DEQ Water Quality Monitoring Strategy 2020

State of Oregon
Department of Environmental Quality

DEQ's mission is to be a leader in restoring, maintaining, and enhancing the quality of Oregon's air, land, and water.

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Cover images (left to right):
South Falls at Silver Falls state park, OR
Haystack rock, Cannon Beach, OR
Tualatin River, Tualatin, OR

Back cover image:
Koosah Falls, Willamette National Forest, OR

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This report covers DEQ's five-year water quality monitoring strategy for Oregon. This monitoring strategy describes the environmental information needed to assess, manage, and ultimately protect water quality. Review and revision of this strategy as needed will occur in 2025.

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Abbreviations

AWQMS Ambient Water Quality Monitoring System
CFR Code of Federal Regulations
CWA Clean Water Act
DQO Data Quality Objectives
DSL Department of State Lands
EJ Environmental Justice
GWMA Groundwater Management Area
GWTAT Groundwater Technical Advisory Team
HAB Harmful Algal Bloom
LIMS Laboratory Information Management System
MAG Monitoring and Assessment Group
NARS National Aquatic Resource Surveys
NCCA National Coastal Condition Assessment
NIST National Institute of Standards and Technology
NLA National Lakes Assessment
NRSA National Rivers and Streams Assessment
NWQMC National Water Quality Monitoring Council
OAH Ocean Acidification and Hypoxia
OAR Oregon Administrative Rules
OBMP Oregon Beach Monitoring Program
ODA Oregon Department of Agriculture
ODF Oregon Department of Forestry
ODFW Oregon Department of Fish and Wildlife
OLCI Ocean Land Color Instrument
OWEB Oregon Watershed Enhancement Board
OWRD Oregon Water Resources Department
PPA Performance Partnership Agreement
PPG Performance Partnership Grant
QAPP Quality Assurance Project Plan
SAP Sampling Analysis Plan
SIA Strategic Implementation Area
STORET EPA's Storage and Retrieval database
STREAM Oregon Strategic Enterprise Approach to Monitoring
TMDL Total Maximum Daily Load
USGS United States Geological Survey

Background

Water quality monitoring and assessment provides necessary information to protect water quality in Oregon. Strategic planning aligns monitoring program objectives and resources with water quality program needs, legal requirements and other information priorities.

DEQ's monitoring programs provide information for all stages of an adaptive management cycle (Figure 1). DEQ uses data to identify the magnitude and extent of emerging issues, determine the appropriate levels of protection for human health and aquatic life, develop water quality management plans, assess compliance with water quality standards and regulations, understand trends in water quality conditions over time, and measure the effectiveness of water protection projects and programs.

Figure 1: *Monitoring, assessment, planning and implementation phases of the management cycle for evaluating, protecting and restoring water quality. Environmental data informs each step.*

Many of the monitoring data and information needs are legally required or provide necessary information to carry out DEQ's water quality programs. Applicable federal and state requirements are shown in Figure 2 below.

Figure 2: *Relevant federal and state requirements for Oregon's monitoring programs.*

Federal Clean Water Act

Section 106(e)	Administrator shall not make any grants under this section to any state which has not provided or is not carrying out as a part of the program - (1) The establishment and operation of appropriate devices, methods, systems, and procedures necessary to monitor, and to compile and analyze data on (including classification according to eutrophic condition) the quality of navigable water and to the extent practicable, groundwaters, including biological monitoring; and provisions for annually updating such data and including it in the report required under Section 305 of this Act.
Section 303(d)(1) (A) and (B)	Requires each state to identify waters within its boundaries for which effluent limits and controls of thermal discharges required by section 301 are not stringent enough to meet water quality standards and to assure protection and propagation of a balanced indigenous population of shellfish, fish and wildlife.
Section 305(b)(1)	Requires each state submit a biennial report by April 1 on even numbered years that includes a description of the water quality of all navigable waters in the state, an analysis of the extent to which they provide for shellfish, fish, wildlife and recreation, the extent to which the elimination of pollutants has provided for the above and recommendations for additional actions necessary to do so, the economic and social costs to do so, and a description of the extent of nonpoint source pollutants and recommended actions to address nonpoint sources including costs.
Section 314	Requires the establishment of a clean lakes program including an assessment of the status and trends in water quality in publicly owned lakes and list of impaired lakes and the pollutant sources in those lakes.
Section 314	Requires the establishment of a coastal recreation water monitoring and notification program.

Code of Federal Regulations

40 CFR 130.4(a)	In accordance with section 106(e)(1), States must establish appropriate monitoring methods and procedures (including biological monitoring) necessary to compile and analyze data on the quality of waters of the United States and, to the extent practicable, ground-waters.
40 CFR 130.4(b)	The State's water monitoring program shall include collection and analysis of physical, chemical and biological data and quality assurance and control programs to assure scientifically valid data. The uses of these data include determining abatement and control priorities; developing and reviewing water quality standards, total maximum daily loads, wasteload allocations, and load allocations; assessing compliance with National Pollutant Discharge Elimination System (NPDES) permits by dischargers; reporting information to the public through the section 305(b) report and reviewing site-specific monitoring efforts.

Oregon Revised Statutes

ORS 468B.110(4)	Requires the department to establish guidelines describing how the department and commission will determine whether water quality standards in waters affected by nonpoint sources are being met.
ORS 468B.035	Authorizes the department to implement the Clean Water Act.
ORS 468B.160(3)	Requires the department to conduct statewide programs to identify and characterize groundwater quality.
ORS 468B.162(3)	Requires the department to submit a report to the legislature on the first of January, of each odd numbered year on the status of groundwater in Oregon.
ORS 468B.190	Requires the department conduct a groundwater monitoring and assessment program based on vulnerability to contamination that determines status, long-term trends, and emerging problems.

Oregon DEQ's Water Quality Monitoring Strategy

DEQ's Water Quality Program staff developed the following mission statement, "The Water Quality Program's mission is to protect and improve Oregon's water quality. Protecting Oregon's rivers, lakes, streams and groundwater keeps these waters safe for a multitude of beneficial uses such as drinking water, fish habitat, recreation and irrigation" (Department of Environmental Quality, Water Quality, January 2019). Implementing this mission requires a monitoring program that supplies information to meet the various needs of the Water Quality program areas and to assess all waterbody types across the state including: rivers and streams, estuaries, lakes and reservoirs, coastal waters, wetlands, and groundwater.

DEQ's monitoring strategy describes a comprehensive, statewide water monitoring and assessment program for providing high quality, publically accessible data, to address water quality program and statewide needs. The strategy outlines the chartered governance structure DEQ uses to propose, evaluate, prioritize and implement monitoring activities. It describes the status of existing monitoring programs and identifies internal and external strategic documents that influence the direction of DEQ's monitoring programs. The strategy emphasizes the important role that monitoring partnerships play in providing needed monitoring data. It outlines the monitoring designs, indicators, quality assurance processes and data management systems required to provide and deliver the right information. Most importantly, the document looks at Oregon's emerging water quality challenges to identify the information needed to understand Oregon's emerging water quality concerns.

Five-year Strategic Goals

Over the next five years, DEQ's monitoring strategy will focus on data acquisition and collection to meet the regulatory information requirements of DEQ's water programs, to provide important public health data, and to inform high priority water quality threats to the environment. Objectives include collecting data to clarify areas of potential concern or that are unassessed for the Integrated Report. Data will be collected to develop and understand the implications of new water quality standards and to revise or develop TMDL's. When appropriate,

data will be collected to interpret the effectiveness of the water quality projects and programs and to support the development of water quality permits.

Monitoring will also focus on providing water quality data to evaluate public health risks associated with drinking water and aquatic recreation. DEQ will continue to support collaborative partnerships that provide high-quality data to address water quality information needs.

As resources and time permit, DEQ will incorporate additional partner data into its Ambient Water Quality System (AWQMS). We will work with our monitoring partners to develop robust quality assurance procedures and leverage monitoring efficiencies. Finally, we will identify monitoring gaps for DEQ's leadership to prioritize for future policy requests or for the redistribution of existing flexible resources.

Looking Forward

On the 10-year horizon, capturing more monitoring data on lakes, reservoirs, coastal estuaries, and territorial seas and wetlands are needed to fill information gaps. In Oregon, lakes that are regularly impaired by harmful algal blooms require more monitoring data to understand the physical and chemical conditions that promote bloom formation. Current coastal water quality issues such as ocean acidification, hypoxia and algal blooms pose a threat to Oregon's coastal ecology and economy. Characterizing regional and local pollution sources requires monitoring data to locate and quantify pollution loads to tailor pollution reduction plans for mitigating coastal water quality impairments. In many cases, these waterbodies lack the comprehensive data needed for understanding water quality impairments, to characterize the status and trends of these waterbodies, or for the developing water quality management plans. Where information gaps remain, additional monitoring resources should sought to collect needed monitoring data.

As snowpack in Oregon declines, groundwater plays an increasingly important role in meeting Oregonian's water needs. Understanding the quality of this critical resource to protect it from contamination or mitigate existing pollution problems is essential as Oregonians increasingly rely on groundwater to meet demands. Monitoring data is critical for tracking and identifying threats to groundwater quality but monitoring resources have been declining. Reduced data collection in Oregon's three Groundwater Management Areas (GWMA's) has slowed our ability to understand water quality trends in these areas. Dwindling statewide groundwater monitoring resources have slowed water quality investigations in new aquifers each year. Seeking to restore and enhance these monitoring capabilities should be considered in the future.

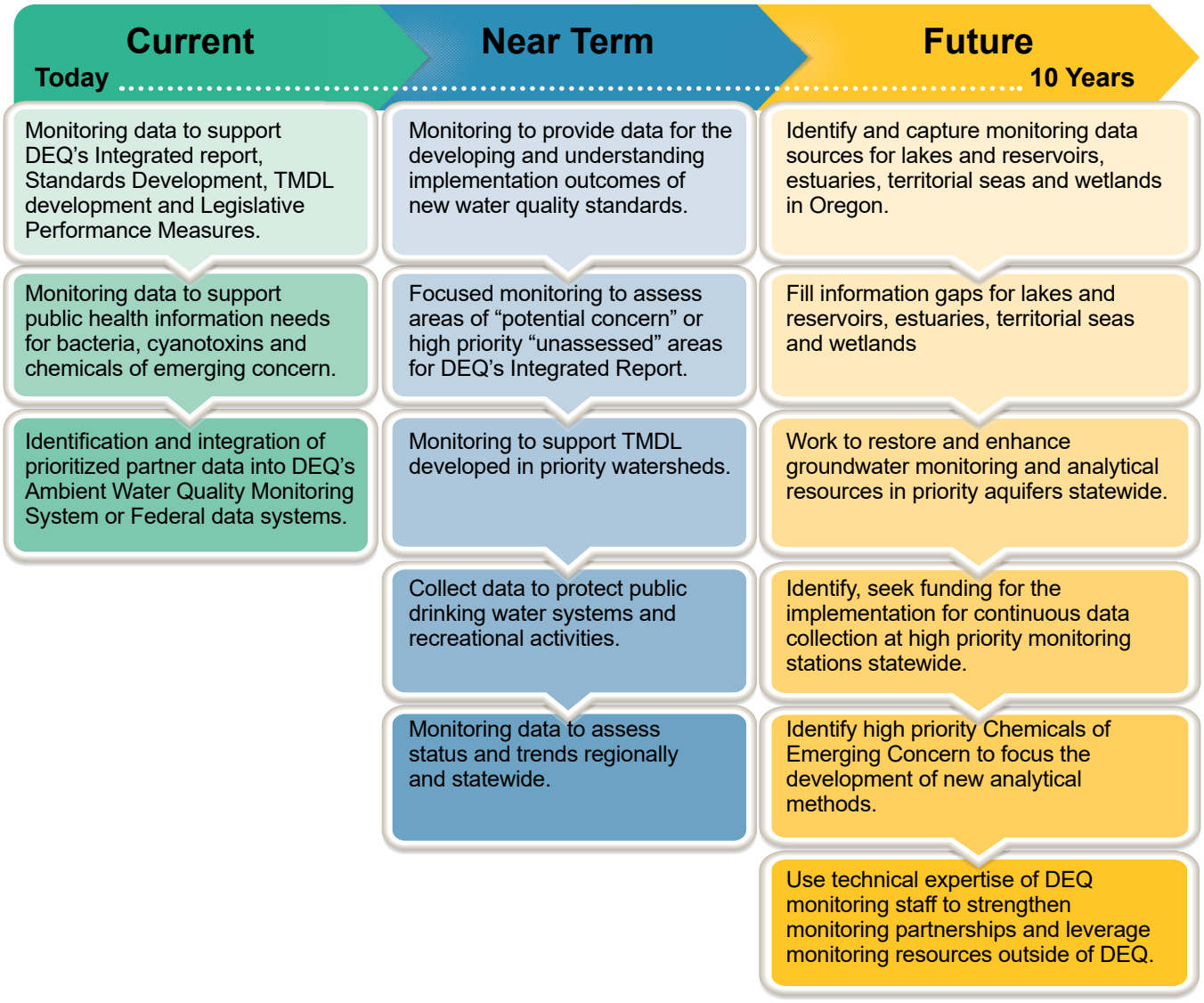
Continuing to incorporate new monitoring technologies will provide DEQ with more comprehensive and refined information for water quality assessments and planning. Improved continuous data instrumentation, capable of providing near real-time access to water quality information, can fill gaps in our understanding of temporal changes in water quality parameters. This information is useful for developing more robust water quality management plans, triggering other monitoring activities, and in strategically important locations, providing publically accessible to real-time water quality information. Handling these large datasets is challenging and DEQ will need to improve data systems and data analysis methods to fully utilize and share the information with stakeholders and the public. Enhanced deployment of continuous monitoring instruments will provide comprehensive data to identify water quality impairments and improve DEQ's water quality management planning efforts.

Ongoing identification, development, and deployment of new analytical methods to monitor for chemicals of emerging concern or to lower detection levels is important to evaluate threats to public health and aquatic life. Analytical method development will be prioritized based on DEQ's Toxics Reduction Strategy focus list. This will be supplemented with

information on chemicals of emerging concern for Oregon using EPA or USGS lists for reference. As DEQ's toxics focus list is updated, additional chemicals will be prioritized for method development. In addition, microbial techniques such as Quantitative Polymerized Chain Reaction (qPCR) will improve the identification of fecal contamination sources and provide early detection of cyanotoxins produced during HABs. This information will help DEQ tailor plans for reducing bacterial sources and protect drinking water sources from cyanotoxins.

Utilizing the expertise of DEQ monitoring staff to support monitoring partnerships will help DEQ accomplish the agency's mission to protect the environment by leveraging resources outside DEQ to meet the agencies needs for water quality data. Engaging watershed partners in monitoring efforts, builds trust with our partners and communities, and increases local commitment to the scientific information being produced. DEQ benefits from local knowledge and additional data in priority areas to cover information gaps. DEQ's monitoring staff could be strategically deployed to assist regional monitoring partners to develop quality assurance plans, train staff and volunteers on field collection methods, collect field data and submit samples for laboratory analysis, provide field audits, and provide data management assistance with the agency partnerships. These efforts need to be tracked to capture, quantify and report on the environmental data these efforts provide.

Figure 3: *Monitoring Strategy Roadmap*



Monitoring Governance at DEQ

DEQ developed an internal governance structure to support planning and resource allocation for monitoring activities. The governance structure consists of a decision-making body and four subcommittees representing the various aspects of the water quality programs that use monitoring data. Subcommittee members are subject matter experts who discuss, consult, and provide recommendations to the Water Quality Monitoring and Assessment Governance Team. The governance team is made of water quality managers and administrators who consider input from each of the subcommittees, make decisions about resourcing monitoring proposals, and discuss topics relevant to water quality monitoring and information needs. The governance structure utilizes the depth of staff experiences and perspectives to develop vetted monitoring activities that meet the information needs of the water programs at DEQ. The structure of the governance team and the subcommittees that represent the following water quality programs: statewide monitoring, groundwater, TMDL/nonpoint source/ drinking water, and permitting and compliance are shown below (Figure 4).

Figure 4: *DEQ Water Quality Monitoring Governance Structure.*

Monitoring to Support DEQ Water Quality Programs

DEQ's monitoring strategy for the department's water quality programs is framed by the objectives identified in EPA's "Elements of a State Water Monitoring and Assessment Program" (EPA, March 2003). This EPA guidance reflects the full range of water quality data and information needs to inform Clean Water Act requirements. They also reflect the objectives required to support scientific and policy questions for states to consider in the development of their monitoring strategies. EPA's six overarching information objectives outlined in the document are:

1. What is the overall quality of waters across the state?
2. To what extent is water quality changing over time?
3. What are the problem areas needing protection?
4. What level of protection is needed?
5. How effective are clean water projects and programs?
6. Where does water quality need to be restored and how?

The monitoring strategy is rooted in the core work of each program characterized by the six EPA monitoring objectives to identify and restore water quality impairments (Table 1). Monitoring emphasis is strategically oriented towards moving water programs forward in their goal to identify, protect and restore water quality.

Table 1: *The relationship between DEQ's water quality programs and EPA guidance for monitoring strategy objectives.*

Water Quality Program	What is the overall quality of waters across the state?	To what extent is water quality changing over time?	What are the problem areas needing protection?	What level of protection is needed?	How effective are clean water projects and programs?	Where does water quality need to be restored and how?
Water Quality Standards			✓	✓		
Water Quality Assessment	✓		✓			✓
TMDL's		✓	✓		✓	✓
Nonpoint Source		✓			✓	
Drinking Water			✓	✓	✓	✓
Permitting and Certification		✓	✓	✓	✓	✓
Groundwater protection	✓	✓	✓	✓	✓	✓
Compliance and Enforcement			✓		✓	

Program Monitoring Data Requirements

Water Quality Standards

The Water Quality Standards Program routinely reviews Oregon's water quality standards and updates or modifies existing standards, as needed, to protect designated beneficial uses of the state's waters. The DEQ Water Quality Standards Program establishes the foundation for other water quality programs. Operational roles of the Water Quality Standards Program include: 1) water body classification and use designations, 2) review and revision of existing water quality criteria, 3) development of new criteria, 4) development of site-specific water quality standards, 5) Outstanding Resource Waters designations, and 6) development of standards variances. Support roles of the section include: 1) advising the DEQ on state and national water quality goals, initiatives, policy and emerging issues, 2) providing interpretation and guidance to DEQ programs, including the 303(d) assessment methodology, and 3) providing oversight to DEQ programs in the application of standards, including antidegradation. The standards being developed or reviewed change over time. Therefore, the specific data and information needs will likewise vary over time.

The monitoring strategy goal relative to Standards is provide the best available scientific information and data in order to support development, review, and updates to water quality standards to protect designated and beneficial uses. This helps to ensure clear and up to date water quality standards are in place for use in water quality assessment, permitting, TMDL, and monitoring priorities decision-making. Specific program objectives that rely on monitoring data include:

- Establishing, reviewing and revising water quality criteria to protect beneficial uses (Section 303(c)), using the best available scientific information.
- As needed, identifying whether new or emerging pollutants of concern are present in Oregon waters and at what concentrations.
- Developing and revising clear procedures for interpreting and applying both numeric and narrative standards (e.g. dissolved oxygen, nuisance or harmful algal growth, sediment, toxic pollutants, and biological condition).
- Understanding the character of the full range of water body types that occur across Oregon, including geographic variability, temporal variability, background or "reference" conditions, and the composition of the aquatic communities they support.
- Continuing to clarify, correct, and update beneficial use designations based on new data. Better understanding of where uses are existing and where they are or are not attainable, or should be further refined.
- Evaluating ancillary data needed to determine chemistry based water quality criteria, and to evaluate new or revised equation or model-based criteria; for example, for ammonia and metals (i.e. copper and aluminium).
- Protect high quality waters from degradation through anti-degradation policy such as Outstanding Resource Waters designations.

Water Quality Assessment

The Water Quality Assessment Program assesses the status of water quality throughout Oregon and reports to the EPA on the condition of Oregon's waters every two years in its Integrated Report https://www.oregon.gov/deq/wq/Pages/WQ-Assessment.aspx. The Integrated Report includes an assessment of each water body where data are available, and includes the list of waters identified under Section 303(d) as water quality limited

and needing a TMDL. These activities meet the requirements of the federal Clean Water Act for Sections 305(b) and 303(d). Operational roles of the Water Quality Assessment Program include: 1) determining water quality standards attainment (CWA section 305(b)); 2) identifying impaired waters (CWA Section 303(d)); 3) describing the status of water quality statewide (CWA Sections 303(d), 305(b)); and 4) developing assessment methodologies for numeric and narrative criteria.

The monitoring strategy goal for Assessments is to have current monitoring data to assess the condition of all waterbodies statewide. Strategically monitoring or identifying data sources areas where there are information gaps on waterbodies or specific pollutants of concern will be implemented as resources permit. Program objectives that require monitoring data include:

- Development of an accurate, up-to-date water quality assessment to support TMDL, permit development and inform the public on Oregon water quality (i.e. data used to list or delist water bodies meets minimum sample sizes and frequency, reflects the most current status of water quality (most recent ten years), and data represent best available technologies.)
- Development and improvement of biological assessment tools for assessment purposes for all water bodies.
- Developing and revising water quality assessment methodologies
- Developing causal analysis and/or Stressor identification procedures and methods for identifying causes of impairment.
- Expansion of data collection to include lakes/ reservoirs, estuaries and coastal waters (Section 314).

Total Maximum Daily Loads

The Watershed Management program includes TMDL, nonpoint source, and drinking water programs. The TMDL program is responsible for: 1) developing TMDL and Water Quality Management Plan documents for waterbodies in Oregon identified as water quality limited on the 303(d) list, 2) developing watershed and water quality models to determine pollutant loading rates and loading capacity for pollutants to waterbodies (where appropriate), 3) working with regional staff and Designated Management Agencies to implement TMDLs, and 4) measuring and assessing effectiveness of TMDL implementation. Priority TMDL monitoring projects are identified and prioritized by a DEQ TMDL monitoring committee annually. The committee makes recommendations to a governance team that make final decisions on which projects to move forward based on priorities and resource availability.

The monitoring strategy goal relative to TMDLs is provide the best available scientific information and data in order to support development and implementation of TMDLs to restore water quality in assessment areas identified with impairments. Program objectives that rely on monitoring data include:

- Identification of pollutant sources.
- Quantification of loads and wasteloads for the calculation of pollution reduction allocations.
- Development of watershed models for pollutant load allocation.
- Assessment of TMDL implementation activities' impacts on water quality restoration.

Nonpoint Source

The nonpoint source program is responsible for: 1) developing and implementing strategies to protect, prevent, control, and eliminate water pollution from nonpoint sources in waters of the state to meet water quality standards and TMDL load allocations, 2) developing status and trends reports to aid in providing feedback to Designated Management Agencies regarding progress toward meeting water quality standards and implementing strategies to achieve TMDL allocations.

The monitoring strategy goal relative to the Nonpoint Source program is to provide the best available scientific information and data in order to support the identification and restoration of water quality impairments associated with nonpoint source pollution. Program objectives that rely on monitoring data include:

- Planning strategies for reducing nonpoint source pollutant loads.
- Assessing water quality trends in agricultural, forested and stormwater management areas.
- Measuring effectiveness of waterbodies with TMDLs in place – determining whether water quality is improving (in relation to standards and TMDL allocations), staying the same, or degrading (Sections 303, 305, 402, 314, 319, and others)
- Developing causal analysis and/or stressor ID procedures and methods for identifying causes of impairment. (Section 305(b) and Section 303(d)).

Drinking Water

The Oregon Health Authority administers the Drinking Water Revolving Loan Fund. OHA, also regulates drinking water under state law and the Safe Drinking Water Act, and works co-operatively with DEQ on source water protection. DEQ's Drinking Water program is responsible for: 1) implementing the Clean Water Act to protect the sources of drinking water across the state, 2) identifying the small watersheds and portions of aquifers that collect surface water and groundwater for each of Oregon's community drinking water supplies, and 3) developing updated source water assessment and resource guides to assist community public water systems in developing "place-based plans" to reduce pollutants in their upstream source waters.

The monitoring strategy goal for Drinking Water is to protect public health from threats to drinking water sources. Program objectives that require monitoring data include:

- Occasional monitoring of source water as requested by public water systems to evaluate environmental conditions in raw (pre-treatment) water used for drinking water.
- Support other water quality programs during development and implementation of TMDLs, watershed models for pollutant load allocation, and causes of impairment identification (Section 305(b) and Section 303(d)) within drinking water source areas for public water systems.

Permitting and Certification

DEQ issues federal National Pollutant Discharge Elimination System permits and state Water Pollution Control Facilities permits in Oregon. DEQ also issues Clean Water Act Section 401 certifications for federal CWA Section 404 permits. These permit and certifications ensure that projects will meet groundwater and surface water quality standards.

The monitoring strategy goal relative to Permitting and Certification is to provide the best available scientific information and data in order to support issuance of permits in a timely manner using consistent standards that protect water quality. Program objectives that rely on monitoring data include:

- Collecting ambient water quality data to facilitate discharge permit development (e.g., to characterize the current conditions of receiving waters, evaluate upstream and downstream conditions, and conduct anti-degradation reviews)
- Implementation of new or revised water quality criteria (e.g. Biotic Ligand Model, aluminium, etc.).
- Implementation of narrative criteria (e.g. sediment, biocriteria, harmful algal blooms, etc.) for issuance of discharge permits
- Developing target discharge concentrations (e.g., benchmarks or guidance values) for the implementation of control measures to minimize the discharge of pollutants from a permitted site.
- Developing statistical distributions of ambient water quality parameter concentrations within geographical regions.
- Assessing the impact of discharges on the receiving waterbodies, including, but not limited to, flow data from industrial permit holders.
- Collecting ambient groundwater data to help assess groundwater quality including potential sources like Water Pollution Control Facilities permittees.
- Identifying municipal separate storm sewer system (MS4) monitoring and analytical requirements for Phase 1 permittees in permits.
- Identifying water quality monitoring and analytical requirements in 401 certifications.

Compliance and Enforcement

Program monitoring strategy goal: Provide the best available scientific information and data in order to support DEQ's efforts to insure responsible parties are complying with water quality regulations, permit requirement and groundwater rules. Program objectives that rely on monitoring data include:

- Collecting data to initiate a water quality complaint.
- Collecting data for evidence in civil and criminal legal investigations of water quality violations.
- Collecting and analyzing split samples to audit contractor performance.

Monitoring Programs and Achievements

DEQ's current monitoring programs have accomplished many of the objectives outlined in the "Strategy for Monitoring Oregon's Waters" in 2005. For over a decade, the strategy has provided DEQ with a framework for identifying the monitoring objectives, programs, and resources to meet the agency's water quality-related data needs, and to answer questions about the quality and conditions of Oregon's water resources. Responsibilities of the Water Quality Monitoring program are to: 1) plan and coordinate environmental data collection efforts (2) collect and analyze chemical, physical, and biological data 3) manage and provide accessible environmental data for agency programs and the general public, and 4) analyze and interpret water quality related data. Below is a summary of DEQ's current monitoring programs and achievements over the past decade.

Ambient Water Monitoring

DEQ's ambient monitoring network is a core statewide program at DEQ. Data from these strategically targeted locations on major river systems are used to assess status and trends in water quality associated with water temperature, dissolved oxygen, turbidity, bacteria, nutrients, conductivity, alkalinity, suspended solids, biochemical oxygen demand, carbon and chlorophyll. Expanded with support from the Oregon Department of Agriculture, the network includes 160 sites statewide that are visited six times annually. This network provides a high-level picture water quality long-term trends in Oregon's major rivers and tributaries. Over the last decade, DEQ's laboratory staff collected and analyzed more than 35,000 discrete samples representing more than 300,000 analyses for this purpose. These data are compiled annually to update the Oregon Water Quality Index trend report, which is made available on DEQ's website. The index is also summarized in three key performance measures, the percentage of sites that are "improving", "declining" and in "good to excellent" condition. The information is provided to the Oregon Legislature as one of DEQ's key performance measures. Key performance measures identify performance and outcomes of Oregon's government agencies. The measures are designed to gauge progress toward an agency's goals and mission, use accurate and reliable data sources, and identify performance targets. Agencies submit annual performance progress reports (https://www.oregonlegislature.gov/lfo/Pages/KPM.aspx).

Ambient monitoring program data are also used along with partner data from watershed councils, soil and water conservation districts, federal partners, sister agencies and tribes to assess attainment of Oregon's water quality standards in Oregon's Integrated Report. In addition, the ambient monitoring program, in conjunction with the partner data, provides data used for the development of statewide watershed status and trends reports that identify progress towards achieving water quality standards.

Image 1: *The Oregon Beach Monitoring Program staff collect and analyze weekly marine water samples from Memorial Day to Labor Day to identify public health risks from fecal bacteria.*

BEACH Program

In 2000, the federal Beaches Environmental Assessment and Coastal Health Act (BEACH) amended the Clean Water Act. The goal of this program is to provide public notification where there are potential human exposure risks from harmful microorganisms along coastal beaches. The program collects data to identify the sources of bacteria so that appropriate actions may be taken to reduce public exposure to these risks. In Oregon, DEQ collaborates with the Oregon Health Authority (OHA) to implement the Oregon Beach Monitoring Program. DEQ collects and analyzes bacteria samples at approximately 75 locations at 25 beaches along 360 miles of Oregon's coast. The data provides OHA with the information it needs to do a public health risk evaluation. When bacteria levels exceed acceptable thresholds, OHA issues beach advisories that are posted to caution beach users about potential health risks. Since 2010, the DEQ beach monitoring team has collected and analyzed over 7,500 bacteria samples on Oregon's beaches. The program has identified areas where bacteria problems are ongoing and conducted investigations to help determine sources of bacteria. Study areas include Cannon Beach, Sunset Bay and Rockaway Beach.

Cyanotoxin Monitoring

Recently, harmful algal blooms, or HABs, have become an increasingly recognized public health threat in Oregon. In 2018, cyanotoxins were discovered in the drinking water distribution system of Salem, Oregon's capital city, which serves a population of almost 200,000. In response, the Oregon Legislature directed the Oregon Health Authority to develop an emergency rule requiring vulnerable public water facilities statewide to conduct routine sampling of their water. The legislature also tasked DEQ with performing the analyses of these samples to evaluate public health risks. Chemists at DEQ rapidly developed the analytical methods and demonstrated the proficiencies needed to analyze samples from 100 public water facilities. DEQ continues to provide analytical service for 60 vulnerable facilities in Oregon.

Biomonitoring

Water quality standards are designed to protect the most sensitive uses of water. In Oregon, fresh water aquatic life, adapted to clean, cold waters often represent the most sensitive use. Understanding how and where water quality conditions impair aquatic life is the primary objective of DEQ's biomonitoring program. In the last 10 years, DEQ's biomonitoring team collected over 700 aquatic invertebrate samples statewide. DEQ developed a model to interpret these data and describe the health of macroinvertebrate communities statewide. This information is used to interpret DEQ's narrative biocriteria (340-041-0011) for the integrated report. In addition, the biomonitoring group has refined methods for selecting "reference" or "least impaired" sites that are used for comparison to study locations. Using those methods, DEQ established a reference trending network that provides information on how background changes in temporal and regional conditions affect baseline conditions for aquatic communities.

Image 2: *Biomonitoring staff at DEQ collect and analyze macroinvertebrate samples to identify watershed impairments. We often train monitoring partners in the appropriate methods to collect macroinvertabrate samples.*

Groundwater

As Oregon strives to meet and balance increasing demands for fresh water, groundwater plays an increasingly important role. “Almost half of the State’s population (1.4 million) is dependent on groundwater for their daily needs, while 77 percent (2.3 million) of the State’s population is at least partially dependent upon groundwater at home, work, or school”. (https://www.oregon.gov/oha/ph/healthyenvironments/drinkingwater/sourcewater/pages/whppsum.aspx) Understanding and protecting the quality of Oregon‘s aquifers ensures that groundwater meets the highest quality uses. Three areas --, the Southern Willamette Valley, the Lower Umatilla Basin and Northern Malheur County -- are currently recognized as groundwater management areas (GWMAs) that require active management to reduce identified contaminants. DEQ monitors these areas to understand water quality trends and the effectiveness of implementation activities designed to mitigate contamination.

Further recognizing the importance of groundwater, in 2013 the Oregon’s Legislature approved additional funding for monitoring outside of the groundwater management areas. The statewide program identifies and visits areas of Oregon that need updated information on groundwater quality. The goal for this work is to provide a comprehensive evaluation of groundwater quality in vulnerable aquifers around the state. A Groundwater Technical Advisory Team formed at DEQ to identify where data were outdated or lacking, what the specific groundwater contamination risk factors are for different areas of the state, and what data are needed to understand the condition of groundwater. The Groundwater Team makes recommendations on new areas for sampling based on groundwater risk factors such as, real estate transaction data from domestic wells, historical groundwater quality data and opportunities to collaborate with other water

Image 3: *A DEQ Water Quality Monitoring Specialist collects a bacteria sample from a domestic well spigot.*

monitoring efforts such as the Toxic Monitoring Program, Pesticide Stewardship Partnership or groundwater quantity studies conducted by Oregon Water Resources Department. Areas studied to date include the Mid-Rogue, North Coast, Walla-Walla and Milton-Freewater, Harney County, Mid-Willamette and Klamath. DEQ compiles these data into geographical area reports.

Pesticide Stewardship Partnerships

For nearly 20 years, the Pesticide Stewardship Partnerships program has been a collaboration between DEQ, Oregon Department of Agriculture and watershed partners. Together these groups work to understand and mitigate the impacts of current use pesticides in surface water. Currently

nine participating watershed groups voluntarily collect samples and submit them to the DEQ laboratory for analysis. Water sampling and analysis is focused during peak agricultural, forest and urban spray application periods to provide timely data for communicating pesticide results with local applicators and stakeholders. The information identifies where pesticide application processes may need adjustments when surface water concentrations are found at levels of concerns.

Response Monitoring

A portion of DEQ's monitoring and analytical work involves responding to reported water quality problems. Issues include accidental or intentional spills into waterways, fish kills, harmful algal blooms or other reported problems. Response monitoring often requires rapid planning and mobilization of staff to capture and characterize the conditions that are causing water quality problems. Requests for response monitoring can be initiated by DEQ's Compliance and Enforcement office, regional offices, through reports from other agencies or an Oregon Emergency Response notification, or a phone call from the public. Monitoring to provide data for legal investigations requires special handling and tracking of samples from collection, through analysis until final reporting.

Image 4: *DEQ monitoring staff collecting a sediment sample using a sieve and scoop for the statewide toxics monitoring program.*

Total Maximum Daily Load

A core function of DEQ's monitoring work is to support the data needs of the Total Maximum Daily Load program. Data are collected to characterize the sources and geographic extent of pollutants causing identified water quality impairments. The information is used for modelling pollution reduction responsibilities and increasingly for understanding the effectiveness of TMDL projects and programs. Over the last 10 years, TMDL monitoring activities collected almost 5,000 samples leading to over 48,000 different analyses across Oregon.

Water Quality Toxics Monitoring

Over the last decade, monitoring and analytical work at DEQ has increasingly included identification of toxic contaminants in water, sediment, and fish tissue. Oregon Senate Bill 737 was passed into law in June 2007, and required 52 major wastewater facilities to evaluate their effluent for persistent, bioaccumulative, and toxic chemicals. This study resulted in analysis by DEQ's laboratory of more than 400 pollutants in the effluent of wastewater facilities. That same year, the Oregon Legislature funded a statewide water quality toxics monitoring program with the goal of identifying toxics of emerging concern in water, sediment, and fish tissue. DEQ laboratory chemists developed analytical methods to look for more than 500 unique chemicals. Over the next five years, samples were collected at over 175 locations statewide. The "Statewide Water Quality Toxics Assessment Report" and "Basin Summary Reports" as well as other information on the toxics monitoring program are available on

DEQ's website at https://www.oregon.gov/deq/wq/Pages/WQ-Monitoring-Statewide.aspx. In 2017, the Toxics Monitoring Program supplemented the EPA's National Lakes Assessment to collect toxics samples at 50 randomly selected lakes across Oregon. This effort monitoring a wide range of toxic contaminants in lakes was the first of its kind in Oregon. Most recently, a statewide toxics trending network of 60 locations was established using information from the 2019 Statewide Water Quality Toxics Assessment Report to screen locations with the most toxics issues. These sites are sampled three times annually.

Image 5: *Toxics monitoring staff collecting a water sample for toxics analysis using a Van Dorn bottle.*

Monitoring Partnerships

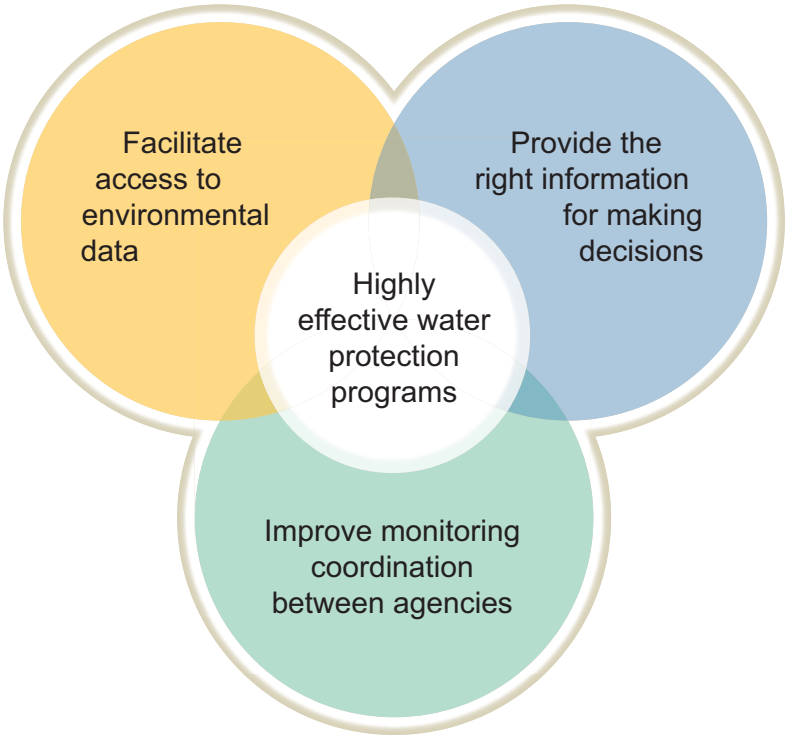
DEQ works closely with monitoring partners across Oregon. The DEQ Volunteer Monitoring Program supports almost 50 organizations in their monitoring efforts by providing equipment, assistance with quality assurance documentation, technical assistance, training and data management support. Some of these groups receive funding from the Oregon Watershed Enhancement Board and DEQ's Non-point source funding to collect data in their watersheds to understand the effectiveness of projects designed to restore water quality over time. Others collect surface water samples for analysis of current use pesticides to inform best management practices during pesticide applications. Monitoring partners provide valuable local data to DEQ for detailed analysis and reporting such as the Integrated Report and Status and Trend reports. DEQ also participates on various monitoring teams including the National Water Quality Monitoring Council (NWQMC), Strategic Enterprise Approach to Monitoring Team (STREAM Team), the Oregon Plan Monitoring Team (OPMT), the Pacific Northwest Aquatic Monitoring Partnership (PNAMP), the Northwest Chapter of Society for Freshwater Science (NWSFS), the Pesticide Stewardship Partnership (PSP) and the Water Quality Pesticide Management Team (WQPMT). Each team has a specific focus area but they share some common objectives to identify and coordinate monitoring activities, discuss and share monitoring methodologies, identify data management challenges and opportunities, and to share monitoring results and information. Through participation on these teams, DEQ staff stay informed about the activities of our monitoring partners and where data gaps still exist that need to be filled.

Additional Strategic Influences

Water quality monitoring in Oregon is a team effort. DEQ's water monitoring program is part of a network of monitoring partnerships that include federal, tribal, state and local groups collecting water data across Oregon. These monitoring partners play an important role in providing water quality information within their jurisdictions. To understand and coordinate among these monitoring partners, teams have formed to work on different aspects of water monitoring. These teams work on water-related issues at different spatial scales and within different jurisdictional responsibilities (see monitoring partnerships above).

Working to understand the strategic objectives and actions of our monitoring partners gives DEQ the opportunity to orchestrate, integrate and advocate for monitoring activities and data collection efforts that provide needed information for our water quality programs. It also provides insights into water quality issues at local, state, regional and national scales. In addition, this strategy also aligns with other DEQ strategic documents to insure that priorities are consistent with larger DEQ program and agency goals. Below are excerpts from strategic documents developed by monitoring partners, teams and DEQ that influence DEQ's 2020 Monitoring Strategy.

Figure 5: *Common themes among agency strategic water quality initiatives*



Oregon Department of Environmental Quality (DEQ):
Water Quality 2035 Vision and Strategy
(DEQ Water Quality 2035 Vision and Strategy, 2015) (references available at DEQ)

"DEQ strategically deploys its monitoring and data acquisition resources to support agency and program priorities and coordinates with other agencies and partners to leverage technological advances and resources and align data collection efforts. All environmental data are accessible to the public through a web-based portal."

"Within 5 years:
DEQ routinely develops and uses its monitoring and data acquisition strategy to capture and address high priority program data-related needs and questions. Monitoring resources and data collection are prioritized accordingly. DEQ can easily access its own data and the data are connected to DEQ's data streams. DEQ supports the creation of a statewide environmental data web portal with the intent of it being functional by 2020. Basic data elements and all data types are accessible to the public through this mechanism."

"Within 10 years:
DEQ's monitoring strategy is coordinated and implemented in concert with other state natural resource agencies in a manner that optimizes the use of state resources and expertise. DEQ routinely seeks opportunities to partner and leverage resources with other partners. DEQ has the data infrastructure in place so that the public can use tools to understand water quality conditions and access original data. Restoration and water quality-related metrics are available to the public."

"DEQ has achieved the vision when:
State natural resource agencies and partners operate under an integrated monitoring plan that ensures most efficient use of resources and collection of needed data. Strategies reflect technological advances and efficiencies for collecting and acquiring water quality-related data. Environmental data accessible in near real-time to the public through a web portal. Data are automatically transformed to commonly used information and metrics."

(Water Quality 2035 Vision and Strategy: Environmental Data Collection, Management and Access, pg. 7)

EPA: EPA's Strategic Plan FY 2018-2022 *(Working Together: FY 2018-2022 U.S.EPA Strategic Plan, September 2019). https://www.epa.gov/sites/production/files/2019-09/documents/fy-2018-2022-epa-strategic-plan.pdf*

"Human health and recreational criteria are the foundation for state, tribal, and territorial tools to safeguard human health. Over the next five years we will improve our understanding of emerging potential waterborne threats to human health; provide technical assistance and resources to help the states, tribes, and territories monitor and prevent harmful exposures; and develop new or revised criteria as needed."

"Many important water quality problems have complex causes that can only be addressed through strategic use of federal, state, tribal, and local authorities. EPA will work closely with its partners to ensure that these issues are addressed in a coordinated and effective manner, particularly where water quality issues cross-jurisdictional lines. The Agency will implement the National Aquatic Resource Surveys to support collection of nationally-consistent data to support these efforts."

(EPA's Strategic Plan FY 2018-2022: Objective 1.2 Provide Clean and Safe Water, Protect Human Health, pg. 13)

"EPA will foster strong partnerships with other federal agencies, states, tribes, local governments, and other organizations that facilitate achieving water quality goals while supporting robust economic growth. In partnership with states, tribes, territories, and local governments, EPA core water programs will:

- Develop recommended water quality criteria for protecting designated uses of water;
- Assist states, authorized tribes, and territories in adopting water quality standards that support designated uses;
- Establish pollution reduction targets for impaired waters;
- Work with partners to protect and restore wetlands and coastal and ocean water resources;
- Prevent or reduce the discharge of pollutants;
- Update analytical methods that enable precise analysis; and
- Conduct monitoring and assessment so we know the status of the nation's waters."

"EPA will partner with states and tribes to implement the National Aquatic Resource Surveys (NARS) to provide nationally consistent and scientifically defensible assessments of America's waters. These surveys will support EPA and its partners in identifying actions to protect and restore water quality and in assessing whether these efforts are improving water quality over time."

(EPA's Strategic Plan FY 2018-2022: Objective 1.2 Provide Clean and Safe Water, Protect and Restore Water Quality, pg. 14)

"An effective partnership (or cooperative federalism) between states, tribes and EPA–is not just about who makes decisions, but about how decisions are made and a sense of shared accountability to provide positive environmental results. EPA understands that improvements to protecting human health and the environment cannot be achieved by any actor operating alone, but only when the states, tribes, and EPA, in conjunction with affected communities, work together in a spirit of trust, collaboration, and partnership. Effective environmental protection is best achieved when EPA and its state and tribal partners work from a foundation of transparency, early collaboration –including public participation– and a spirit of shared accountability for the outcomes of this joint work."

(EPA's Strategic Plan FY 2018-2022: Objective 2 More Effective Partnerships, pg. 25)

"The rule of law must also be built on the application of robust science that is conducted to help the Agency meet its mission and support the states and tribes in achieving their environmental goals. Research, in conjunction with user-friendly applications needed to apply the science to real-world problems, will help move EPA and the states forward in making timely decisions based on science."

(EPA's Strategic Plan FY 2018-2022: Objective 3 Greater Certainty, Compliance and Effectiveness, pg. 35)

"EPA will identify, assess, conduct, and apply the best available science to address current and future environmental hazards, develop new approaches, and improve the scientific foundation for environmental protection decisions. EPA conducts problem-driven, interdisciplinary research to address specific environmental risks, and is committed to using science and innovation to reduce risks to human health and the environment, based on needs identified by EPA's program and regional offices and as well as state and tribal partners. Specifically, over the next five years, the Agency will strengthen alignment of its research to support EPA programs, regions, states, and tribes in accomplishing their top human health and environmental protection priorities for improved air quality, clean and safe water, revitalized land, and chemical safety."

(EPA's Strategic Plan FY 2018-2022: Objective 3.3 Prioritize Robust Science, pg. 42)

"Over the next five years, the Agency will:

- Support safe drinking water by focusing research on assessing the distribution, composition, remediation, and health impacts of known and emerging chemical and biological contaminants.
- Improve methods for fast and efficient waterborne pathogen monitoring in recreational waters.
- Investigate health impacts from exposure to harmful algal/cyanobacteria toxins, and develop innovative methods to monitor, characterize, and predict blooms for early action.
- Support states and tribes in meeting their priorities and setting water quality and aquatic life thresholds.
- Assist states, tribes, communities, and utilities in addressing stormwater and wastewater infrastructure needs through applied modeling, technical assistance, and capture-and-reuse risk assessments.
- Provide water reuse research support on potable and non-potable use guidance for states and tribes."

(EPA's Strategic Plan FY 2018-2022: Objective 3.3 Prioritize Robust Science, pg. 44)

"EPA also will transform and modernize its information systems, tools, and processes to improve how the Agency collaborates both internally and with external stakeholders. EPA will enhance the power of information by delivering on-demand data to the right people at the right time. To enable the Agency, its partners, and the public effectively to acquire, generate, manage, use, and share information–a critical resource in protecting human health and the environment–EPA will improve its IT/IM capabilities and customer experiences. EPA will employ enterprise risk management and financial data analytics to support data management decision making, using the enterprise risk management framework mandated by OMB Circular A-123."

(EPA's Strategic Plan FY 2018-2022: Objective 3.5 Improve Efficiency and Effectiveness, pg. 49)

Oregon Watershed Enhancement Board (OWEB):
Oregon's 100-Year Water Vision: A Call to Action
(OWEB: Oregon Water Vision, 2019) https://www.oregon.gov/oweb/resources/OregonWaterVision/Pages/default.aspx

"We support formation of regional, coordinated and collaborative partnerships that include representatives of local, state, federal, and tribal government, private and non-profit sectors, stakeholders, and the public to plan and invest strategically."

"The best solutions come when we recognize that both science and local knowledge have value. We will build investment approaches that allow for learning, adaptation, and innovative ideas."

(Oregon's 100-Year Water Vision: Principles: Best Use of Available Science Combined with Local Knowledge, pg. 3)

"Data and Information Management Challenge: Communities across Oregon lack basic data and information to make strategic, long-term decisions about water investments and water management. Data and Information Management Opportunity: Good data is the foundation of wise and coordinated decisions. We can work across agencies at all levels, with tribes, and with the private sector to improve access to accurate, relevant, trusted, and current water data and infrastructure condition. We can also use science and information to anticipate future trends. Access to quality information will help communities strategically plan for and invest in their water future."

(Oregon's100-Year Water Vision: Management Challenges: Data and Information Services, pg. 5)

Oregon Department of Agriculture (ODA):
Agricultural Water Quality Management Program Monitoring Strategy *(ODA, 2017) https://www.oregon.gov/oda/shared/Documents/Publications/NaturalResources/AgWQStrategy.pdf*

Complement other agencies' roles and data collection. Monitoring is jointly designed and carried out by ODA and DEQ, optimally with the support of other partners. DEQ generally leads water quality data collection and management for Oregon. Instream monitoring may be carried out by a variety of parties. Implementation, land condition, and instream monitoring must be integrated so that data are complementary and support an integrated strategy."

"Use monitoring data for adaptive management. Adaptive management is achieved through evaluation and reporting of implementation, land condition, and water quality monitoring results. Monitoring and reporting may occur at the scale of Management Areas, smaller areas with focused implementation (including FAs and SIAs), regions, or statewide."

(Agricultural Water Quality Management Program Monitoring Strategy: Principles Guiding this Strategy, pg. 9)

Key Partners: DEQ and ODA review each Area Plan for sufficiency prior to the biennial review, and have agreed to jointly evaluate monitoring data prior to the biennial review to determine whether the data suggest that changes need to be made to the Area Plan. Further, ODA and DEQ are collaborating to track water quality at agriculturally influenced sites as part of DEQ's statewide long-term ambient monitoring network."

(Agricultural Water Quality Management Program Monitoring Strategy: Principles Guiding this Strategy, pg. 27)

Oregon Water Resources Department (WRD):
Oregon's Integrated Water Resource Strategy *(IWRS, 2017). https://www.oregon.gov/OWRD/programs/Planning/IWRS/Pages/default.aspx*

"Improving our knowledge of water resources requires investments in inter-agency work, analytical methods and approaches, scientific modeling tools, and platforms to share information with the public and other partners. Oregon's surface water and groundwater resources, by their very nature, are ever-changing. By day, month, and year, water resources managers need up-to-date information in order to manage the resource and make sound decisions. This requires measurement of baseline conditions, trends over time, and evaluating the effectiveness of water monitoring programs. Data-sharing among agencies supports informed decisions and more efficient management of water resources. As one example, the Department of Environmental Quality and Department of Fish and Wildlife provide information and advice to properly evaluate water allocation decisions made by the Water Resources Department. Their understanding of species and water quality needs helps determine whether a proposed use of water is in the public interest."

(Oregon's Integrated Water Resource Strategy: Critical Issue: Improve Water Quality & Water Quantity Information, pg. 23)

"Monitor and Evaluate Groundwater Quality: During the past few decades, dwindling budget resources and other water quality priorities have significantly decreased groundwater quality protection efforts. In the early 1990s, DEQ had 12 staff dedicated to the groundwater quality program. By the early 2000s, program staff had decreased to five. The groundwater program only consisted of technical assistance, minimal statewide coordination, and implementation of groundwater monitoring and restoration activities in three designated Groundwater Management Areas

(GWMAs) — Northern Malheur County, the Lower Umatilla Basin, and the Southern Willamette Valley. DEQ identifies areas of groundwater contamination, as well as potential health risks from the contaminated groundwater, informing each user of this risk and providing educational and technical resources to address those risks. For each study area, DEQ provides a brief data summary and technical report, along with a public presentation of results. Currently, resources are not available for an in-depth analysis of the results, but the data are available for the public and outside organizations to use to support local programs and outreach activities. With continued funding, DEQ plans to rotate to new study areas around the state and will be working closely with local organizations and interested participants. Continuation of this type of collaborative and widespread monitoring will help fill in data gaps and begin to identify long-term trends in groundwater quality."

(Oregon's Integrated Water Resource Strategy: Critical Issue: Improve Water Quality & Water Quantity Information, pg. 26)

"Although the state has several monitoring programs, the geographic scope and frequency of data collection and analysis is limited due to resource constraints. Water quality data is not available for all waterbodies and all pollution types, and therefore the assessment is not comprehensive. With additional resources for monitoring and data analysis, more impaired waterbodies may be identified, improving the process for meeting Oregon's water quality standards for the protection of public health and aquatic life. Monitoring data are also pivotal for ensuring that water quality improvement strategies and investments are cost-effective and achieve the desired results."

*(*Oregon's Integrated Water Resource Strategy*: Critical Issue: Improve Water Quality & Water Quantity Information, pg. 27)*

"Enhance Data Coordination:
Several years' worth of water quantity and quality data still needs to be processed, analyzed, and shared with the public and other partners. Methods to enhance data collection, processing and sharing include:

- Coordination – Better integrating federal, state, and local data collection efforts, while adhering to quality control standards
- Training – Improving data collection standards, manuals, training, and technical support
- Access – Providing on-line platforms for data submittal and quality control
- Real-Time – Adding remote and real-time monitoring to existing stations
- Backlogs – Processing the backlog of water quantity and water quality data

The lack of stable resources to maintain the state's monitoring networks, to collect and share data, to conduct studies, and to develop modeling tools presents a significant, ongoing challenge."

*(Oregon's Integrated Water Resource Strategy***:** *Critical Issue: Further Understand our Water Management Institutions, pg. 36)*

Strategic Enterprise Approach to Monitoring Team (STREAM Team): Monitoring Strategy for Oregon's Waters: An Inter-Agency Approach
(Interagency STREAM Team: 2017) *https://www.oregon.gov/oweb/data-reporting/EM/Pages/Monitoring-OPSW.aspx*

1. Build upon existing inter-agency monitoring approaches, including those from the Oregon Plan for Salmon and Watersheds. Monitoring teams developed under the Oregon Plan, the Agricultural Water Quality Pesticide Management Plan, and other efforts are valuable for fostering communication and data sharing among agency partners. Agencies and decision-makers should continue building upon existing efforts such as these. Collaborative efforts, such as the STREAM team, offer an ongoing forum to identify questions of mutual

interest among agency natural resources specialists, and to develop solutions to common problems.

2. Support agency efforts around sharing results, and assist other agencies with data collection so that managers can allocate resources more efficiently, reducing costs and potential duplication of efforts.

   While this recommendation is well documented, it is difficult to implement because there are no incentives for individual agency leaders to support the work of other agencies. The Governor's Natural Resources Office and / or the legislature could consider ways to create incentives to promote efficiencies.

3. Provide information about metrics, variables, and data management practices so that agency results can be easily shared and understood by tribal, state and federal agencies, along with key partners.

   Support monitoring leaders and scientists within agencies to identify variables of interest to multiple agency partners (e.g. temperature, stream flow, presence of important fish species), along with identifying a permanent interagency funding source for ongoing efforts such as the monitoring calendar, map, and data sharing portals which can strengthen collaborative monitoring efforts.

4. Assure monitoring is undertaken at the appropriate scale.

   The scale of inference for the sampling design needs to correspond to the scale of the question to be addressed (e.g. site, stream, watershed, or ecoregion). As such, identifying a set of standard scales for monitoring has the potential to lead to efficiencies in data collection and integration of different agency monitoring efforts.

5. Support web-based data tools. Promote web-based tools that provide and interpret information about Oregon's waters. Web-based tools facilitate sharing of data, reduce duplication and create efficiencies, ensure consistent data entry by multiple partners, maintain data integrity, and enhance public participation.

6. Promote ecosystem services and markets. Ecosystem services and the markets that can follow have the potential to expand the restoration and conservation water and aquatic habitats in the state. For these to be successful, more information needs to be available to allow for those working in these markets to be able to measure improvements and to track credit generation. These markets can both promote conservation and restoration and lead to better understanding of aquatic systems.

7. Develop regional monitoring strategies for the eight monitoring strategy basins, and continue to use regional "summits" to link local and regional groups to statewide and national efforts.

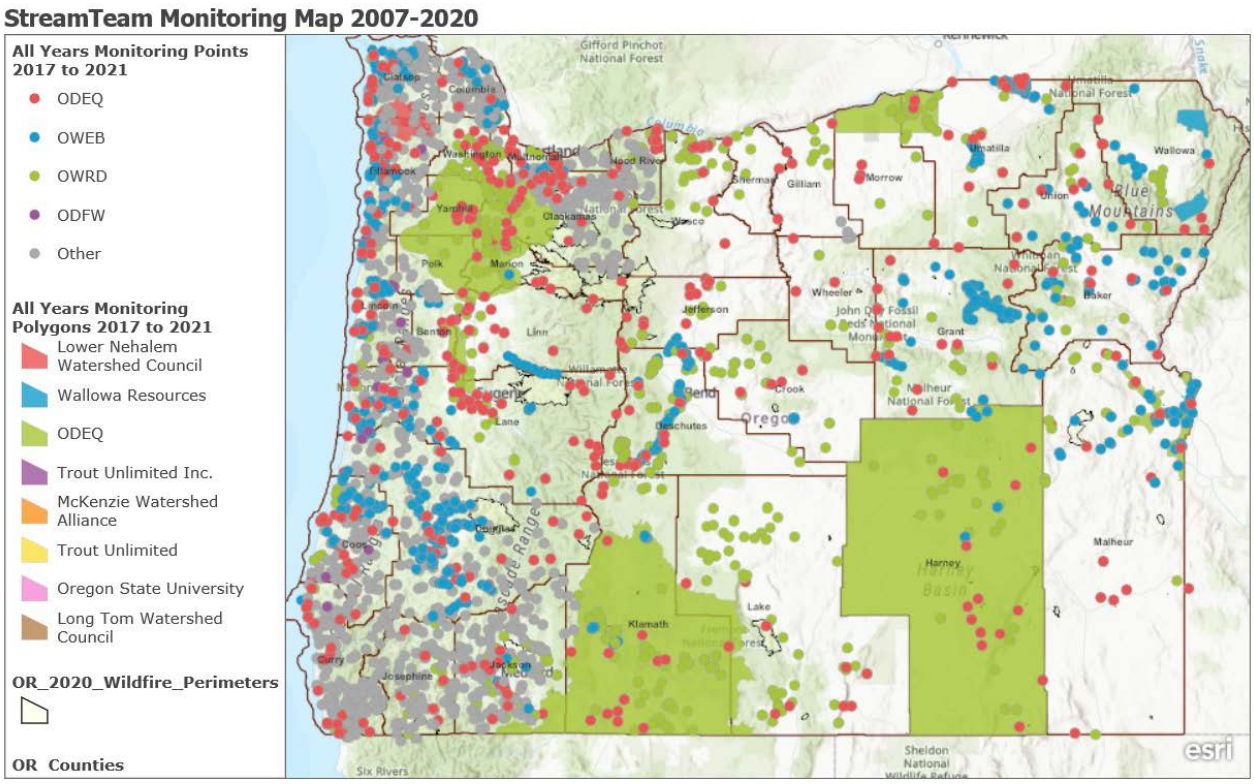
   (Monitoring Strategy for Oregon's Waters: An Inter-Agency Approach: Needs Assessment pg. 35).

Common themes from these documents relate to providing accessible environmental data, having the right data available when it is needed for decision-making and improving coordination of monitoring efforts among Oregon's natural resource agencies. DEQ plays an important role in coordinating these statewide water quality information objectives.

Statewide Monitoring Partners and Teams

Water program data needs are greater than the monitoring resources available at DEQ. As part of DEQ's monitoring strategy, we identify and leverage other agency and partner data collection efforts when feasible as seen in Figure 6.

Figure 6: *Statewide water-related 2019 monitoring locations for DEQ, ODFW, WRD, ODA and OWEB monitoring grant recipients.*



Map of Oregon areas being monitored by OWEB, ODEQ, OWRD and ODFW for biological, habitat, groundwater, meteorological, surface water and tissue to determine future areas for monitoring.

Esri, USGS | County of Crook, State of Oregon GEO, Esri, HERE, Garmin, FAO, NOAA, USGS, Bureau of Land Management, EPA, NPS

In recent years, DEQ's sample tracking and environmental data storage systems have been updated. These new data systems, coupled with our quality assurance procedures, ensure that DEQ and partner data is of known quality and accessible to DEQ, monitoring partners, and the public. Also, improved data analysis and reporting mechanisms have been developed to convert data into useful information for making management decisions. These processes, procedures and improvements maximize the utility of data collection efforts and increase the ability of DEQ's water quality programs to meet agency primary objectives.

In addition, DEQ staff facilitate and participate on multiple internal and external water quality teams that work together to define information needs and objectives for water-related data collection programs, improve coordination on data collection efforts, and discuss better way to facilitate access to environmental data. These teams include:

Image 6: *Sharing science makes it useful to people. It helps establish common ground for understanding issues, making decisions and identifying information gaps. Oregon's STREAM Team sponsored a monitoring summit in 2018 bringing together monitoring partners form the Mid- and North Coast region of Oregon to share the most current water science in the region.*

Water Monitoring and Assessment Governance Team: The team discusses and makes decisions on monitoring resource allocations for DEQ. Annually, four technical advisory teams within DEQ provide monitoring recommendations for the governance team's consideration. The team may request more information, approve, deny, or defer proposals submitted by technical advisory teams.

STREAM Team: This state level interagency monitoring team formed to facilitate coordinated planning, monitoring, and communication of water related data and information among Oregon's natural resource agencies. The team has membership from DEQ, Oregon Watershed Enhancement Board, Oregon Department of Fish and Wildlife, Oregon Department of Agriculture, Water Resources Department, Oregon Department of Forestry, Department of State Lands, the Oregon Health Authority and technical assistance from Oregon State University. The team developed a strategic document outlining the water-related monitoring authorities, roles, responsibilities, opportunities and challenges Oregon's natural resource agencies face together. (Monitoring Strategy for Oregon's Waters An Inter-Agency Approach, 2017). The team also develops an annually updated monitoring map and calendar depicting current and future monitoring activities to identify opportunities for collaboration, fill information gaps, and depict where, when and what water-related indicators are being collected. The STREAM Team also sponsored a monitoring summit on the Mid- and North Coast region of Oregon in 2018 to share water related science among state, federal, tribal and local monitoring partners and identify future monitoring needs. The summit brought together over 40 different organizations to learn and discuss the diverse and important water issues in this region.

Water Quality Pesticide Management Team: The team was established to coordinate activities between agencies that have statutory authority related to pesticide use. Oregon Department of Agriculture sponsors the team that has representatives from DEQ, ODF, OHA, OWEB and OSU. The team identifies pesticides of concern and coordinates water quality activities such as monitoring, data analysis and interpretation, evaluation of program effectiveness and adaptive management planning.

Pesticide Stewardship Partnership: The partnership is led by the Oregon Department of Agriculture and includes members from DEQ, ODF, OWEB, OHA, OSU, the tribes and local watershed partners. The partnership encourages voluntary actions to reduce pesticides in surface and groundwater by changing pesticide use and management practices. Watershed partners collect water samples and submit them to DEQ's laboratory for current-use pesticide analysis during peak applications periods. The goal is to identify and address pesticide issues before they become problems. The partnership has demonstrated measurable environmental improvements in several watersheds, making Oregon waters safer for aquatic life and humans. The partnership continues work to develop new local partnerships in watersheds across Oregon with recommendations from a stakeholder advisory committee.

Oregon Plan Monitoring Team: The team is convened by the Oregon Watershed Enhancement Board to review open solicitation citizen science monitoring proposals for funding consideration and to foster communication and data sharing among agency partners. The team has representatives from OWEB, ODFW, DEQ, OWRD, ODA, and ODF.

Monitoring and Assessment Group: The Monitoring and Assessment Group was formed to guide the efforts of monitoring in ODA's Strategic Implementation Areas or SIA's. SIA's are focus areas selected by ODA for implementation of measures to control water quality pollution sources on agricultural lands. The goal of monitoring in these areas is to track the implementation of management actions in these areas and their performance through time to inform an adaptive management process. The group has representatives from ODA, OWEB, DEQ and ODFW.

Pacific Northwest Aquatic Monitoring Partnership: The partnership "is a forum to facilitate collaboration around aquatic monitoring topics of interest, promote best practices for monitoring, and encourage coordination and integration of monitoring activities as appropriate. The forum's activities are conducted by participant working groups and teams as endorsed by the partner-based steering committee. The coordinating staff serves to enhance and support PNAMP collaboration on topics of importance." (https://www.pnamp.org/) Membership consists of federal, tribal, and state partners; other interested participants; and a coordinating staff.

Monitoring Designs and Considerations

DEQ utilizes monitoring designs that are appropriate for addressing specific programmatic data, information and decision needs. Monitoring questions, operational scales, and available monitoring resources for various programs and projects dictate the selection of appropriate monitoring designs. No single design can provide the information that is needed to support water program information needs. Rather, they are complementary for addressing the different aspects of the six objectives of a comprehensive monitoring program outline by the EPA. Below are a variety of monitoring designs that DEQ currently uses to provide data for our water quality programs and how they address the six objective of a comprehensive monitoring strategy.

Remote sensing

Remote sensing data collected by instruments deployed on satellites, aircraft, or drones provides valuable water quality information at spatial and temporal scales that are unattainable by other means. These data are useful for understanding the relationships between land use changes and water quality and for identifying seasonal or long-term trends in water quality temperature and harmful algae blooms. DEQ staff participate in workgroups that identify and plan for uses of remote sensing imagery and works with NASA, EPA, USGS and other organizations to identify information needs that will benefit Oregon's understanding of water issues into the future.

Image 7: *This earth observation satellite has an Ocean Land Color Instrument or OLCI is for used to monitor harmful algae blooms in Oregon.*

Probabilistic Design

This design is useful for answering the following questions: What is the overall quality of waters across the state? To what extent is water quality changing over time?

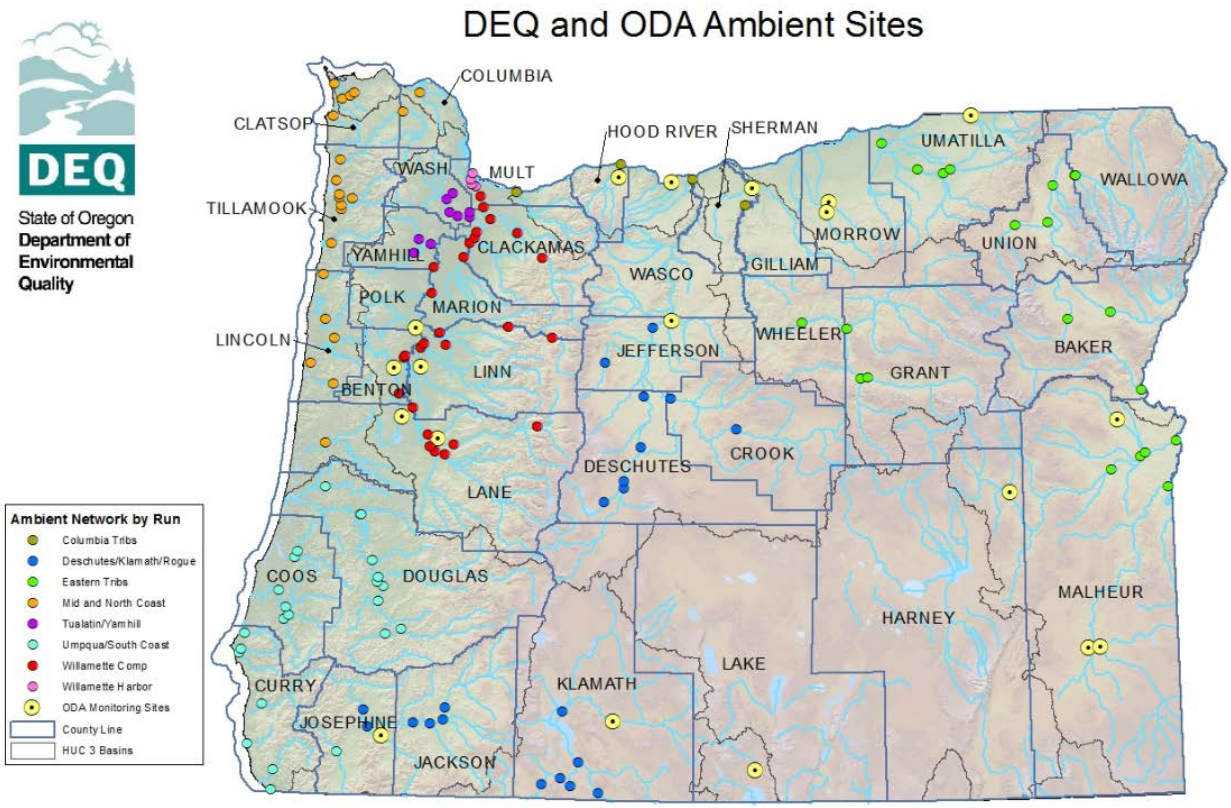
Probabilistic monitoring designs are used when a population of interest is too large for a census approach. For example, while our goal is to assess all waters of the state, it is difficult to do so in an unbiased manner. Using a probabilistic design, randomized sub-sample locations that represent the population of interest are monitored to provide information on the condition the population with known statistical confidence. A good example of a DEQ assessment using probabilistic sampling design is the 2009 Willamette Rivers and Streams Assessment. In the future, the information produced from statewide or regional probabilistic design studies could be used to inform the Section 305 b portion of the integrated report. It should be noted that this type of assessment of the state's overall water quality is different from the assessment methodology used to produce the 303d list for the integrated report. Probabilistic designs are not intended to provide site-specific assessments. They describe the overall condition of the target population.

Targeted Designs

Depending on how targeted designs are structured, they are useful for answering a variety of questions including: To what extent is water quality changing over time? How effective are clean water projects and programs? Where does water quality need to be restored and how?

A targeted sampling design uses intentional selection of monitoring locations. When there are questions about specific waters, targeted monitoring can be the most effective approach for providing needed information. This approach requires careful use of existing information to make the appropriate selection of sampling locations.

Figure 7: *DEQ and ODA Ambient Sites*



Factors that can influence targeted designs may include water quality risk factors, land use activities, watershed restoration actions, illicit discharges, and others.

Fixed Station: To what extent is water quality changing over time? Targeted monitoring conducted at sites on a continuous basis is known as fixed station monitoring. These locations may have permanent or semi-permanent instrument installations collecting one or multiple water quality parameters simultaneously. These stations may be set up with telemetry to access water quality data through the web or have data downloaded periodically by field staff.

Intensive surveys: Where does water quality need to be restored and how? Intensive surveys are used when detailed water quality information is required. At DEQ, this approach is typically used to identify pollution sources and loading for use in TMDL modelling applications. Sampling location and water quality indicators are selected to supply the specific data needed to complete various water quality models with a known degree of confidence.

DEQ and ODA support the Ambient Water Quality Monitoring program (Figure 7). These 160 monitoring sites are sampled six times annually to provide information on the status and trends at these stations. Locations were targeted to capture water quality conditions in key watersheds statewide. Most are strategically located to integrate the influences of upstream pollution sources and water quality risk factors. Other monitoring sites are targeted to represent the influences of specific land uses.

Compliance and Enforcement monitoring

Compliance and Enforcement monitoring has the specific objective of measuring for compliance with clean water laws. This type of monitoring helps to answer the question: What are the problem areas needing protection? Where does water quality need to be restored and how?

Monitoring to interpret compliance with water quality regulations or to evaluate water quality violations requires specific information about the point of compliance or violation. Compliance monitoring may be scheduled or random and is usually in the form of an audit or split sample alongside the responsible party to insure that their discharge monitoring requirements are being appropriately conducted and reported. Enforcement monitoring is typically conducted in response to an environmental complaint. Depending on the severity of the case, monitoring plans may include DEQ's Compliance and Enforcement Section, the EPA, and the Oregon State Police. Monitoring water quality complaints requires specific information on what has been discharged and where the reported discharge occurred. Samples taken at locations are usually targeted to provide background condition data to assess the point of the reported discharge. Other samples are from multiple downstream locations to understand the zone of potential impact.

Image 8: *The Oregon Beach Monitoring Program is a partnership between DEQ and OHA. DEQ collects and analyzes marine water samples for fecal indicator bacteria and OHA issue advisories to beach users if warranted.*

Public Health Monitoring

What level of protection is needed?

Public health monitoring locations are targeted to assess public health risks associated with water consumption or water contact. Monitoring locations are targeted to identify water potentially contaminated with toxics contaminants or pathogens that could adversely affect public health. These data are evaluated to inform decisions on whether consumption or contact advisories or closures are warranted.

Reference Monitoring

What level of protection in needed?

Reference condition monitoring involves identifying and selecting monitoring locations with the least amount of human disturbance possible. Data from reference locations are used for establishing baseline conditions and benchmarks for evaluating study locations. Targeting reference sites for monitoring involves a rigorous screening process that takes into consideration measures of human disturbance and the unique eco-regional characteristics across Oregon that are represented and characterized to evaluate study sites.

Environmental Justice (EJ)

EJ considerations have often been overlooked in monitoring designs. Regardless of which monitoring design is used, using screening tools to identify EJ areas will help to insure that monitoring designs, locations and indicators are deployed equitably and represent the environmental conditions of all communities across Oregon.

Using EJ tools in monitoring designs helps to answer the following questions: What level of protection is needed for communities that have suffered a disproportionate burden of past water pollution? What are the problem areas needing protection?

In 2008, Oregon passed environmental justice legislation that requires state natural resource agencies to follow steps to improve involvement of communities who may be impacted by agency actions (ORS 182.535-183.550). Pollution Environmental hazards generally has had a disproportionate impact on minority and low-income communities nationwide. To help address this discrepancy, an environmental justice policy guides DEQ's work in this area (DEQ Environmental Justice Policy, 1997 February). Monitoring design plays an important role in identifying and bring forward environmental risks to underserved communities. While Environmental justice factors have been considered during the design of monitoring programs such as groundwater monitoring, toxics monitoring and monitoring for advisories there is room for improvement. Screening tools such are EPA's "EJ SCREEN" make it possible to identify affected communities during monitoring planning and implementation (EPA Environmental Justice Screening and Mapping Tool, 2019)

Water Quality Indicators

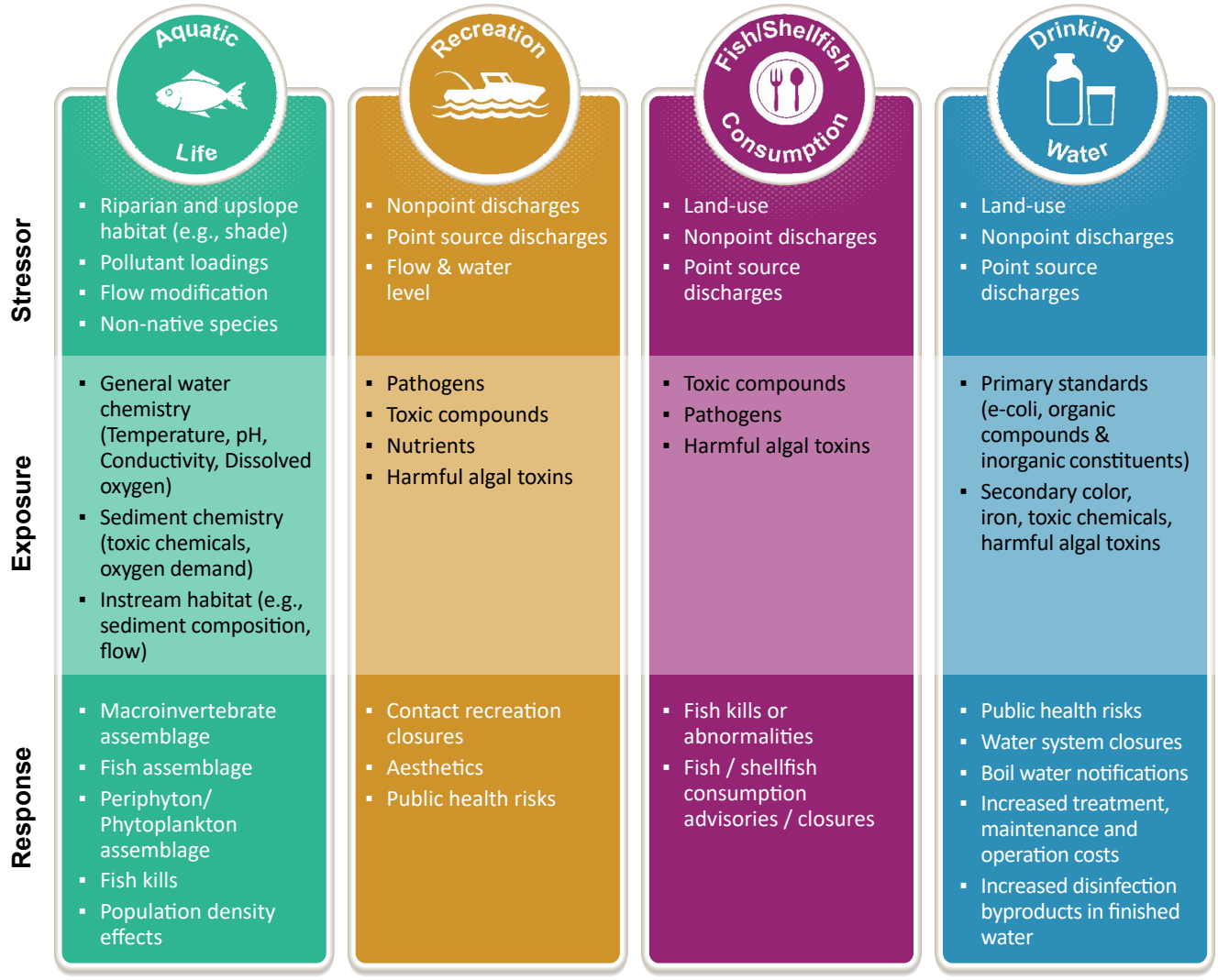
Implementing a successful monitoring design, requires selecting indicators that provide the best answer to the questions and requirements for each DEQ water quality program. Different categories of indicators are monitored depending on where a program falls in the adaptive management cycle. For example, "stressor variables" are indicators that measure the relationship between human activities, water quality, and beneficial use support. They are important intermediate measures for assessing progress towards meeting in-stream water quality goals. Some stressor indicators may have an immediate, measureable impact on water quality, while others may take decades or longer before in-stream, responses can be measured.

Exposure indicators are the primary measurements taken by DEQ's monitoring programs. These indicators are direct in-water measurements of water chemistry, pathogens, or in-stream habitat conditions that directly influence the beneficial use condition. These indicators are used in a wide variety of DEQ water programs from the development of new standards, for water quality assessments, for water quality modeling, for assessing compliance, and for measuring the effectiveness of project and programs. A large portion of DEQ's regulatory authority is used for controlling exposure indicators.

Response indicators are direct measurements of the condition of the most sensitive water quality uses, such as aquatic life. These indicators inform whether water quality standards are protective, whether new standards may need to be developed, how well water quality management plans are working, and what additional measures may be required to fully protect or restore beneficial uses.

Figure 8 shows beneficial uses and indicators. The three categories of indicators: *stressor, exposure, and response* are used to inform DEQ's programs when making strategic decisions based on potential priorities.

Figure 8: *Examples for types of beneficial use measured in association with indicators: stressors, exposure, and response to stressors and exposure.*



Quality Assurance

The primary objective of a robust quality assurance system is to provide DEQ and our stakeholders with data of known and documented high quality that meets the requirements of the data user. DEQ's policy includes using professional practices for the following: to maintain quality, to provide the highest quality of service, and to comply with all applicable standards and regulations. This clear policy direction is implemented and enforced through the commitment of management, at all levels, to the quality assurance principles and practices of the agency.

As described in DEQ's Quality Management Plan, the quality management system fully encompasses all DEQ activities and involves the collaboration and involvement of staff and management at all levels from across the agency. The plan describes a quality system for DEQ activities involving environmental data, environmental data operations and technol-

ogies, and relevant support activities that DEQ performs. The DEQ quality management system is a structured and documented system that provides a basic framework for ensuring that data the agency uses to support its environmental programs and decisions are of the appropriate type and quality. The basic framework of the quality management system encompasses management, administrative, and technical activities pertinent to the planning, implementing, assessing, and improving of quality management activities within the agency.

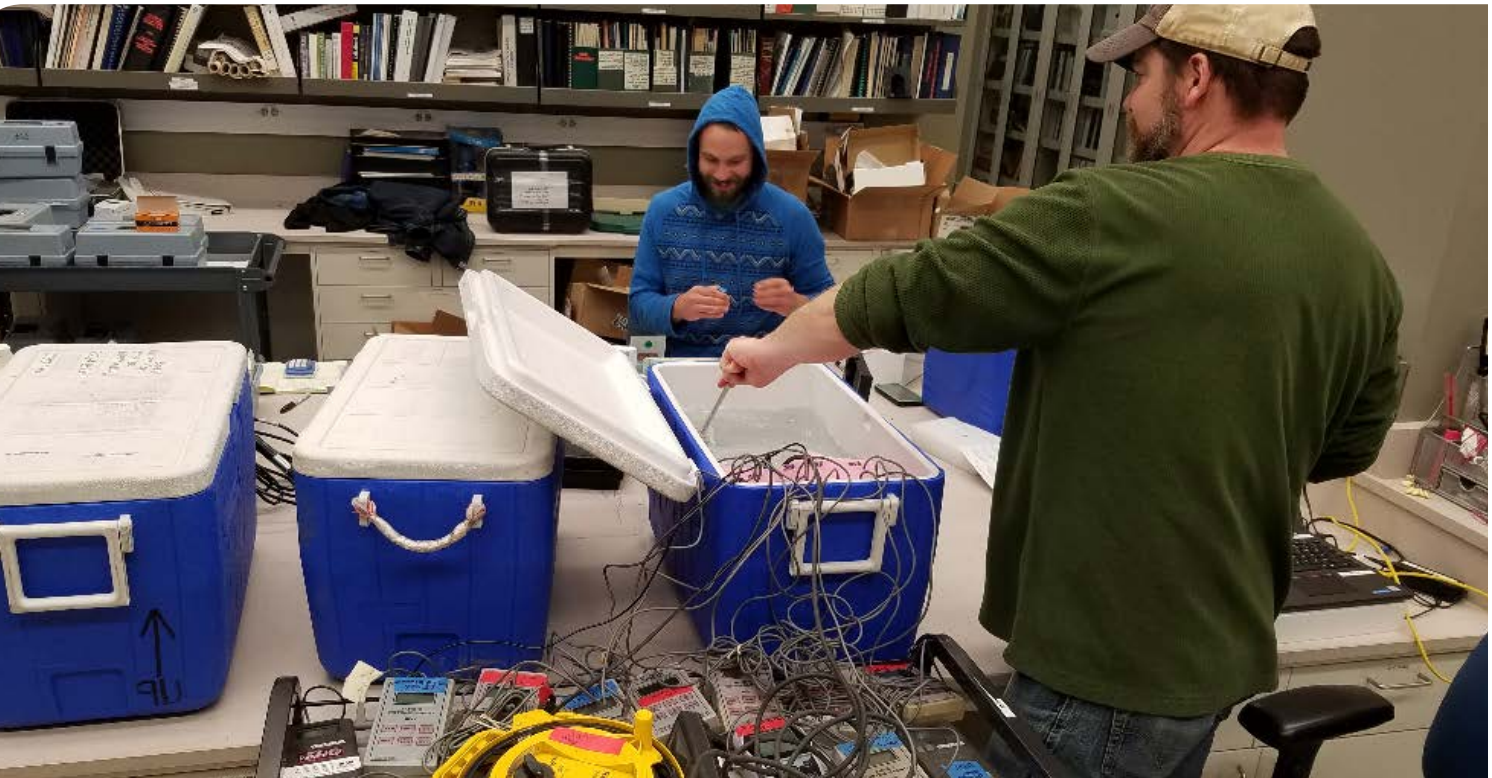
Quality Assurance Project Plans (QAPP's) are critical in ensuring the projects information needs are adequately addressed. The QAPP summarizes the Data Quality Objectives of the project and integrates all technical and quality aspects, including planning, implementation, and assessment, into a single document. The primary purpose of a QAPP is to systematically document project activities and provide a roadmap to the type and quality of environmental data needed for a specific decision or use. The QAPP documents all activities that will take place during the project. This documentation includes field and laboratory activities; data verification and validation; data storage and retrieval; data assessment; and, project evaluation and process improvement.

QAPPs must be written for all DEQ projects involving environmental data regardless of whether data is generated directly by DEQ or submitted to the agency through the efforts of contractors, third parties, or partners. In addition to the QAPP, some projects may include a Sampling and Analysis Plan (SAP), which document site-specific monitoring activities and requirements. SAPs must reference the parent QAPP and may not make substantial changes to the DQOs established in the parent document. Data generated from projects led by external or secondary sources must have an accompanying approved QAPP and where applicable, approved SAPs. With few exceptions, SAPs are acceptable only to document changes in sampling location and monitoring data.

DEQ's laboratory also operates under a rigorous quality system. The laboratory holds accreditation from the National Environmental Laboratory Accreditation Conference (NELAC). Requirements under these standards include rigorous record keeping, adherence to established Standard Operating Procedures (SOPs) and quality control measures throughout the laboratory. These quality measures ensure that the data produced by the DEQ laboratory are high quality, traceable and defensible.

References: DEQ15-HQ-0014-QMP, DEQ91-LAB-0006-LQM

Image 9: *DEQ staff checking volunteer monitoring partners field instruments against National Institute of Standards and Technology (NIST) certified standards.*

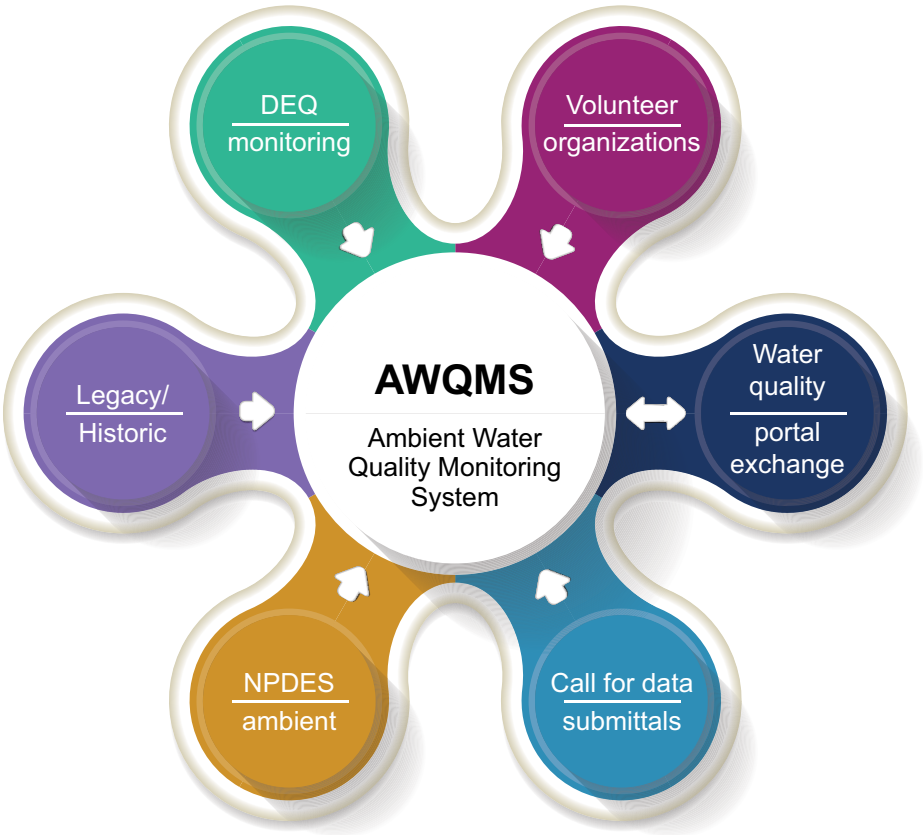


Data Management

DEQ must maintain a robust information structure and system in order to meet strategic objectives. Without a reliable, trusted, stable data delivery platform, data can be lost, corrupted, or inaccessible. Data management systems are often overlooked, but are paramount for delivering high quality data to the programs, stakeholders, and Oregonians. DEQ utilizes two commercial data systems to track sample collection, processing, and analysis and to organize and publically share DEQ and partner data. DEQ's Laboratory uses ELEMENT, a commercial Laboratory Information Management System to track samples coming through the laboratory for analysis. This system captures detailed project specifications such as stations locations, sample collectors, time of collection, analytical specifications outlined in the QAPP, data qualifications, and the data review status. Once samples are collected, analysed, reviewed, and qualified, they receive a "final" status and are uploaded into DEQ's data repository.

The Ambient Water Quality Monitoring System (AWQMS) is DEQ's publically accessible water quality repository. This system includes water, sediment and tissue chemistry data, for both grab and continuous samples. It also includes summary metrics for biological and habitat data. These data exchange on a weekly basis with the federal Water Quality Portal system maintained by EPA, USGS and the National Water Quality Monitoring Council. All monitoring data are publically accessible to data users unless they are part of a civil or criminal investigation. This system facilitates DEQ's Integrated Report assessment by serving as the repository for all data submitted during the open "Call for Data". Figure 9 shows the inputs into AWQMS.

Figure 9: *AWQMS data input*



Data Analysis, Assessment, Reporting and Communication

Accessible data analysis, assessment, and reporting are fundamental to DEQ's monitoring strategy. DEQ strives to provide a transparent, consistent, and scientifically defensible framework for evaluating and reporting on monitoring data. Reports are developed to meet federal and state requirements, to interpret water quality status and trends for the identification of emerging water quality issues, to identify sources of pollution, and for summarizing investigations. DEQ data are analysed relative to water quality criteria, aquatic life and human health benchmarks, EPA benchmarks and action values and in comparison to eco-regionally based reference site benchmarks.

DEQ's reporting goal is to provide information in a clear, concise manner that is accessible to a wide variety of audiences and for DEQ's water program needs. Understanding an audience's general knowledge of water quality issues are considered so that communication can be tailored to effectively deliver the information. DEQ employs a variety of formats and media types to target specific audiences. In additional to traditional written reports, formats including story maps, videos and interactive web applications are used when appropriate. Table 2 shows water quality reports developed by DEQ to meet federal and state requirements and to evaluate the condition of Oregon's waters.

Table 2: *Federal and state required reports*

Report Name	Reporting to	Report description	Report publish date	Communication tools
Integrated Report	EPA	Development and submission of the Integrated Report that combines requirements from Section 305(b), the status of water quality and Section 303(d), the list of impaired waters. EPA requires states to submit their Integrated Reports through their ATTAINS database.	April 1, of each even numbered year	DEQ Online maps, story maps, and data interaction tools. EPA's "How's my Waterway?" tool.
TMDL	EPA	Report outlining wasteload and load responsibilities for Designated Management Agencies and responsible parties.	As completed	
Beach Report	EPA	Section 406 of the Clean Water Act, as amended by the Beaches Environmental Assessment and Coastal Health Act of 2000, requires states with Section 406 grants to submit information on monitoring and notification programs for coastal recreation waters.	December 31, Annually	Online map and data interaction tool. EPA Beacon and PRAWN
Nonpoint Source Annual Report	EPA	Nonpoint Source Annual Report	March, Annually	Report

Report Name	Reporting to	Report description	Report publish date	Communication tools
The Annual Performance Progress Report (APPR)	Oregon Legislature	ORS 291.110: The Annual Performance Progress Report (APPR) is the primary expression of agency performance measured against legislatively approved Key Performance Measures (KPM). DEQ's Water Quality Program's KPMs rely on monitoring data collected for the Oregon Water Quality Index.	February, Annually	Web, OWQI Report
Groundwater Report	Oregon Legislature	ORS468B.162 (4): Requires the department submit a report to the legislature on the status of groundwater in Oregon.	January 1, each odd-numbered year	Report, Web
Drinking Water Source Assessments	Public health risks	The 1996 Amendments to the Safe Drinking Water Act required states to prepare source water assessments for public water systems.	ongoing	Online reports and mapping application
Status and Trend Reports	Basin Coordinators, ODA staff, Public	Report outlining the status and trends of targeted water quality parameters at basin, watershed and plan area scales	Annually	Report, Web
Toxics Monitoring Report	Public, Leadership, Legislature	Statewide and basin specific reports on legacy and emerging contaminants	Periodically	Online reports, online map
PSP Reporting	Stakeholder advisory Group, Legislature, Leadership	Biennial Programmatic summaries, Watershed summaries	Biennially	Online reports
Special studies	DEQ Leadership	Project reports highlighting issues of emerging concern or new information about ongoing water quality issues.	Project specific	Report, Web, Story Map
National Aquatic Resource Surveys	EPA & Public	Statistical survey of the nations and Oregon's waters.	Project specific	Nationwide report (EPA), State report (OR)

Emerging Water Quality Issues

Oregon's environment is changing. While there has been tremendous progress restoring Oregon's water quality since the adoption of the Clean Water Act in 1972, climate change is threatening some of those gains. Climate patterns in the Northwest are shifting the timing and quantity of flows in our rivers and streams and warming our fresh and marine waters (National Climate Report, 2014). More severe and frequent storms are likely to increase surface erosion and the potential for landslides threatening water quality and our drinking water supplies (Oregon Public Water Systems: Surface Water Resource Guide, 2018). Combined with excessive nutrient inputs in some waterbodies, these changes are creating favorable conditions for the formation of harmful algal blooms. HABs can produce dangerous cyanotoxins that threaten our public drinking water supplies and recreational uses. They can also lead to extreme swings in oxygen concentrations and pH that can stress or even kill sensitive aquatic life. Improving predictive tools using monitoring data will help to respond quickly and appropriately to the impacts of HABs. Understanding the rate and magnitude of these various environmental changes and the degree to which they are affecting the beneficial uses in our waterways will require a variety of monitoring designs, tools, approaches and indicators to gather the information our water programs and leadership need to make decisions on strategies to mitigate adverse impacts.

The impacts of climate change on forest and agriculture practices will also affect water quality in new ways. Warmer conditions in the northwest are shifting plant, insect and pathogen distributions. These conditions and rising CO2 levels may increase agricultural production for some crops in the coming decades. However, these same conditions will benefit new pests. "Higher average temperatures generally can exacerbate pest pressure through expanded geographic ranges, earlier emergence or arrival, and increased numbers of pest generations. Increasing CO2 boosts weed growth, adding to the potential for increased competition between crops and weeds. Several weed species benefit more than crops from higher temperatures and CO2 levels." (National Climate Report, 2014) In order to combat these new threats to our forests and agriculture, new chemicals, application rates and timing will be required. These new chemicals will pose yet unknown risks to our waterbodies and the beneficial uses they support. We will need to develop new methods and monitoring plans to provide the necessary information to understand these changes and new risks to water quality in Oregon.

Less snowpack to provide summer flows in Oregon's rivers and streams will create increasing demands on groundwater supplies to provide for domestic and agricultural needs (Geophysical Research Letters). Data to understand the availability, quantity and quality of the water in Oregon's aquifers will be an essential part of a strategy to meet future demands for clean water. DEQ will need to work closely with the Oregon Water Resource Department to monitor and identify aquifer conditions and contamination threats to groundwater so that plans to mitigate and protect groundwater supplies are developed.

Oregon's increasing population also places increasing pressure on Oregon's water quality. Since 2010, Oregon's population has increased by 400,000 people (Portland State University). This increases the demands on Oregon's water treatment infrastructure and creates housing demands that extends Oregon's urban footprint into new areas. In some areas, fertile agricultural lands are being converted to housing developments while in other areas, forest uses are being converted for agricultural purposes (Land Use Change on Non-Federal Land in Oregon and Washington 2018 Update). As the landscape changes, local impacts to water quality also

change. DEQ's programs will need monitoring data and information to understand the trends associated with these land use changes so that we can work to develop and tailor our water quality management plans to protect beneficial uses.

Oregon's territorial ocean waters are also changing. In recent years warm water "blobs," hypoxic zones, HABs and acidification are posing threats to the marine ecology that sustain coastal communities. Oregon's commercial marine fisheries contributed approximately $270 million to the state's economy in 2017 (Economic Contributions of Oregon's Commercial Marine Fisheries, ODFW 2019 Update). Information suggests that ocean acidification is reducing available carbonate that shellfish and crabs rely on to develop and harden their shells (Science of The Total Environment Available online 22 January 2020, 136610). DEQ and our monitoring partners will need environmental data to understand how local coastal pollution sources are contributing to these emerging issues that affect coastal economies and communities relying on healthy ocean waters.

DEQ Monitoring Strategy Future Direction

In the future, DEQ's water monitoring programs will stay focused on meeting the environmental data requirements of the Clean Water Act and Oregon's environmental rules and regulations. This includes providing data to develop or refine water quality standards, for assessing impairments, to assess unassessed waterbodies, for the development of water quality permits, TMDL's and water quality management plans, for understanding compliance with rules and regulations, and for evaluating the effectiveness of our projects and programs. In addition, DEQ monitoring programs will focus on identifying new water quality threats and trends. Given the increasingly dynamic nature of water quality issues, maintaining monitoring and analytical capacity to respond quickly to urgent environmental requests and emergencies will be essential.

This strategy and the monitoring committee structure will be used to meet and prioritize these multiple monitoring needs. DEQ will use its monitoring subcommittees to make recommendations to our Governance Team for decisions about appropriate allocations of monitoring resources. This structure ensures that subject matter experts, from different water program areas, are communicating, coordinating and making recommendations on monitoring and information needs. The Governance Team's responsibility is to balance monitoring and information needs with available resources and identify monitoring gaps for policy development.

Rivers and Streams

The majority of DEQ's water quality monitoring resources focus on Oregon's flowing waters. Monitoring over 100,000 miles of waterways requires a variety of monitoring approaches. Newly developed assessment units for the integrated report create a framework for identifying river and stream segments that are either unassessed or require additional monitoring data to clarify their status. DEQ's will use this framework to target sampling locations and indicators that require more data (DEQ Integrated Report, 2018/2020).

Ongoing monitoring at DEQ's statewide ambient water quality network will continue to provide annual information on the status and trends of key water quality parameters at these strategically targeted locations. When additional information is needed to support water quality standards, permit development and water quality assessment,

Image 10: *Large woody debris spanning the channel of the McKenzie River.*

supplemental indicators/parameters can be added to this network to provide needed data. Refreshed data from these locations will be incorporated into the integrated report assessment every two years.

Data collection to support the information needs of the TMDL, nonpoint source and drinking water programs will be identified annually by the DEQs' subcommittee established to review monitoring proposals and make recommendations to the Governance Team for final approval. This structure ensures that data collection for these programs is strategically focused on where and when the information is needed most.

The statewide toxics monitoring program will continue to focus on collecting data at 60 statewide locations three times annually. Past data, land use, 303(d) listing status, assessment unit considerations and spatial coverage all factored into the selection of toxics network sites. Data from the toxics network will be used to identify and characterize new chemical threats, track trends in contaminant concentrations in water, sediment and tissue and help to identify sources of these chemical. As new "focus list chemicals" are identified, they will be prioritized for analytical methods development and added to the sample collection requirements at network sites. DEQ's "Team Toxics" and statewide monitoring subcommittee will periodically review the toxics monitoring program objectives to make sure that the information is providing the most value with available monitoring resources for making decisions about reducing toxic contaminant concentrations in surface water.

Biomonitoring efforts will focus on refining the methods used for assessing biological conditions and stressor identification. Statewide reference sites will be re-evaluated to strengthen biomonitoring models, fill gaps in underrepresented ecoregions and refine benchmarks for parameters that do not have water quality standards. Monitoring locations will target 303(d) assessment units listed as "Category 3: Not enough information to determine beneficial use support" to resolve their status. DEQ will continue monitoring statewide trending reference sites to understand how regional climate change and other global environmental factors are affecting biological conditions, water quality and habitat measurement at reference sites. This information will provide context for evaluating environmental outcomes from projects and programs designed to restore water quality and beneficial uses. DEQ's will utilize the expertise of biomonitoring staff to provide more training, technical support and data analysis to regional monitoring partners. This will fill biomonitoring gaps in unassessed areas for the integrated report and support local partners in their efforts to understand and protect sensitive beneficial uses. Current and historical biomonitoring data will be migrated from outdated data management systems into DEQ's Ambient Water Quality Monitoring System.

Image 11: *Fish are collected to analyze their tissue for bioaccumulation of toxic chemicals.*

Lakes

More comprehensive monitoring of Oregon's thousands of lakes and reservoirs is needed. The department has participated in three cycles of EPA's National Lakes Assessment in 2007, 2012 and in 2017. In 2017, DEQ supplemented EPA's sites with additional lakes and indicators to provide a more robust assessment of the condition of 50 of Oregon's lakes and reservoirs. DEQ plans to continue participation and the incorporation of supplemental sites and indicators if possible for the NLA in 2022. Participation in NLA assessments beyond 2022 is recommended.

Additional lake monitoring at DEQ occurs when HABs are reported on lakes and reservoirs. These data are used to characterize risks associated with recreational contact. Lakes with multiple advisories are listed as impaired and will receive further monitoring and assessment to determine mitigation strategies or to develop TMDL's. DEQ will continue work to identify other monitoring partners that collect lake data to assist with filling information gaps on these important waterbodies in Oregon. As these partners and datasets are identified, DEQ will work toward assimilating lake data into the AWQMS as resources permit.

Image 12: *DEQ staff collect a sediment sample as part of EPA's National Lakes Assessment.*

Groundwater

Groundwater monitoring activities will focus on data collection in two key programmatic areas. Monitoring will continue in Oregon's three designated Groundwater Management Areas to provide data on groundwater trends and to understand the effectiveness of implementation of plans design to mitigate contamination problems. The Statewide Groundwater Monitoring Program will use DEQ's Groundwater Technical Advisory Team to identify aquifers and indicators that require monitoring data to update their status and identify new contamination risks. Opportunities to coordinate and co-locate groundwater studies with the Toxics Monitoring Program, the Pesticide Stewardship Program, and Oregon

Image 13: *Collecting a groundwater sample in Harney*

Water Resource Department and United States Geological Survey groundwater studies will considered when feasible.

As new groundwater contamination risks are identified, such as per- and polyfluoroalkyl substances (PFAS), analytical methods will be developed and incorporated into risk-based study designs. Reports summarizing regional groundwater studies will be developed and presented to leadership, groundwater stakeholders, and local community groups. Aquifers where results suggest area-wide contamination will be identified and prioritized for further study to determine if declaration of a groundwater management area is warranted.

Oceans and Estuaries

In 2017, Senate Bill 1039 created the Oregon Ocean Acidification and Hypoxia Coordinating Council to provide recommendations on actions Oregon should implement to adapt and mitigate OAH impacts. The coordinating council released the "Oregon Ocean Acidification and Hypoxia Action Plan: 2019-2025" in 2019 (https://www.oregonocean.info/index.php/oah-action-plan). The plan identifies five actions for the State of Oregon over the next six years to address ocean acidification and hypoxia threats:

1. Advance scientific understanding to address OAH vulnerabilities.
2. Develop and use strategies to reduce causes of excess CO2 and other causes of OAH
3. Support resilience to OAH in Oregon's ecosystems and communities
4. Share OAH science, impacts, and solutions to raise awareness
5. Build sustained support and mobilize agencies to address OAH

Image 14: *Lowering an Eckman Dredge to collect benthic samples for the National Coastal Condition survey.Harney*

As a partner in this effort, DEQ will play a role helping to provide water quality data to advance our scientific understand of these issues. In addition, DEQ will continue to participate and share OAH science with partner agencies coordinating on these issues.

Currently, DEQ participates in EPA's National Coastal Condition Assessment once every five years and consistently monitors beaches for bacteria using the Oregon Beach Monitoring Program funds. DEQ plans to continue to participate in the NCCA and supplement EPA's sites and indicators to provide a comprehensive assessment of water quality in Oregon's estuaries and support the actions identified in the Oregon Ocean Acidification and Hypoxia Action Plan. DEQ supports the recommendations of this action plan.

Wetlands

In Oregon, the Department of State Lands is the lead agency on wetlands issues, including monitoring activities. DSL's monitoring approach is outlined in the "Oregon Wetland Program Plan: 2017-2021." Their stated goal for wetlands monitoring is "To guide and coordinate statewide monitoring and assessment efforts in order to improve the states' ability to sustainably manage and conserve Oregon's wetlands." When applicable, DEQ consults with DSL and EPA on issues related to wetlands condition and monitoring. For more information on the specifics of DSL's wetlands monitoring and assessment objectives, visit their website at https://www.oregon.gov/dsl/Pages/index.aspx.

In addition, DEQ participates in the planning of the National Wetlands Assessment with EPA.

Data Management and Reporting

In order to maintain a robust data management structure and accommodate the changing needs of the program, this strategy establishes short and long-term goals for data management. The first goal is to make all water quality related data collected by DEQ accessible through the AWQMS. This will be accomplished by completing the migration of DEQ's continuous data into AWQMS and developing process improvements to integrate raw biological and habitat results into the system.

The next objective is to develop direct data entry and review processes for volunteer monitoring partners. Currently, as part of DEQ's volunteer monitoring program, staff work with volunteer organizations on the design, collection, and management of their data. . As part of that process, volunteer monitoring data are submitted to and reviewed by DEQ staff to establish the appropriate data quality level. DEQ will pursue data management improvements to allow volunteer organizations to submit, review and qualify data directly. DEQ will provide training, technical assistance, and oversight to volunteer organizations for both the data review and upload.

In the longer term, DEQ's and other state natural resource agencies would like to integrate water quality data collected by data partners in an easily accessible web-based portal .

Oregon's natural resource agencies collect a variety of data describing environmental conditions including temperature, flow, riparian habitat, biological communities and other parameters. Some of these data are collected using continuous in-stream monitors so data volumes can be large. Meeting this goal will require additional research, information technology hardware and staff resources to identify and implement solutions to provide a readily accessible portal for these types of data.

DEQ will coordinate on quality assurance requirements for these data. This will ensure consistent data collection and evaluation processes. Over time, the system will become a repository for Oregon's monitoring data, not just the data collected by DEQ. The ease of having the data in one location will facilitate the use of these data by DEQ programs as well as by partners, stakeholders and the public. DEQ is investigating options to meet this need through collaborations on the STREAM team and other interagency workgroups.

Additionally, DEQ will include all ambient data collected by DEQ programs or program permittees in AWQMS data system. AWQMS contains all data collected by the laboratory's water quality monitoring program. However, other programs in the water quality and land quality divisions also facilitate collection of ambient water quality data as part of permit requirements. Currently these data are not included in AWQMS and are not utilized during assessments. Limited staffing resources within the programs and at the laboratory are a main roadblock to achieving this objective. This goal may be accomplished by documenting and training program staff to review their program's data and upload it directly to AWQMS.

Monitoring Resources

Current resource levels at DEQ are not sufficient to meet all of the monitoring, data, and information goals identified in the monitoring strategy. If DEQ is unable to acquire additional resources through policy option packages associated with the agency request budget or other legislative actions, affordability gaps will require reprioritization of existing resources, new funding agreements with EPA, or a commensurate reduction in the achievable goals. Some of the data needs may also be achieved through continuing to engage in collaborative monitoring efforts with partner agencies or other stakeholders. Developing and supporting strategic monitoring collaborations maximizes the utility of monitoring data among participating organizations and ensures that high quality, water-related data is collected, shared and accessible where and when it is needed.

Monitoring resources at DEQ come from multiple funding sources. The EPA provides project-specific grant funding for DEQ to implement programs such as the Oregon Beach Monitoring Program and for work on the National Aquatic Resources Surveys. DEQ also receives funds from other state agencies through Interagency Agreements for monitoring activities, technical assistance, analytical support and data management services for their water quality programs. A majority of DEQ's monitoring funding comes from Oregon's general funds, lottery funds, or through EPA section 106 CWA grants (33 U.S. Code §1256). For section 106 CWA grants, DEQ specifies monitoring work that will be supported by the Performance Partnership Agreement in consultation with EPA staff. Mutually agreed upon commitments are funded in the Performance Partnership Grant for a two year period.

In order to receive state general funds for monitoring work, DEQ develops policy option packages and an agency request budget to identify funding needs on a two-year cycle. Policy packages are developed by DEQ's managers and staff and prioritized by the Leadership Team in the final agency request budget. The agency request budget is submitted to the Governor's office and Legislature for review. At each stage, DEQ's funding requests are either approved, modified, or rejected. Additionally, other funding packages may be developed and incorporated into DEQ's budget independently by the Governor's office or the Legislature. When the agency request budget receives final approval for funding by the Legislature, the work is implemented by DEQ.

Within the base budget of DEQ's water quality program there is a degree of flexibility that allows for modification or reprioritization of monitoring resources. This provides some flexibility to adapt to changing circumstances and information needs and to respond to emerging environmental issues. Decisions about shifting monitoring resources reside with the Water Quality Governance Team comprised of program administrators and managers. As this strategy guides DEQ's water quality monitoring over the next five years, priorities may shift due to environmental, political, or budgetary factors. However, the principles outlined in this document will guide the monitoring program, as a whole, to collect and assess high quality, relevant, and timely water quality data to protect the beneficial uses of the state's aquatic resources.

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