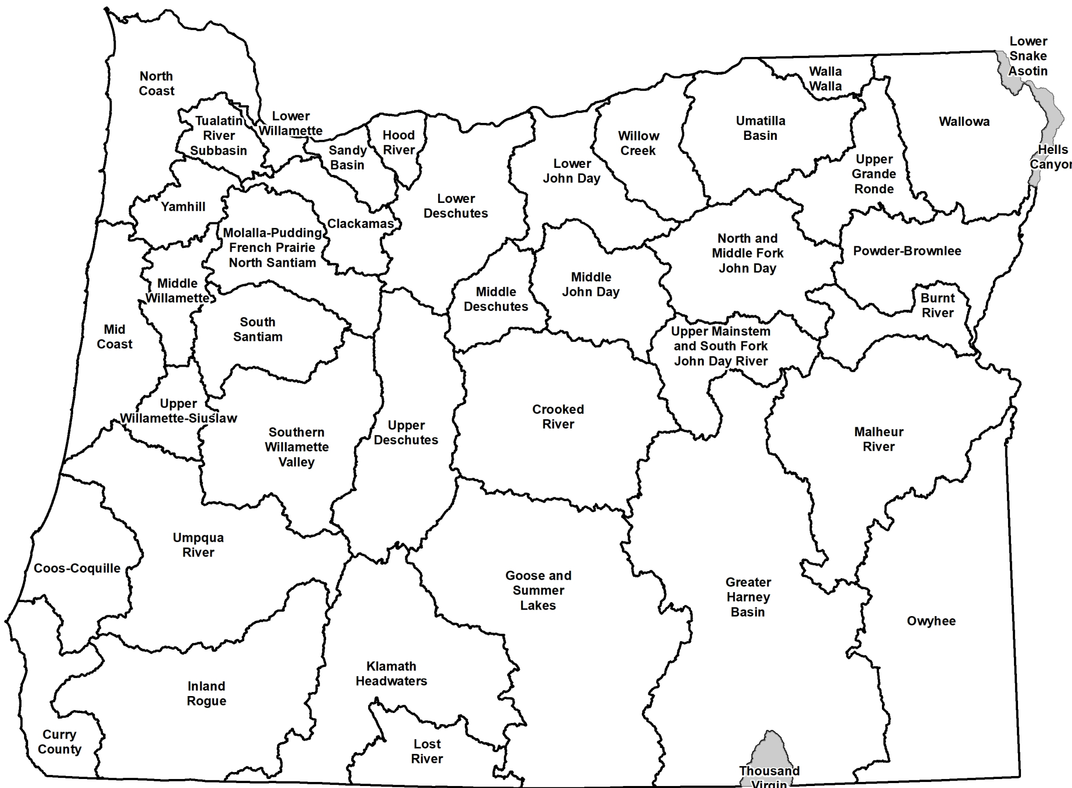
In 1993, the Oregon Legislature passed the Agricultural Water Quality Management Act directing ODA to develop plans to prevent and control water pollution from agricultural activities and soil erosion and to achieve water quality standards (ORS 568.900 through ORS 568.933). The Oregon Legislature passed additional legislation in 1995 to clarify that ODA is the lead agency for regulating agriculture with respect to water quality (ORS 561.191).

Between 1997 and 2004, ODA worked with LACs and SWCDs to develop Area Plans and Area Rules in 38 watershed-based Management Areas across Oregon (Figure 1.2). Since 2004, ODA, LACs, SWCDs, and other partners have focused on implementation including:

- Providing education, outreach, and technical assistance to landowners,
- Implementing projects to improve agricultural water quality,
- Investigating complaints of potential violations of Area Rules,

- Conducting biennial reviews of Area Plans and Area Rules,
- Monitoring, evaluation, and adaptive management,
- Developing partnerships with state and federal agencies, tribes, watershed councils, and others.

Figure 1.2 Map of 38 Agricultural Water Quality Management Areas*



*Gray areas are not included in Ag Water Quality Management Areas

1.3 Roles and Responsibilities

1.3.1 Oregon Department of Agriculture

ODA is the agency responsible for implementing the Ag Water Quality Program (ORS 568.900 to 568.933, ORS 561.191, OAR 603-090, and OAR 603-095). The Ag Water Quality Program was established to develop and implement water quality management plans for the prevention and control of water pollution from agricultural activities and soil erosion. State and federal laws that drive the establishment of an Area Plan include:

- State water quality standards,
- Load allocations for agricultural or nonpoint source pollution assigned under Total Maximum Daily Loads (TMDLs) issued pursuant to the federal Clean Water Act (CWA), Section 303(d),
- Approved management measures for Coastal Zone Act Reauthorization Amendments,
- Agricultural activities detailed in a Groundwater Management Area (GWMA) Action Plan (if DEQ has established a GWMA in the Management Area and an Action Plan has been developed).

ODA bases Area Plans and Area Rules on scientific information (ORS 568.909). ODA works in partnership with SWCDs, LACs, DEQ, and other partners to implement, evaluate, and update the Area Plans and Area Rules. If and when other governmental policies, programs, or rules conflict with the Area

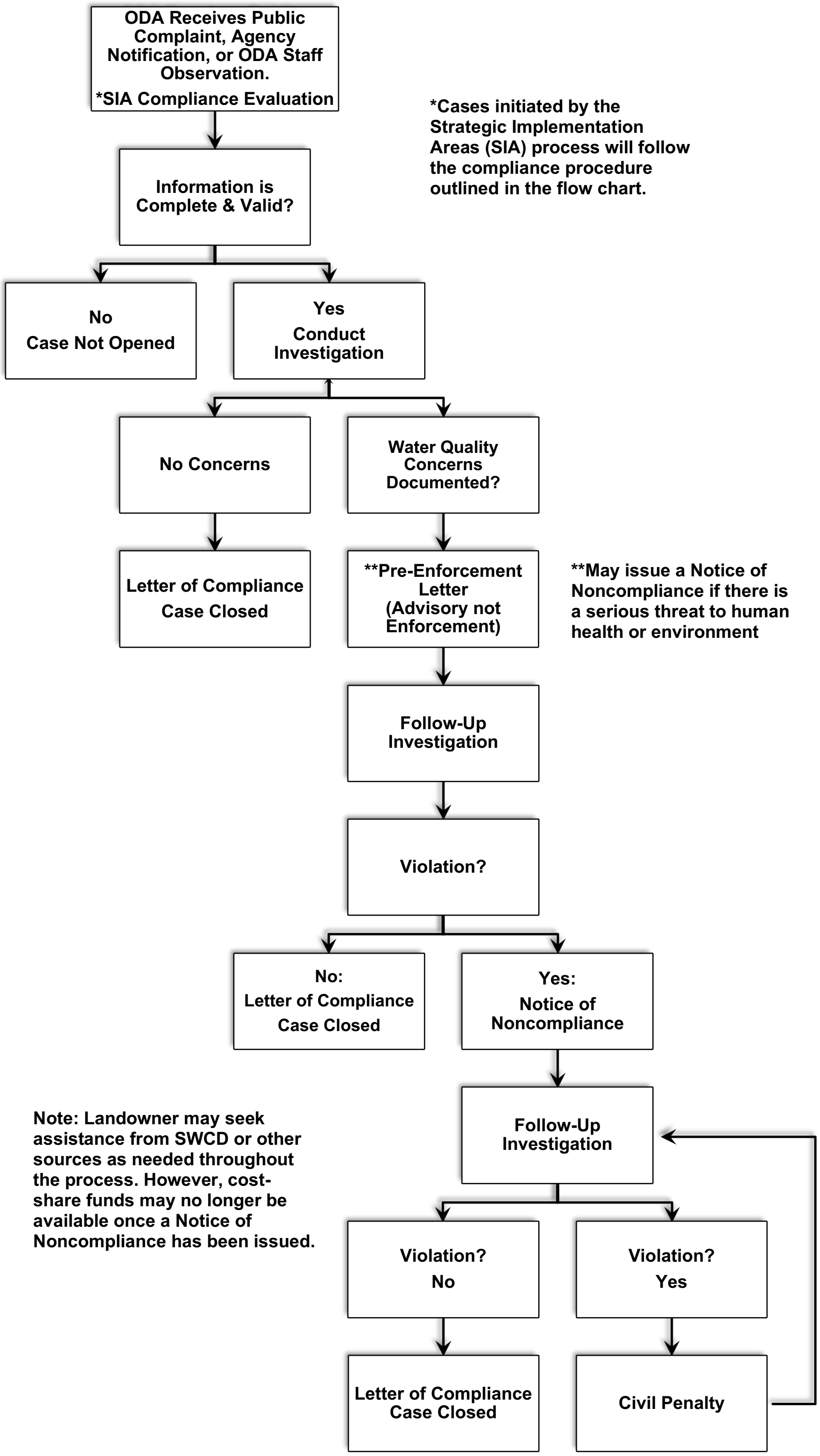
Plan or Area Rules, ODA will consult with the appropriate agencies to resolve the conflict in a reasonable manner.

ODA is responsible for any actions related to enforcement or determination of noncompliance with Area Rules (OAR 603-090-0080 through OAR 603-090-0120). ORS 568.912(1) and ORS 568.912(2) give ODA the authority to adopt rules that require landowners to perform actions necessary to prevent and control pollution from agricultural activities and soil erosion.

The Area Rules are a set of standards that landowners must meet on all agricultural or rural lands. "Landowner" includes any landowner, land occupier, or operator per OAR 603-95-0010(24). All landowners must comply with the Area Rules. ODA will use enforcement where appropriate and necessary to achieve compliance with Area Rules. Figure 1.3.1 outlines ODA's compliance process. ODA will pursue enforcement action only when reasonable attempts at voluntary solutions have failed (OAR 603-090-0000(5)(e)). If a violation is documented, ODA may issue a pre-enforcement notification or an enforcement order such as a Notice of Noncompliance. If a Notice of Noncompliance is issued, ODA will direct the landowner to remedy any conditions through required corrective actions under the provisions of the enforcement procedures outlined in OAR 603-090-060 through OAR 603-090-120. If a landowner does not implement the required corrective actions, ODA may assess civil penalties for continued violation of the Area Rules.

Any member of the public may file a complaint, and any public agency may file a notification of a potential violation of the Area Rules. ODA also may initiate an investigation based on its own observation or from cases initiated through the Strategic Implementation Area process (See Figure 1.3.1).

Figure 1.3.1 Compliance Flow Chart



1.3.2 Local Management Agency

A Local Management Agency (LMA) is an organization designated by ODA to assist with the implementation of an Area Plan (OAR 603-090-0010). The Oregon Legislature intended that SWCDs be LMAs to the fullest extent practical, consistent with the timely and effective implementation of Area Plans (ORS 568.906). SWCDs have a long history of effectively assisting landowners to voluntarily address natural resource concerns. Currently, all LMAs in Oregon are SWCDs.

The day-to-day implementation of the Area Plan is accomplished through an Intergovernmental Grant Agreement between ODA and each SWCD. Every two years, each SWCD submits a scope of work to ODA to receive funding to implement the Area Plan. Each SWCD implements the Area Plan by providing outreach and technical assistance to landowners. SWCDs also work with ODA and the LAC to establish implementation priorities, evaluate progress toward meeting Area Plan goals and objectives, and revise the Area Plan and Area Rules as needed.

1.3.3 Local Advisory Committee

For each Management Area, the director of ODA appoints an LAC (OAR 603-090-0020) with up to 12 members. The LAC serves in an advisory role to the director of ODA and to the Board of Agriculture. The role of the LAC is to provide a high level of citizen involvement and support in the development, implementation, and biennial reviews of the Area Plan and Area Rules. The LAC's primary role is to advise ODA and the LMA on local agricultural water quality issues as well as evaluate the progress toward achieving the goals and objectives of the Area Plan. LACs are composed primarily of agricultural landowners in the Management Area and must reflect a balance of affected persons.

The LAC is convened at the time of the biennial review, however, the LAC may meet as frequently as necessary to carry out its responsibilities, which include but are not limited to:

- Participate in the development and subsequent revisions of the Area Plan and Area Rules,
- Recommend strategies necessary to achieve the goals and objectives in the Area Plan,
- Participate in biennial reviews of the progress of implementation of the Area Plan and Area Rules,
- Submit written biennial reports to the Board of Agriculture and the ODA director.

1.3.4 Agricultural Landowners

The emphasis of the Area Plan is on voluntary action by landowners to control the factors affecting water quality in the Management Area. In addition, each landowner in the Management Area is required to comply with the Area Rules. To achieve water quality goals or compliance, landowners may need to select and implement an appropriate suite of measures. The actions of each landowner will collectively contribute toward achievement of water quality standards.

Technical assistance, and often financial assistance, is available to landowners who want to work with SWCDs or other local partners, such as watershed councils, to achieve land conditions that contribute to good water quality. Landowners may also choose to improve their land conditions without assistance.

Under the Area Plan and Area Rules, agricultural landowners are not responsible for mitigating or addressing factors that are caused by non-agricultural activities or sources, such as:

- Hot springs, glacial melt water, unusual weather events, and climate change,
- Septic systems and other sources of human waste,
- Public roadways, culverts, roadside ditches, and shoulders,

- Dams, dam removal, hydroelectric plants, and non-agricultural impoundments,
- Housing and other development in agricultural areas,
- Impacts on water quality and streamside vegetation from wildlife such as waterfowl, elk, and feral horses,
- Other circumstances not within the reasonable control of the landowner.

However, agricultural landowners may be responsible for some of these impacts under other legal authorities.

1.3.5 Public Participation

ODA, LACs, and LMAs conduct biennial reviews of the Area Plan and Area Rules. Partners, stakeholders, and the general public are invited to participate in the process. Any revisions to the Area Rules will include a formal public comment period and a formal public hearing.

1.4 Agricultural Water Quality

The federal CWA directs states to designate beneficial uses related to water quality, decide on parameters to measure to determine whether beneficial uses are being met, and set water quality standards based on the beneficial uses and parameters.

1.4.1 Point and Nonpoint Sources of Water Pollution

There are two types of water pollution. Point source water pollution emanates from clearly identifiable discharge points or pipes. Point sources are required to obtain permits that specify their pollutant limits. Agricultural operations regulated as point sources include permitted Confined Animal Feeding Operations (CAFOs), and all permitted CAFOs are subject to ODA's CAFO Program requirements. Irrigation return flow from agricultural fields may drain through a defined outlet, but is exempt under the CWA and does not currently require a permit.

Nonpoint-source water pollution originates from the general landscape and is difficult to trace to a single source. Nonpoint water pollution sources include runoff from agricultural and forest lands, urban and suburban areas, roads, and natural sources. In addition, groundwater can be polluted by nonpoint sources including agricultural amendments (fertilizers and manure).

1.4.2 Beneficial Uses and Parameters of Concern

Beneficial uses related to water quality are defined by DEQ for each basin. The most sensitive beneficial uses usually are fish and aquatic life, water contact recreation, and public and private domestic water supply. These uses generally are the first to be impaired because they are affected at lower levels of pollution. While there may not be severe impacts on water quality from a single source or sector, the combined effects from all sources can contribute to the impairment of beneficial uses in the Management Area. Beneficial uses that have the potential to be impaired in this Management Area are summarized in Chapter 2.

Many waterbodies throughout Oregon do not meet state water quality standards. The most common water quality concerns statewide related to agricultural activities are temperature, bacteria, biological criteria, sediment and turbidity, phosphorous, nitrates, algae, pH, dissolved oxygen, harmful algal blooms, pesticides, and mercury. Water quality impairments vary across the state; they are summarized for this Management Area in Chapter 2.

1.4.3 Impaired Waterbodies and Total Maximum Daily Loads

Every two years, DEQ is required by the CWA to assess water quality in Oregon, resulting in the "Integrated Report." CWA Section 303(d) requires DEQ to identify waters that do not meet water quality standards. The resulting list is commonly referred to as the "303(d) list" (http://www.oregon.gov/deq/wq/Pages/WQ-Assessment.aspx). In accordance with the CWA, DEQ must establish TMDLs for pollutants on the 303(d) list. For more information, visit www.oregon.gov/deq/wq/tmdls/Pages/default.aspx.

A TMDL includes an assessment of conditions (based on water quality data, land condition data, and/or computer modeling) and describes a plan to achieve water quality standards. TMDLs specify the daily amount of pollution a waterbody can receive and still meet water quality standards. TMDLs generally apply to an entire basin or subbasin, not just to an individual waterbody on the 303(d) list. In the TMDL, point sources are assigned "waste load allocations" that are then incorporated into National Pollutant Discharge Elimination System (NPDES) permits. Nonpoint sources (agriculture, forestry, and urban) are assigned a "load allocation."

As part of the TMDL process, DEQ identifies Designated Management Agencies and Responsible Persons, which are parties responsible for submitting TMDL implementation plans. TMDLs designate ODA as the lead agency responsible for implementing the TMDL on agricultural lands. ODA uses the applicable Area Plan(s) as the implementation plan for the agricultural component of the TMDL. Biennial reviews and revisions to the Area Plan and Area Rules must address agricultural or nonpoint source load allocations from relevant TMDLs.

The 303(d) list, the TMDLs, and the agricultural load allocations for the TMDLs that apply to this Management Area are summarized in Chapter 2.

1.4.4 Oregon Water Pollution Control Law – ORS 468B.025 and 468B.050

In 1995, the Oregon Legislature passed ORS 561.191. This statute states that any program or rules adopted by ODA "shall be designed to assure achievement and maintenance of water quality standards adopted by the Environmental Quality Commission."

To implement the intent of ORS 561.191, ODA incorporated ORS 468B.025 and 468B.050 into all 38 of the Area Rules in Oregon.

ORS 468B.025 (prohibited activities) states that:
"(1) Except as provided in ORS 468B.050 or 468B.053, no person shall:
(a) Cause pollution of any waters of the state or place or cause to be placed any wastes in a location where such wastes are likely to escape or be carried into the waters of the state by any means.
(b) Discharge any wastes into the waters of the state if the discharge reduces the quality of such waters below the water quality standards established by rule for such waters by the Environmental Quality Commission.
(2) No person shall violate the conditions of any waste discharge permit issued under ORS 468B.050."

ORS 468B.050 identifies the conditions when a permit is required. A permit is required for CAFOs that meet minimum criteria for confinement periods and have large animal numbers or have wastewater facilities. The portions of ORS 468B.050 that apply to the Ag Water Quality Program state that:

"(1) Except as provided in ORS 468B.053 or 468B.215, without holding a permit from the Director of the Department of Environmental Quality or the State Department of Agriculture, which permit shall specify applicable effluent limitations, a person may not:
(a) Discharge any wastes into the waters of the state from any industrial or commercial establishment or activity or any disposal system."

Definitions used in ORS 468B.025 and 468B.050:

' "Pollution" or "water pollution" means such alteration of the physical, chemical, or biological properties of any waters of the state, including change in temperature, taste, color, turbidity, silt or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state, which will or tends to, either by itself or in connection with any other substance, create a public nuisance or which will or tends to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses or to livestock, wildlife, fish or other aquatic life or the habitat thereof.' (ORS 468B.005(5)).

' "Water" or "the waters of the state" include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters which do not combine or affect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.' (ORS 468B.005(10)).

' "Wastes" means sewage, industrial wastes, and all other liquid, gaseous, solid, radioactive or other substances, which will or may cause pollution or tend to cause pollution of any waters of the state.' (ORS 468B.005(9)). Additionally, the definition of "wastes" given in OAR 603-095-0010(53) 'includes but is not limited to commercial fertilizers, soil amendments, composts, animal wastes, vegetative materials or any other wastes.'

1.4.5 Streamside Vegetation and Agricultural Water Quality

Across Oregon, the Ag Water Quality Program emphasizes streamside vegetation protection and enhancement. Streamside vegetation can provide three primary water quality functions: shade to reduce stream temperature warming from solar radiation, streambank stability, and filtration of pollutants. Other water quality functions from streamside vegetation include: water storage in the soil for cooler and later season flows, sediment trapping that can build streambanks and floodplains, narrowing and deepening of channels, and biological uptake of sediment, organic material, nutrients, and pesticides. In addition, streamside vegetation provides habitat for numerous species of fish and wildlife. Streamside vegetation conditions can be monitored to track progress toward achieving conditions that support water quality.

Site-Capable Vegetation
The Ag Water Quality Program uses the concept of "site-capable vegetation" to describe the streamside vegetation that can be expected to grow at a particular site, given natural site factors (e.g., elevation, soils, climate, hydrology, wildlife, fire, floods) and historical and current human influences that are beyond the program's statutory authority (e.g., channelization, roads, modified flows, previous land management). Site-capable vegetation can be determined for a specific site based on: current streamside vegetation at the site, streamside vegetation at nearby reference sites with similar natural characteristics, Natural Resources Conservation Service (NRCS) soil surveys and ecological site descriptions, and/or local or regional scientific research.

The goal for Oregon's agricultural landowners is to provide the water quality functions (e.g., shade, streambank stability, and filtration of pollutants) produced by site-capable vegetation along streams on agricultural lands. The Area Rules for each Management Area require that agricultural activities allow for the establishment and growth of streamside vegetation to provide the water quality functions equivalent to what site-capable vegetation would provide.

Occasionally, mature site-capable vegetation such as tall trees may not be needed along narrow streams. For example, shrubs and grass may provide shade, protect streambanks, and filter pollutants. However, on larger streams, mature site-capable vegetation is needed to provide the water quality functions.

In many cases, invasive, non-native plants, such as introduced varieties of blackberry and reed canarygrass, grow in streamside areas. This type of vegetation has established throughout much of Oregon due to historic and human influences and may provide some of the water quality functions of site-capable vegetation. ODA's statutory authority does not require the removal of invasive, non-native plants, however, ODA encourages landowners to remove these plants voluntarily. In addition, the Oregon State Weed Board identifies invasive plants that can impair watersheds. Public and private landowners are responsible for eliminating or intensively controlling noxious weeds, as described in state and local laws. For more information, visit www.oregon.gov/ODA/programs/weeds.

1.4.6 Soil Health and Agricultural Water Quality

An increasingly important concept in Oregon and across the United States is soil health. The Ag Water Quality Program promotes soil health to reduce erosion and keep sediment out of surface waters, thereby helping to maintain and improve water quality. Healthy soils have relatively high organic matter and well-formed soil structure. These characteristics may resist erosion and increase water infiltration, leading to less surface runoff and greater groundwater recharge; the resultant groundwater flows in some cases can help moderate stream water temperatures. According to the NRCS and others, there are four Soil Health Principles that together build highly productive and resilient soils: minimize disturbance and maximize cover, continuous living roots, and diversity above and below the surface.

Healthy soils make farms and ranches more resilient. The western United States is experiencing higher temperatures, more weather variability, and greater storm intensity. Forecasts predict continued high-intensity storms in the winter and spring, combined with more frequent droughts, which may result in more erosion, especially on bare ground. Building soil health increases resiliency to extreme weather, protects water quality, and helps keep farms and ranches viable. Incorporating soil health practices can help landowners adapt and reduce risks. For more information, visit www.nrcs.usda.gov/wps/portal/nrcs/detail/or/soils/health.

1.5 Other Water Quality Programs

The following programs complement the Ag Water Quality Program and are described here to recognize their link to agricultural lands.

1.5.1 Confined Animal Feeding Operation Program

ODA is the lead state agency for the CAFO Program, which was developed to ensure that operators do not contaminate ground or surface water with animal manure or process wastewater. The CAFO Program coordinates with DEQ to issue permits. These permits require the registrant to operate according to a site-specific, ODA-approved, Animal Waste Management Plan that is incorporated into the CAFO permit by reference. For more information, visit oda.direct/CAFO.

1.5.2 Groundwater Management Areas

Groundwater Management Areas (GWMAs) are designated by DEQ where groundwater is polluted from, at least in part, nonpoint sources. After designating a GWMA, DEQ forms a local groundwater management committee comprised of affected and interested parties. The committee works with and advises the state agencies that are required to develop an action plan to reduce groundwater contamination in the area.

Oregon DEQ has designated three GWMAs because of elevated nitrate concentrations in groundwater: Lower Umatilla Basin, Northern Malheur County, and Southern Willamette Valley. Each GWMA has a voluntary action plan to reduce nitrates in groundwater. After a scheduled evaluation period, if DEQ determines that voluntary efforts are not effective, mandatory requirements may become necessary.

If there is a GWMA in this Management Area, it is described in Chapter 2.

1.5.3 The Oregon Plan for Salmon and Watersheds

In 1997, Oregonians began implementing the Oregon Plan for Salmon and Watersheds, referred to as the Oregon Plan (www.oregon-plan.org). The Oregon Plan seeks to restore native fish populations, improve watershed health, and support communities throughout Oregon. The Oregon Plan has a strong focus on salmonids because of their great cultural, economic, and recreational importance to Oregonians, and because they are important indicators of watershed health. ODA's commitment to the Oregon Plan is to develop and implement Area Plans and Area Rules throughout Oregon.

1.5.4 Pesticide Management and Stewardship

ODA's Pesticides Program holds the primary responsibility for registering pesticides and regulating their use in Oregon under the Federal Insecticide Fungicide Rodenticide Act. ODA's Pesticide Program administers regulations relating to pesticide sales, use, and distribution, including pesticide operator and applicator licensing as well as proper application of pesticides, pesticide labeling, and registration.

In 2007, Oregon formed the interagency Water Quality Pesticide Management Team (WQPMT) to expand efforts to improve water quality in Oregon related to pesticide use. The WQPMT facilitates and coordinates activities such as monitoring, analysis and interpretation of data, effective response measures, and management solutions. The WQPMT relies on monitoring data from the Pesticides Stewardship Partnership (PSP) program and other federal, state, and local monitoring programs to assess the possible impact of pesticides on Oregon's water quality. Pesticide detections in Oregon's streams can be addressed through multiple programs and partners, including the PSP.

Through the PSP, state agencies and local partners work together to monitor pesticides in streams and to improve water quality (www.oregon.gov/ODA/programs/Pesticides/Water/Pages/PesticideStewardship.aspx). ODA, DEQ, and Oregon State University Extension Service work with landowners, SWCDs, watershed councils, and other local partners to voluntarily reduce pesticide levels while improving water quality and crop management. Since 2000, the PSPs have made noteworthy progress in reducing pesticide concentrations and detections.

ODA led the development and implementation of a Pesticides Management Plan (PMP) for the state of Oregon (www.oregon.gov/ODA/programs/Pesticides/water/pages/AboutWaterPesticides.aspx). The PMP, completed in 2011, strives to protect drinking water supplies and the environment from pesticide contamination, while recognizing the important role that pesticides have in maintaining a strong state economy, managing natural resources, and preventing human disease. By managing the pesticides that are approved for use by the US EPA and Oregon in agricultural and non-agricultural settings, the PMP sets forth a process for preventing and responding to pesticide detections in Oregon's ground and surface water.

1.5.5 Drinking Water Source Protection

Oregon implements its drinking water protection program through a partnership between DEQ and the Oregon Health Authority. The program provides individuals and communities with information on how to protect the quality of Oregon's drinking water. DEQ and the Oregon Health Authority encourage preventive management strategies to ensure that all public drinking water resources are kept safe from current and future contamination. For more information, visit www.oregon.gov/deq/wq/programs/Pages/dwp.aspx.

1.6 Partner Agencies and Organizations

1.6.1 Oregon Department of Environmental Quality

The US EPA delegated authority to DEQ to implement the federal CWA in Oregon. DEQ is the lead state agency with overall authority to implement the CWA in Oregon. DEQ works with other state agencies, including ODA and the Oregon Department of Forestry (ODF), to meet the requirements of the CWA. DEQ sets water quality standards and develops TMDLs for impaired waterbodies, which ultimately are approved or disapproved by the US EPA. In addition, DEQ develops and coordinates programs to address water quality including NPDES permits for point sources, the CWA Section 319 grant program, the Source Water Protection Program, the CWA Section 401 Water Quality Certification, and Oregon's Groundwater Management Program. DEQ also coordinates with ODA to help ensure successful implementation of Area Plans.

A Memorandum of Agreement between DEQ and ODA recognizes that ODA is the state agency responsible for implementing the Ag Water Quality Program. ODA and DEQ updated the Memorandum of Agreement in 2012 and reviewed and confirmed it in 2018 (http://www.oregon.gov/ODA/shared/Documents/Publications/NaturalResources/DEQODAmoa.pdf).

The Environmental Quality Commission, which serves as DEQ's policy and rulemaking board, may petition ODA for a review of part or all of any Area Plan or Area Rules. The petition must allege, with reasonable specificity, that the Area Plan or Area Rules are not adequate to achieve applicable state and federal water quality standards (ORS 568.930(3)(a)).

1.6.2 Other Partners

ODA and SWCDs work in close partnership with local, state, and federal agencies and other organizations, including: DEQ (as described above), the United States Department of Agriculture (USDA) NRCS and Farm Service Agency, watershed councils, Oregon State University Agricultural Experiment Stations and Extension Service, tribes, livestock and commodity organizations, conservation organizations, and local businesses. As resources allow, SWCDs and local partners provide technical, financial, and educational assistance to individual landowners for the design, installation, and maintenance of effective management strategies to prevent and control agricultural water pollution and to achieve water quality goals.

1.7 Measuring Progress

Agricultural landowners have been implementing conservation projects and management activities throughout Oregon to improve water quality for many years. However, it has been challenging for ODA, SWCDs, and LACs to measure progress toward improved water quality. ODA is working with SWCDs, LACs, and other partners to develop and implement strategies that will produce measurable outcomes. ODA is also working with partners to develop monitoring methods to document progress.

1.7.1 Measurable Objectives

A measurable objective is a numeric long-term desired outcome to achieve by a specified date. Milestones are the interim steps needed to make progress toward the measurable objective and consist of numeric short-term targets to reach by specific dates. Together, the milestones define the timeline and progress needed to achieve the measurable objective.

The Ag Water Quality Program is working throughout Oregon with SWCDs and LACs toward establishing long-term measurable objectives to achieve desired conditions. ODA, the LAC, and the SWCD will establish measurable objectives and associated milestones for each Area Plan. Many of these measurable objectives relate to land conditions and primarily are developed for focused work in small geographic areas (section 1.7.3). ODA's longer-term goal is to develop measurable objectives, milestones, and monitoring methods at the Management Area scale.

The State of Oregon continues to improve its ability to use remote-sensing technology to measure current streamside vegetation conditions and compare these to the conditions needed to meet stream shade targets. As the State's use of this technology moves forward, ODA will use the information to help LACs and LMAs set measurable objectives for streamside vegetation. These measurable objectives will be achieved through implementing the Area Plan, with an emphasis on voluntary incentive programs.

At each biennial review, ODA and its partners will evaluate progress toward measurable objectives and milestone(s) and why they were or were not achieved. ODA, the LAC, and LMA will evaluate whether changes are needed to continue making progress toward the measurable objective(s) and will revise strategies to address obstacles and challenges.

The measurable objective(s) and associated milestone(s) within the Management Area are in Chapter 3 and progress toward achieving the measurable objective(s) and milestone(s) is summarized in Chapter 4.

1.7.2 Land Conditions and Water Quality

Land conditions can serve as useful surrogates (indicators) for water quality parameters. For example, because shade blocks solar radiation from warming the stream, streamside vegetation, or its associated shade, generally is used as a surrogate for water temperature. In some cases, sediment can be used as a surrogate for pesticides or phosphorus, which often adhere to sediment particles.

The Ag Water Quality Program focuses on land conditions, in addition to water quality data, for several reasons:

- Landowners can see land conditions and have direct control over them,
- Improved land conditions can be documented immediately,
- Water quality impairments from agricultural activities are primarily due to changes in land conditions and management activities,
- It can be difficult to separate agriculture's influence on water quality from other land uses,

- There is generally a lag time between changes on the landscape and the resulting improvements in water quality,
- Extensive monitoring of water quality would be needed to evaluate progress, which would be expensive and may not demonstrate improvements in the short term.

Water quality monitoring data will help ODA and partners to measure progress or identify problem areas in implementing Area Plans. However, as described above, water quality monitoring may be slower to document changes than land condition monitoring.

1.7.3 Focused Implementation in Small Geographic Areas

Focus Areas

A Focus Area is a small watershed with water quality concerns associated with agriculture. The Focus Area process is SWCD-led, with ODA oversight. The SWCD delivers systematic, concentrated outreach and technical assistance. A key component is measuring conditions before and after implementation to document the progress made with available resources. The Focus Area approach is consistent with other agencies' and organizations' efforts to work proactively in small watersheds.

Focus Areas have the following advantages: a proactive approach that addresses the most significant water quality concerns, multiple partners that coordinate and align technical and financial resources, a higher density of projects that may lead to increased connectivity of projects, and a more effective and efficient use of limited resources.

The current Focus Area for this Management Area is described in Chapter 3.

Strategic Implementation Areas

Strategic Implementation Areas (SIAs) are small watersheds selected by ODA, in consultation with partners, based on a statewide review of water quality data and other available information. ODA conducts an evaluation of likely compliance with Area Rules and contacts landowners with the results and next steps. The Oregon Watershed Enhancement Board (OWEB) and other partners make funding and technical assistance available to support conservation and restoration projects. These efforts should result in greater ecological benefit than relying solely on compliance and enforcement. Landowners have the option of working with the SWCD or other partners to voluntarily address water quality concerns. ODA follows up, as needed, to enforce the Area Rules. Finally, ODA completes a post-evaluation to document progress in the SIA.

Any SIAs in this Management Area are described in Chapter 3.

1.8 Progress and Adaptive Management

1.8.1 Biennial Reviews

The ODA, LAC, LMA, and partners evaluate progress of Area Plan implementation through the biennial review process. At each biennial review, they discuss: 1) progress toward meeting measurable objectives and implementing strategies, 2) local monitoring data from other agencies and organizations, including agricultural land conditions and water quality, and 3) ODA compliance activities. As a result of these discussions, ODA and partners revise implementation strategies and measurable objectives in Chapter 3 as needed.

ODA provides information from the Oregon Watershed Restoration Inventory (OWRI) on restoration project funding and accomplishments at biennial reviews and uses the information for statewide reporting.

The majority of OWRI entries represent voluntary actions of private landowners who have worked in partnership with federal, state, and local groups to improve aquatic habitat and water quality conditions. OWRI is the single largest restoration information database in the western United States. For more information, visit www.oregon.gov/oweb/data-reporting/Pages/owri.aspx.

1.8.2 Water Quality Monitoring

In addition to monitoring landscape conditions, ODA relies on water quality monitoring data where available. These data may be provided by other state or federal agencies or local entities; ODA seldom collects water quality samples outside of compliance cases.

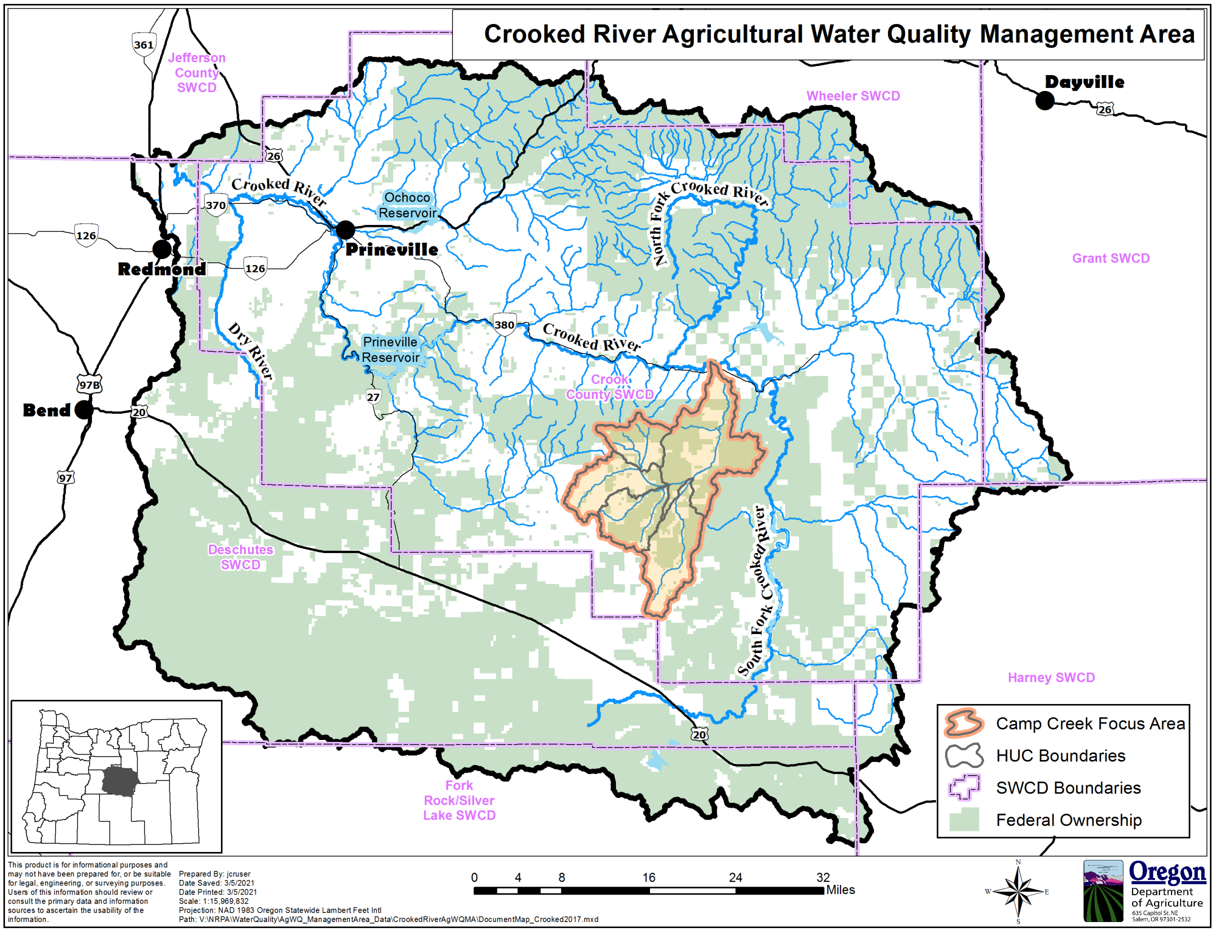
As part of monitoring water quality status and trends, DEQ regularly collects water samples every other month throughout the year at over 130 sites on more than 50 rivers and streams across the state. Sites are located across the major land uses (forestry, agriculture, rural residential, and urban/suburban). Parameters measured include alkalinity, biochemical oxygen demand (BOD), chlorophyll a, specific conductance, dissolved oxygen (DO), DO percent saturation, bacteria (*E. coli)*, ammonia, nitrate and nitrite, pH, total phosphorus, total solids, temperature, and turbidity.

DEQ provides status and trends reports for selected parameters in relation to water quality standards. ODA will continue to work with DEQ to summarize the data results and how they apply to agricultural activities.

Water quality monitoring efforts in this Management Area are described in Chapter 3, and the data are summarized in Chapter 4.

Chapter 2: Local Background

The Management Area consists of the Crooked River Basin with the following exceptions near the mouth of the Crooked River: 1) lands south of the Crooked River and west of the range line between R12E and R13E in T14S to exclude the entire Crooked River Ranch subdivision, which is in the Upper Deschutes Agricultural Water Quality Management Area, and lands north of the Crooked River and west of Sherwood Canyon near Smith Rock, which are in the Middle Deschutes Agricultural Water Quality Management Area.



2.1 Local Roles

2.1.1 Local Advisory Committee

The Area Plan was developed with the assistance of the LAC. The LAC was formed to assist with the development of the Area Plan and Area Rules and with subsequent biennial reviews. Table 2.1.1 lists the current members of the LAC.

Table 2.1.1 Current LAC members

Name	Geographic Representation	Agricultural Product or Interest Representation
Greg Bedortha (Chair)	Paulina (Beaver and Sugar creeks)	Cattle
Bill Sigman (Vice-Chair)	Lower Crooked River; and Lone Pine, Camp and Beaver creeks	Cattle, Hay, Grain, Mint
Scott Duggan	Management Area	OSU Livestock Extension Faculty
Bruce Scanlon	Management Area	Ochoco Irrigation District
Tim Huntley	Prineville	Crook County High School, Trout Unlimited
John Morgan	Prineville, Ochoco Creek and Lower Crooked River	Cattle and hay
Trent Smith	Paulina (North Wolf and Widow creeks)	Cattle ranching, sheep and bees
Libby Stahancyk	Upper Ochoco Creek	Cattle, Natural Resources
Jim Eisner (technical support)	Management Area	Bureau of Land Management
Wade Flegel	Powell Butte, Lyttle Creek	CAFO permittee; cattle ranching; alfalfa; carrot and grass seed; and wheat

2.1.2 Local Management Agency

Implementation of the Area Plan is accomplished through an Intergovernmental Grant Agreement between ODA and the Crook County and Deschutes SWCDs. This Intergovernmental Grant Agreement defines the SWCD as the LMA for implementation of the Ag Water Quality Program in this Management Area. The SWCD was also involved in development of the Area Plan and Area Rules.

The LMA implements the Area Plan by conducting the activities detailed in Chapter 3, which are intended to achieve the goals and objectives of the Area Plan.

2.1.3 Local Watershed Council

The Crooked River Watershed Council (CRWC) is composed of a diverse group of landowners, residents, government agencies, and organizations working together to enhance watershed health in the Crooked River Basin. The CRWC is another local entity that assists landowners with improvement projects that address the strategies and goals of this Area Plan.

2.2 Area Plan and Area Rules: Development and History

The director of ODA initially approved the Area Plan and Area Rules in 2004.

Since approval, the LAC has met biennially to review the Area Plan and Area Rules. The biennial review process includes an assessment of progress toward achieving the goals and objectives in the Area Plan.

2.3 Geographical and Physical Setting

Location
The Management Area is in central Oregon and consists of the Crooked River Basin, except for the Crooked River Ranch area near the mouth of the Crooked River and the Trail Crossing area west of Smith Rock. (The Crooked River Ranch area is in the Upper Deschutes Management Area, and the Trail Crossing area is in the Middle Deschutes Management Area). The Management Area encompasses approximately 4,500 square miles (2.9 million acres) and includes the towns and communities of Terrebonne, Powell Butte, Prineville, Paulina, Post, Suplee, Alfalfa, Millican, Brothers, and Hampton. The Management Area includes portions of seven counties.

Table 2.3 Counties within the Management Area

County	% of Management Area
Crook	64%
Deschutes	26%
Grant, Jefferson, Harney, Lake, Wheeler	1 - 4% each

The Management Area includes a wide range of ecological conditions; from moist forest in the north and east to desert in the west and south. Landforms include valleys, plains, foothills, the Maury and Ochoco mountain ranges, headwaters, and downstream watersheds.

The highest point is Snow Mountain (elevation 7,162 feet) on the southeastern boundary of the Management Area near the Harney County Line. The lowest point is near the mouth of the Crooked River, with an elevation of approximately 1,900 feet.

Climate[1]
The Crooked River Basin is located in the south-central Oregon climatic zone; a semi-arid area of high desert prairie punctuated by small mountain ranges and isolated peaks. Average annual precipitation is a range between eight and ten inches per year at lower elevations and may reach 30-40 inches at higher elevations (falling primarily as snow in the winter). The highest monthly precipitation totals occur in the winter months, with a secondary maximum during the late spring and early summer. High intensity thunderstorms can contribute large proportions of annual rainfall locally and contribute to increased erosion. As distance increases to the east, away from the Cascade Mountains, the spring-summer peaks become much more pronounced.

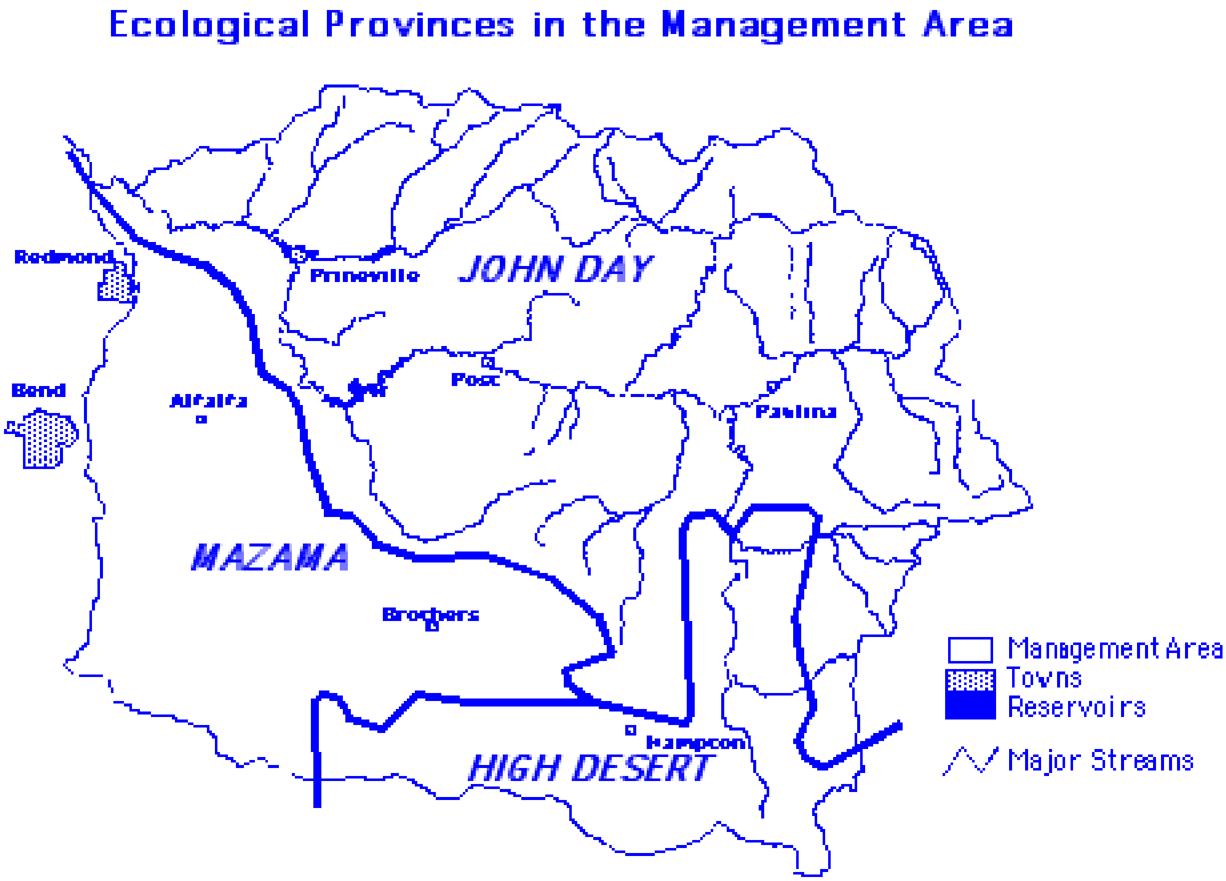
Climate is characterized by cold nights throughout the year (particularly at higher elevations) and hot daytime summer temperatures. Although summer daytime temperatures are quite warm at lower elevations, the growing season is relatively short and frost has been recorded in every month.

Mean annual temperatures, total precipitation, and snowfall vary widely from year to year. Precipitation at higher elevations follows the general patterns recorded at Prineville, except that there is more rain and snowfall.

Ecological Provinces: Geology, Soils and Vegetation Patterns
The Crooked River Basin includes three ecological provinces, which are based on broad soil/plant relationships determined from a combination of geologic and ecological features.

[1] Oregon Climate Service: http://www.ocs.orst.edu

Figure 8: Ecological Provides of Management Area



The **John Day ecological province** is characterized by extensive geologically eroded, steeply dissected hills of thick, ancient sedimentary materials interspersed with buttes and plateaus capped with basalt or tuffaceous rock. The majority of the Management Area is located within this ecological province, including the entire Upper Crooked River Subbasin, and most of the Lower Crooked River and the Beaver South Fork subbasins.

The soils are finely textured, sticky when wet, and highly susceptible to precipitation-driven erosion. Irrigated agriculture occurs around Prineville but cropland in the remainder of this ecological province is limited to narrow irrigated valleys. Most of the land is used to produce livestock and livestock forage. The original vegetative potential of these sites has been lost or diminished throughout most of the basin, except at relict sites where perennial grasses are present. Control of juniper and noxious weed expansion, and reduced soil erosion can increase the potential for vegetation recovery on these arid rangelands.

The southwestern portion of the Management Area is located in the **Mazama ecological province,** which is covered by a continuous mantle of pumice and other volcanic material deposits distributed when Mt. Mazama erupted explosively about 6,500 years ago. Communities include Alfalfa, Powell Butte, Brothers, Millican, Terrebonne, and the eastern portions of Redmond's urban growth boundary.

Soils have developed in combinations of pumice and volcanic ash overlying basaltic bedrock or ancient soils at a depth from 10 inches to 15 feet. Upland soils are characterized by thick deposits of pumice, or pumice overlying loamy soil. Low lying areas include deep, coarse, gravelly pumicey soils of basins and draws in forested uplands, and deep, gravelly loam adjacent to marsh areas.

The overlying pumice mantle is believed to act as mulch, which aids vegetation. Pumice soils are one of the easiest to modify through management activities, such as compaction from equipment and livestock use. Pumice also weathers more rapidly than other volcanic rock types.

Vegetation is typically sagebrush and bunchgrass. Portions of the Mazama province are used for irrigated agriculture (deep well irrigation or the irrigation district).

The **High Desert ecological province** is characterized by closed basins surrounded by terraces formed in ancient lakes. Low mountains, isolated buttes, basaltic ridges, and block faulted igneous formations are interspersed. Elevations average between 4,000 and 4,500 feet. The only community within this province is Hampton.

Soils range from deep loam to deep clayey soils in basins and from deep sandy to shallow clayey soils on terraces and fans where hardpans are common. On most terraces and fans, the soil surface is rocky, likely a result of fractured basalt.

The province is a dry and cold region, with an average annual precipitation of approximately ten inches and a possibility of frost throughout each week of the year. Extremes of hot and cold temperatures are common throughout the province. Vegetation communities are dominated by shrub-grasslands, and the limited conifer areas that are present are dominated by juniper. There is some deep well irrigation.

Hydrology: River Systems & Water Flows

The Crooked River flows east to west from headwaters in North Fork Crooked River, South Fork Crooked River and Beaver Creek systems. The total length of the Crooked River from the headwaters of the North Fork Crooked River is approximately 155 miles. Average annual discharge of the Crooked River is 1,131,000-acre feet (at Lake Billy Chinook). The streams naturally experience sudden high flows, but are even more prone to flooding now due to suboptimal upland conditions.[2]

Natural stream flow is relatively low due to the semi-arid climate. Many streams are intermittent. Approximately two-thirds of the total annual precipitation comes in the form of snow during the months of October through April. Large variations occur on an annual and seasonal basis, with snowmelt and summer rainstorms contributing to high runoff and flow events. Tributaries originating in the Ochoco Mountains contribute substantially to the flow of the Crooked River with inputs from both snow and rain. Tributaries originating to the south do not contribute as much water but can be influenced heavily by high intensity storm events such as summer thunderstorms. Flow within the Crooked River originates from springs in the upper headwaters and lower mainstem, and from snowmelt at the higher elevations.

The South Fork of the Crooked River is formed by the outflow of several springs, some of them hot, and exceed the DEQ water quality temperature standard at the source. The mainstem Crooked River begins at the confluence of the South Fork and Beaver Creek, which receives its flow from springs as well as snow melt and rain from the Ochoco Mountains. Temperatures of springs near Paulina and Suplee have been measured at 70-112°F[4]. The North Fork Crooked River, also fed by springs and snowmelt, adds considerable flow to the mainstem. Springs and tributary streams continue to contribute flow above Prineville. Below Prineville, there are no known springs of significant size until river mile 15 (downstream of the Management Area) where large springs augment the flow to the confluence.

Bowman Dam creates Prineville Reservoir, and Ochoco Dam creates Ochoco Reservoir. They have multiple benefits: flood control, irrigation, recreation, cooler water temperatures below the dam, summer flows down-stream, and redband trout fisheries below the dam. The construction of Bowman dam

[2] Crooked River Local Advisory Committee. Personal communication.

changed the timing of peak flows as well as their size in the Crooked River. Before construction of the dam, 75 percent of the average flow of the Crooked River occurred in March, April, and May. Natural seasonal flow patterns are altered below both dams, with high flows during the irrigation season when water is released, and lower flows while water is stored for the next irrigation season. Altered stream flow has resulted throughout the basin from the numerous public and private reservoirs created for water storage. Post-reservoir characteristics below large reservoirs such as Ochoco and Prineville include: reduced annual maximum mean flow, elimination of peak high flows, reduction in late winter and early spring flows, and an increase in summer and fall flows. Agriculture in the Lower Crooked River Subbasin depends almost totally on storage behind dams.

In 2013, the Crooked River Watershed Council along with collaborating partners OWEB, NOAA-American Rivers, BLM, and the project owner Quail Valley Ranch, removed the Stearns Dam in the Crooked River below Bowman Dam. The dam removal project was undertaken to improve fish passage and allow free movement of fish at the site.

A water reallocation plan for Prineville Reservoir may be forth-coming from the Bureau of Reclamation that will address agricultural and non-agricultural land and water uses.

Historic Land Conditions

In the mid-to-late-1800s, there were more springs and watercourses in the basin. Many streams that are currently intermittent were perennial. There was more riparian* vegetation, including sedges, grasses, and woody species, and stream channels were still well connected to the broad valley bottom floodplains. The Crooked River ‘flooded’ practically annually, with a meandering channel that took up the entire valley floor.

In the 1800s, riparian and floodplain areas had significantly more woody vegetation than now. Willows were a primary component of riparian species (Ochoco means ‘willow’ in Paiute) but other common species included cottonwoods, aspen, alder, as well as shrub species such as chokecherry, hawthorn, or dogwood. The floodplains were dominated by Great Basin wild rye, other bunchgrass species, and sedges and rushes, with very little invasion of juniper and sagebrush.

Vegetation in riparian areas declined rapidly after Euro-American settlement in the basin during the middle 1800s.

In the mid-to-late 1800’s, vegetation was more open in both forests and rangelands. Western juniper distribution and density were much less, with juniper restricted to the rocky ridge tops, which are areas naturally resistant to fire. In general, the western edge of the Management Area (in the Mazama Ecological Province) had more juniper than the remainder of the basin. Early journals commonly note the valleys full of waist high grasses and the abundance of forage for livestock. Forests in the Ochoco Mountains had more open Ponderosa pine stands. Fire was much more frequent and less severe, mostly burning grasses and low ground covers.

Agriculture in the Past

From the time of European settlement in roughly 1870 through the 1930s, livestock grazing was the major land use throughout the entire basin. Initial grazing was dominated by cattle and horses, sheep moved into the area around 1880. By the turn of the century, the lack of grazing control coupled with the high numbers of sheep, cows, and horses, were contributing to the conversion of shrub steppe to encroaching

* Riparian areas are a transition between saturated areas and upland areas. Riparian areas are characterized by vegetation that requires permanent surface or subsurface water.

western juniper. Horses were a significant source of range damage in the South Fork Crooked River/Hampton Buttes region of the basin.

The change from native grasses to sagebrush affected the streams. The interaction between high grazing pressure and variable climate (drought followed by intense summer storms), as well as the loss of beaver through extensive trapping and its associated habitats, contributed to major stream incision and loss of riparian vegetation in the late 1800 to early 1900s. This was accompanied by increasing conflicts over use of the range.

In 1906, the Ochoco National Forest was created as part of the Blue Mountain and Maury Mountain Forest Reserves. In 1911, the Ochoco National Forest was formally created. Logging and livestock overuse and grazing conflicts (cattle versus sheep) were the early issues addressed. Unrestricted grazing on public domain lands ended with the passage of the Taylor Grazing Act of 1934.

Stream alterations have occurred over time. The Crooked River and many tributary streams were channelized following the 1964 flood to facilitate water movement out of the system. This effort disconnected the streams from their floodplains and increased the energy of the streams on the channel banks. Expansion of agricultural, industrial, and residential developments in valley bottoms altered stream morphology and vegetation throughout the basin. As a result, many streams eroded vertically or laterally, water tables dropped, sagebrush replaced meadow grasses, and subsequent recovery of riparian vegetation communities is slow. An extensive reservoir and irrigation system (Ochoco, 1916 and Prineville, 1961) has altered the timing and intensity of flows in much of the lower basin. In some locations, this has resulted in impairing the ability of native vegetation to remain established or re-colonize denuded areas. In other locations, stable flows and cold water created by these developments have created blue-ribbon fisheries, sought after by fly fisherman from throughout the region.

The majority of water rights in the upper basin (Paulina/Post) were allocated by the late 1880s. Irrigated agriculture expanded rapidly just after the turn of the century, with major diversion systems installed on the Crooked and Deschutes rivers in 1908. In late summer and early fall, the lower reaches of some small tributaries to the Lower Crooked River are dry, whereas the North Fork and uppermost tributaries typically have water. Overall effects of irrigation expansion included: positive and negative effects on water quality; changed timing of water availability; and fish passage barriers created by dams and diversions.

Reservoirs limit the amount of sediment available in streams throughout the Lower Crooked River sub-basin. Changes in the timing and size of peak and channel maintenance flow events have changed channel-forming processes in the Crooked River and Ochoco Creek. Natural wetland and riparian areas, particularly within the Prineville urban area, have been filled, removed, or relocated, altering the storage and transport of water through this area of the basin. Roads in the basin generally follow stream courses; many riparian areas are modified by the presence of roads and road crossings can result in channel degradation.

Historically, management practices implemented reflected the best available knowledge at the time to resolve natural resource concerns. For instance, in the 1950s the federal government encouraged the removal of willows in creek bottoms to help the water move through the system faster. Government reports in the late 1970s considered riparian areas to be “sacrifice areas” for livestock grazing. And, the federal government for years had advocated straightening of stream channels.

Current Land Conditions

Riparian Areas

Stream channelization and land use practices have contributed in down cutting of many of the streams and rivers within the Crooked River Basin. As such, these channels do not connect with their floodplains and water moves quickly through the system. In addition, 7upland soil and vegetation conditions contribute to flash floods. The "upper country" (Post/Paulina area) of the watershed is heavily impacted by floods due to landscape conditions that lead to flash floods and a lack of control structures. Additionally, thunderstorms, geology, soils, and topography also contribute to flash floods in the Post/Paulina area. Prineville and Ochoco reservoirs are critical in controlling floodwaters in the Lower Crooked River Sub-basin.

Voluntary involvement by private landowners in riparian improvements has increased since the 1960s. Management changes continue to reduce livestock impacts to riparian areas. Primary management changes include riparian fencing to exclude cattle, the creation of riparian pastures, and modified grazing schedules, and off-stream water developments to encourage livestock use of upland areas.

These management changes have resulted in increased vegetation in the riparian zone but the composition and extent of the riparian community has not been restored. Particularly at lower elevations, riparian areas are dominated by non-native grasses or herbaceous vegetation that lacks the root stability of the woody vegetation or sedge communities that existed historically. Restoring riparian function may take a long time due to current channel conditions.

Rangelands

- Approximately two-thirds of the land within the Management Area is range. Characteristics include:
  - High levels of junipers and shrubs,
  - Expansion of noxious weeds (often worse when cattle are excluded),
  - Increasing fragmentation between blocks of native range habitat,
  - Fire regimes that are more severe than historical conditions, and
  - Slow recovery from past damage in lower precipitation regions of the basin.

The Management Area has historically supported juniper, but since 1936, western juniper has spread rapidly throughout the John Day ecological province, and into the Upper Beaver South Fork Subbasin. The spread of this species is primarily a result of the exclusion of fire and intensive grazing pressures in the early 1900s. In addition, juniper has an affinity for calcium, and the clay ancient sediments of the John Day province are typically calcareous.

Forestlands

Approximately 20 percent of the land within the Crooked River Basin is forested (excluding juniper areas), with the majority contained within the Ochoco and Deschutes National Forests. The current pattern and occurrence of forested vegetation in the Crooked River Basin has changed from historic conditions, which is influencing watershed function and water yield.

Major changes to forest communities in the basin include:

- Overall increase in stand density,
- Increase in small to medium sized trees,
- Shortage of large structure and old trees, and
- Increase in the expanse, density, and canopy cover of western juniper and conifers.

Croplands and Irrigated Agriculture

Approximately 106,215 acres of land within the Crooked River Basin is used for irrigated agriculture and its significance has increased over recent decades due to agricultural and livestock market changes. Presently, irrigated crops within the basin are predominately hay, pasture, and wheat with smaller acreages of mint, garlic, grass and vegetable seed.

The 20,000+ acres served by irrigation districts near Prineville (Ochoco, Lowline, and People's) receive water stored by reservoirs on the Crooked River and Ochoco Creek. Water applied to irrigated lands west of Prineville (e.g. Terrebonne, Alfalfa, Powell Butte, and Lone Pine) is stored in Deschutes River reservoirs before being delivered to the Management Area. The remaining Management Area irrigators rely on non-stored runoff from healthy watersheds to supply their irrigation needs.

Land Use

Fifty-nine percent of the Management Area is publicly owned, primarily by the Federal government. The Bureau of Land Management (BLM) manages 35 percent of the Management Area; and the US Forest Service (USFS) manages 23 percent as the Ochoco, Deschutes, and Malheur National Forests. The remaining one percent of public lands are owned by the state of Oregon.

Fifty-one percent of stream miles run through private lands, 31 percent run through BLM-managed lands, and 16 percent run through National Forests.

Land use is dominated by agriculture and forestry (over 90 percent), with rural residential comprising the third largest category.

In the late 1970s, 73 percent of the Management Area was classified as range, with grazing as the primary use, 21 percent as forest, four percent as irrigated agriculture, and two percent as urban and other uses. Since then, the percent of forestlands has remained about the same, but the proportion of irrigated lands has increased relative to the proportion of grazed lands as the economic significance of crops has expanded. In addition, the conversion of agricultural lands to rural residential and urban development is increasing in the Management Area, which could harm water quality due to a lack of comprehensive riparian guidelines.

Livestock grazing is still a major land use in the basin; however, the advent of irrigation in the early-1900s brought large-scale agriculture to the basin. Soil capabilities, a short growing season, and limited sources and supplies of water for irrigation limit agricultural cropland in the basin.

The number of farms in Crook County increased from 334 in 1978 to 620 in 2017. The average size of farms decreased from an average of 2,580 acres in 1978 to 1,290 acres in 2017.[3]

Livestock ranching and hay production dominate economic and land use activity in the county. Crop alternatives are severely limited by the availability of water and the short growing season. Potential production of forage is low except in restricted meadows and high precipitation areas. Improved grazing management techniques have resulted in a gradual improvement in range quality over the past few decades.

Recreation is a growing enterprise but the potential is constrained by the distance from populated areas, limited year-round access roads, and the seasonal nature of most recreational activities. Reservoirs provide recreation, such as camping, fishing, and boating that depend on water quantity and are becoming a key sector of the economy. Also, excellent tail water fisheries have been created below the reservoirs.

[3] Census of Agriculture. www.agcensus.usda.gov

Socio-economic Conditions
The majority of the Management Area lies within Crook County. The Management Area also includes small portions of Deschutes, Grant, Lake, Jefferson, Wheeler, and Harney counties. While there are significant differences in the socio-economic conditions between Crook and Deschutes counties, the areas of Deschutes that lie within this management area are very similar to Crook County.

In 2017, Crook County's population is estimated to be 21,105 people. Portland State University Population Research Center reported that as of July 1, 2017, the population of Crook County had decreased by 2.4 percent from 2016. Of that population, about 47 percent live in Prineville (the only incorporated town in Crook County) with the remainder of the population living in the unincorporated parts of the County.[4]

Traditionally, the economy has been based on natural resources. Forest products (primary and secondary manufacturing) and agriculture have provided the underlying stability to the community. Today, Crook County's economy also includes manufacturing, trade, government, data centers, and recreation/tourism.[5]

As of October 2017, Crook County's unemployment rate was 6.5 percent. Since 1990, Crook County's unemployment rate has always been higher than Deschutes County and the state average for Oregon. [6]

In general, the top two sales of agricultural commodities produced in Crook County are livestock (primarily cattle and calves) and hay (alfalfa and other hays). [7]

2.4 Agricultural Water Quality

A healthy watershed captures, stores, and beneficially releases water.

Watershed health results from properly functioning uplands and riparian areas. Most of the capture and storage of precipitation occurs in the uplands, which generally make up 98-99 percent of the watershed area. Healthy riparian areas have sufficient vegetation to stabilize streambanks, filter out nutrients, provide shade, and store moisture in the soil profile. A properly functioning stream transports water and sediment in such a way that the stream channel can withstand a 25-year flood event without excessive erosion (which 80 period of the time the flood events are a 25-year event or less).

Capture = Precipitation is captured by vegetation and the soil surface. Fixed site factors that influence the efficiency of capture includes: soil texture and depth, topography, and weather. Landowners can enhance the opportunity for water to enter the ground where it falls by managing upland vegetation. Key management objectives are to:
- Provide sufficient vegetative cover to reduce raindrop impact and to trap precipitation,
- Increase organic litter on top of the soil, and
- Improve root mass to enhance permeability.

Storage = Water is stored in the soil profile and in groundwater. Fixed site factors include soil depth, structure, and texture. Management objectives include:
- Desirable vegetation with healthy root systems to promote soil structure,
- Vegetative cover and organic matter to help reduce excess evaporation.

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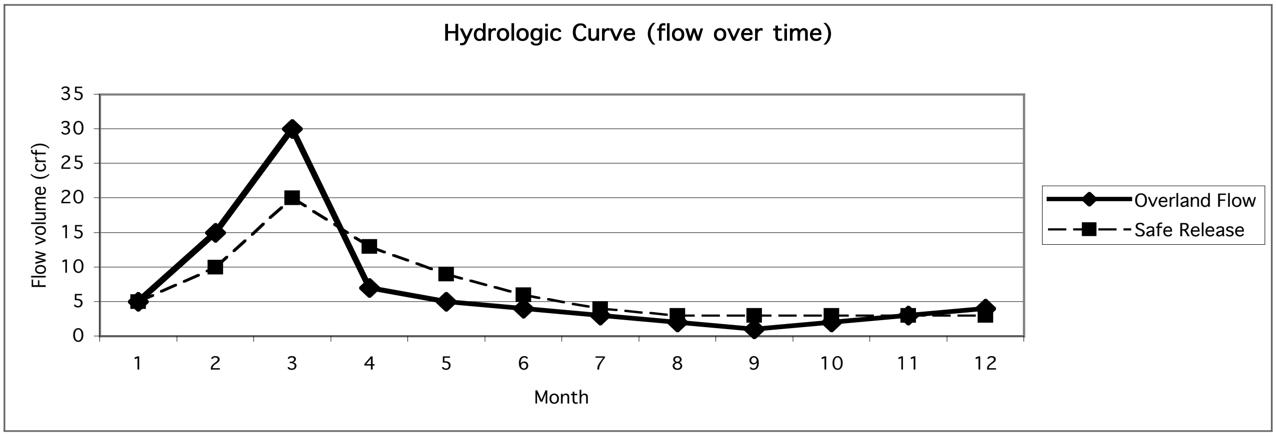
[4] Portland State University Population Research Center. www.pdx.edu/prc/annual-oregon-population-report
[5] Crook County Rural Living Handbook, 2009
[6] Oregon Workforce Statistics, http://www.qualityinfo.org/olmisj/OlmisZine

Beneficial Release = Water is released beneficially via increased subsurface flows and decreased overland flows, resulting in extended late-season flows and reduced erosion and sedimentation. Management objectives consist of having desirable, vigorous vegetation to reduce stream temperature and to promote capture and storage of water.

The overall objective is to moderate peak flows in the spring and to maintain late season flows. This is known as "taking the peak off the hydrologic curve," as shown in the hypothetical example below.

Figure 2.4.1. Hydrologic Curve



Vegetation is key to watershed health! Watershed health is key to water quality! Healthy vegetation in both the uplands and in the riparian areas improves soil conditions, which improves water infiltration and reduces soil erosion. This helps to capture, store, and safely release water later in the season. Releasing water later in the summer reduces water temperatures in two ways. The first way is that a higher volume of water requires more energy to heat it. Secondly, infusion of groundwater, usually between 45 and 55°F, can help moderate stream temperatures and provide cold water refugia for aquatic life.

Threats to Watershed Health

Noxious Weeds (see Appendix A)

Noxious weeds are a threat to native ecosystems, competing with native vegetation and changing forage availability for wildlife and livestock. Noxious weeds negatively impact watershed conditions, often leading to increased runoff and erosion[8]. Invasive plant species are also recognized as a serious threat to agriculture, impacting both livestock and croplands. Many landowners are actively controlling or eliminating infestations on their own lands.

[8] Lacey, J.R., C.,B. Marlow, and J.R. Lane. Influence of spotted knapweed (*Centaurea maculosa*) on surface runoff and sediment yield. Weed Technol. 3:627-631. 1989

Western Juniper[9,10, 11,12,13]
Although western juniper is a native plant, the **expansion of western juniper** into rangelands is a primary watershed health concern. Crook County has more than 857,000 acres of juniper (covers over 50 percent of Crook County's rangeland). Juniper expansion has reduced vegetative ground cover, which has contributed to: increased overland flow, loss of topsoil, and sedimentation of streams during high intensity precipitation events. Juniper expansion is also changing vegetation communities and reducing forage availability for livestock and wildlife, in addition to increasing erosion potential. Juniper crowns intercept more than half of the annual precipitation (reduced capture), and juniper transpires water year-round compared to seasonal transpiration of other vegetation (reduced storage). Juniper woodlands have up to 10 times the erosion rate of sagebrush-grass ecotypes.

Juniper were naturally restricted to rocky ridges and cliffs where there was little grass to fuel fires. Juniper expansion is largely a result of fire suppression policies, although land management trends have also accelerated its expansion. Climate changes in the late 1800s (a period of cooler and wetter years) and grazing practices supported seedling establishment.

While juniper is recognized as valuable habitat for some wildlife species; Oregon's commitment to water quality must include effective control of juniper *expansion* because of the vegetative impact on sage grouse, mule deer, and small bird populations.

Increased Forest Canopy
Forests in the Management Area historically consisted of a diverse mosaic of uneven-aged trees; now they consist more of small trees growing close together. Increased forest canopy often reduces stream flows[14,15, 16] due to factors such as increased evapotranspiration and the capture of precipitation by the forest canopy.[17,18]

Excessive or Inadequate Sediment
Erosion, sediment movement, and deposition are natural watershed processes. Aquatic organisms have evolved with the local natural rate and pattern of erosion and sedimentation. Many streams in the Management Area have naturally high sediment loads due to geology, topography, and climate characteristics. This is particularly true for the steeper portions of the basin. One of the most dramatic examples of sediment movement is runoff events associated with thunderstorms.

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[9] Deboodt, Tim. Crook County OSU Extension Livestock Agent. Personal communication. 2003.

[10] Miller, R.F. and J.A. Rose. Historic expansion of *Juniperus occidentalis* (western juniper) in southeast Oregon. Great Basin Natur. 5591): 37-45. 1995.

[11] Miller, R.F., T.J. Svejcar, and J.A. Rose. Impacts of western juniper on plant community composition and structure. J. Range Manage. 53:574-585. 2000.

[12] Wall, T.G., R.F. Miller, and T.J. Svejcar. Juniper encroachment into aspen in the northwest Great Basin. J. Range Manage. 54:691-698. 2001.

[13] Owens, M.K., R. Lyons, and C. Kneuper. Evaporation and interception water loss from juniper communities on the Edwards Aquifer Recharge Area. Texas Agricultural Experiment Station and Extension Service Quarterly Report. April 2, 2001.

[14] Douglass, J.E, and W.T Swank. Streamflow and modification through management of eastern forests. USDA For. Serv. Res. Paper SE-94. Southeastern For. Exp. Sta. Asheville, N.C. 15 pp. 1972.

[15] Hornbeck, J.W., Martin, C.W. and C. Eagan. Summary of water yield experiments at the Hubbard Brook Experimental Forest, New Hampshire. Can. J. For. Res. 27:2043-2052. 1997.

[16] Books, R.T. and N. Lust, eds. *The Science of Managing Forests to Sustain Water Resources*. Special issue of Forest Ecology Volume 143. 2001.

[17] *Stream Corridor Restoration; Principles, Processes and Practices*. Federal Interagency Stream Restoration Working Group. October 1998.

[18] Bormann, F.H. and G.E. Likens. *Pattern and Process in a Forested Ecosystem*. Springer-Verlag, New York. 256 pp. 1979.

Land management activities and changes in land cover patterns can accelerate the natural erosion rate and alter the timing and amount of sediment delivered to streams. Primary human-related factors related to increased erosion and sedimentation on non-forest lands includes: expansion of western juniper and noxious weeds, irrigation systems, roads, rural residential development, and agriculture. High sedimentation rates within Prineville Reservoir reduce photosynthesis in the reservoir, thereby reducing available food and habitat for fish. While excessive erosion is a concern in many areas of the basin, a lack of bedload and sediment transfer due to Bowman Dam at Prineville Reservoir is a concern for maintenance and restoration of riparian and channel conditions on the lower Crooked River. Due to the construction of the Bowman Dam, the lower Crooked River is often faced with long periods of controlled high-water flows (45-60 days) within the riverbanks instead of a flash flood system of an uncontrolled watershed. The long periods of high water flows are causing sediment issues, which need to be addressed.

2.4.1 Water Quality Issues

2.4.1.1 Beneficial Uses

The Federal Clean Water Act required states to designate beneficial uses related to water quality that must be protected for the public interest. These beneficial uses of water are codified in OARs and generally apply basin-wide to all waters of the state (Table 2). Waters of the state include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, marshes, inlets, canals, and all other bodies of surface or underground waters, natural or artificial, public or private (except those private waters which do not connect to natural surface or underground waters) within Oregon (from ORS 468B.005(10)).

Table 2.4.1.1. Beneficial uses (related to the Clean Water Act) in the Management Area (OAR 340-41-0130; date 2003)

Beneficial Use	Crooked River Mainstem	All Other Basin Streams
Public Domestic Water Supply[1]	X	X
Private Domestic Water Supply[1]	X	X
Industrial Water Supply	X	X
Irrigation	X	X
Livestock Watering	X	X
Fish & Aquatic Life[2]	X	X
Wildlife & Hunting	X	X
6	X	X
Boating	X	X
Water Contact Recreation	X	X
Aesthetic Quality	X	X
Hydropower	X	

[1]With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.

[2] Figures 130A and 130B in OAR 340-41-0130 indicate where specific salmonid Beneficial Uses are designated. All streams in the Crooked River watershed appear to be designated for “Salmon and Trout Rearing and Migration”; no streams are designated for “Salmonid Spawning”.

Beneficial Uses Most Likely to be Adversely Affected

The focus of this Area Plan is to encourage the positive management of streams, riparian areas, and uplands to support beneficial uses of the water. Salmonids, resident fish, and aquatic life are the most sensitive beneficial uses for a number of water quality parameters (including temperature, sedimentation, turbidity, nutrients, pH, and dissolved oxygen). The bacteria standard protects the beneficial use of Water Contact Recreation.

Salmonids (includes salmon and trout)[19]
The Pelton-Round Butte Dam complex was completed in 1968 on the Deschutes River, below the mouth of the Crooked River. Before completion of the complex, summer steelhead, spring chinook salmon, bull trout and redband trout were historically present. The first formal fish surveys took place in the 1950s after substantial habitat and population declines had already occurred. Despite 75 years of major habitat changes, the 1952-54 surveys located steelhead up to 120 miles from the mouth of the Crooked River. Historical accounts indicate that most salmon and steelhead in the Upper Deschutes Basin historically spawned and reared young in the main tributaries: Crooked River, Wychus Creek, and Metolius River. The completion of the dam complex eliminated upstream passage of anadromous fish to the Crooked River Subbasin. However, starting in 2007 and continuing to the present, a reintroduction effort annually releases steelhead and Chinook salmon as a result of relicensing the dam complex. Opal springs hydroelectric facility prevented upstream migration for all fish species into the Crooked River from the Deschutes River. In 2019, a fish ladder passage was completed that allows fish to migrate over Opal dam unaided. Offspring of wild redband were reintroduced into the South Fork and were starting to naturally reproduce. It was likely that wild redband naturally repopulated the South Fork.

2.4.1.2 WQ Parameters and 303(d) list
Primary parameters of concern identified on the 303(d) list are temperature, pH, dissolved oxygen, bacteria, biological criteria, and total dissolved gas (see Appendix B). Because data have been collected from relatively few sites, the 303(d) list may: 1) not accurately reflect the extent of water quality concerns in the Management Area, 2) over-emphasize water quality concerns, or 3) not reflect the capability to meet the state water quality criteria.

Water Quality Parameters of Concern
Water quality conditions within the Crooked River Basin are highly variable, with higher elevation streams in the Ochoco Mountains generally having good to excellent water quality, and lower elevation sites having lower overall water quality[21]. Primary contributors to the poor water quality are related to land and water conditions such as: low summer flows, the existence of reservoirs and diversions, degraded upland and riparian vegetation, and stream channels that lack stable banks and connection with the floodplain. Land uses that can influence water quality in the basin include logging, roads, grazing, irrigated and non-irrigated agriculture, confined animal feeding operations (CAFO), recreation, urban and rural residential development, reservoirs, and seasonal sewage treatment plant activities.

The Department of Environmental Quality currently maintains two water-quality monitoring stations on the Crooked River, located at Lone Pine Road (30 miles above the mouth) and Conant Basin Road (92 miles above the mouth of the Crooked River and approximately six miles above Prineville Reservoir). Through 1993, DEQ monitored an additional station on the Crooked River at Highway 126 on the west edge of Prineville, 48 miles above the mouth. The US Forest Service and BLM monitor water quality on their lands in the Management Area. The Crooked River Watershed Council has been monitoring stream temperatures, bacteria, dissolved oxygen, and pH throughout the watershed.

Elevated summer temperatures
Oregon's temperature standard was revised in March 2004 and has several different temperature requirements (criteria), based on the type of aquatic use being supported[20]. Only one currently applies to the Management Area: waters supporting salmonid rearing and migration or other aquatic life should not exceed 64.4˚F. No streams are currently designated in the Management Area for salmonid spawning, which has a criterion of 55.4˚F. However, that will likely change in the lower Crooked River with the

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[19] *Crooked River Basin Characterization*. Crooked River Watershed Council. 2002.

[20] *Oregon's 2012 Section 303(d) List of Water Quality Limited Waterbodies*. Oregon Department of Environmental Quality.

reintroduction of the steelhead. Determining whether the stream temperature is above or below the temperature standard is based on the average of the maximum daily water temperatures for the stream's warmest, consecutive seven-day period during the year. Water temperature measurements must be taken with continuous recording temperature sensors, in well-mixed and representative locations of streams. A one-time measurement above the standard is not a violation of the standard. When stream flow is exceptionally low or air temperature is exceptionally high, the temperature criteria may be waived (340-041-0028(12).

Water temperatures are critical to fish growth and survival at all life stages. Warm stream temperatures increase stress and disease, raise metabolism, lower growth rates, and enhance conditions for introduced non-native predators. Temperature affects the dissolved oxygen potential in water - the warmer the water, the less dissolved oxygen it can hold. Fish cope with thermal stress by adjusting their behavior during the warmer summer months. Sometimes cold-water fish will seek refuge during the heat of the day in nearby cooler waters that are fed by springs or ground water, while others may migrate great distances to seek out the cooler headwaters. Coldwater species of fish also adapt their body structure, chemistry and physiology to become more efficient at the metabolic processes that regulate swimming, avoiding predators, etc. during thermal stress.

Stream temperatures are influenced primarily by direct solar radiation, air temperature, and movement of groundwater into streams[21]. Basic approaches to minimizing increases in water temperature include: provide shade where appropriate, keep the stream narrow, increase volume of water, and keep water flowing. Vegetation affects all these factors, and human activity, depending on the site, may have a direct influence on vegetation.

Elevated pH

Excessive aquatic plant or algal growth can harm fish and other aquatic life by creating extremes in water pH and low levels of dissolved oxygen. (The death and subsequent decomposition of aquatic plants can consume large quantities of dissolved oxygen.) These conditions can be stimulated by the availability of nutrients, warm temperatures and light, which in turn may be exacerbated by low stream flows and lack of protective vegetative cover. DEQ monitoring at their two ambient sites indicates high concentrations of nutrients both during periods of low flow (little dilution) and during heavy precipitation (high runoff). Increased nutrient concentrations can affect both in-stream pH and dissolved oxygen.

Spawning and rearing of salmonid fish species are the most sensitive beneficial uses affected by pH. Values of pH outside the range in which a species evolved may result in both direct and indirect toxic effects. Elevated pH levels can cause dramatic increases in toxicity of other pollutants and cause fish kills.

The maximum pH criterion for the Deschutes River Basin is 8.5. The Crooked River drains the Ochoco Mountains and is similar geologically to the rest of eastern Oregon, which has a maximum pH criterion of 9.0. As part of the Total Maximum Daily Load (TMDL) process, the LAC believes that DEQ should raise the maximum pH criterion for the Crooked River Subbasin from 8.5 to 9.0, to reflect the local geology. Soil pH from the City of Prineville (analyzed by AgriCheck Laboratory) has been documented as high as 11.0 along the Crooked River. In order for the pH to be changed to correctly reflect the Crooked River Subbasin, the pH parameter listing will need to go through the TMDL process.

Elevated total dissolved gases

The mainstem Crooked River is listed for total dissolved gases from Baldwin Dam to Prineville Reservoir because of elevated saturation levels below Bowman Dam after periods of high flows. The way the water is released from the dam during high flows is the only believed source of this problem.

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[21] Moore, J.A. and J.R. Miner. *Stream Temperatures: Some Basic Considerations*. Oregon State University Extension Service. EC 1489. May 1997.

Elevated bacteria

High levels of bacteria can cause human illnesses. Thus, the most sensitive beneficial use protected by the bacteria standard is water contact recreation (activities such as swimming or fishing where people could swallow or have water touch open cuts or sores). The bacteria standard also does not allow bacteria in numbers high enough to interfere with waters used for domestic purposes, livestock watering, irrigation, or other beneficial uses. *Escherichia coli (E. coli)* is one bacterial contaminant that is monitored as an indicator of fecal contamination. DEQ has established acute and chronic water quality criteria for *E. coli*. Potential sources of fecal contamination and *E. coli* include livestock manure, sewer or septic system leaks, urban storm water runoff, water foul and wildlife waste. DNA source testing should be done for *E. coli* samples to identify where the source of *E. coli* is coming from.

Biological Criteria

Biological Criteria listings indicate waters that don't adequately support aquatic insects and similar invertebrates (benthic macroinvertebrates). These organisms are important as the basis of the food chain and are very sensitive to changes in water quality. To assess a stream's biological health, the community of benthic macroinvertebrates is sampled and compared to the community expected if the stream were in good shape ("reference community"). If the difference is too great, the stream section is designated as 'water quality limited.' This designation does not identify the limiting factor (e.g. sediment, excessive nutrients, temperature).

Potential Water Quality Concerns

Sediments carried in streams can adversely affect aquatic life by increasing water temperature through thermal absorption, reducing light penetration and visibility, reducing water infiltration through stream substrate (harming incubating fish eggs), and irritating gill filaments. **Turbidity** is a measure of the cloudiness of water and is often used as a surrogate measure for suspended sediment.

Three other factors related to fish habitat can influence water quality. **Reduced stream flows** can contribute to a general reduction in available habitat and interfere with fish migration. In addition, low flows can contribute to warmer water, increased pH, and reduced dissolved oxygen. Slow-moving streams may be more susceptible to warming and they are less turbulent, all of which can contribute to reduced oxygen levels. **Modification of physical habitat** can harm all aquatic life. Historical channelization reduced the amount of habitat (stream length is reduced as meanders are eliminated), as well as the instream habitat complexity such as the normal mixture of pools, riffles, and runs. Loss of riparian vegetation often destabilizes streambanks, which results in increased erosion, increased stream sedimentation, loss of instream habitat complexity and cover, and the loss of future large woody debris that naturally falls into streams. In addition, **drought** conditions have been a contributing factor for the decline of fish habitat in the Crooked River Management Area. Habitat throughout the basin has been improving in some locations because of numerous fencing and habitat restoration projects, improvements to irrigation diversions and improved grazing management on both private and public lands.

In September 2011, DEQ published the Deschutes Basin Water Quality Status and Action Plan[22]. It discusses water quality concerns and emphasizes the following actions related to agriculture:

1. Surface Water Actions
    a. Reduce temperatures, improve flow volume and patterns, and improve habitat through:
        - Better land management and conservation,
        - Increasing native, streamside habitat,
        - Improved water conservation,
        - Increased instream flows,
        - Channel restoration,

[22] Deschutes Basin Water Quality Status and Action Plan. www.deq.state.or.us/wq/watershed/Docs/DeschutesPlan.pdf

        - Juniper reduction,
        - Combating invasive weeds.
    b. Reduce erosion and nutrient and pesticide levels in water through better land and crop management
2. Groundwater Actions
    - Minimize nitrate contamination from agriculture,
    - Assess effects of groundwater pumping and irrigation efficiency projects on stream flows,
    - Assess cause, extent and magnitude of risks associated with bacteria in groundwater.

The LAC believes that the Deschutes Watershed Action Plan, as it addresses the Crooked River Basin, is limited in its available data and reference to agriculture activities and influences.

2.4.1.3 TMDLs and Agricultural Load Allocations
Total Maximum Daily Loads expected from DEQ for the Management Area have not yet been completed. DEQ began work on TMDLs in the Management Area in 2005, however, they have not been completed due to lack of resources. At this point, DEQ does not have a schedule for resuming this work. The Area Plan will serve as the implementation plan for Agriculture's Load Allocation for each TMDL parameter in the Management Area and may be revised to address TMDL requirements.

2.4.1.4 Drinking Water
Drinking water in the Management Area is from both public and private systems, and the majority of drinking water is from groundwater. Fifty-nine active public water systems obtain domestic drinking water from groundwater sources to serve approximately 22,000 persons in the Management Area.

Drinking water contaminates of concern within this Management Area are: *E. coli*, nitrate, arsenic, radium and lead. Of this list, only *E. coli* and nitrate are potentially sourced from agriculture.

Of the soils in the Management Area that have been rated, most have moderately high or high nitrate leaching potential. Nitrate from sources such as fertilizers and septic systems can readily penetrate to the aquifers used for drinking water when leaching potential is moderately high or high, and bacteria removal through soil filtration can be less effective in sandy soils.

Six community public water systems in the management area have had alerts for bacteria within the last 10 years; it is unclear based on their locations whether any of these are related to agriculture.

Nitrate alerts are generated when nitrate exceeds 5 mg/L (the standard is 10 mg/L). Six public systems had alerts for nitrates in the last 10 years; based on the types of these systems (mostly trailer parks and recreational parks along a reservoir), these alerts may be related to septic systems.

The drinking water maximum contaminant level for nitrates is 10 mg/L. Nitrate concentrations greater than 10 mg/L have been measured in private wells north of Prineville in soils with high leaching potential. The Domestic Well Testing Act database (real estate transaction testing data) for 1989-2018 showed that 11 percent of 647 private wells had significant detections of nitrate (>7mg/L). Of these, 31 had concentrations ≥10mg/L, including one near Prineville with a measurement of 23 mg/L nitrate. The highest nitrate levels northwest of Prineville are 15 to 20 years old (years 2,000 to 2,015), with no recent data. High levels in the past five years (2015-2020) are south of Prineville. Nitrates could be sourced from septic systems or agricultural practices.

It is difficult to determine how much of an impact agriculture is having on groundwater sourced for drinking water in this Management Area. Landowners should always properly manage manure and fertilizer to minimize leaching of nitrates and *E. coli* to groundwater.

2.4.2 Sources of Impairment

Sources of water pollution can be generalized into two types: point source pollution and nonpoint source pollution. Point source pollution emanates from clearly identifiable discharge points such as wastewater treatment plants, piped effluent from industrial operations and other discrete conveyances. Permits are required for significant point source discharges. These permits, administered by DEQ, require that certain effluent standards be met or require a zero-discharge level. Certain CAFOs require permits, which are administered by ODA.

Nonpoint source pollution is pollution emanating from landscape scale sources and cannot be traced to a single point. Agricultural operations are concerned with preventing or controlling pollution from nonpoint sources and concentrated runoff from these sources. Nonpoint sources of pollution in the Crooked River watershed may include eroding agricultural and forest lands, eroding streambanks, runoff and erosion from roads and urban areas, and runoff from areas used by livestock and other agricultural operations. Pollutants from nonpoint sources are carried to the surface water or groundwater through the action of rainfall, snowmelt, irrigation and urban runoff, and seepage. Runoff from nonpoint sources can concentrate into identifiable sources entering waterways as point sources.

A major nonpoint source of water quality impairment is heat input that results in high water temperatures. Water temperature naturally fluctuates with air and soil temperatures on a daily and seasonal basis, however, temperature increases may be caused by both natural and man-caused events resulting from vegetation removal, low seasonal flows, changes in channel shape and alteration to the floodplain (among others). Channelization or alteration of stream courses can alter gradient, width/depth ratio and sinuosity, causing sediment and temperature increases.

While there may not be severe impacts on water quality from a single source or activity, the combined effects from all sources may contribute, along with impacts from other land uses and activities, to the impairment of beneficial uses of the Crooked River.

2.5 Regulatory and Voluntary Measures

2.5.1 Area Rules

Area Rules (OAR 603-095-3400 through 603-095-3460) complement the voluntary strategies. ODA pursues enforcement to gain compliance with the Area Rules **only** when reasonable attempts at a voluntary solution have failed.

The Area Rules are enforceable by ODA and are cited here for your information. The Area Plan is not enforceable; it provides an overall proactive strategy for meeting the Plan's water quality objectives and for complying with the Area Rules.

All landowners conducting agricultural activities on non-Federal and non-Tribal Trust lands (including timber lands) must comply with the Area Rules (OAR 603-095-3400 through 603-095-3460). 'Landowner' includes any landowner, land occupier or operator (ORS 568.903). The landowner's responsibility is to implement measures that ensure compliance with these Area Rules. Sanctions can come into effect from ODA if a landowner is out of compliance with the Area Rules.

Some Area Rules may become more specific over time, as information becomes available on land conditions and water quality.

Area Rules

Oregon Administrative Rules 603-095-3440

(1) Landowners must comply with OAR 603-95-3440(2) through (3) within the following limitations. A landowner is responsible for only those conditions resulting from activities controlled by the landowner. A landowner is not responsible for conditions resulting from activities by landowners on other lands. A landowner is not responsible for conditions that: are natural, could not have been reasonably anticipated, or that result from unusual weather events or other exceptional circumstances.

(2) Streamside Riparian Area Management

(a) Effective January 1, 2009, agricultural management must allow establishment, growth, and active recruitment of streamside riparian vegetation, consistent with site capability, to moderate solar heating, stabilize streambanks, and filter sediment and nutrients from overland flows.

(b) Except as provided in (a), grazing, weed control, and other common agricultural activities are allowed in riparian areas.

(c) Water gaps and hardened crossings are allowed in streams that otherwise meet conditions required under (a).

(3) Waste Management

Effective on rule adoption, no person subject to these rules shall violate any provision of ORS 468B.025 or ORS 468B.050.

The Streamside Riparian Area Management Rule requires activities that prevent streamside riparian vegetation from developing to cease by 2009; it does not require that adequate vegetation be present by 2009. The rule does not specify particular activities that must cease and does not require any specific activity to take place. Landowners are not responsible for wildlife browsing and grazing use.

This Rule does not require that all sediment be kept out of streams by 2009. This rule refers to the filtration of sediment caused by human activities, not sediment resulting from natural processes. Sufficient vegetation to filter out sediment also helps reduce the amount of bacteria and nutrients entering streams.

The Waste Management Rule currently is State Law (ORS 468B.025 and ORS 468B.050). ORS 468B.025 states that no person shall:

(1) (a) Cause pollution of any waters of the state or place or cause to be placed any wastes in a location where such wastes are likely to escape or be carried into the waters of the state by any means.
(b) Discharge any wastes into the waters of the state if the discharge reduces the quality of such waters below the water quality standards established by rule for such waters by the Environmental Quality Commission.

(2) Violate the conditions of any waste discharge permit issued under ORS 468B or ORS 568.

ORS 468B.050 refers to situations when permits are required, such as for certain CAFOs. This rule ensures that concentrated nutrients, pathogens associated with high animal density areas, high sediment concentrations in run-off, toxics, or other potential pollutants are not readily transported to waters of the state.

Wastes associated with livestock operations can include manure from seasonal feeding and birthing areas, gathering areas and corrals, rangelands and pasture, and any other situations not already covered by Oregon's CAFO laws. Fecal coliform counts that exceed state water quality criteria indicate noncompliance with the Waste Management Rule. Livestock grazing is allowed to the extent it does not violate state water quality standards and complies with the Area Rules. Compliance with the Streamside Riparian Area Management Rule will help keep wastes from being carried into waters of the state.

Wastes may also include excess sediment discharges. Landowners who are actively discharging significant quantities of sediment may be in violation of the Waste Management Rule.

Area Rule Enforcement

In addition to the voluntary strategies, Area Rules (OAR 603-095-3400 through 603-095-3460) are included as an implementation strategy; ODA uses enforcement where appropriate and necessary to gain compliance with the Area Rules. Any enforcement action is pursued only when reasonable attempts at a voluntary solution have failed. ODA seeks input from the local SWCD prior to evaluating conditions for compliance or requiring a schedule of corrective practices. ODA will consult with the local SWCD regarding appeals and requests for alternate measures provided by ORS 568.912 and OAR 603-090-0040 and 0050. The following Area Rules provide for resolution of complaints.

ODA is required to make a reasonable attempt to notify the landowner that entry of property is necessary prior to entering. ODA will not enter private property to collect information without landowner consent or a search warrant, except as provided by state and federal law.

Complaints and Investigations (OAR 603-095-3460)

(1) When the department receives notice of an alleged occurrence of agricultural pollution through a written complaint, its own observation, through notification by another agency, or by other means, the department may conduct an investigation. The department may, at its discretion, coordinate inspection activities with the appropriate Local Management Agency.
(2) Each notice of an alleged occurrence of agricultural pollution will be evaluated in accordance with the criteria in ORS 568.900 to 568.933 or any rules adopted thereunder to determine whether an investigation is warranted.
(3) Any person allegedly being damaged or otherwise adversely affected by agricultural pollution or alleging any violation of ORS 568.900 to 568.933 or any rules adopted thereunder may file a complaint with the department.
(4) The department will evaluate or investigate a complaint filed by a person under section OAR 603-095-3460(3) if the complaint is in writing, signed and dated by the complainant and indicates the location and description of:
(a) The waters of the state allegedly being damaged or impacted; and
(b) The property allegedly being managed under conditions violating criteria described in ORS 568.900 to 568.933 or any rules adopted thereunder.
(5) As used in section OAR 603-095-3460(4), "person" does not include any local, state or federal agency.
(6) Notwithstanding OAR 603-095-3460, the department may investigate at any time any complaint if the department determines that the violation alleged in the complaint may present an immediate threat to the public health or safety.
(7) If the department determines that a violation of ORS 568.900 to 568.933 or any rules adopted thereunder has occurred, the landowner may be subject to the enforcement procedures of the department outlined in OARs 603-090-0060 through 603-090-0120.

2.5.2 Voluntary Measures

Voluntary efforts are the primary means to prevent and control agricultural sources of water pollution. Landowners in the Management Area are generally aware of water quality concerns and appropriate practices to address those concerns. Many landowners are actively implementing projects to improve upland and riparian conditions.

SWCDs are the main support agencies at the local level. The NRCS, Crooked River Watershed Council, Crook County Weed Board, Oregon State University Extension Service and Central Oregon Agricultural Research and Extension Center, Deschutes Resources Conservancy, Oregon Watershed Enhancement Board (OWEB), ODA, DEQ, Oregon Water Resources Department (WRD), Oregon Department of Fish & Wildlife, ODF, US Forest Service, Bureau of Land Management (BLM), United State Department of Agriculture Farm Service Agency (USDA FSA), and others may provide information and/or technical and financial assistance.

Landowners have flexibility in choosing management approaches and practices to address water quality issues on their lands. Landowners may choose to develop management systems to address problems on their own, or they may choose to develop a voluntary conservation plan (e.g. an NRCS-approved farm plan) to address applicable resource issues. Landowners may seek planning and financial assistance from any agency or a consultant.

Natural factors that may limit improvement in land conditions may include area precipitation patterns, soil types, stream channel morphology, upland topography, wildlife, and invasive plants.

The LAC would like to see a priority placed on development and promotion of economic benefits of juniper control. This would encourage landowners to manage or control juniper, thereby improving watershed health.

To help achieve water quality standards in the Management Area, an effective strategy should result in:

- Healthy, productive riparian areas,
- Healthy, productive uplands,
- Properly managed croplands,
- Properly managed livestock.

Site capability is a key concept for vegetation management. *Site capability* is the vegetative condition that can be expected at any given site, based on site potential and human infrastructure. *Site potential* is the highest ecological status of vegetation that an area can attain. Site potential is influenced by physical and biological factors such as elevation, aspect, geology, climate, wildlife, and the current plant community. It is also influenced by disturbances found in riparian systems, such as flooding. Site conditions that affect the establishment and development of streamside vegetation are further modified by human infrastructure (such as roads, power and telephone lines, and irrigation and drainage systems) and resident wildlife and wild horse use.

Proper Functioning Condition (PFC)[23] is a familiar concept to many landowners in the Management Area. A stream at PFC can withstand a 25-year storm event without excessive bank erosion. Streams at PFC have the ability to provide most if not all of the functions required to help achieve water quality standards.

A stream is considered to be at PFC when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve flood-water retention and ground-water recharge;
- Develop root masses that stabilize streambanks against erosion;

[23] *Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas*. TR 1737-15. BLM. 2015.

- Develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and
- Support greater biodiversity.

1. Healthy, Productive Riparian Areas

Healthy riparian areas have appropriate vegetation and stable streambanks. Depending on site capability, these streams also have sufficient structure such as rock and large woody debris to reduce flow velocities and reduce the damage from flooding.

Riparian Vegetation

Riparian vegetation consists of plants that depend on or tolerate the presence of water near the soil surface for at least part of the year. Riparian vegetation can include sedges, rushes, willows, cottonwoods, and other herbaceous or woody vegetation, depending on conditions at the site such as soil type, slope, aspect, stream gradient, and elevation.

Riparian vegetation helps:

- Minimize streambank erosion by increasing the cohesiveness and structural strength of streambanks and by reducing flow velocities, [24,25,26]
- Moderate summer water temperature, [27]
- Maintain later season flows by increasing the ability of the adjacent soils to store water during runoff seasons,[28,i,29]
- Filter out and process excess nutrients, bacteria, and sediment in runoff that could pollute adjacent streams. [30,31,32,33]

Riparian vegetation should:

- Include a variety of plant species and ages. Land managers and agency personnel should recognize that differing climate, soils, and water regimens within the basin precludes all streams from having the same vegetative potential;
- Include plants that have root masses capable of withstanding high stream flows;
- Provide adequate cover to protect the streambank and dissipate energy during high flows;
- Include sufficient ground cover to filter out excess sediment or nutrients in overland flows;
- Provide shade, where allowed by site capability.

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[24] Green, T.R., S.G. Beavis, C.R. Dietrich, and A.J. Jakeman. Relating stream-bank erosion to in-stream transport of suspended sediment. Hydrological Processes 13:777-787. 1999.

[25] Selby, M.J. *Hillslope materials and processes*. Oxford University Press, Oxford. 1982.

[26] Abernathy, B., and I.D. Rutherford. Where along a river's length will vegetation most effectively stabilize stream banks? Geomorphology 23:55-75. 1998.

[27] Bilby, R.E. Characteristics and frequency of cool-water areas in a western Washington stream. Journal of Freshwater Ecology 2:593-602. 1984.

[28] Auble, G.T., J.M. Friedman, and M.L. Scott. Relating riparian vegetation to present and future streamflows. Ecological Applications 4:544-554. 1994.

[29] Whiting, P.J., and M. Pomeranets. A numerical study of bank storage and its contribution to streamflow. Journal of Hydrology 202:121-136. 1997.

[30] Godwin, D. and J.A. Moore. *Manure management in small farm livestock operations: Protecting surface and groundwater*. Extension Bulletin EM 8649. Oregon State University Extension Service. Corvallis, OR. 1997.

[31] Munoz-Carpena, R., J.E. Parsons, and J.W. Gilliam. Modeling hydrology and sediment transport in vegetative filter strips. Journal of Hydrology 214:111-129. 1999.

[32] Castelle, A.J., A.W. Johnson, and C. Conolly. Wetland and stream buffer size requirements: A review. Journal of Environmental Quality 23:878-882. 1994.

[33] Hjelmfelt, A. and M. Wang. Modeling hydrologic and and water quality responses to grass waterways. Journal of Hydrologic Engineering 4:251-256. 1999.

Riparian vegetation required by the Area Rules is based on site capability and includes: visible ongoing renewal of riparian vegetation, vigorous growth, and the maintenance of a majority of each year's new growth of woody vegetation (trees and shrubs). Noxious weeds are undesirable as they generally provide: less shade, filtering capacity, and less stabilizing root mass than the plants they replace as well as decreasing economic output. Due to its integral role within the ecosystem, native vegetation is preferred where practical.

Stable Streambanks

A stream is considered stable if its banks maintain their integrity during a 25-year storm event. Channel morphology is key to streambank stability. [34, 35]

Channel morphology refers to the shape and physical characteristics of a stream. These include: how much the stream meanders ("sinuosity"), the slope of the streambanks, how deeply cut ("incised") the stream is, etc. Morphology is influenced by natural features such as geology and weather and by human activities.

Vegetation and structure (rocks and large woody debris) are key to maintaining bank stability by reducing flow velocities and protecting streambanks from excessive erosion.

As riparian vegetation matures, channels of low gradient streams are expected to narrow and deepen (known as a 'low width to depth ratio'). These stream channels will have less water surface area exposed to solar radiation (thereby moderating heating rates during summer) and will be more connected to their floodplain. Better floodplain connectivity has the added benefit of increasing storage during periods of high streamflow, reducing velocities during periods of high streamflow, and increasing releases of water later in the year. Streams with a low width to depth ratio will also meander more, which will reduce flow velocities and reduce the damage from flooding.

Streambanks naturally change in form or location over time; some bank instability usually occurs in undisturbed streams. Excessively unstable streambanks can contribute to:

- Sediment in the stream channel caused by slumps and surface erosion,
- Fine sediment in the water,
- Wider channels, which increases exposure of water to solar radiation,
- Decreasing stream depth and alteration of fish habitat.

Management options that may contribute to healthy riparian areas include:

- Use of management-intensive grazing,
- Proper management of upland vegetation,
- Use of herding and/or fencing to better control livestock access to riparian areas,
- Off-stream watering areas for livestock,
- Early-season flood irrigation to recharge groundwater and sub-surface water storage that help augment late season stream flows,
- Control of noxious weeds,
- Timing of livestock grazing to allow recovery of riparian vegetation,
- Planting of willows and other riparian shrubs,
- Maintain a vegetative buffer along creeks,

[34] Rosgen, D.L. *Applied River Morphology*. Wildland Hydrology. 1996.

[35] *Riparian Area Management: Process for Assessing Proper Functioning Condition*. Bureau of Land Management. Technical Reference 1737-9. 2015.

- Proper design, location, installation and maintenance of roads, culverts, bridges, stream crossings and upstream storage systems,
- Leave large, woody debris in streams if possible,
- Proper use of grade control structures.

2. Healthy, Productive Uplands

Approximately 40 percent of the uplands in the Management Area are privately owned.[36] The Management Area receives little precipitation and experiences prolonged droughts. Upland sites in good condition may naturally include sparsely vegetated areas.

With a protective cover of grass, shrubs or trees consistent with site capability, uplands capture, store and safely release precipitation thereby reducing the potential of excessive soil erosion or pollution in spring and augmenting the volume of late season stream flows.[37]

Indicators of healthy uplands include:

- Healthy riparian areas,
- Recruitment of beneficial plant species,
- Ground cover to aid in infiltration of water and to limit runoff of nutrients and sediment,
- Lack of noxious weeds.

Proper management of upland vegetation considers physical and biological conditions of the management area, and controls soil erosion and minimizes transport of soil and nutrients to the stream. Upland management also considers wildlife habitat, livestock production, and fish protection.

Factors to evaluate upland area condition may include:

- Plant species composition to measure plant health and diversity,
- Ground cover (live plants, standing plant litter, or ground litter) as a measure of potential erosion,
- Bare areas are a natural condition in many places,
- Evidence of overland flow (e.g. rills and gullies),
- Site productivity (domestic livestock and wildlife carrying capacity),
- Riparian area health and condition.

To limit erosion and augment late season stream flows, upland management should consider the following:

- Minimize bare or exposed soil. Based on site capability, soil surface should be occupied by herbaceous vegetation, shrubs, and/or trees,
- Presence of soil organic matter (litter and biotic crust) and rock,
- In forested areas, optimize tree spacing to best utilize tree productivity and snow storage. Dense stands of trees catch too much snow on the branches and lose the precipitation to sublimation and limit storage on the surface. Stands that are too open lose forest productivity and do not provide enough shading to preserve snow pack late into the spring. Proper tree stand density is site-specific,
- Healthy stands of perennial grasses are usually better at filtering sediments and limiting erosion than stands of annual grasses.

Management options that may contribute to healthy uplands include:

- Thinning of overstocked stands of trees, including juniper,

[36] Dedrick, Jason. Crooked River Watershed Council Coordinator. Personal communication. 2003.

[37] Interpreting Indicators of Rangeland Health, NCRS Technical Reference 1734-6. Available at: ftp://ftp.ftw.nrcs.udsa.gov/pub/glti/IntIndRangeHealth.pdf

- Controlled burning,
- Seeding of perennial grass plants,
- Livestock grazing designed to maintain or improve vegetation and encourage the incorporation of organic matter into the soil,
- Control of noxious weeds,
- Well-designed off-stream water aimed at improving grazing distribution of livestock.

3. Properly Managed Croplands

Diversion of water from a water body to be applied on land to grow crops is a recognized beneficial use of water. Irrigation water use is regulated by the WRD in the form of water rights, which specify the rate and amount of water that can be applied to a particular parcel of land. Water rights are not addressed in this Area Plan; they are under the jurisdiction of the WRD (refer to WRD Rules OAR 690-300-0010 for more details).

Irrigation in the Management Area is done by flooding, sprinkler, or drip application. Water usually is diverted from a surface source (stream or pond) but may also be from groundwater sources. Irrigation water is often used more than once as it returns to the stream and is available for instream uses or by other irrigators.

This Area Plan addresses irrigation activities of individuals. Activities of irrigation districts are outside the scope of ODA's Agricultural Water Quality Management Area Program.

Characteristics of an irrigation system that has minimal effect on water quality include:

- Delivery of water efficiently to the land within legal water rights,
- Minimal overland return flows that do not carry sediment, farm chemicals, or excess nutrients to a stream,
- Scheduling of water application appropriate to the site including consideration of soil conditions, crop needs, weather and topography,
- Applied nutrients do not leach to groundwater in unacceptable amounts.

Management options for croplands that may protect water quality may include:

1) Cropping
    - Properly place, design, and maintain roads, culverts, bridges, and crossings,
    - Use conservation tillage: reduced tillage, direct seeding, subsoiling, and chemical fallow,
    - Plant annual and perennial cover crops,
    - Farm on the contour: strip cropping, divided slopes, terraces, contour tillage,
    - Select crops that hold soil in place and enhance a crop rotation,
    - Create and maintain sediment basins and vegetative buffer strips: riparian buffers, filter strips, grassed waterways, field borders, contour buffer strips, interception ditches,
    - Control weeds.
2) Irrigation
    - Schedule irrigation based on crop needs, soil type, weather, topography, and infiltration rates,
    - Improve irrigation efficiency by upgrading to the most water use efficient system when economically feasible,
    - Select, locate, maintain, and operate diversions to minimize effects on water quality,
    - Minimize return flows through the use of cover crops, straw mulch, and grass filter strips,
    - Install backflow devices ("check valves"),
    - Grade and slope property to retain runoff whenever possible,
    - Manage vegetation: burning, chemical, clipping, critical area planting,

- Stabilize ditch banks (structural and bioengineering),
- Install outfall protection to reduce erosion at culverts,
- Size ditches appropriately to handle maximum flows.

3) Crop Nutrients and Farm Chemicals
   - Apply nutrients based on plant needs through water, soil, and tissue testing,
   - Use Integrated Pest Management.

4. Properly Managed Livestock

Ranches of various sizes, including small noncommercial operations, should be able to support healthy livestock. Careful management of areas used for grazing, feeding, and handling is useful to the success of livestock operations and these areas have the potential to affect water quality.

Livestock management can be done in a manner that limits soil erosion and minimizes the delivery of sediment and animal wastes from drylots and pastures to nearby streams or irrigation conveyances. A proper grazing management program promotes and maintains adequate vegetative cover for protection of watershed health.

Management options for livestock that may protect water quality include:

- Managed grazing: livestock distribution; grazing intensity, duration, frequency, and season of use,
- Maintain riparian vegetation along streams and filter strips along canals and ditches,
- Use of fencing: temporary, cross, and/or riparian,
- Manage livestock watering,
- Provide salt, minerals, and shade away from streams,
- Manage livestock wastes properly,
- Manage runoff from irrigated pastures,
- Harrow irrigated pastures if needed,
- Use or compost organic waste.

Chapter 3: Implementation Strategies

Goal: Prevent and control water pollution from agricultural activities and soil erosion, and achieve applicable water quality standards.

The following conditions on agricultural lands contribute to good water quality in this Management Area:

1. Sufficient site-capable vegetation is established along streams to stabilize streambanks, filter overland flow, and moderate solar heating,
2. Crop lands are generally covered throughout the year with either production crops, crop residues, or cover crops,
3. Pastures have minimal bare ground,
4. Irrigation runoff does not deliver sediment, nutrients, or chemicals to streams,
5. Leachate and residues from livestock manure are not entering streams or groundwater.

LAC Mission: Promote cost-effective agricultural management practices through education and voluntary implementation that maintain or enhance water quality in the Crooked River Management Area.

3.1 Measurable Objectives and Strategic Initiatives

Measurable objectives allow the Ag Water Quality Program to evaluate progress toward meeting water quality standards and TMDL load allocations. Any measurable objectives are stated here. Progress is reported in Chapter 4.

3.1.1 Management Area

ODA is working with SWCDs and LACs throughout Oregon toward establishing long-term measurable objectives to achieve desired conditions. Currently, ODA, the LAC and the Crook County SWCD are using Focus Area measurable objectives to show progress in this Management Area. Additionally, local partners are coordinating efforts in watersheds to also show progress in the Management Area. These are described below.

3.1.2 Focus Areas and Other Coordinated Efforts in Small Watersheds

3.1.2.1 Camp Creek Focus Area (current)

Camp Creek, Crook County SWCDs current Focus Area, is located approximately 70 miles southeast of Prineville. This creek drains a large area (111,514 acres) and ranges in elevation from over 6,100 feet on Hampton Ridge to around 3,500 feet at its confluence with the Crooked River. Approximately 46 percent of the Camp Creek Focus Area is privately owned and land use is primarily for livestock grazing. Some haying, dryland farming, and mining (bentonite) also occur in this watershed. Crook County SWCD is focusing efforts in Camp Creek to: 1) provide landowner education on a variety of land practices to improve agricultural water quality; 2) apply for technical assistance funds for sediment retention designs and watershed restoration prioritization; and 3) improve watershed health and water quality by addressing loss of sediment, reducing erosion, stabilizing banks, improving riparian vegetation, improving management of private forest lands to lessen agriculture impact on water quality, and improve upland health.

Assessment Methods: Crook County SWCD will evaluate sediment using three different methods: upland plant communities, riparian vegetation, and streambank erosion. The SWCD will assess the area of juniper infestation and phase of juniper succession (Phase I, II, and III) as described in Miller et al[38]. Riparian vegetation will be assessed to determine which areas provide protection from erosion and filtering of sediment. Also, streambank erosion will be assessed into six different classifications.

Riparian corridor vegetation:
0 Greater than 40% coverage
1 20-40% coverage
2 10-20% coverage
3 5-10% coverage
4 Less than 5% (root stock visible)
5 Less than 5% (no root stock visible)

Streambank erosion:
0 Less than 10% active erosion
1 10-20% active erosion
2 20-30% active erosion
3 30-40% active erosion
4 40-50% active erosion
5 50%- and greater active erosion

Milestones: By June 30, 2021, decrease

- Acres with juniper by 1,300 acres,
- Corridor Vegetation Condition class 4 and 5 from 7.63 miles to 6.33 miles, and
- Active Streambank Erosion Class 3, 4, and 5 from 6.14 miles to 4.84 miles.

Measurable Objectives: By June 30, 2031, decrease

- Acres with juniper by 7,500 acres,
- Corridor Vegetation Condition class 4 and 5 from 7.63 miles to 5.03 miles, and
- Active Streambank Erosion Class 3, 4, and 5 from 6.14 miles to 3.54 miles.

Results from the Focus Areas are discussed in Chapter 4.

3.2 Proposed Activities

Education is the key to the success of this Area Plan. Groups and agencies work together to provide landowners in the Management Area and the interested public with information about the goals and objectives of the Area Plan and requirements of the Area Rules. ODA, SWCDs and LAC will continue to include landowners, land managers, and the communities in the revisions and implementation of the Area Plan and associated Area Rules.

Landowners may need financial and technical assistance to meet Area Plan objectives and Area Rule requirements. Technical and cost-sharing assistance for installation of certain management practices may be available through current USDA conservation programs such as Environmental Quality Incentive Program (EQIP) and Continuous Conservation Reserve Program (CCRP), and other programs such as the EPA's nonpoint source implementation grants and the OWEB. Other agencies may also be available to provide technical assistance or financial assistance to private landowners.

ODA, the LAC, the LMA, and other partners have identified the following priority activities, described in Table 3.2, to track progress toward meeting the goal and objectives of the Area Plan.

[38]Miller, R.F. et al. Oregon State University Agricultural Experiment Station. *Biology, Ecology, and Management of Western Juniper*. Technical Bulletin 152. June 2005)

Table 3.2 Planned Activities for 2020-2024 by Crook Co SWCD and CRWC

Activity	5-year Target	Description
Community and Landowner Engagement		
# active events that target landowners/operators	16	Gatherings of Lower Crooked River (LCR) landowners targeted for water quality improvement projects; about 1 per year.
# landowners/managers participating in active events	230	LCR: focused group of landowners selected due to land location and proximity to river or water body connected to the river.
Technical Assistance (TA)		
# landowners/operators provided with TA	55	
# site visits	400	
# conservation plans written*	34	Site specific plans for CCAAs. LCR: NRCS standards for conservation plans consistent with the RCPP program and award for the LCR reach.
# of acres covered in conservation plans	252,300	CCAA: see paragraph below. LCR: Acres are tightly focused on areas that have potential to directly improve water quality by reducing nitrogen levels.
On-the-ground Project Funding		
# funding applications submitted	65	NRCS conservation plans for each landowner in the target reach.
# funding applications awarded	45	NRCS grant in place to award 100% of approved plans and actions.
* Definition: any written management plan to address agricultural water quality. Can include NRCS-level plans. Can include: nutrients, soil health, grazing, riparian planting, forest thinning to improve upland pastures to reduce livestock pressure on riparian areas, etc. Cannot include projects with no or weak connection to agricultural water quality (weed eradication not for riparian restoration, fuels reduction, alternative energy, rain gardens/rain harvesting, non-agricultural culvert replacement, and instream habitat enhancement that does not also improve water quality)		

3.2.1 Crook County Candidate Conservation Agreements

In support of the efforts of private landowners to restore healthy sagebrush ecosystems, Crook County SWCD partnered with US Fish and Wildlife Service and seven different SWCDs in prime sage grouse habitat to offer a Candidate Conservation Agreements with Assurances (CCAA), which are voluntary agreements where landowners agree to manage their lands to remove or reduce threats to sage grouse. Threats to sage grouse include juniper encroachment, poor livestock management, and annual grass invasion. These threats can also have negative impacts on healthy watersheds and water quality. In return, landowners receive assurances against additional regulatory requirements if the sage grouse are listed. To date, two site-specific conservation plans have been approved covering approximately 28,600 acres. Crook County SWCD plans to write nine more conservation plans that will encompass an estimated 250,000 acres of privately owned ranches in Crook County.

3.2.2 Nitrogen Characterization & Reduction in the Lower Crooked River

In 2019, the CRWC led the formation of a partnership focused on improving water quality in the lower Crooked River reach that extends from the base of both Ochoco and Bowman dams located approximately six and twenty miles upriver of Prineville, respectively. The lower Crooked River is a working lands area with active irrigated lands with some winter pasturing. Water quality has long been understood to be a resource issue in the watershed. The partnership will work to develop a comprehensive approach to improving water quality derived from the watershed. Nitrogen is the primary nutrient of concern because it drives most all of the water quality degradation. Several additional parameters will be characterized by the collaborative effort.

Assessment Method(s):
Water quality data will be assembled from a variety of sources; some existing, some new. Because the partnership wants to be thorough in their work, they are assembling nitrogen data from a variety of origination sources, including agriculture, residential and commercial. Sampling periods and locations have been recently developed and active data collection is underway to fill data gaps, particularly for the winter months. The partnership is taking steps to enhance organizational needs and secure adequate funding. A sampling and analysis plan will be developed prior to any sampling of water under an external funding source whether contract or grant.

Targets:
- In 2023, key nitrogen sources documented;
- In 2025, formal report and action plan developed;
- In 2030, at least six active projects will be in place reducing nitrogen the enters the Crooked River and ultimately the Deschutes River.

3.3 Water Quality Monitoring

DEQ monitors two sites in the Management Area as part of their ambient monitoring network (Crooked River at Lone Pine and at Conant Basin).

DEQ retrieved data from their databases and federal databases for January 1, 1999 to December 31, 2019 for the Management Area. DEQ determined status for the last four consecutive years of recent data at a station and trends for stations with at least eight years of data. Their report is summarized in Chapter 4 and can be found at https://www.oregon.gov/deq/wq/programs/Pages/wqstatustrends.aspx. The report will be updated for future biennial reviews.

For a description of monitoring and evaluation results, see Chapter 4.

Chapter 4: Progress and Adaptive Management

4.1 Measurable Objectives and Strategic Initiatives

The following tables provide the assessment results and progress toward measurable objectives and milestones in the last two years. See Chapter 3.1 for background and assessment methods.

4.1.1 Management Area

ODA is working with SWCDs and LACs throughout Oregon toward establishing long-term measurable objectives to achieve desired conditions. Currently, ODA and the Crook County SWCD are using Focus Area measurable objectives to show progress in this Management Area. Additionally, local partners are coordinating efforts in watersheds to also show progress in the Management Area. These are described below.

4.1.2 Focus Area and Other Coordinated Efforts

4.1.2.1 Camp Creek Focus Area

Milestones: By June 30, 2021, decrease

- Acres with juniper by 1,300 acres,
- Corridor Vegetation Condition Class 4 and 5 from 7.63 miles to 6.33 miles, and
- Active Streambank Erosion Class 3, 4, and 5 from 6.14 miles to 4.84 miles.

Measurable Objectives: By June 30, 2031, decrease

- Acres with juniper by 7,500 acres,
- Corridor Vegetation Condition Class 4 and 5 from 7.63 miles to 5.03 miles, and
- Active Streambank Erosion Class 3, 4, and 5 from 6.14 miles to 3.54 miles.

Assessment Results (Current Conditions):

Table 4.1.2.1a: Upland Plant Community (in acres).

Phase	2019: Pre-Assessment
I	5,508.0
II	18,081.1
III	2,648.9
Treated Acres	0
Total	**26,238.0**

Table 4.1.2.1b: Corridor Vegetation Condition (in streambank miles).

Class	2019: Pre-Assessment
0	0.0
1	0.52
2	1.45
3	3.41
4	7.25
5	0.38
Total	**13.01**

Table 4.1.2.1c: Active Streambank Erosion (in streambank miles).	
Class	**2019: Pre-Assessment**
0	2.46
1	2.50
2	1.91
3	3.02
4	2.77
5	0.35
Total	**13.01**

Table 4.1.2.1d Camp Creek Focus Area Activities Conducted in 2018-2019

Activities and Accomplishments	
Community and Landowner Engagement	
# active events that target landowners/ operators	**0**
# landowners/operators participating in active events	**0**
Technical Assistance (TA)	
# landowners/operators provided with TA	**25**
# site visits	**12**
# conservation plans written	**0**
Ag Water Quality Practices Implemented in the Focus Area	
Riparian Fence	4,344 feet

Progress Toward Measurable Objectives and Milestones: The pre-assessment was completed in 2019 and now the Crook County SWCD is focusing on engaging landowners to plan and implement projects on the ground.

Adaptive Management Discussion: The first milestone is set for June 30, 2021, after which the SWCD, ODA, and LAC will discuss the progress and if any adjustments should be made to strategies to achieve the measurable objective.

4.2 Activities and Accomplishments

ODA, the LAC, the LMA, and other partners identified the following priority activities to track progress toward meeting the goal and objectives of the Area Plan. ODA will review the four-year results and then provide a report at the end of the 2021-2023 Biennium.

Future Area Plans will compare results and targets in Table 4.2a.

Table 4.2a Activities conducted in 2018-2019 by Crook County SWCD and CRWC.

Activity	2-year results	Description
Community and Landowner Engagement		
# active events that target landowners/operators	16	Sage-brush steppe restoration strategies, water quality, irrigation efficiencies, water rights, Deschutes River Basin Habitat Conservation Plan. Gatherings of Lower Crooked River (LCR) landowners targeted for water quality improvement projects; about 1 per year. LCR landowners selected by criteria.

# landowners/managers participating in active events	121	Focused group of landowners selected due to land location and proximity to river or water body connected to the river. Meetings and outreach activities thus far; plans to reach 40+ total knowing that some will opt out of the project.
Technical Assistance (TA)		
# landowners/operators provided with TA	746	TA provided via emails, phone calls and office visits.
# site visits	103	Site visits focused on water quality impact from agriculture including: juniper management, erosion control/bank stabilization, irrigation efficiency, grazing management tools, fish and wildlife habitat, and range improvement.
# conservation plans written*	2	Site specific plans for CCAAs
# of acres in conservation plans that were written	592	
On-the-ground Project Funding		
# funding applications submitted	17	
# funding applications awarded	8	
* Definition: any written management plan to address agricultural water quality. Can include NRCS-level plans or simpler plans. Can include: nutrients, soil health, water quality, irrigation, grazing, riparian planting, forest thinning to improve upland pastures to reduce livestock pressure on riparian areas, etc. Cannot include projects with no or weak connection to ag water quality (weed eradication that is not for riparian restoration, fuels reduction, alternative energy, non-ag rain gardens/rain harvesting, non-ag culvert replacement, and instream habitat enhancement that does not also improve water quality.)		

Tables 4.2b and 4.2c summarize information from the OWRI on restoration project funding and accomplishments in the Management Area. The majority of OWRI entries represent voluntary actions of private landowners who have worked in partnership with federal, state, and local groups to improve aquatic habitat and water quality conditions. OWRI data includes most, but not all projects, implemented in the Management Area.

Table 4.2b Implementation funding for projects on agricultural lands reported 1997-2018 (in $)

Landowners	OWEB	DEQ[1]	NRCS	PGE[2]	ODFW	Other[3]	TOTAL
2,007,094	6,577,119	0	269,740	2,184,414	1,744,691	3,742,867	16,525,925

[1]No 319 funding is available because there is no TMDL or equivalent in the management area.

[2]Portland General Electric

[3]includes city, county, tribal, other state and federal programs, and non-profit organizations. There were too many entities to list.

Table 4.2c Miles and acres treated on agricultural lands reported 1997-2018

Activity Type	Miles	Acres	Count*	Activity Description Examples Include:
Riparian	119	1,510	NA**	Fencing, off site water, and planting
Fish Passage	152	NA	18	Fish screening and passage on irrigation diversions
Instream	74	NA	NA	
Wetland	NA	5	NA	Off site water, fending, and planting
Road	0	NA	8	
Upland	NA	125,917	NA	Juniper treatment, weed treatment, forest health improvement, range planting, cross fencing, stock water development
TOTAL	345	127,432	26	

* # of hardened crossings, culverts, etc.
**Not applicable

4.3 Water Quality Monitoring

Water quality was evaluated from six sources for this biennial review:

1. DEQ's 2019 Status and Trends Report (see Table 4.3.1) (https://www.oregon.gov/deq/wq/programs/Pages/wqstatustrends.aspx),
2. Additional data in DEQ's AWQMS data system,
3. 2019 Water Quality Study for the Pelton Round Butte Project and the Lower Deschutes River: Monitoring & Modeling (https://www.portlandgeneral.com/corporate-responsibility/environmental-stewardship/water-quality-habitat-protection/deschutes-river/deschutes-water-quality),
4. water quality data collected by the Crooked River Watershed Council in 2010-2014 (summarized in previous Area Plan),
5. Domestic well testing data from the Oregon Health Authority, and
6. The NorWest stream temperature model (https://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html).

Crooked River monitoring sites at Lone Pine (near Terrebonne) and Conant Basin (above Prineville Reservoir) are part of DEQ's ambient monitoring program and have been monitored regularly for over 20 years.

Table 4.3 Attainment of water quality standards for 2015-2018 in Management Area from DEQ's 2019 Status and Trends Report (nitrogen is not yet included in their evaluation). Results highlighted in grey are potential agricultural water quality concerns based on *all* data sources.

Watershed	Sites	Parameter					
		Dissolved oxygen	*E. coli*	pH	Temperature	Total Phosphorus (mg/L)[1]	Total Suspended Solids (mg/L)[2]
		Attainment?				Minimum - median - maximum	
Below Prineville Reservoir	Crooked R @ Lone Pine	Yes	Mostly (exceedance every 1-2 years)	No (at upper limit)	-	0.06-0.11-0.17	2 - 8 - 77
	Above Lone Pine	Yes	Zero below the dam	Yes, and improving below dam	Forest sites: mostly no	-	-
Above Prineville Reservoir	Crooked R @ Conant Basin	Yes, but degrading	Yes	No, but improving	-	0.02-0.03-0.1	1 - 2 - 37
	Above Conant Basin	-	-	No (North Fork below Big Summit Prairie)	Forest sites: no, except for Maury Mtns	Low in forest headwaters, increase as move downstream	-

[1] DEQ has no benchmark for total phosphorus in this Management Area; ODA benchmark for potential water quality concerns = 0.08 mg/L
[2] DEQ has no benchmark for total suspended solids in this Management Area

Data generally show that water quality problems in the Crooked River watershed below Prineville Reservoir are mostly due to inputs of nutrients and *E. coli*. Above the reservoir, water quality problems are mostly due to stream channel and riparian vegetation alterations. Water quality both above and below is affected by changes in stream flow from withdrawals and releases.

<u>Dissloved Oxygen:</u> attaining standard at Lone Pine and Conant Basin. However, past data from the CRWC showed 23 stations violated the standard, 8 consistently (Crooked River @ Lone Pine, Dry Canyon, Mallot Drain, and 5 in the upper watershed). Unsurprisingly, DO concentrations are highest when stream temperatures are lowest at both of DEQ's ambient sites. Although attaining at Conant Basin, oxygen concentrations are declining. Likely causes are low stream flows (partly due to irrigation withdrawals) and warm water.

<u>E. coli</u>: most values throughout the Management Area met the standard; *E. coli* below Bowman Dam is essentially zero, but there are occasional exceedances of the standard at Lone Pine. Values at Lone Pine peak in August/September and are lowest in winter. Potential sources of *E. coli* at Lone Pine include livestock manure in irrigation return flows and the city of Prineville. More data are needed for the Lower Crooked River to determine the bacteria source(s).

<u>pH</u>: values throughout the Management Area barely met the upper limit of the water quality standard (8.5 SU), with regular exceedances. However, pH has been slowly declining (improving) at Conant Basin over the last 20 years. The LAC recommends that DEQ raise the maximum pH criterion for Crooked River Subbasin from 8.5 to 9.0 to refelect the local geology (see above Section 2.4.1.2 WQ Parameters and 303(d)list, subsection Elevated pH).

<u>Nutrients:</u>
According to the PGE report, the Crooked River is the largest contributor of nutrients to Lake Billy Chinook (about half of the dissolved phosphorus and 86% of the dissolved nitrate), while only providing 22% of the flow. The report concludes that much of the phosphorus entering Lake Billy Chinook is likely provided by Opal Springs from natural weathering of the rock, however data also show high concentrations of phosphorus near Terrebonne. The report also concludes that most of the nitrate is a result of human activities.

Data from DEQ show that phosphorus concentrations are low in the headwaters from the forest and increase as water flows towards the Deschutes River. The median at Conant Basin is lower than the ODA guideline of 0.8 mg/L, but Lone Pine exceeds that guideline. Fortunately, the concentrations at Lone Pine have been decreasing over time. Phosphorus concentrations did not peak with total suspended solids, suggesting that much of the phosphorus is entering the Crooked River dissolved in the water, not attached to soil. Nitrate concentration peaks at Lone Pine in the winter, with the lowest values in May-July. Could this be because both nitrate and phosphorus are being leached into the shallow groundwater and then released instream when water levels rise in winter?

The CRWC data show that phosphorus and nitrate concentrations increased in the Crooked River as it flowed from Prineville to Lone Pine; phosphorus values doubled between Conant Basin and Lone Pine. Irrigation drains were significant sources of phosphorus, and lower elevation tributaries flowing through agricultural lands (Lytle, McKay, and Ochoco creeks) were significant sources of nitrate (>2 mg/L nitrate).

Potential sources of nutrients include irrigation runoff, livestock manure, city of Prineville (nine domestic wells within city limits with 3-9 mg/L nitrate), eroding streambanks, and natural upland erosion. The PGE report states on page 553 that "The greatest opportunity for reducing phosphorus inputs to [Lake Billy Chinook] is through reduction of anthropogenic sources in the Crooked River Basin. The vast majority of [nitrate] inputs are also derived from the Crooked River, specifically from irrigation return flow associated with crop production."

Temperature:
Temperature standards were only met at two locations: below Bowman Dam and in forested lands on the north slope of the Maury Mountains. In fact, most of the stations in the national forest exceeded the standard. The NorWeST stream temperature model predicts that stream temperatures in August are above temperature criteria throughout the basin. Lack of riparian shade, wide, and shallow channels in valley bottoms, low flows due to irrigation diversions, and geothermal springs all contribute to warm water.

Sediment:
Almost all the turbidities measured by the CRWC were less than salmon-related guidelines.

There is no standard for Total Suspended Solids (TSS). TSS concentrations evaluated by DEQ peaked at Conant Basin in July-September (likely due to low flows?), and were lowest in March-May. TSS was also lowest at Lone Pine in March-May, with no seasonal pattern of peak concentrations.

4.4 Biennial Reviews and Adaptive Management

ODA, the LAC, the LMA, and other partners met on February 21, 2021, to review implementation of the Area Plan and provided recommendations for the future (Tables 4.4a and 4.4b).

Table 4.4a Summary of biennial review discussion

Summary of Progress and Impediments
Progress: A partnership was formed in 2019 to focus on improving water quality in the lower Crooked River. The partnership will work to develop a comprehensive approach to improving water quality derived from the watershed. Impediments: *Landownership*: No single source of information of what types of projects have been completed on a property, except the landowner for the period of time. High and frequent landowner turnover presents challenges with historical knowledge of the property. New landowners may not be knowledgeable of projects that were done by the previous landowner, or what their next planned conservation projects were going to be. Monitoring data often does not go with sale of land as it is often considered a deterrent to the sale of the property. Recently, landowner turnover has increased and many of the new property owners do not reside on site, do not live in the watershed, nor are they familiar with the watershed. This presents additional new challenges in engaging landowners. Moreover, new landowners, particularly absentee landowners, often lack understanding of local conservation issues and management conservation practices. *Resources*: funding resources for projects and capacity resources for local conservation agencies are a limiting factor. Permits required for implementing restoration work can add challenges. Particularly when assessments and analysis add cost and complexity to core permits. Difficult to document effectiveness of a project (are past and current projects effective in accomplishing their goals), without long-term, and sometimes extensive, monitoring. Additionally, monitoring grants are more complex (e.g. SAP) and thus more difficult to obtain. Elk damage to fencing and riparian areas.
Recommended Modifications and Adaptive Management
Landownership turnover: Encourage • consultants that complete environmental analysis to include streambank/vegetation analysis, • realtors to provide handouts (e.g. Crook County Rural Living Handbook, • ODA/SWCD/WC/etc. to create an evaluation process for ranches that identifies potential issues/concerns. Additionally, create a rating system to identify at a glance the properties likely compliance with AgWQ rules as well as the ranches overall watershed health. Resources: encourage governor's natural resource office to seek new funding sources for project implementation and local conservation agency capacity. Encourage ODFW assistance in funding repairs from wildlife (elk) damage to fences.

Table 4.4b Number of compliance actions in 2018-2019.

Actions	Letter of Compliance	Pre-Enforcement Notification	Notice of Noncompliance	Civil Penalty
Compliance Actions Outside SIA(s)	0	0	0	0
Compliance Actions Within SIA(s)	NA	NA	NA	NA

Appendix A: Crook County Noxious Weed Lists

The Crook County SWCD board of directors also serve as the County Weed Board.

LIST A
These weeds occur in small enough infestations to make eradication/containment possible, or are not known to occur, but their presence in neighboring counties make future occurrence in the county seem imminent. List A also includes weeds that are actively managed by neighboring counties due to agricultural concerns (e.g. Jefferson County produces carrots, and wild carrot poses a threat to agricultural carrot crops). List A weeds are high priority sites for treatment.

Management Goal: Eradicate or contain populations; prevent List A weeds from becoming more abundant and moving onto List B.

Aegilops cylindricaa	jointed goatgrass
Carduus nutans	musk thistle
Centaurea solstitialis	yellow starthistle
C. virgata	squarrose knapweed
Chondrilla juncea	rush skeletonweed
Daucus carota	wild carrot
Euphorbia esula	leafy spurge*
Iris pseudacorus	yellow flag iris
Linaria dalmatica	Dalmatian toadflax
Lythrum salicaria	purple loosestrife
Onopordum acanthium	Scotch thistle
Peganum harmala	African rue
Salvia aethiopis	Mediterranean sage
Senecio jacobaea	tansy ragwort
Myriophyllum spicatum	Eurasian watermilfoil

* All areas except Mill Creek drainage and within 50 feet of the high-water mark on the Crooked River

LIST B
These weeds are abundant in the county and of great concern because they cause economic and ecological losses. Eradication of List B weeds in the county may not be realistic; however, they are still high priority species for strategic treatment and control to prevent further spread.

Management Goal: Control List B weeds to prevent their spread into new areas. Management strategies should focus on outlying populations to protect native ecosystems, as well as high public use areas.

Cardaria spp.	Whitetop
Centaurea diffusa	diffuse knapweed
C. maculosa	spotted knapweed
C. repens	Russian knapweed
Cirsium arvense	Canada thistle
Conium maculatum	poison hemlock
Cynoglossum officinale	common houndstongue
Cytisus scoparius	Scotch broom
Hypericum perforatum	St. Johnswort
Lepidium latifolium	perennial pepperweed
Senecio vulgaris	common groundsel
Sonchus asper	spiny sowthistle
Taeniatherum caput-medusae	medusahead rye
Tribulus terrestris	puncturevine
Euphorbia myrsinites	Myrtle Spurge

LIST C

These weeds are abundant. They are not high priority species to control. However, it may be desirable to treat localized populations to prevent their spread into new areas, and/or to protect from economic and ecological losses.

Management Goal: Treat List C species as "incidental" and control on a case-by-case basis.

Cicuta maculata	western water hemlock
Cirsium vulgare	bull thistle
Convolvulus arvensis	field bindweed
Dipsacus fullonum	common teasel
Kochia scoparia	kochia
Melilotus officinalis	yellow sweetclover
Ranunculus testiculatus	bur buttercup
Salsola iberica (= S. kali)	Russian thistle
Ventenata dubia	Ventenata
Verbascum thapsis	common mullein
Stellaria	Chickweed

2. MANAGEMENT AREA PRIORITY WEEDS

The Management Area contains portions of six counties, in addition to almost all of Crook County. The following weeds are found on the lists of at least six of the seven counties:

Acropitlon repens	Russian knapweed
Cardaria spp.	whitetop
Centaurea diffusa	diffuse knapweed
Centaurea maculosa	spotted knapweed
Centaurea solstitialis	yellow starthistle
Centaurea virgata	squarrose knapweed
Chondrilla juncea	rush skeletonweed
Cirsium arvense	Canada thistle
Convolvulus arvensis	field bindweed/morning glory
Euphorbia esula	leafy spurge
Hypericum perforatum	St. Johnswort/Klamath weed
Kochia scoparia	kochia
Lepidium latifolium	perennial pepperweed
Linaria dalmatica	Dalmatian toadflax
Lythrum salicaria	purple loosestrife
Onopordum acanthium	Scotch thistle
Salvia aethiopis	Mediterranean sage
Senecio jacobaea	tansy ragwort
Taeniatherum caput-medusae	medusahead rye
Tribulus terrestris	puncturevine

Appendix B: Waterbodies on the 2012 303(d)

Water Body (Stream/Lake)	River Miles	Parameter
Beaver-South Fork Subbasin		
Beaver Creek	0 to 20	DO
Beaverdam Creek	0 to 10.8	Temp
Begg Creek	0 to 2.2	Temp
Dipping Vat Creek	0 to 7.7	Temp
Dry Paulina Creek	0 to 13.1	Temp
East Wolf Creek	0 to 3.3	Temp
North Wolf Creek	0 to 10.3	Temp
Powell Creek	0 to 12.7	Temp
Rager Creek	0 to 8.5	Temp
Roba Creek	0 to 7.2	BC
Roba Creek	0 to 7.2	Temp
South Fork Beaver Creek	0 to 26.4	Temp
South Fork Crooked River	0 to 54	DO
South Fork Crooked River	0 to 18	Temp
Sugar Creek	0 to 11.5	Temp
Twelvemile Creek	2.2 to 2.8	BC
Wolf Creek	0 to 17.1	Temp
Lower Crooked Subbasin		
Canyon Creek	0 to 5.5	Temp
Crooked River	0 to 51	E. Coli
Crooked River	0 to 51	pH
Crooked River	0 to 51	Temp
Crooked River	51 to 70	pH
Crooked River	51 to 70	TDG
Crooked River/Lake Billy Chinook	0 to 5	Chl a
Dry River	0 to 91.9	E. Coli
East Fork Mill Creek	0 to 7.6	Temp
Hamilton Creek	0 to 1.7	Temp
Harvey Creek	0 to 1.4	Temp
Little Hay Creek	0 to 3.6	Temp
Little McKay Creek	0 to 6.7	Temp
Marks Creek	7.5 to 17.1	BC
Marks Creek	0 to 17.1	Temp
McKay Creek	0 to 14.7	E. Coli
McKay Creek	0 to 19.5	pH
McKay Creek	0 to 19.5	Temp
Mill Creek	0 to 11.5	Temp
Ochoco Creek	0 to 36.4	E. Coli
Ochoco Creek	0 to 36.4	Temp
Ochoco Creek	25.3 to 30	BC
West Fork Mill Creek	0 to 4.9	Temp

Water Body (Stream/Lake)	River Miles	Parameter
Upper Crooked Subbasin		
Allen Creek	0 to 10.1	Temp
Bear Creek	0 to 34.3	BC
Bear Creek	0 to 34.3	Temp
Cow Creek	0 to 7.2	Temp
Crazy Creek	0 to 3.5	Temp
Crooked River	82.6 to 109.2	pH
Crooked River	82.6 to 109.2	Temp
Deep Creek	6.3 to 10.6	BC
Deep Creek	0 to 10.6	Temp
Deer Creek	0.9 to 4	Temp
Double Corral Creek	0 to 5.4	Temp
Fox Canyon Creek	0 to 6.8	BC
Fox Canyon Creek	0 to 6.8	Temp
Fox Creek	0 to 4.9	Temp
Gray Creek	0 to 6.7	Temp
Happy Camp Creek	0 to 6.7	Temp
Horse Heaven Creek	0 to 14	Temp
Howard Creek	0 to 9.5	Temp
Indian Creek	0 to 9.1	Temp
Jackson Creek	0 to 5.9	Temp
Klootchman Creek	1 to 5.3	Temp
Little Horse Heaven Creek	0 to 2.9	Temp
Little Summit Creek	0 to 10	BC
Little Summit Creek	0 to 10	Temp
Lookout Creek	0 to 1.5	Temp
Lytle Creek	0 to 4.2	Temp
North Fork Crooked River	26.8 to 44.7	BC
North Fork Crooked River	0 to 44.7	Temp
Peterson Creek	0 to 10.7	Temp
Porter Creek	0 to 4.5	BC
Porter Creek	0 to 4.5	Temp
Shotgun Creek	0 to 5.9	Temp
Toggle Creek	0 to 5.3	Temp
Wickiup Creek	0 to 8.6	Temp
Wildcat Creek	0 to 4.3	Temp
Upper Crooked; Lower Crooked		
Crooked River	0 to 124.4	BC
Crooked River	0 to 124.4	DO

DO = Dissolved Oxygen, Temp = Temperature, BC = Biological Criteria, TDG = Total Dissolved Gas, Chl a = Chlorophyll a

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i Hirschi, M., R. Frazee, G. Czapar, and D. Peterson. *Sixty ways farmers can protect surface water*. North Central Regional Pub. 589. University of Illinois, Urbana, IL. 1997.