Arizona's Comprehensive Water Quality Monitoring Strategy

For Fiscal Years 2021 to 2025

Prepared by the Arizona Department of Environmental Quality

July 2020

Arizona's Comprehensive Monitoring Strategy

For Fiscal Years 2021-2025

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The Arizona Department of Environmental Quality
shall preserve, protect and enhance the environment
and public health, and shall be a leader in the develop-
ment of public policy to maintain and improve
the quality of Arizona's air, land and water resources.

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CHAPTER 1 – MONITORING STRATEGY

The purpose of this document is to provide a vision and strategic direction for ADEQ's water quality monitoring programs in accordance with EPA's *Elements of a State Water Monitoring and Assessment Program* (EPA, March 2003), the Clean Water Act (CWA) and Arizona law. The strategy identifies current monitoring program capacities, deficiencies and resource needs. The document makes recommendations for implementing ADEQ's monitoring programs over a five-year period.

The development of a comprehensive monitoring strategy that adequately implements all of the recommendations of the *Elements* guidance will be a long-term process, which is largely dependent on adequate resources and staffing. ADEQ's strategy will cover fiscal years 2021 through 2025 (July 1, 2020 to June 30, 2025). The strategy identifies current monitoring program gaps and makes recommendations for filling those gaps and improving ADEQ programs.

DOCUMENT ORGANIZATION

This document is organized into 10 chapters. Chapters 1 and 2 discuss general programmatic concepts such as the overall monitoring strategy and monitoring objectives. Chapters 3 through 10 discuss specific elements of the monitoring process. An implementation schedule to reach the goals outlined in Chapters 3 thru 10 is included in the Appendix A. This appendix provides goals, target dates for completion, a strategy for implementation and resources needed to complete each task.

PREVIOUS MONITORING STRATEGY

ADEQ's 2007 to 2017 Comprehensive Water Quality Monitoring Strategy covered 35 monitoring initiatives. ADEQ completed 25 of the 35 initiatives (Table 1-1). . Shifting priorities and inadequate resources prevented the remaining ten initiatives from getting complete.

Table 1-1. Initiatives from the 2007 to 2017 Strategy.

Initiative	Comment	Status
Conduct additional special studies, such as impacts from wildfires to lakes and streams	Several special studies such as impacts from the Wallow Fire were completed.	Complete
Coordinate with tribes, states, and Mexico when monitoring and research goals overlap	ADEQ has attended numerous national conferences and workshops to collaborate with national peers.	Complete
Monitor wetlands	Participated in the National Wetland Condition Survey.	Complete
Monitor Effluent Dependent Waters (EDWs)	ADEQ has sampled multiple EDWs such as the Santa Cruz river in southern Arizona.	Complete
Address assessment data gaps identified on Arizona's 2004 §305(b) report	Addressing data gaps is an ongoing task.	Complete
NPS effectiveness monitoring	Several projects implemented on the San Pedro and for metal related activities.	Complete
Use sensors or remote monitoring devices to more efficiently collect data	ADEQ has successfully used remote monitors to help identify when streams are flowing and to better manage autosampler collection.	Complete

Initiative	Comment	Status
Monitor intermittent streams	Probabilistic study completed in 2018.	Complete
Monitor for emerging contaminants	Emerging contaminants such as microcystin sampled throughout the state.	Complete
Compare and assess Arizona indicators compared to other states, tribes and Mexico	ADEQ has reviewed indicators used by neighboring states, tribes and Mexico.	Complete
Draft a QAPP that covers all Surface Water Sampling	QAPP approved in 2016.	Complete
Define the geographic location of assessment units using the National Hydrography Dataset (NHD)	NHD is the base for all geographical data.	Complete
Follow data standards for digital geospatial metadata to label geospatial datasets	All data is geo-located.	Complete
Develop a data entry portal for outside data to be entered for assessment purposes	Data submission guidelines and database portal developed.	Complete
Update and enhance AZAC	Real time assessment tool developed and implemented in 2018.	Complete
Develop criteria and guidance to include volunteer monitoring results in assessments	Volunteer coordinator hired and procedures refined to use all external data in assessments.	Complete
Improve and update website	Website received a major update in 2017.	Complete
Allow public access to data through the internet	All data available through ADEQ's website and the water quality portal.	Complete
Ensure that data submitted by volunteers meets minimum qualifications	Volunteer coordinator hired and procedures created so volunteer data meets minimum requirements	Complete
Develop specific report cards for each program for evaluation	Key performance indicators developed for each value stream	Complete
Contact other state monitoring programs to learn evaluation criteria for internal review and goal setting	ADEQ has coordinated with regional partners to assess evaluation criteria.	Complete
Provide training/ growth opportunities, and a supportive work environment to retain qualified staff	ADEQ regularly sends staff to national conferences and workshops to train staff and allow staff to network with experts and peers.	Complete
Provide salaries that are comparable to other water quality professionals	ADEQ provides salaries that are on average 7% higher than other state agencies.	Complete
Create a career path that provides financial rewards to valued staff	ADEQ helped develop a career path for scientists, hydrologists, technicians and engineers.	Complete
Identify midge specimens to the genus level	ADEQ now has a level 3 biocriteria program.	Complete.
Increase number of samples for the stream, lakes and groundwater programs to improve confidence in data evaluation.	ADEQ collects fewer samples than in previous years. Focus switching to number of decisions made.	Not Complete
Increase size of groundwater monitoring program	ADEQ does not currently have an ambient groundwater program.	Not Complete
Increase the use of trend analysis in the groundwater monitoring program	ADEQ does not currently have an ambient groundwater program.	Not Complete

Initiative	Comment	Status
APP effectiveness monitoring program	ADEQ does not currently have an ambient groundwater program.	Not Complete
Monitor geomorphological condition of wadeable perennial streams	No longer a priority.	Not Complete
Develop narrative standards for toxics	Need to revise both the Impaired Waters Rule and the Water Quality Standards.	Not Complete
Add second biological assemblage for stream assessments	Algal and chlorophyll samples taken for streams. Additional collection and analysis needed before this initiative can be completed.	Not Complete
Refine narrative standards for nutrients and bottom deposits	Revisions need to be made to the impaired waters rule and standards so narrative standards can be effectively used for impairment decisions.	Not Complete
Develop modules within WQDB to house time series data	Not a priority until ADEQ starts receiving or collecting time series data.	Not Complete
Develop and implement an information exchange program between AZ, CA, NV, CO, UT, NM, WY and the Arizona tribes to facilitate the exchange of ideas, to coordinate monitoring on a watershed level, to compare methodologies and to compare water quality between states	Not a priority at this time. Staff have collaborated with other states and tribes to improve monitoring programs.	Not Complete

WHY MONITOR?

Monitoring provides information that is critical for directing policies that can protect and restore Arizona's waters. ADEQ uses monitoring data to determine if surface waters can be used for drinking water, recreation, agriculture and is protective of aquatic life. ADEQ also uses monitoring data to evaluate if restoration activities improved water quality for impaired lakes and streams.

Attainment and impairment decisions for lakes and streams can only be made through monitoring and is required by Arizona statute (A.R.S. § 49-225) and the Clean Water Act (CWA).

Figure 1-1 illustrates the relationship between water quality monitoring, assessments, Total Maximum Daily Load (TMDL) development, and the implementation of water quality improvement strategies. This cyclical process often begins with monitoring. Once water quality is monitored, the results are assessed against the surface water quality standards. The results of the assessment are included in the CWA Section 305(b) report, while impaired waters are placed on the 303(d) list. TMDLs are developed for impaired surface waters on the CWA Section 303(d) list. The National Pollutant Discharge Elimination System (NPDES) is a permitting program, which addresses point source discharges to surface waters. These permits are written to meet water quality standards to protect water quality and designated uses. Arizona received delegation for this program in December 2002. The Clean Water Act Section 319 program addresses nonpoint source programs and provides grants for projects to improve water quality.

Figure 1-1. Water quality monitoring is integrated with the development of water quality standards, TMDLs, assessments and the implementation of water quality strategies.

WHAT DOES THE STRATEGY COVER?

This strategy addresses the water quality monitoring of rivers and streams, lakes and reservoirs, and wetlands in accordance with the Clean Water Act and Arizona Revised Statutes (A.R.S.) § 49-225.

Arizona has approximately 108,559 stream miles and 285,962 lake acres based on the National Hydrography Dataset (excluding Native American reservations). Arizona is an arid state, and perennial and intermittent streams make up less than 10 percent of its stream miles. More than 90 percent of the total stream miles are ephemeral drainages. EPA's Navigable Waters Protection Rule defines which waters are covered by the Clean Water Act. This rule became effective on June 22, 2020, and regulates only perennial and intermittent streams.

Intermittent waters are defined in Arizona Administrative Code (A.A.C.) R18-11-101(25) as a stream or reach that flows continuously only at certain times of the year. Flows in intermittent waters are variable and highly dependent on climactic conditions, which make them difficult to monitor.

Ephemeral waters are defined in A.A.C. R18-11-101(18) as a surface water that has a channel that is at all times above the water table and flows only in direct response to precipitation. Ephemeral waters may flow for a few hours or days depending upon the amount of rain. It is difficult to predict when and where flows will occur in ephemeral waters because of Arizona's "flashy" hydrology and the often highly localized and variable nature of storms.

ADEQ focuses its monitoring strategy on perennial surface waters because of the importance of these waters to human health and aquatic life but also because of the logistical difficultly involved in sampling ephemeral and intermittent systems.

Arizona has approximately 561,645 acres of wetlands (ADEQ, 2012). ADEQ includes wetlands within its regulatory definition of "surface water" consistent with the inclusion of wetlands within the federal definition of "waters of the United States." Arizona's wetlands have not been extensively studied and ADEQ has not yet developed water quality standards specifically for wetlands.

WHAT IT DOESN'T COVER

This strategy does not cover groundwater monitoring including monitoring associated with water quality assurance revolving fund/superfund, underground storage tanks or drinking water programs. It also does not cover monitoring for waterbodies on tribal lands. A significant percentage (28 percent) of the land in Arizona is tribal land. ADEQ does not have jurisdiction to conduct water quality monitoring of surface waters located on tribal lands and only conducts such sampling at the express request of a tribe. For this reason, ADEQ does not perform Clean Water Act assessments of waters located on Native American lands.

CHAPTER 2 – MONITORING OBJECTIVES

ADEQ has a variety of objectives for its monitoring programs. All objectives are tied either directly or indirectly to meeting state and federal statutes and rules.

ADEQ'S OBJECTIVE

ADEQ's main objective for surface water is to reduce the number of impaired waters in Arizona (ADEQ Strategic Plan, 2020). ADEQ's focus is on reducing metal and E. coli impairments. Monitoring plays a critical role in determining if this objective is met.

MONITORING OBJECTIVES REQUIRED BY ARIZONA LAW

Arizona Revised Statute (A.R.S.) §49-225(A) mandates that ADEQ conduct ongoing monitoring of the waters of the state, including Arizona surface waters and aquifers to:

- Detect the presence of new and existing pollutants;
- Determine compliance with applicable water quality standards;
- Determine the effectiveness of best management practices, agricultural best management practices and best available demonstrated control technologies;
- Evaluate the effects of pollutants on public health or the environment; and
- Determine water quality trends.

MONITORING OBJECTIVES OF THE CLEAN WATER ACT

The first line of the Clean Water Act reads, "The objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters". This objective is carried out through programs of the Clean Water Act including monitoring, assessment, permits, standards and grants. The Clean Water Act accomplishes this objective by:

- Establishing, reviewing, and revising water quality standards §303(c);
- Determining water quality standard attainment §305(b);
- Identifying impaired waters §303(d);
- Identifying causes and sources of impairment §§ 303(d) and 305(b);
- Supporting implementation of water management programs §303, 314, 319, 402, etc.; and
- Supporting evaluation of program effectiveness §303, 305, 314, 319, 402, etc.

SPECIFIC MONITORING OBJECTIVES

1. AMBIENT MONITORING PROGRAM

The ambient monitoring program is a statewide data collection program. The primary purpose of the ambient monitoring is to assess Arizona's lakes and streams to determine if standards are being met and if designated uses are being supported. ADEQ accomplishes this goal by implementing the following:

A. ADEQ has a cooperative agreement with the USGS to monitor a network of sampling sites on Arizona's large rivers. Sites are chosen to maximize Clean Water Act assessment decisions (impairment or attainment decisions).
B. Arizona uses a targeted and probabilistic monitoring design to assess lakes and streams.

C. Special studies are conducted on a case-by-case basis when needed. For example, ADEQ is currently monitoring the San Pedro River as part of a settlement with the American Smelting and Refining Company (ASARCO).

The specific objectives of the Ambient Monitoring Program are to:

- Make assessment decisions at the parameter, use and waterbody level as required by §305(b) of the Clean Water Act;
- Identify impaired surface waters pursuant to §303(d) of the Clean Water Act;
- Provide credible data;
- Fill data gaps for waterbodies that have not been assessed or have been assessed as 'inconclusive';
- Develop water quality standards;
- Characterize baseline water quality for Arizona's lakes and streams;
- Determine compliance with applicable surface water quality standards;
- Characterize baseline water quality in outstanding Arizona waters and to determine whether water quality is being maintained, protected or is being degraded.

2. BIOCRITERIA PROGRAM

The biocriteria program monitors biological assemblages such as benthic macroinvertebrates and algae in Arizona's lakes and streams. Biological assemblages provide a different picture of water quality than chemical data. Chemical data tends to give a snapshot of what is happening at the time of sample collection, while biocriteria describe how healthy a biological community is over a longer period of time.

The objectives of the biocriteria program are to:

- Establish and refine biocriteria standards;
- Assess biological condition of AZ streams and identify biologically "impaired waters";
- Identify biological stressors;
- Update reference conditions through ambient monitoring.

3. FISH CONSUMPTION ADVISORY PROGRAM

The primary objective of the program is to obtain fish tissue data to assess the need for the issuance of a fish consumption advisory. The primary target analyte for the Fish Advisory Program is mercury in fish tissue. Current fish advisories are located at https://www.azgfd.com/fishing/fishconsumption.

Specific fish advisory program objectives are:

- To monitor fish contaminants statewide;
- To protect human health by issuing advisories in lakes and streams when standards are exceeded;
- To provide credible data;
- To fill data gaps for waterbodies that have not been sampled for fish species likely to be consumed.

4. WATERSHED IMPROVEMENT

The Watershed Improvement Program focuses on identifying pollution sources and restoring impaired waters. Development of a Total Daily Maximum Daily Load (TMDL) is one of several tools used to restore waters. Watershed improvement plans and application of water quality grants are also key to restoring impaired waters.

Specific Watershed Improvement Program objectives are:

- To restore water quality in impaired waters;
- To remediate sources of impairment;
- To develop watershed implementation plans;
- To identify sources and causes of pollutant loadings;
- To provide data for water quality models used to calculate waste load allocations, load allocations, and margins of safety in TMDL analyses;
- To develop TMDLs for the Clean Water Act §303(d) listed waterbodies;
- To conduct effectiveness monitoring;
- Provide grant funding for restoration activities;
- To determine Best Management Practice effectiveness.

CHAPTER 3 – MONITORING DESIGN

CURRENT MONITORING DESIGNS

A monitoring design describes how samples are to be collected and analyzed in order to meet program objectives. ADEQ employs the following monitoring designs for each of its different programs (Table 3-1).

Table 1-1. Monitoring design by program.

Program	Design
Ambient Monitoring	Targeted & Probabilistic
Biocriteria	Targeted & Probabilistic
Fish Consumption	Targeted & Probabilistic
Watershed Improvement	Targeted

Each type of monitoring design has advantages and disadvantages. Targeted designs can give specific information about a particular location but may not be comprehensive or representative enough for basin or statewide analysis. Conversely, probabilistic designs can address overall water quality for the state, but may not be suited for describing a particular impact. ADEQ integrates targeted and probabilistic monitoring approaches to meet program objectives.

Arizona has been using probabilistic monitoring designs to study water quality since 2006. ADEQ will continue to use probabilistic monitoring moving forward but will try to capitalize on the strengths while avoiding the weaknesses inherent in probabilistic designs.

Weaknesses

- Probabilistic designs are hard to implement. It is a challenge to hike to remote random sites. Access issues in the Grand Canyon and other remote locations increase sampling costs dramatically.
- Site reconnaissance is difficult in Arizona due to arid conditions and inaccurate maps (Figure 3-1). Arizona had the lowest targeted samplable rate in the compared to 12 other states for the 2004 Western EMAP study (2004, WEMAP). Arizona spends a disproportionate amount of time doing site reconnaissance compared to other states because many of the perennial streams identified on our maps are dry.
- State assessments do not integrate well with EPA's National Aquatic Resource surveys. This effectively doubles the amount of work needed if answering questions at the national and state level.
- Random designs have limited utility for highly monitored waterbodies such as perennial streams. The 2020 Clean Water Act Assessment used a targeted design and assessed 62% of Arizona's perennial streams. The 2012 probabilistic survey assessed 66% of Arizona perennial streams by contrast.

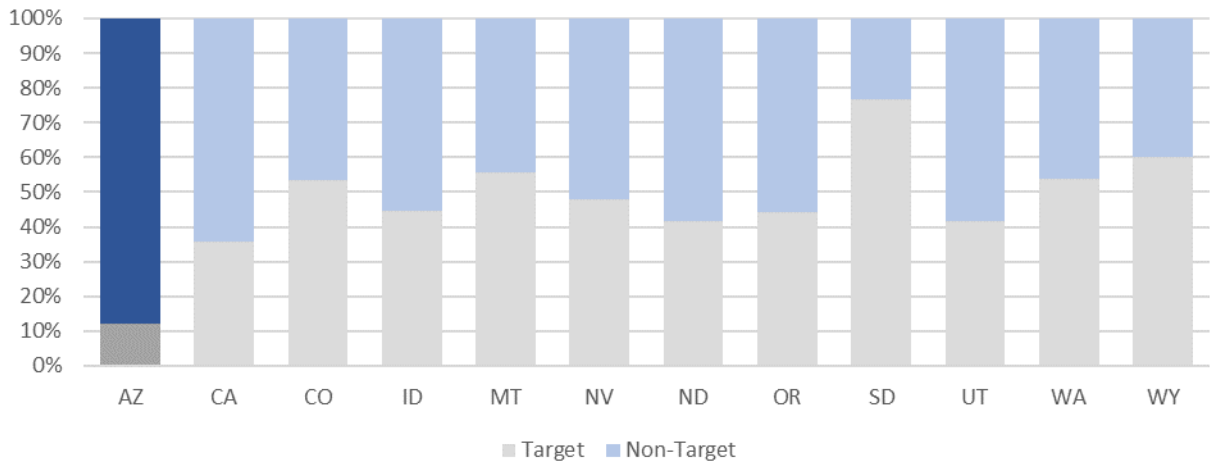

Figure 3-1. For the 2004 Western EMAP study AZ had the lowest target samplable rate of the 12 participating states with just 12 % target. In other words, only one site was perennial out of the 10 that were visited.

Strengths

- Probabilistic studies are highly effective at assessing understudied waterbodies like intermittent streams.
- Probabilistic studies can assess impact of parameters that do not have standards based on biological endpoints.
- Probabilistic studies can answer questions like 'how many impaired waters or attaining waters there actually are'. The Clean Water Act Assessment only gives the impairments we know about.
- Probabilistic studies can determine the condition of all waters. EPA and states were criticized by the Government Accountability Office for not having monitoring programs that 'represent all states waters either through a census or through a statistical sampling that would yield data that are projectable to all state waters (GAO, 2000). The GAO report prompted the development of the National Aquatic Resources surveys and annual 106 funding by EPA to encourage states to develop statistically based monitoring programs.
-

ADEQ has completed several statewide probabilistic surveys on:

- Perennial streams (2006, 2010)
- Intermittent streams (2018)
- Fish consumption (2020, in progress)

Reports are located on our website at http://www.azdeq.gov/node/4908.

MONITORING DESIGNS FOR IMPAIRED WATERS

Answering the question, "How many actual impaired waters are in Arizona?" would be difficult using a targeted approach. There are currently 155 known impaired waters in Arizona (ADEQ, 2018 Impaired Waters List). The actual number of impaired waters is larger. Samplers would have to visit roughly 2,500 lakes and streams multiple times if a targeted approach was used to determine the actual number impaired waters (excluding ephemeral streams). The amount of staff and lab budget to answer this question using a targeted approach would be substantial.

A probabilistic approach can answer the question of how many actual impaired waters are in Arizona with much fewer resources. There are at least 83 additional impaired streams according to the perennial and intermittent studies conducted by ADEQ (ADEQ 2012 & 2018). There are at least 238 impaired waters in Arizona (Figure 3-2). The actual number of impaired waters is likely much higher than 238.

Figure 3-2. Arizona has 155 known impaired waterbodies. Previous probabilistic studies show there are at least 83 additional waterbodies that are impaired.

FUTURE GOALS

The first part of this chapter outlined how each program is currently functioning. This section describes areas that can be improved in the future. Appendix A gives an implementation schedule for each goal.

#	Conduct additional special studies, such as impacts from wildfires to lakes and streams
1	Coordinate with tribes, states, and Mexico when monitoring and research goals overlap
2	Increase number of surface water samples to meet objectives
3	Determine the time and cost to restore surface waters based on different circumstances
4	Monitor understudied waterbodies like wetlands or intermittent streams or effluent dependent waters
5	Use sensors or remote monitoring devices to more efficiently collect data
6	Conduct state scale probabilistic assessments
7	Conduct monitoring to determine impacts from legacy mines
8	Collect additional reference site data and revise macroinvertebrate indexes and to identify high quality waters
9	Utilize biological data to identify tiers of aquatic life uses for water quality standards and classify streams accordingly
10	Monitor large river systems.
11	Monitor outstanding Arizona waters (OAW) for anti-degradation
12	Create a process for OAW nomination
13	Conduct regular monitoring for trend analysis
14	Collaborate with state and federal partners to test the streamflow duration assessment method survey approach for identifying flow regime
15	Develop and implement new standards, reevaluate existing standards
16	Ensure design accounts for various timeframes. For example, the assessment is done every even year and covers a five-year window. Acute and E. coli samples use the last three years of monitoring data.
17	Predict impairment and potential delist based on different scenarios
18	Conduct additional special studies, such as impacts from wildfires to lakes and streams

CHAPTER 4 – CORE AND SUPPLEMENTAL WATER QUALITY INDICATORS

One of the key elements in each monitoring program is the selection of water quality indicators to be measured. Water quality may be characterized by hundreds of chemical, biological and physical indicators (USGS, 2013). The selection of water quality indicators for a monitoring program is based primarily on their relevance to program objectives, the chemical composition of natural freshwater, anthropogenic activities in the watershed, and the probability of a water quality standard exceedance.

ADEQ has begun using an adaptive sampling plan to fill assessment data gaps. This approach uses data from the real time assessment tool to identify the specific parameters that need to be collected to make an assessment decision. The real time tool is run weekly and informs sampling across the state.

CURRENT STATUS

SURFACE WATER CORE PARAMETERS

Monitoring data are collected at sites during representative conditions. ADEQ uses a set of indicators, called "core parameters" to determine if each designated use is being supported. Arizona's core parameters are shown in the Table 4-1. Core parameters were selected based on EPA's CALM guidance (2002).

Table 2-1. Core parameters.

Designated Use	Parameters
Aquatic and Wildlife	Dissolved oxygen, flow (if a stream), depth (if a lake), pH, turbidity, total nitrogen, dissolved metals (specifically copper, cadmium, and zinc) and hardness
Fish Tissue	Total mercury
Body Contact	Escherichia coli, pH, metals
Domestic Water Source	Nitrate / nitrite or nitrate, pH, fluoride, and metals (Total arsenic, chromium, and lead)
Agriculture Irrigation	Total boron and manganese, pH
Agriculture Livestock Watering	Total copper and lead, pH

SUPPLEMENTAL INDICATORS

ADEQ identifies supplemental indicators on a case-by-case basis when there is a reasonable probability that a specific pollutant may be present in a watershed, when core indicators indicate impairment, or to support special studies.

FUTURE GOALS

#	Goal
1	Develop narrative standard implementation procedures for all narrative standards. Close the IWIR loophole where waterbodies cannot be listed as impaired for narrative standards even if criteria are not met (A.A.C. R18-11-605(D)(3)).
2	Reevaluate core parameters
3	Monitor for emerging contaminants
4	Add a second biological assemblage for stream assessments
5	Compare and assess Arizona indicators compared to other states, tribes and Mexico
6	Expand use of technology such as X-Ray fluorescence (XRF) to identify sources of metal contamination and progress toward remediation
7	Develop macroinvertebrate bioassessment tool for intermittent streams
8	Refine standards (such as dissolved oxygen) for intermittent streams
9	Explore adoption of harmful algal bloom recreational criteria for Arizona
10	Explore selenium in fish tissue for implementation of new EPA standard
11	Explore developing standards that neighboring states have as top impairments
12	Refine dissolved oxygen standards for lakes
13	Update water quality standards and impaired waters identification rule

CHAPTER 5 – QUALITY ASSURANCE

Quality monitoring data is essential to each of the water quality programs at ADEQ. ADEQ has developed a Quality Assurance Program Plan (QAPP) to assure quality at each step in the monitoring process (ADEQ, 2016). A draft QAPP was submitted to EPA for review in 2020. Figure 5-1 illustrates the role of the QAPP during the monitoring process. The QAPP addresses reconnaissance, the sample plan, monitoring and data quality assessment.

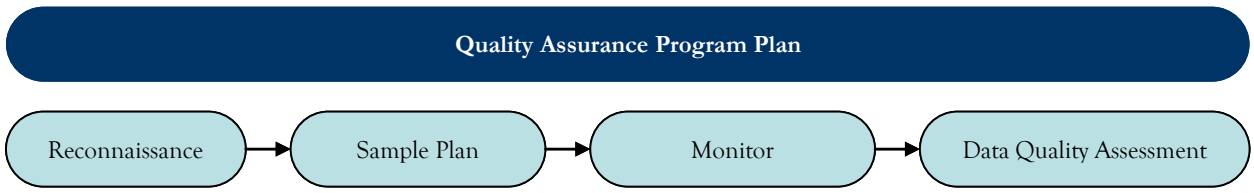

Figure 5-1 Monitoring Process.

The effective implementation of ADEQ's quality system has the following benefits:

- Credible data: ADEQ will produce data of known and documented quality based on sound scientific principles;
- Proper evaluation and assessment: The ADEQ quality system provides documentation and oversight of monitoring activities which allows errors to be identified and reduced;
- More reliable and defensible decisions: When data quality is known and documented, it is easier to determine whether the data can be used for a specific decision. ADEQ will make better decisions and reduce the potential for legal or technical challenges to water quality assessments, §303(d) listings, and permit appeals if an effective quality system is in place; and
- Continuous improvement: The implementation of an ADEQ quality system helps to create a culture of continuous improvement, which will lead to additional monitoring program improvements over the next five years.

CURRENT STATUS OF THE ADEQ QUALITY SYSTEM

The ADEQ quality system is the means by which ADEQ manages and assures quality in its monitoring in an organized and systematic way. The ADEQ quality system provides a framework for planning, implementing and assessing work performed by ADEQ staff and for carrying out quality assurance (QA) and quality control (QC) activities.

EPA requires compliance with American National Standards Institute / American Society for Quality (ANSI / ASQ) specifications and guidelines for quality systems for all recipients of funds for projects involving environmental data collection (such as §106 grant funds). The standards for quality systems were developed to promote consistency among the many quality systems for environmental programs at all levels of government and in the private sector. The ANSI/ASQ standards describes the minimum elements that should be in place to ensure that a functional quality system exists for organizations engaged in environmental data collection. Required documentation for ADEQ includes:

- Documentation of an agency-wide quality system (provided in ADEQ's Quality Management Plan). and

- Documentation of the application of quality assurance and quality control activities at the specific program level or project level

ADEQ QUALITY MANAGEMENT PLAN

ADEQ's Quality Management Plan (QMP) was finalized in 2016 in accordance with the requirements of EPA Order 5360.1 entitled "Policy and Program Requirements for the Mandatory EPA Quality System" and EPA guidance entitled "Requirements for Quality Management Plans" (EPA QA / R-2). The QMP describes the agency wide quality management system. The QMP contains a description of the quality management policies and procedures to be employed agency wide to ensure that ADEQ programs involved in environmental data collection produce results of known quality and the data obtained are of the type and quality needed and expected for their intended uses.

The QMP establishes a foundation for implementing effective quality assurance and quality control programs within ADEQ. At a minimum, the QMP is intended to cover all monitoring programs involving the generation of environmental data by programs that are funded by EPA.

The QMP is implemented largely through the following activities:

- Mandated use of Quality Assurance Program Plans (QAPPs),
- Mandated use of Quality Assurance Project Plans,
- Clearly defined QA/QC roles and responsibilities,
- Periodic quality management system reviews and technical system audits, and
- A quality assurance forum to focus on continuous improvement of QA/QC policies and procedures.

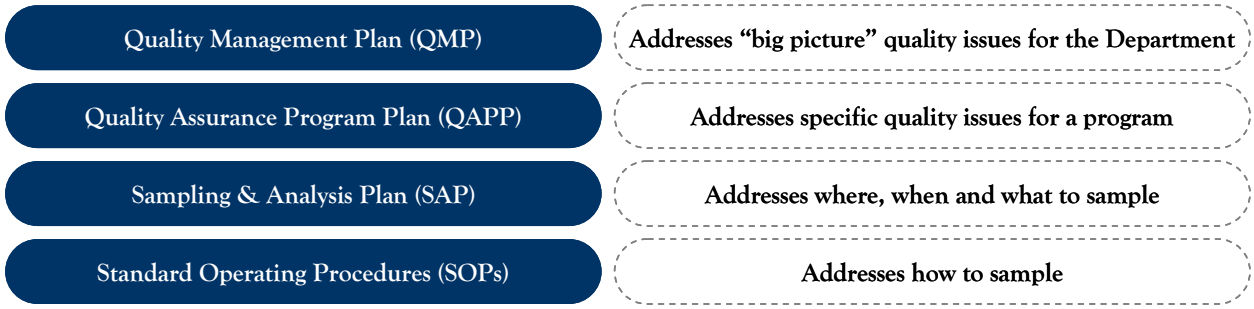

Figure 5-2. Common Quality Assurance acronyms and what they mean.

QUALITY ASSURANCE PROGRAM PLANS

ADEQ's surface water quality assurance program plan provide the specific framework for collecting quality data for each of the following surface water quality programs.

1. Ambient Monitoring
2. Biocriteria
3. Fish Consumption Advisories
4. Watershed Improvement

The QAPP was prepared according to EPA guidance provided in EPA Requirements for Quality Assurance Project Plans, EPA QA / R-5, U.S. Environmental Protection Agency, Quality Staff (EPA, 2012).

ARIZONA'S CREDIBLE DATA REGULATION

ADEQ uses data that meets the credible data requirements defined in Arizona Administrative Code R18-11-602. The rule requires that:

- Data must be collected and analyzed following an appropriate Quality Assurance Plan (QAP) and Sampling and Analysis Plan (SAP), by adequately trained personnel using approved field and laboratory methods.
- Data must be evaluated to determine whether it is reliable, accurately reflects current water quality conditions, and is valid. This is determined by considering factors such as:
    - Laboratory detection limits,
    - Lab notations or qualifiers,
    - Whether the sampling was representative and reproducible,
    - Whether approved sampling and analysis methods were used, and
    - Quality control of the data when collected and analyzed.
- The monitoring entity must submit documentation that these requirements have been met and other information necessary to assist ADEQ in interpreting and validating the data.

Data from organizations that do not meet the credible data rule is excluded from the assessment and is not used to make impairment decisions.

FUTURE GOALS

#	Completed Goal
1	Update QAPP and submit to EPA for Approval

CHAPTER 6 – DATA MANAGEMENT

CURRENT STATUS

Data management is a critical function for storing and sharing water quality data. The data management process has three main steps.

1. Acquisition of data includes collection of data and entry into a database system by manually or electronically adding data to the database:
2. Validation and storage of data.
3. Data analysis using statistical software, query tools, database custom reports, and Geographic Information Systems.

ADEQ uses a centralized Water Quality Database for all chemistry, fish, algae, macroinvertebrate and habitat data. Data is sent nightly to EPA's Water Quality Exchange through ADEQ's node and is available through the Water Quality Portal at www.waterqualitydata.us.

As of April 29, 2020, ADEQ had 1,865,074 records in the WQDB (Figure 6-1). Water chemistry data makes up 94.4 % of the database. Macroinvertebrate, algae, habitat and fish tissue data comprise the remaining 5.6% (Figure 6-2). More data is collected from streams than lakes because there are roughly 20 times the number of stream reaches compared to lakes in the state.

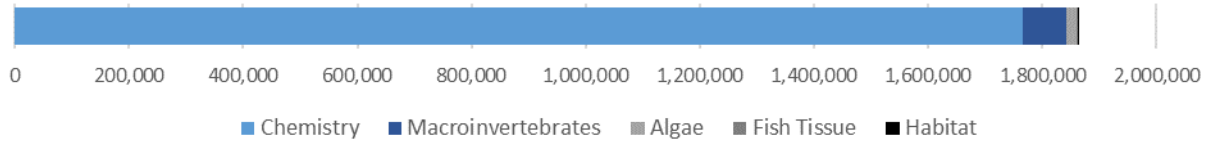

Figure 6-1. Number of surface water records by analysis type.

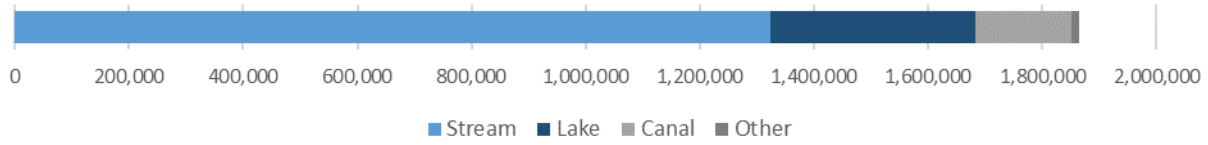

Figure 6-2. Number of surface water records by waterbody.

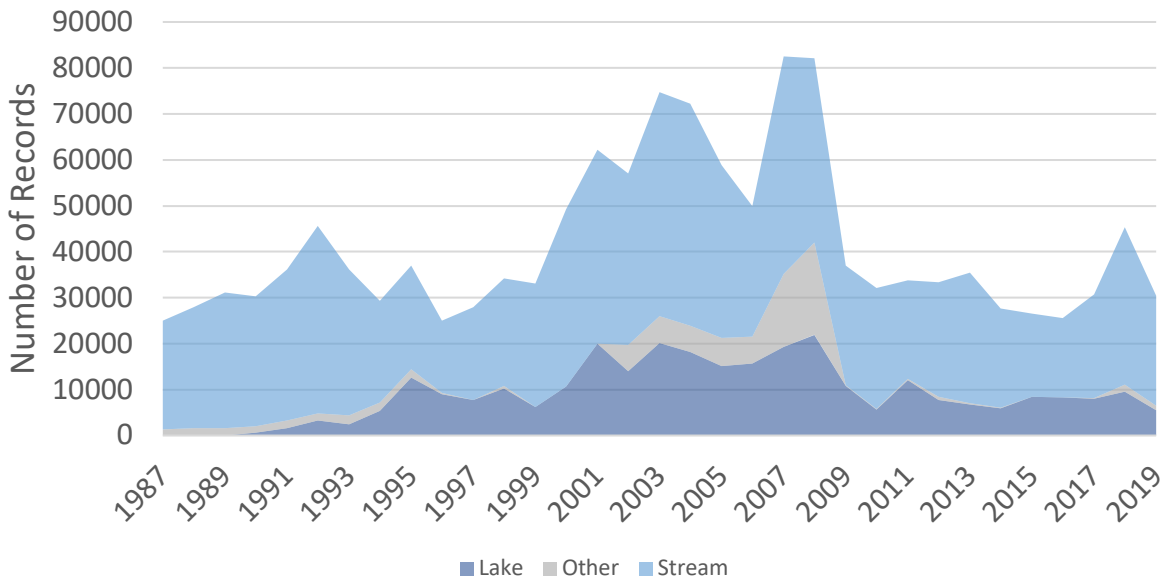

Figure 6-3. Stacked line chart of the number of records in ADEQ's database by waterbody type from 1987 to 2019.

ADEQ typically collects around 30,000 surface water quality records per year. Approximately 60,000 records per year were collected from 2000 to 2008 due to higher numbers of monitoring staff and budget.

Roughly half of the data used in the 2020 Clean Water Act was from external sources such as USGS or volunteers (Figure 6-4). The assessment uses all readily available data from the portal as the main input. This data is analyzed using a real time assessment tool on a weekly basis to determine if criteria are met, uses are supported and if waterbodies are attaining.

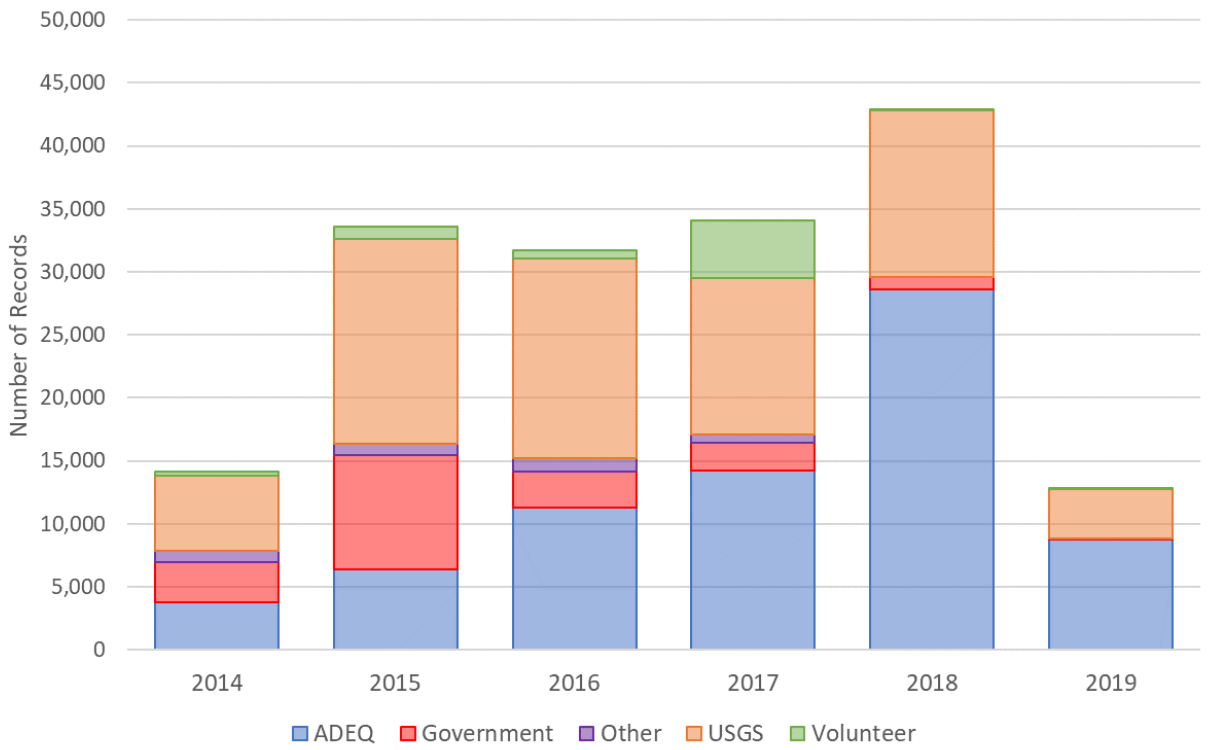

Figure 6-4. Number of records used in the Clean Water Act Assessment by organization.

FUTURE GOALS

#	Goal
1	Develop modules within WQDB to house time series data
2	Develop tools that make it easier to explore and analyze water quality data
3	Data gap identification for volunteers
4	Improve flow regime identification to better distinguish what is a waters of the United States
5	Improved parsing of external data to the WQX schema
6	Expand use of external data

CHAPTER 7 – DATA ANALYSIS/ASSESSMENT

CURRENT STATUS

Every two years, ADEQ is required by the federal Clean Water Act to conduct a comprehensive analysis of water quality data associated with Arizona's surface waters to determine whether state water quality standards are being met and designated uses are being supported.

The surface water quality assessment process can be summarized by the following steps:

1. Prepare and format the draft Clean Water Act Assessment. Assemble all readily available monitoring data and water quality related information. Determine whether the data meets requirements under the state's Impaired Water Identification Rule.
2. Review the draft assessment.
3. Public comment.
4. Publish the impaired waters list and public comments to the Arizona Administrative Register.
5. Submit the Clean Water Assessment to ATTAINS for EPA Approval.
6. EPA finalizes the Assessment.

ARIZONA'S IMPAIRED WATER IDENTIFICATION RULE

Arizona developed the Impaired Water Identification Rule Arizona Administrative Code R11-18-601 through 606) in 2002. These rules establish methods and criteria to:

- Identify an assessment unit as impaired,
- Determine when an assessment unit is no longer impaired (delisting),
- Prioritize the development of Total Maximum Daily Loads,
- Determine whether a dataset is "credible," and therefore, used for assessments and TMDL development,
- Specify general data interpretation requirements,
- Apply a weight-of-evidence approach, that considers contextual information regarding conditions when and where the samples were collected, and
- Determine the spatial extent of the surface water listing.

REAL TIME ASSESSMENTS

In December 2018, ADEQ developed and began using a real time assessment tool. The tool allows ADEQ to import internal and external data from the water quality portal and use an automated process to make assessment decisions. The real time assessment tool formats and aggregates hundreds of thousands of records and determines if standards are meeting criteria. The tool then summarizes the number of samples and exceedances to determine assessment decisions at the parameter, use and waterbody level. Reports are automatically generated for EPA's ATTAINS system, weekly metrics that detail the number of provisional impairments and a full assessment report.

FUTURE GOALS

#	Goal
1	Refine macroinvertebrate stressor identification process to make as unambiguous as possible for staff as to what pollutants may be causing index of biological integrity scores that do not meet standards.
2	Improve the real time assessment tool by adding additional functionality such as better reporting, visualizations, or ability to handle time series data.
3	Improve traceability of real time tool by using github and incorporating database connections to assessment information

CHAPTER 8 – REPORTING

ADEQ must sends EPA various reports related to monitoring. ADEQ also generates reports to inform the public about water quality issues in the state.

CURRENT STATUS

ADEQ produces the following reports for the EPA.

- 305(b) Integrated Report,
- 303(d) list,
- EPA work plan report,
- TMDL Reports,
- Technical reports,
- Routine upload of data to WQX,
- Upload of assessment data to ATTAINS,
- Website enabled GIS maps for public access regarding impaired streams and lakes.

FUTURE GOALS

#	Goal
1	Improve connections between all data sources related to water to make it easier for the public to get the information they want from our databases. This may include integration with EPA's how's my waterway tool.

CHAPTER 9 – PROGRAMMATIC EVALUATION

ADEQ's goal is to build the Water Quality Division's capacity to conduct periodic internal and external reviews of its water quality monitoring programs to determine if each program is meeting its stated goals.

CURRENT STATUS

- EPA and ADEQ conduct midyear and end of year evaluations of all program activities, including monitoring. These periodic reviews and discussions will continue in the future;
- ADEQ monitors performance of delivery, quality and cost of several metrics such as the number of impaired waters. ADEQ culture is focused on improvement and problem solving to identify obstacles to meeting objectives.
- The biocriteria program was officially evaluated as a level 3 program by Chris Yoder, an independent consultant for the EPA in September 2017. Chris provided critical feedback to strengthen the program including the recommendation to add a second biological assemblage and identifying midge larvae to the genus level.

FUTURE GOALS

#	Goal
1	Develop specific report cards for each program for evaluation
2	Develop and implement an information exchange program between AZ, CA, NV, CO, WY, UT, NM and the Arizona tribes to facilitate the exchange of ideas, to coordinate monitoring on a watershed level, to compare methodologies and to compare water quality between states
3	Develop interim metrics to show progress on metrics like reduce the number of impaired waters.

CHAPTER 10 – GENERAL SUPPORT AND INFRASTRUCTURE

The successful implementation of a comprehensive monitoring strategy for the State of Arizona is dependent upon attracting and retaining qualified and experienced personnel along with adequate funding. ADEQ's current staffing and funding levels are outlined below. Successful monitoring programs must also have basic infrastructure in place including items like:

- Up to date foundational documents that support program activities such as standard operating procedures, quality assurance plans, and sample plans,
- Adequate training for staff,
- Up to date and maintained sampling equipment,
- Maintained data systems for water quality data,
- Maintained data systems for metadata that supports water quality data such as flow regimes, assessment history,
- Adequate budget to maintain infrastructure and foundational components of monitoring programs.

CURRENT STAFF AND BUDGET

The Surface Water Improvement Value Stream currently consists of two units. ADEQ currently has eight full-time employees (FTEs) to monitor streams and lakes.

- Monitoring Unit (nine FTEs/four dedicated to sampling),
- Watershed Improvement Unit (nine FTEs/ three dedicated to sampling),

ADEQ's monitoring budget for fiscal year 2020 was $1.6 million. This amount includes all personnel, contract and travel costs. Eighty-five percent of the FY2020 monitoring budget is funded by the State of Arizona (Water Quality Assurance Revolving Fund, Clean Water Revolving Fund) while 15 percent is funded by federal money (performance partnership grant, 106 grant, non-point source, and the wellhead protection program funds) (Figure 10-1).

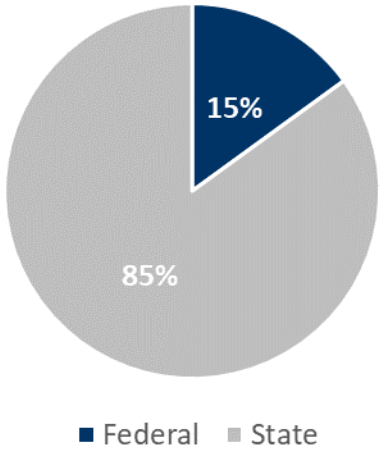

Figure 2. Percentage of state and federal funding for FY 20.

Approximately $150,000 of the budget goes toward laboratory costs while the rest is used for administrative costs such as staff salaries, vehicles, and computers. Funding for monitoring has

varied over the years. Lower funding does not necessarily mean less samples are collected or that monitoring objectives were not met. Recently, ADEQ leveraged a real time assessment tool to reduce the lab budget by approximately 90% while increasing the number of assessment decisions, which better focused resources and reduced the need to replace some FTE positions that became vacant in recent years.

Turnover continues to be an issue as staff look for opportunities outside ADEQ and others retire. ADEQ has made some major gains with the adoption of a career path and salaries that are more competitive to increase retention at the agency. The loss of FTE positions in FY2020 that were not immediately backfilled has impacted the amount of monitoring and rate of potential restoration of impaired waters. As vacancies occurred, lower level scientists move into higher level roles, and the value stream is now lacking lower level scientists to conduct sampling. Instead, more senior staff are doing that work which takes them away from solving the problems that contribute to impaired waters. ADEQ continues to leverage technology and apply lean management to streamline monitoring and assessment, but there is a clear need to hire lower level positions to free up capacity for those in higher level roles.

FUTURE GOALS

#	Goal
1	Provide training opportunities and a supportive work environment to retain qualified staff
2	Continue to provide salaries that are comparable to other water quality professionals
3	Continue to use the career path that provides financial rewards to valued staff
4	Streamline the use attainability analysis process
5	Determine effectiveness of various treatment strategies on impaired waters. For example, determine effectiveness of polymers to treat mine drainage water.
6	Support and expand the monitoring, assessment, TMDL and standards (MATS) tables that hold meta data for the value stream

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APPENDIX A – IMPLEMENTATION SCHEDULE

The following table summarizes and prioritizes the areas that could be improved for each of the 9 elements. The time frame assumes that the identified resource needs have been met. Resources are categorized in three major groups: Time, money, and people.

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
Monitoring Design – Chapter 3					
1	Conduct additional special studies, such as impacts from wildfires to lakes and streams	Determine and prioritize special study needs and objectives.	Medium	People, time and money	As needed
2	Coordinate with tribes, states, and Mexico when monitoring and research goals overlap	Facilitate communication between water quality staff in different states, tribes and Mexico.	Medium	People and time	On-going
3	Increase number of surface water samples to meet objectives	Determine optimal number of samples to meet objectives	Medium	People, time and money	On-going
4	Determine the time and cost to restore surface waters based on different circumstances	Track time to implement for existing projects and cost to implement those. Group into logical categories. Use available literature if available..	High	People, time, and money	FY21
5	Monitor understudied waterbodies like wetlands or intermittent streams or effluent dependent waters	Explore most effective way to conduct sampling such as randomized sample designs	Low	People, time and money	FY25
6	Use sensors or remote monitoring devices to more efficiently collect data	Leverage existing remote device technology such as flow detection and autosampler triggering on other sampling problems.	High	People, time and money	FY22
7	Conduct state scale probabilistic assessments	Do state intensification using state methods to maximize lake assessments	Medium	Time	FY21
8	Conduct monitoring to determine impacts from legacy mines	Prioritize legacy mine projects based on impact to surface water and restoration difficulty/success rate.	High	People, time, management and money	FY21

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
9	Collect additional reference site data and revise macroinvertebrate indexes and to identify high quality waters	Identify high quality waters using existing datasets. Analyze and recalculate macroinvertebrate indexes.	Low	People and time.	FY23
10	Utilize biological data to identify tiers of aquatic life uses for water quality standards and classify streams accordingly	Analyze data to tier aquatic life use	Low	People, time and money	FY23
11	Monitor large river systems.	Work with internal and external resources to sample large river systems such as the Colorado, Verde and Salt especially in underrepresented locations like the Grand Canyon	High	People, time and money	FY21
12	Monitor outstanding Arizona waters (OAW) for anti-degradation	Collect baseline data for Arizona's outstanding waters	Medium	People, time and money	FY22
13	Create a process for OAW nomination	Develop a process to evaluate important high quality waters in the state such as Wet Beaver Creek or streams of the Grand Canyon to be included as OAWs.	Low	People, time and money	FY22
14	Conduct regular monitoring for trend analysis	Regularly go back to lakes and streams to determine if water quality is improving or degrading using a statistical approach	Medium	People, time and money	FY22
15	Collaborate with state and federal partners to test the streamflow duration assessment method survey approach for identifying flow regime	Test New Mexico and other state approaches on Arizona streams.	High	People, time and money	FY21
16	Develop and implement new standards, reevaluate existing standards	Determine monitoring and research needs for creating new standards or modifying existing standards.	High	People, time and money	FY22

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
17	Ensure design accounts for various timeframes. For example, the assessment is done every even year and covers a five-year window. Acute and E. coli samples use the last three years of monitoring data.	Incorporate maximum assessment decisions into sample plan design by mapping out multiple assessment cycles.	High	People, time and money	FY21
18	Predict impairment and potential delist based on different scenarios	Write code to determine which waterbodies could be listed as impaired or potentially delisted given different inputs (change in WOTUS, change in standards, etc.).	High	People, time and money	FY22
Core and Supplemental Indicators – Chapter 4					
19	Develop narrative standard implementation procedures for all narrative standards. Close the IWIR loophole where waterbodies cannot be listed as impaired for narrative standards even if criteria are not met (A.A.C. R18-11-605(D)(3)).	Write implementation procedure. Revise rule.	Medium	People and time	FY22
20	Reevaluate core parameters	Revise assessment technical support chapter for core parameters.	Medium	People and time	FY21
21	Monitor for emerging contaminants	Prioritize emerging contaminants and choose lab(s) that can meet parameter needs. Consider whether existing standard exists, risk to human health and prevalence of contaminant in the environment when prioritizing	Medium	Money	On-going

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
22	Add a second biological assemblage for stream assessments	Evaluate any data gaps for using a second assemblage. Perform analysis to draft standard based on second assemblage. Explore nutrient endpoints.	Low	People, time and money	FY25
23	Compare and assess Arizona indicators compared to other states, tribes and Mexico	Create list of core indicators used by other states, tribes and Mexico.	Low	People and time	FY22
24	Expand use of technology such as X-Ray fluorescence (XRF) to identify sources of metal contamination and progress toward remediation	Create standard operating procedure. Add to sampling plans.	High	People and time	FY21
25	Develop macroinvertebrate bioassessment tool for intermittent streams	Collect data. Determine appropriateness for standard development.	Low	People, time and money	FY25
26	Refine standards (such as dissolved oxygen) for intermittent streams	Determine which standards may be different between intermittent and perennial streams. Collect data to support rule change. Change rule.	Low	People, time and money	FY25
27	Explore adoption of harmful algal bloom recreational criteria for Arizona	Determine if EPA criteria is appropriate for Arizona. Collect data to support rule. Incorporate change into triennial review.	Medium	People, time and money	FY23
28	Explore selenium in fish tissue for implementation of new EPA standard	Determine if EPA criteria is appropriate for Arizona. Collect data to support rule. Incorporate change into triennial review.	Low	People, time and money	FY25

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
29	Explore developing standards that neighboring states have as top impairments	Review top impairments from other states. Either justify why a standard is not needed or work to adopt the standard. Collect data to support rule. Incorporate change into triennial review.	Medium	People, time and money	FY22
30	Refine dissolved oxygen standards for lakes	Determine appropriate standard for lakes. Collect data to support rule change if needed. Incorporate change into triennial review.	Low	People, time and money	FY23
31	Update water quality standards and impaired waters identification rule	Revise rule	Medium	People and time	FY22
Quality Assurance – Chapter 5					
32	Update QAPP and submit to EPA for Approval	Submit draft QAPP to EPA	High	People and time	FY21
Data Management – Chapter 6					
33	Develop modules within WQDB to house time series data	Evaluate if time series data needs to be housed in the WQDB. If needed, work with database contractor to develop process for storing time series data	Low	People, time and money	FY22
34	Develop tools that make it easier to explore and analyze water quality data	Coordinate with IT to complete task.	Low	People, time and money	On-going
35	Data gap identification for volunteers	Use existing real time assessment tool to provide assessment. Develop strategy to communicate data gap needs to volunteers	Low	People and time	FY21
36	Improve flow regime identification to better distinguish what is a waters of the United States	Gather data (ground trothing and remote). Create/add data to geodatabases to clearly identify jurisdictional waters	High	People, time and money	FY21

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
37	Improved parsing of external data to the WQX schema	Write code to parse data with required elements from external sources into WQX's schema	Medium	People and time	FY23
38	Expand use of external data	Create metrics for effectiveness of call for data and rejection of non-credible data. Develop procedures that make sharing data easier between organizations, reduces data ambiguity and increases data credibility.	Medium	People, time and money	On-going
Data Analysis and Assessments – Chapter 7					
39	Refine macroinvertebrate stressor identification process to make as unambiguous as possible for staff as to what pollutants may be causing index of biological integrity scores that do not meet standards.	Test and refine the new CAST tool to identify stressors; Develop/refine stressor-biological index statistical relationships to identify biological response signatures to strengthen the Stressor ID process.	Low	People and time	FY22
40	Improve the real time assessment tool by adding additional functionality such as better reporting, visualizations, or ability to handle time series data.	Write code.	Medium	People and time	FY22
41	Improve traceability of real time tool by using github and incorporating database connections to assessment information	Write code.	Medium	People and time	FY22
Reporting – Chapter 8					

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
42	Improve connections between all data sources related to water to make it easier for the public to get the information they want from our databases. This may include integration with EPA's how's my waterway tool.	Explore web service connections to How's My Waterway for ADEQ's website to communicate water quality information to the public	Medium	People and time	FY22
Program Evaluation – Chapter 9					
43	Develop specific report cards for each program for evaluation	Report cards will be used to measure program effectiveness based on specific criteria.	Low	Time	FY25
44	Develop and implement an information exchange program between AZ, CA, NV, CO, WY, UT, NM and the Arizona tribes to facilitate the exchange of ideas, to coordinate monitoring on a watershed level, to compare methodologies and to compare water quality between states	Meetings/workshops through Western States Water Council.	Low	Time	FY24
45	Develop interim metrics to show progress on metrics like reduce the number of impaired waters.	Communicate directly with management about progress toward objectives.	High	Time	FY21
General Support and Infrastructure – Chapter 10					
46	Provide training opportunities and a supportive work environment to retain qualified staff	Continue to allow staff to participate in conferences and workshops related to monitoring and other Clean Water Act Programs	High	People, time and money	On-going
47	Continue to provide salaries that are comparable to other water quality professionals	Continue to provide competitive salaries.	High	Money	On-going

#	Goal	Implementation Plan	Priority	Resources Needed	Time Frame
48	Continue to use the career path that provides financial rewards to valued staff	Continue to support career path and allow for promotions for staff.	High	Money	On-going
49	Streamline the use attainability analysis process	Create process map of UAA. Identify and eliminate ambiguity in the process,	Medium	People and time	FY22
50	Determine effectiveness of various treatment strategies on impaired waters. For example, determine effectiveness of polymers to treat mine drainage water.	Monitor for effectiveness of treatment strategies before and after implementation.	High	People, time and money	FY23
51	Support and expand the monitoring, assessment, TMDL and standards (MATS) tables that hold meta data for the value stream	Add critical water quality metadata to the MATS tables.	High	People and time	On-going