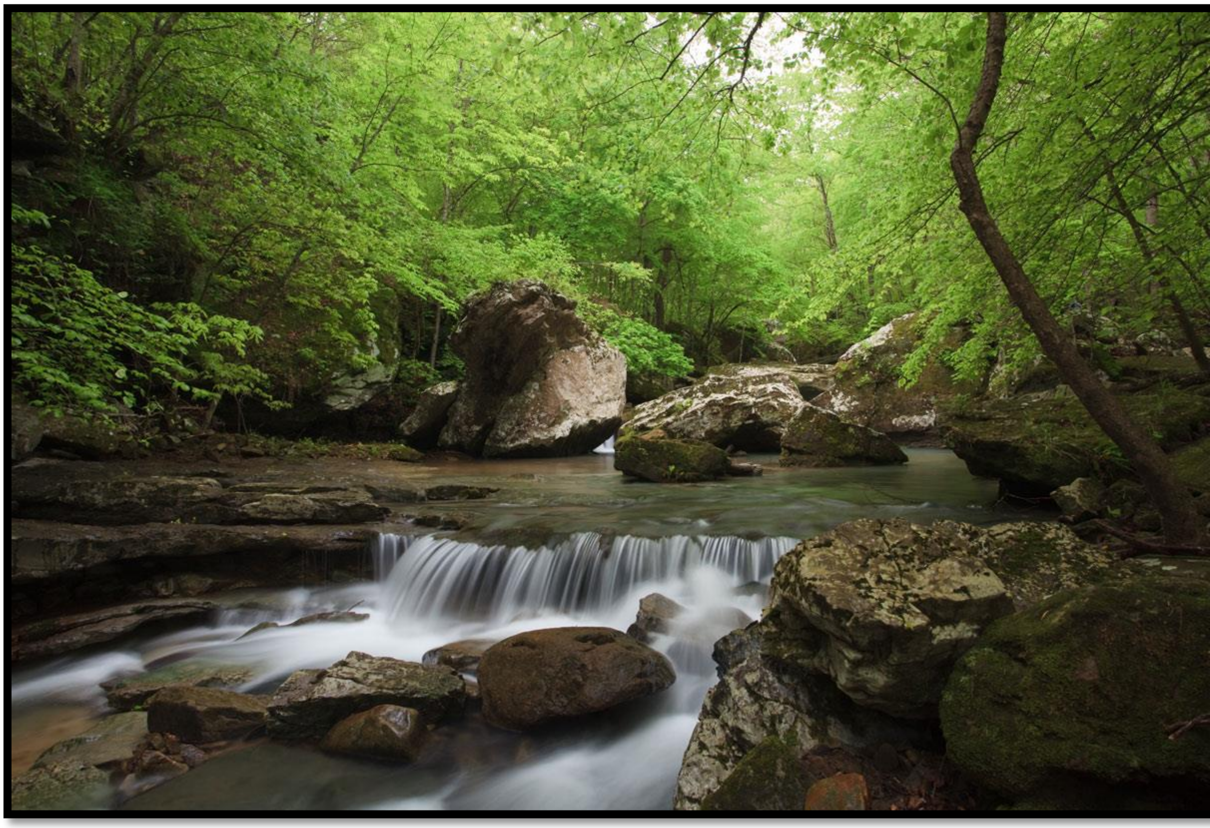
Integrated Water Quality Monitoring Assessment Report

Prepared pursuant to Section 305(b) and 303(d) of the Federal Pollution Control Act



2018

ARKANSAS ENERGY & ENVIRONMENT

"To Protect, Enhance, and Restore

the

Natural Environment

for the

Well-being of all Arkansans."

This report is maintained by:

Arkansas Department of Energy and Environment

Division of Environmental Quality

Office of Water Quality

Prepared pursuant to Sections 305(b) and 303(d)
of the
Federal Water Pollution Control Act

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ABBREVIATIONS AND ACRONYMS

ADEQ	Arkansas Department of Environmental Quality
ADPC&E	Arkansas Department of Pollution Control and Ecology
ADH	Arkansas Department of Health
AGFC	Arkansas Game and Fish Commission
AGS	Arkansas Geological Survey
ANRC	Arkansas Natural Resources Commission
AOGC	Arkansas Oil and Gas Commission
APC&EC	Arkansas Pollution Control and Ecology Commission
AST	Aboveground Storage Tanks
AWAG	Arkansas Watershed Advisory Group
AWAPCA	Arkansas Water and Air Pollution Control Act
AWQMN	Ambient Water Quality Monitoring Network
AWWCC	Arkansas Water Well Construction Commission
BMP	Best Management Practice
BOD5	Biochemical Oxygen Demand (5 day)
CBA	Cost/Benefit Analysis
CBOD5	Carbonaceous Biochemical Oxygen Demand (5 day)
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CPP	Continuing Planning Process
CSI	Community Structure Index
CWA	Clean Water Act
CWS	Community Water System
DEQ	Arkansas Department of Energy and Environment, Division of Environmental Quality
DLG	Digital Line Graph
DMR	Discharge Monitoring Report
DO or D.O.	Dissolved Oxygen
E&E	Arkansas Division of Energy and Environment
EPA	Environmental Protection Agency
EPT	Ephemeroptera/Plecoptera/Trichoptera
ERW	Extraordinary Resource Waters
ESW	Ecologically Sensitive Waterbody
HBI	Hilsenhoff Biotic Index
HUC	Hydrologic Unit Code
ICIS	Integrated Compliance Information System
IGP	Industrial Stormwater General Permit
IWC	Instream Waste Concentration
MC	Methylene Chloride
MCL	Maximum Contaminant Level
MIT	Mechanical Integrity Testing
MS4	Municipal Separate Storm Sewer System

NFH	National Fish Hatchery
NH3-N	Ammonia Nitrogen
NHD	National Hydrography Dataset
NOEC	No Observed Effect Concentration
NPDES	National Pollutant Discharge Elimination System
NPS	Non-Point Source
NRCS	Natural Resources Conservation Service
NRSA	National Rivers and Streams Assessment
NSW	Natural and Scenic Waterways
PWS	Public Water Suppliers
PWSSP	Public Water Supply Supervision Program
QA/QC	Quality Assurance / Quality Control
RF3	River Reach File
RST	Regulated Storage Tanks
RWQMN	Roving Water Quality Monitoring Network
SDWA	Safe Drinking Water Act
SIC	Standard Industrial Code
SMCL	Secondary Maximum Contaminant Level
SOP	Standard Operating Procedure
SVOC	Semi-Volatile Organic Compounds
SWAP	Source Water Protection Program
SWMP	Storm Water Management Plan
SWP	Source Water Program
SWPPP	Stormwater Pollution Prevention Plan
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TRE	Toxicity Reduction Evaluation
TSS	Total Suspended Solids
UIC	Underground Injection Control
USDW	Underground Sources of Drinking Water
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
W/A	Watershed to Lake Area Ratio
WER	Water Effects Ratio
WET, Testing	Whole Effluent Toxicity
WET, Project	Water Education for Teachers
WHPA	Wellhead Protection Area
WHPP	Wellhead Protection Program
WQAR	Water Quality Analysis Reporter
WQMP	Water Quality Management Plan
WWTP	Waste Water Treatment Plant

Acknowledgements

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PART I EXECUTIVE SUMMARY AND OVERVIEW

Section 305(b) of the Clean Water Act (CWA) requires states to perform a comprehensive assessment of the State's water quality, which is to be reported to Congress every two years. In addition, Section 303(d) of the Clean Water Act requires states to prepare a list of impaired waters on which Total Maximum Daily Loads (TMDL) or other corrective actions must be implemented. Current U.S. Environmental Protection Agency (EPA) guidance recommends producing an integrated report combining requirements of the Clean Water Act for Sections 305(b) reporting and 303(d) submissions. The combined report is the *Integrated Water Quality Monitoring and Assessment Report.* This report is prepared using the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act* (EPA 2005) and supplements (EPA 2006, 2009, 2011, 2013a, 2015, and 2017).

Specific guidance developed by EPA is used by all states to aid in making water quality standards and designated use attainment determinations. This guidance is intended to provide national consistency in the assessment process. However, to be meaningful, assessments must take into account the variations in ecology and water quality standards within a state, as well as data type, quantity, and quality. Accordingly, the assessment methodology should address federal requirements and reflect each state's individual reference conditions and water quality objectives and goals.

The Department of Energy and Environment, Division of Environmental Quality's (DEQ or the Division) water quality monitoring networks database is the primary database used for this assessment in Arkansas. Data are gathered for inclusion into DEQ's database through several monitoring networks: Ambient, Lakes and Reservoirs, and Groundwater. The Ambient Surface Water Network comprises approximately 180 stations sampled monthly for chemical parameters and flow when available. The Ambient network focuses on characterizing big river systems, potentially problematic nonpoint source areas, and least-disturbed reference streams. Samples are collected year round as appropriate for each network and parameter.

Special projects also comprise part of DEQ's database. Special project area and sampling parameters are project specific. Parameters can be physical, chemical, and biological. Among other special projects this cycle, DEQ continues work on nutrient criteria development that has rotated through Arkansas's ecoregions two to three years at a time. See part III for a full list of special projects for this cycle.

The Lakes and Reservoirs Monitoring Network comprises 16 lakes that are sampled quarterly. The Lakes & Reservoirs network focuses on identifying potential reference lakes, verifying reference lakes, and developing water quality standards for lakes.

The Ambient Groundwater Monitoring Network comprises approximately 200 stations sampled triennially for major ions, metals, nutrients, total organic carbon, and pesticides at selected sites. The Ambient Groundwater network focuses on characterizing major aquifers and documenting natural background conditions.

In addition to the data gathered by DEQ's Office of Water Quality, all readily available data are solicited from other DEQ offices, state and federal agencies, universities, public, and private entities. All data received are evaluated against the acceptability requirements outlined in Arkansas's Assessment Methodology as described in Appendix B.

Data included in the database described above and evaluated outside data are compared against Regulation No. 2 (Reg. 2) and Arkansas's Assessment Methodology in order to make water quality standard and designated use attainment decisions.

The number of evaluated waterbodies meeting all of the assessed designated uses and water quality standards remains similar to previous years. Exact estimates and percentages cannot be extrapolated to all waters of the State for the following reasons: (a) if any of the designated uses or assigned water quality standards of a waterbody are not met, the waterbody is listed as "not supporting water quality standards" even though other designated uses and/or water quality standards are adequately met; (b) a large number of the water quality monitoring stations are purposely located in areas known or suspected of having water quality contamination. Thus, this results in a higher percentage of areas of concern being monitored, thereby skewing results toward the impaired use category; (c) much of the data from the Delta ecoregion of the State were listed as "insufficient data" due to the difficulty of determining water quality impacts where severe physical alteration of the habitat has occurred; and (d) although fish consumption is not a statutory or a water quality standard designated use, EPA guidelines require this be evaluated. Waters with restricted fish consumption advisories as per Arkansas Department of Health (ADH) are evaluated as impaired; therefore, these waters do not meet all designated uses. Previously, overall use support was based on the full support of all designated uses; if one designated use is unable to be assessed, the stream segment was not counted as supporting all uses. New guidance requires tabulation of waters supporting all *assessed* uses; therefore, if one or more uses were not assessed, but all assessed uses were fully supported, the water is counted as "supporting all assessed uses."

Potential impacts to water quality could include point and nonpoint sources. Arkansas's point source discharge controls are managed through the National Pollutant Discharge Elimination System (NPDES) program which was delegated to the State by the EPA. This program is guided by the State's Water Quality Management Plan and the State's Surface Water Quality Standards. Enforcement activities are based on non-compliance as reported through the NPDES permitting system, with monitoring data compiled through discharge monitoring reports and inspections of NPDES facilities. Additionally, Section 401 (water quality certification) is utilized to review all federal licenses or permits, including but not limited to Section 404, which may result in any discharge of dredged or fill materials into navigable waters. Such certification is determined on the basis of protection of designated uses and the antidegradation requirement of the State's water quality standards.

Nonpoint source impacts to water quality are managed through non-regulatory activities. The formation of watershed groups and educational outreach programs has encouraged the implementation of watershed restoration activities which have begun to address nonpoint source issues through the voluntary implementation of watershed management plans. Arkansas's Nonpoint Source Pollution Assessment Report (ADEQ[1] 1997) indicates land use related to agricultural activities as the major source of impacts to rivers and streams.

[1] References cited as "ADEQ" are still Arkansas Department of Energy and Environment, Division of Environmental Quality under a previous name: Arkansas Department of Environmental Quality ADEQ).

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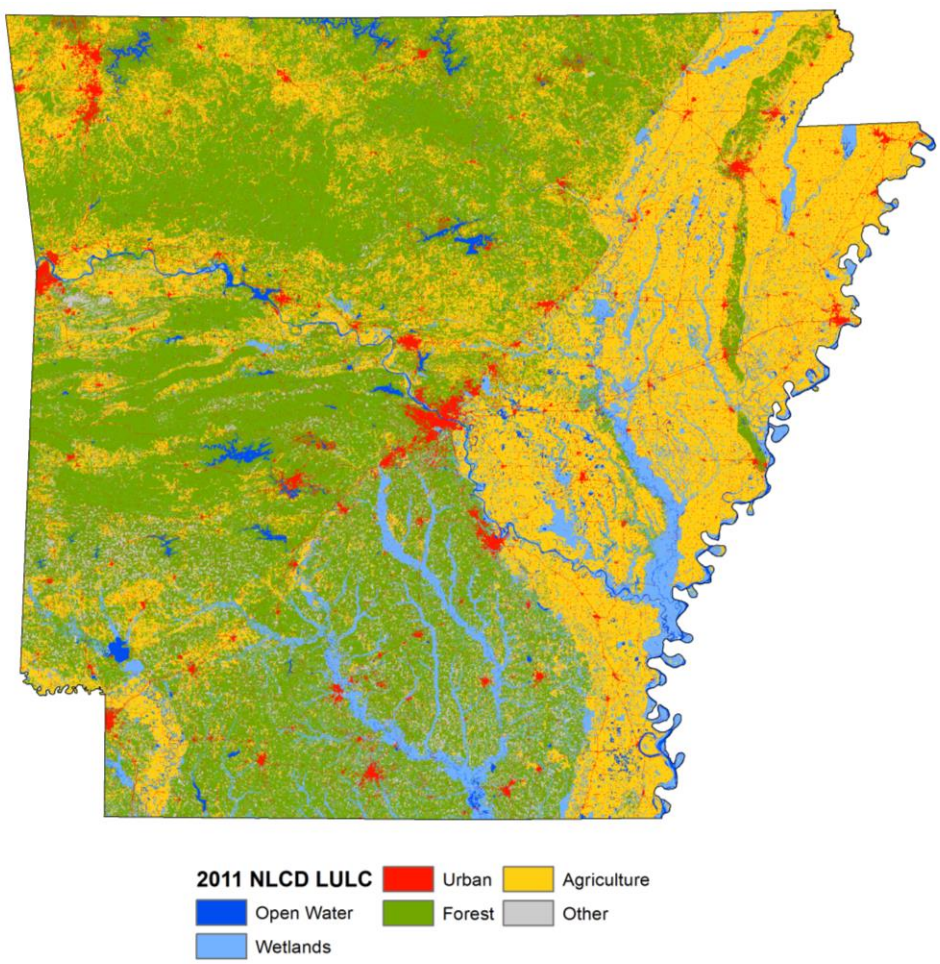
PART II BACKGROUND

Chapter One ATLAS OF ARKANSAS

Introduction

According to the Multi-Resolution Land Characteristics Consortium's 2011 National Land Cover Database, Arkansas boasts approximately 34 million acres of land and surface water. Of this total, approximately 11 million acres are in agriculture production: approximately 7 million acres in cultivated crop production and approximately 4 million acres in pasture land and hay production. There are approximately 15 million acres of forests in the State; however, not all of this acreage is managed for timber production. There are approximately 800 thousand acres of open water and approximately 3 million acres of wetlands and approximately 2 million acres in urban areas. The remaining acreage is in barren land, shrub/scrub land, and herbaceous lands. Figure II-1 is a depiction of the overall land use in the state.

Figure II-1: Land Use



Ecoregions

The original ecoregion survey (ADPC&E 1987) identified six distinct ecoregions (Level III Ecoregions) in the State. Since that time there has been continued discussion concerning the boundaries of the ecoregions and if Crowley's Ridge, located in eastern Arkansas, should be identified as a separate ecoregion. In the late 1990s and early 2000s, a diverse group of scientists convened to better define the Level III Ecoregion boundaries and subdivide them into smaller sections: Level IV Ecoregions. Woods, et al. (2004), identified seven Level III Ecoregions and 32 Level IV Ecoregions in the State of Arkansas (Figure II-2).

Classification of the State's waters by ecoregion not only categorizes them by physical, chemical and biological features, but separates major pollution concerns, most of which are related to land use.

Water quality in the Delta Ecoregion is primarily influenced by nonpoint source runoff from agricultural areas. The vast majority of waterways within this region form a network of extensively channelized drainage ditches. Government programs have been used to develop this highly productive agricultural land. In contrast, many of the practices utilized in making this land more productive actually impair designated water quality uses. Most agency work within this region indicates that, in the majority of these waters, the best that can be expected in terms of a fishery is an altered fishery. Once a natural stream has been channelized, only those organisms which do not require in-stream cover and can exist in highly turbid waters will flourish and/or survive. Within these systems the fishable goal of the Clean Water Act is being met, even though the aquatic life communities have been substantially altered.

The Gulf Coastal Ecoregion of southern Arkansas exhibits site specific impacts due to historic resource extraction activities including the extraction of petroleum products, brine, bromine, barite, gypsum, bauxite, gravel, and other natural resources. Water quality impacts occur from the extraction, storage, transport, and processing of resources. Although timber is the major resource harvested in this area as well as the primary land use, no large scale impairments from silviculture (timber harvest) activities have been identified in this area.

The Ouachita Mountain Ecoregion has characteristically been described as a recreational region with exceptionally high quality water. The predominant land use is silviculture, both in private timber companies and National Forest holdings. Some areas of the Ouachita Mountains have been identified nationally as areas potentially sensitive to acidification (acid rain). Data are currently inconclusive concerning any impact on the region due to acid precipitation. Additional concerns have been voiced by various groups and organizations regarding potential erosion and siltation as a result of management practices used in timber harvest. Periodic water quality monitoring data have not indicated significant impairments to the streams within this region. Occasional elevated turbidity values have been observed during periods of significant rainfall.

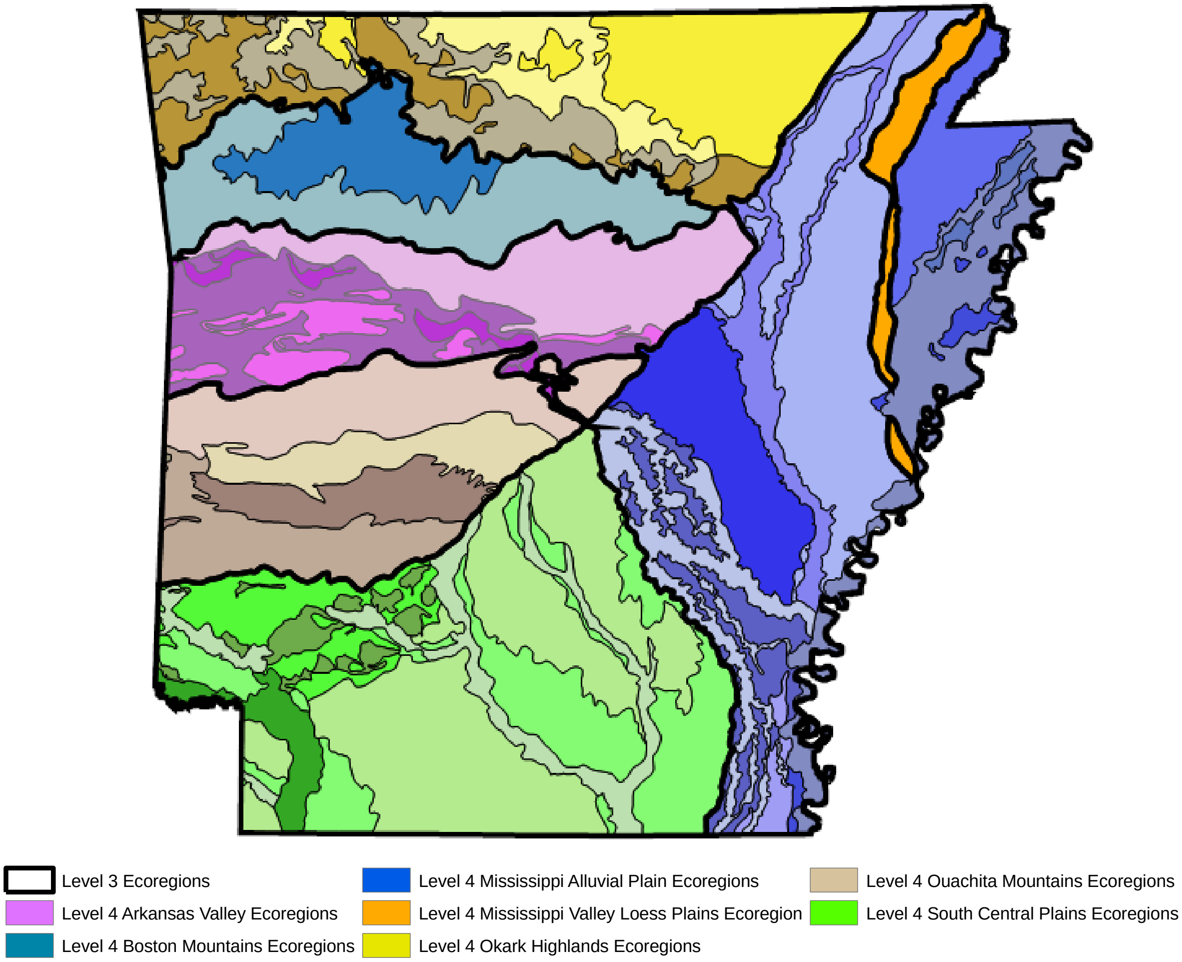
Potential impairments to waters in this region include land clearing for pasture without protective riparian zones, in-stream gravel removal, resource extraction remediation areas, and existing areas of confined animal production.

The Arkansas River Valley Ecoregion exhibits distinct seasonal characteristics of its surface waters with zero flows common during summer critical conditions. Peak runoff events from within this region tend to introduce contaminants from the predominantly agricultural land uses, which are primarily pasture lands with increasing poultry production. Fecal coliform bacteria have been a parameter of concern due to its preclusion of the swimmable use. Measurements during storm events routinely exceed the water quality standard, although the source usually is not fecal contamination. The use of *E. coli* as the indicator organism provides a more accurate measurement of contamination from warm-blooded animals and has indicated no significant problems. Exploitation of natural gas deposits has resulted in some site specific water quality degradation. Soil types in much of this area are highly erosive and tend to stay suspended in the water column, thus causing long-lasting, high turbidity values.

The Boston Mountains Ecoregion, located in north central Arkansas, is a sparsely populated area. The dominant land use is silviculture and much of the region is located within the Ozark National Forest. It is a high recreational use region with exceptionally high quality water. Many of the streams from this region are designated as Extraordinary Resource Waters (ERW). Major concerns about potential water quality degradation include: 1) conversion of hardwood timberland to improved pastures, 2) confined animal operations, 3) even-aged timber management, and 4) localized natural gas production. Current monitoring data from within this region continue to reflect high quality water. Periodic, elevated levels of turbidity are noted in some waters in this region. Elevated turbidity is most likely caused by clearing of timberland adjacent to major streams for conversion to pastures, which accelerates stream channel and bank erosion. In addition, secondary and tertiary road construction and maintenance and in-stream gravel removal are exacerbating turbidity problems.

The Ozark Highlands Ecoregion, located in extreme northern Arkansas, is noted for its mountainous terrain with steep gradients and fast-flowing, spring-fed streams. Many of the streams from within this region are designated as ERWs. The fractured limestone and dolomite lithology of the region allows a potential direct linkage from surface waters to groundwater. The water quality concerns within this region are primarily directly related to land use. The large human population increase in this area also has the potential to result in increased water contamination from infrastructure development as well as surface erosion from construction activities. This region has some of the highest animal production rates in the State. Additionally, removal of gravel from the banks and beds of streams is a frequent activity that causes direct habitat degradation and greatly accelerates siltation within the streams.

Figure II-2: Arkansas's Ecoregions



River Basins / Total River Miles

Arkansas is divided into six major river basins: Red River, Ouachita River, Arkansas River, White River, St. Francis River, and the Mississippi River. Arkansas has 17,193 miles of rivers and streams digitized in the DEQ Water Base Layer. The DEQ Water Base Layer was created from the High Resolution (1:24,000-scale) National Hydrography Dataset (NHD). The High Resolution NHD includes the 1st order streams, or the intermittent streams and ephemeral drainages that flow only during a rainfall event. Stream mileage differences in AUs between the 2016 and 2018 list may occur due to updating from medium resolution NHD to high resolution NHD. The 2016 list used a combination of RF3, Medium Res. NHD, and hand measurements on ArcMap to determine AU mileage. In 2018 DEQ began using High Res. NHD for determination of AU mileages. Several AUs that got longer due to better defined headwaters. Others got shorter due to High Res. NHD not naming some upper headwaters as the main body of the AU.

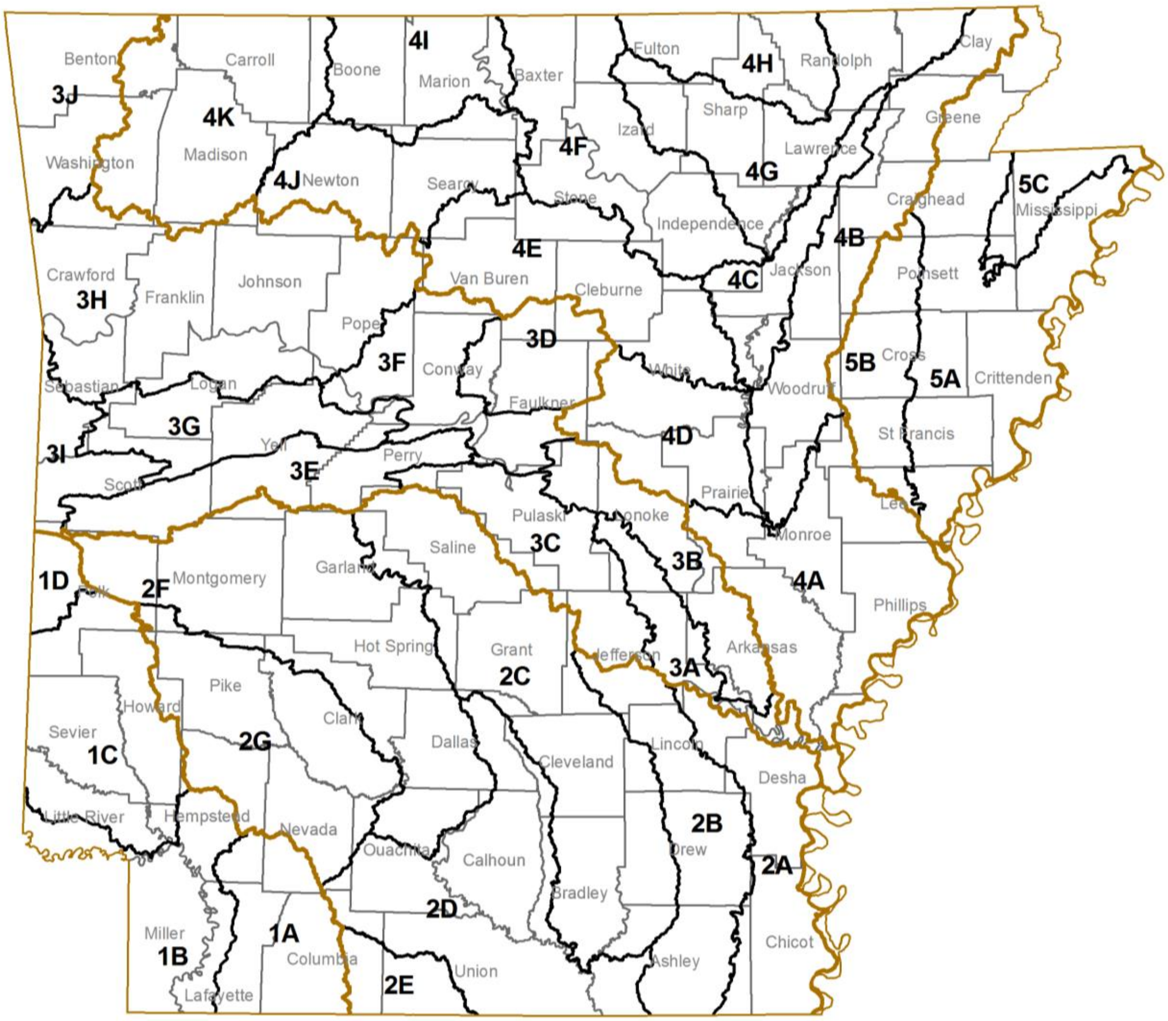
The NHD combines elements of the Digital Line Graph (DLG) and EPA River Reach File (RF3): spatial accuracy and comprehensiveness from the DLG and network relationships, names, and a unique identifier (reach code) for surface water features from RF3. The NHD supersedes DLG and RF3 by incorporating them, not by replacing them.

DEQ Base Water Layer (miles/Kilometers)	>17,000/27,359.848
DEQ High Resolution Water Layer (miles/Kilometers)	>223,600/360,000
DEQ Base Lakes Layer (Acres/Hectares)*	>301,600/122,000

*The DEQ base lakes layer does not delineate sections of Lake Felsenthal, nor does it recognize Lake Dardanelle.

The six river basins are subdivided into thirty-eight (38) planning segments (Figure II-3) based on hydrological characteristics, human activities, geographic characteristics, and other factors. The planning segments are further broken down into almost 1,600 smaller watersheds, based on discrete hydrological boundaries as defined by the United States Geological Survey (USGS) 12-digit hydrologic unit codes (HUC).

Figure II-3: DEQ Planning Segments



- 1 Red River Basin
- 2 Ouachita River Basin
- 3 Arkansas River Basin
- 4 White River Basin
- 5 St. Francis River Basin
- 6 Mississippi River Basin

Publically Owned Lakes and Reservoirs

A discussion of lakes and reservoirs is included in Part III, Chapter Five, and includes a map and list of Arkansas's significant publicly owned lakes and reservoirs and their trophic status. The State has a total of 299,699 acres of significant publicly-owned lakes. The USGS High Resolution NHD identifies a total of 1,500,210 acres of lakes, ponds and other impounded waters in the State. This value is calculated on waterbodies that range from 0.005 acres to 44,944acres. This value is significantly larger than the previous EPA RF3/DLG calculation of 515, 635 acres due to the increased accuracy and detail of the USGS High Resolution NHD.

Summary of Classified Uses

Waters of the State are classified for specific designated uses. Based on the USGS Medium Resolution NHD, approximately 1,297 miles of Arkansas's streams and 94,649 acres of Arkansas's lakes are classified as high quality, outstanding state or national resources (Extraordinary Resource Waters, Ecologically Sensitive Waterbody, and Natural and Scenic Waterways).

As stated in Reg. 2.302 (APC&EC 2018), the designated uses assigned to various waterbodies include:

Extraordinary Resource Waters (ERW) (Figure II-4) – This beneficial use is a combination of the chemical, physical, and biological characteristics of a waterbody and its watershed which is characterized by scenic beauty, aesthetics, scientific values, broad scope recreation potential, and intangible social values.

Ecologically Sensitive Waterbody (ESW) (Figure II-5) – This beneficial use identifies stream segments known to provide habitat within the existing range of threatened, endangered, or endemic species of aquatic or semi-aquatic life forms.

Natural and Scenic Waterways (NSW) – This beneficial use identifies stream segments which have been legislatively adopted into a state or federal system.

Primary Contact Recreation – This beneficial use designates waters where full body contact recreation is involved.

Secondary Contact Recreation – This beneficial use designates waters where secondary activities like boating, fishing, or wading are involved.

Aquatic Life – This beneficial use provides for the protection and propagation of fish, shellfish, and other forms of aquatic life and is further subdivided in these following categories:

Trout

Lake and Reservoir

Stream

Ozark Highlands

Boston Mountains

Arkansas River Valley

Ouachita Mountains

Typical Gulf Coastal

Spring water-influenced Gulf Coastal

Least-altered Delta

Channel-altered Delta

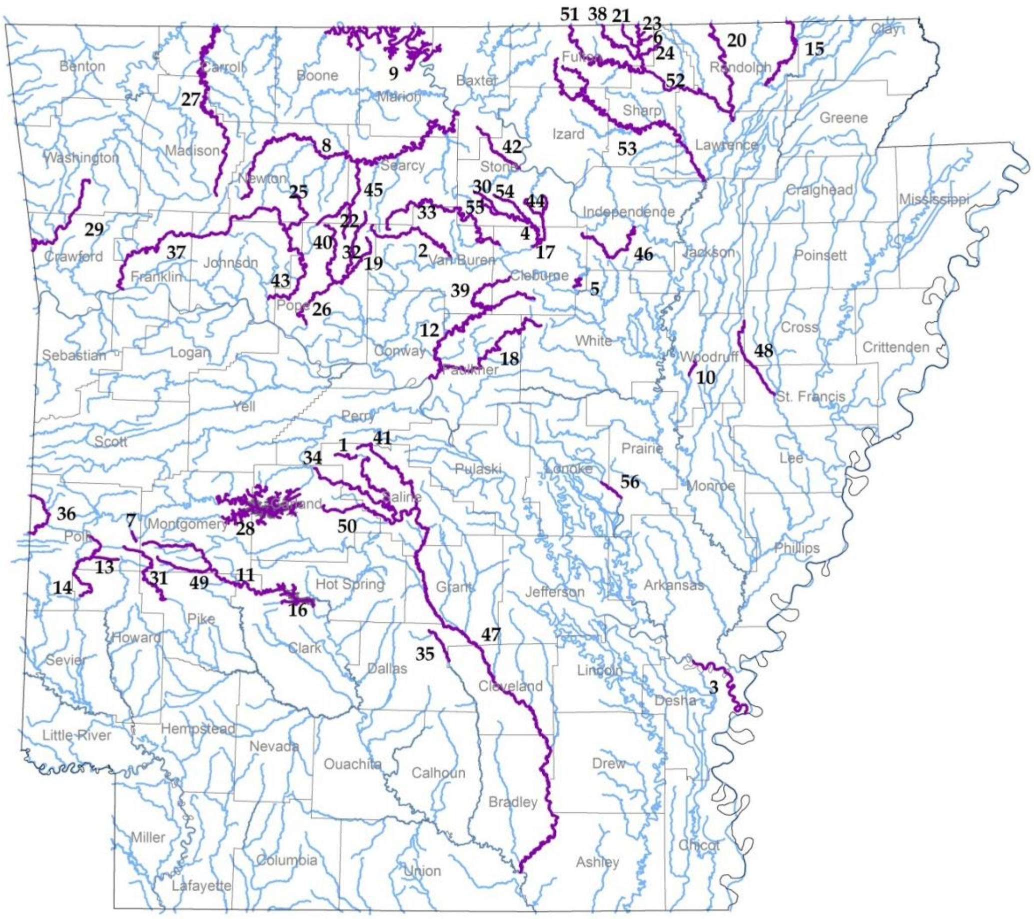
Domestic Water Supply – This designated use designates water which will be protected for use in public and private water supplies. Conditioning or treatment may be necessary prior to use.

Industrial Water Supply – This beneficial use designates water which will be protected for use as process or cooling water. Quality criteria may vary with the specific type of process involved and the water supply may require prior treatment or conditioning.

Agricultural Water Supply – This beneficial use designates waters which will be protected for irrigation of crops and/or consumption by livestock.

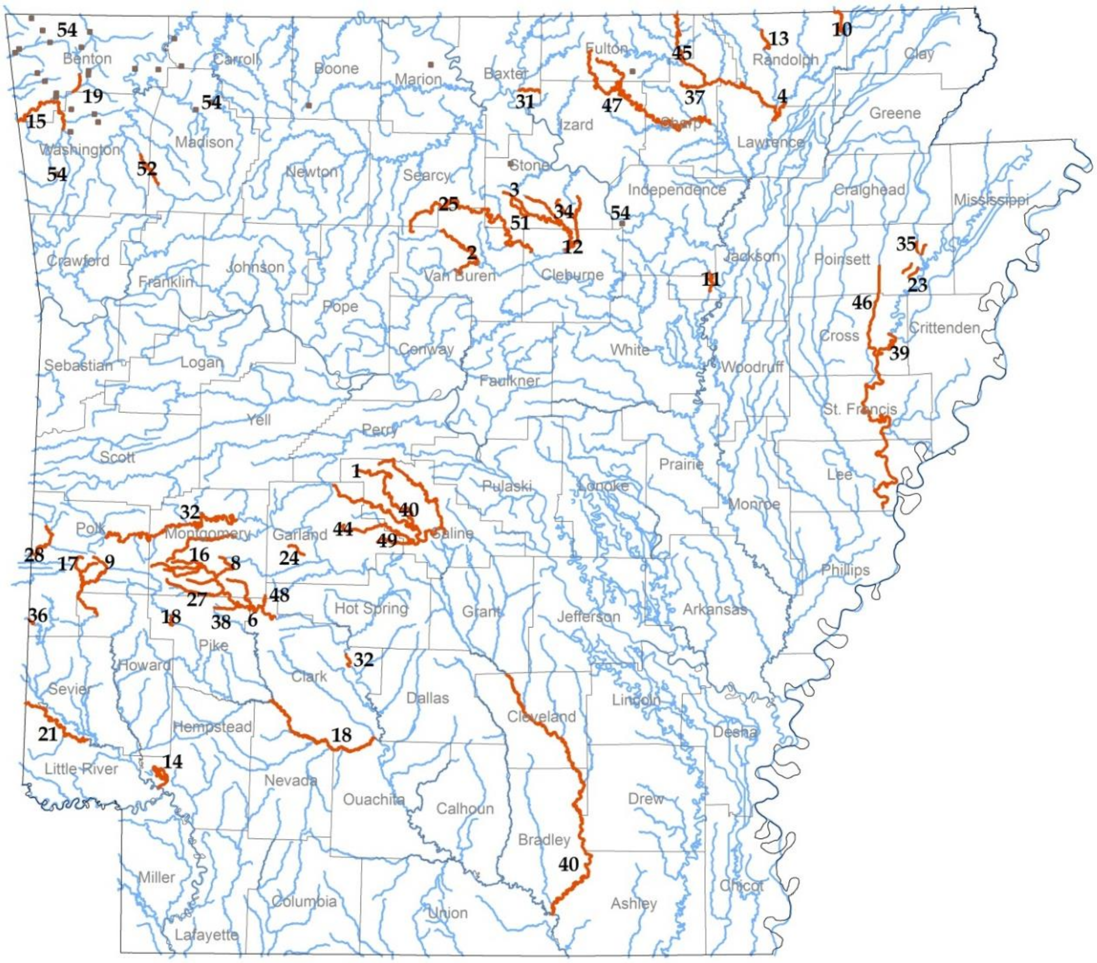
Other Uses – This category of beneficial use is generally used to designate uses not dependent upon water quality such as hydroelectric power generation and navigation.

Figure II-4: Arkansas's Extraordinary Resource Waters



1 Alum Fork Saline River
2 Archey Fork
3 Arkansas River
4 Beech Creek
5 Big Creek, Cleburne Co.
6 Big Creek, Fulton Co.
7 Big Fork Creek
8 Buffalo River
9 Bull Shoals Reservoir
10 Cache River
11 Caddo River
12 Cadron River
13 Caney River
14 Cossatot River
15 Current River
16 DeGray Reservoir
17 Devil's Fork Little Red R.
18 East fork Cadron Creek
19 East Fork Illinois River
20 Eleven Point River
21 English Creek
22 Falling Water Creek
23 Field Creek
24 Gut Creek
25 Hurricane Creek
26 Illinois Bayou
27 Kings River
28 Lake Ouachita
29 Lee Creek
30 Lick Creek
31 Little Missouri River
32 Middle Fork Illinois R.
33 Middle Fork Little Red R.
34 Middle Fork Saline River
35 Moro Creek
36 Mountain Fork River
37 Mulberry River
38 Myatt Creek
39 North Fork Cadron Cr.
40 North Fork Illinois R.
41 North Fork Saline R.
42 North Sylamore Creek
43 Big Piney Creek
44 Raccoon Creek
45 Richland Creek
46 Salado Creek
47 Saline River
48 Second Creek
49 South Fork Caddo R.
50 South Fork Saline R.
51 South Fork Spring R.
52 Spring River
53 Strawberry River
54 Tomahawk Creek
55 Turkey Creek
56 Two Prairie Bayou

Figure II-5: Arkansas's Ecologically Sensitive Waters



1 Alum Fork Saline River
2 Archey Fork
3 Beech Creek
4 Black River
5 Brushy Creek
6 Caddo River
7 Caney River
8 Collier Creek
9 Cossatot River
10 Current River
11 Departee Creek
12 Devils Fork Little Red
13 Eleven Point River
14 Grassy Lake
15 Illinois River
16 Lick Creek
17 Little Brushy Creek
18 Little Missouri River
19 Little Osage Creek
20 Little Raccoon Creek
21 Little River
22 Little Strawberry River
23 Lower St. Francis River
24 Mayberry Creek
25 Middle Fork Little Red R.
26 Middle Fork Saline R.
27 Mill Creek
28 Mountain Fork River
29 North Fork Saline R.
30 Osage Creek
31 Otter Creek
32 Ouachita River
33 Polk Creek
34 Raccoon Creek
35 Right Hand Chute Little R.
36 Robinson Creek
37 Rock Creek
38 Rock Creek
39 St. Francis River
40 Saline River
41 South Fork Caddo R.
42 South Fork Little Red R.
43 South Fork Ouachita R.
44 South Fork Saline R.
45 Spring River
46 Straight Slough
47 Strawberry River
48 Sugarloaf Creek
49 Tenmile Creek
50 Tomahawk Creek
51 Turkey Creek
52 White River
53 Yellow Creek
54 Seeps and Springs

Water Quality Standards

The Arkansas Water and Air Pollution Control Act (AWAPCA) designates the Division as the state water pollution control agency for purposes of the CWA pursuant to Arkansas Code Ann. § 8-4-206. Under the AWAPCA, pursuant to Ark. Code Ann. § 8-4-201, DEQ is empowered to administer and enforce all laws and regulations relating to the pollution of waters of the state and the Arkansas Pollution Control and Ecology Commission (APC&EC or the Commission) is authorized to promulgate rules and regulations, including water quality standards and the classification of the waters of the state. "Waters of the state" is broadly defined in Ark. Code Ann. § 8-4-102 as:

> *...all streams, lakes, marshes, ponds, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, which are contained within, flow through, or border upon the state or any portion of the state.*

Surface Water

Arkansas's water quality standards are based, in part, on the physical, chemical, and biological characteristics of least-disturbed streams within ecoregions that were established by land surface forms, potential natural vegetation, soil types, and land uses. Waters of the State have been designated to support multiple uses based on the potential attainability of the use.

Specific criteria to protect the designated uses of each waterbody were developed, in part, from the intensive ecoregion studies, an abundance of historical data, numerous additional scientific data, and considerable public and other governmental agency input. Criteria are numeric or narrative and may prohibit physical alterations of certain waters. Aquatic life uses are specifically defined to provide a framework for aquatic life designated use support, which includes community structure and toxicity investigations.

In part, standards were developed with data from least-disturbed streams with characteristics most typical of a particular Level III ecoregion. A single Level III ecoregion can span from one edge of the State to the other and encompass two or three major river basins. The physical, chemical, and biological characteristics of one river basin within a particular Level III ecoregion may or may not be similar to the characteristics of the other river basins in the same ecoregion. In addition, the characteristics of transitions zones between ecoregions, the transition zone of a stream from a highland stream to a lowland stream, and the areas within atypical features of ecoregions may or may not be similar to typical ecoregion characteristics. Therefore, provisions are established in the water quality standards to allow modifications of the criteria and the designated uses of specific waterbodies based on: current actual uses, social and economic needs of the area of concern, existing uses, and ERW, ESW, or NSW designation.

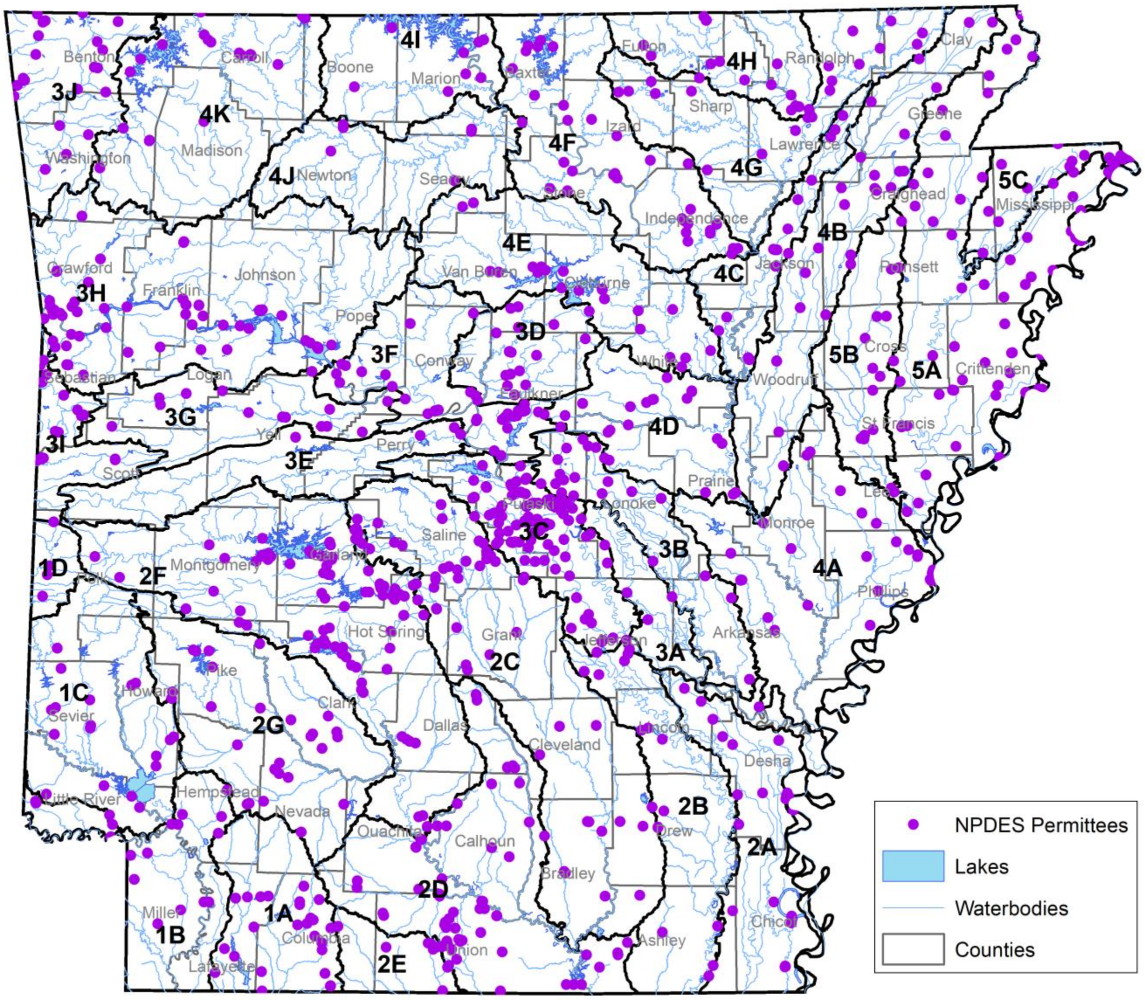
Point Source Control Program

On November 1, 1986, EPA delegated the NPDES Permit Program to DEQ. This program is administered by the Permits Branch of the Office of Water Quality.

In accordance with the CWA, Section 303(e), Arkansas maintains a Continuing Planning Process (CPP) to integrate the NPDES Program, the State's water quality standards, and the Water Quality Management Plan (WQMP). In accordance with Section 208 of the Clean Water Act, the WQMP is an inventory of all permitted municipal and industrial point source dischargers in Arkansas that contain permit limits for water quality-based conventional pollutants such as Carbonaceous Biochemical Oxygen Demand (CBOD5), Biochemical Oxygen Demand (BOD5), Total Suspended Solids (TSS), Ammonia Nitrogen (NH3-N), Dissolved Oxygen (D.O.). The WQMP also contains information associated with each facility such as facility name, permit number, location, design flow, receiving stream name and critical flow along with wasteload allocations consistent with an approved TMDL. As new information is developed, revisions to the WQMP are made in accordance with the public participation requirements of the CWA.

The NPDES Permits Branch administers Arkansas's NPDES program. The Commission has adopted by reference in Regulation No. 6, most of the federal regulations applicable to an NPDES wastewater discharge permitting program. The distribution of Arkansas' major and selected minor NPDES permits is illustrated in Figure II-6. Individual NPDES Permits include all point source discharges made to Waters of the State. The NPDES Permits Branch also issues non-stormwater General Permits for discharges from Sanitary Landfills, Aggregate Facilities, Individual Sanitary Treatment Units, Water Treatment Plants, Hydrostatic Testing, Car/Truck Washes, Groundwater Cleanup, Non-Contact Cooling Water, Cooling Tower Blowdown, and Boiler Blowdown. A General Permit for Pesticide Discharges has also been issued and provides automatic coverage.

Figure II-6: Active NPDES Permitted Facilities



Stormwater Requirements

The Permits Branch manages three general permits covering various stormwater discharges. The Construction Stormwater General Permit (ARR150000) covers any type of construction activity that is subject to permitting requirements. This general permit requires the development of a Stormwater Pollution Prevention Plan (SWPPP) using Best Management Practices (BMP) to control stormwater contamination from sediment runoff and erosion and other waste generated at a construction site. The SWPPP must include a detailed description of the construction project; a detailed site map showing drainage, sediment and erosion controls, discharge locations, etc.; a description of the sediment and erosion controls used on the site; inspection and maintenance procedures for the sediment and erosion controls, documentation for TMDL and Water Quality Standards compliance; and certifications.

The Industrial Stormwater General Permit (IGP) (ARR000000) covers many industry types that are required by federal regulation to obtain permit coverage based on the specific Standard Industrial Code (SIC) or specific industrial activity. All industries covered under the IGP are required to monitor for two basic parameters, TSS and pH, once per year within the first thirty minutes of a storm event. In addition, some industries, based on the specific industrial sector or activity defined in the IGP, are required to monitor for additional parameters. Facilities with permit coverage must conduct quarterly visual inspections. They are also required to conduct a comprehensive site evaluation once a year. They must schedule and conduct corrective action if their monitoring results indicate a parameter benchmark exceedance. The monitoring results, comprehensive site evaluation, four visual inspections and any corrective action needed must be included with the annual report and kept at the site with the annual report. This general permit requires the development of a SWPPP using BMPs to address the reduction in pollutants exposed to the stormwater runoff and/or removal of the pollutants after the stormwater has been contaminated. The SWPPP must include a list of personnel that will inspect the facility, a non-stormwater discharge certification, good housekeeping, spill prevention and response, and inventory of exposed material.

Industries that do not have any part of their operation exposed to stormwater may submit a no exposure certification request to be covered under no-exposure. Facilities with a no-exposure certification are not required to develop a SWPPP, monitor, or produce an annual report.

The Small Municipal Separate Storm Sewer System (MS4) General Permit (ARR040000) covers all of the regulated small MS4s (generally serving populations less than 100,000) in the State. This general permit requires the development of a Stormwater Management Plan (SWMP) to address the six minimum control measures: public education, public participation, illicit discharge detection, construction site control, post-construction control, and good housekeeping, as required by federal regulation. Each Small MS4 permittee with coverage under this general permit is required to submit an annual report explaining the different activities carried out under their SWMPs that year and the progress toward the defined goals set out in the SWMP.

The Permits Branch also manages one individual MS4 Permit (ARS000002) covering the storm sewer discharges from the City of Little Rock and the Arkansas Highway and Transportation Department. This permit requires the development of a program to address the same basic measures as the ARR040000 general permit. This permit also requires the co-permittees to sample the stormwater discharges from the permitted outfalls on a quarterly basis.

Point Source Impacts Monitoring

Impacts from major point source discharges of concern are monitored primarily through strategically located water quality monitoring stations within the statewide Ambient Water Quality Monitoring Network. The water quality data collected at these stations enable the Division to monitor the discharges from the permitted facilities and identify areas of concern needing enforcement or some other type of abatement activity. Data can also indicate improvement of water quality conditions resulting from pollution control activities. In addition, self-monitoring through monthly discharge monitoring reports is required in the NPDES permits of most dischargers (see “Enforcement” section below).

Toxics Strategy

Since FY 1987, the Division has utilized toxicity testing as a monitoring tool to measure compliance with its narrative toxicity standard, which states (in part) “Toxic substances shall not be present in receiving waters, after mixing, in such quantities as to be toxic to human, animal, plant or aquatic life, or to interfere with the normal propagation, growth and survival of the indigenous aquatic biota” (Reg. 2.508). The implicit intent of the toxics strategy is that there shall be no discharge of any wastewater from any source that:

1. Results in the endangerment of any domestic water supply;
2. Results in aquatic bioaccumulation which endangers human health;
3. Results in any in-stream acute or chronic aquatic toxicity; or
4. Violates any applicable general or numerical state or federal water quality standard.

The current toxicity testing program consists of self-monitoring conducted by the permittees. The State has been and will continue to implement the post-third round permit policy endorsed by EPA Region 6, with minor revisions. Whole effluent toxicity testing requirements are included in all major and selected minor permits.

In 1991, the Commission adopted specific numeric Aquatic Life criteria for 12 pollutants in terms of their acute and chronic toxicity: Reg. 2.508 of Reg. 2. On December 22, 1992, EPA promulgated numeric criteria for ten heavy metals and cyanide into Arkansas’s water quality standards. These criteria were initially expressed as total recoverable metals. Later EPA modified these values by applying a conversion factor to the total recoverable values and expressed them as dissolved values. The promulgated standards for chromium (VI), mercury and cyanide are expressed as a function of the pollutant's water-effect ratio (WER), while standards for cadmium, chromium (III), copper, lead, nickel, silver, and zinc are expressed as a function of the pollutant's WER and as a function of hardness. In January 1998, the Commission adopted the National Toxics Rule numbers previously promulgated by EPA as a part of the State's water quality standards.

When NPDES permit applications are submitted, in-stream waste concentrations (IWC) for all potential pollutants for which there is no adopted state standard are calculated and compared to values listed in the *Quality Criteria For Water* (EPA 1986) also known as the "Gold Book." If toxicity values published in the Gold Book are exceeded by the calculated IWC, whole effluent toxicity testing is required.

Self-Monitoring for Toxicity

The objective of Whole Effluent Toxicity (WET) testing is to estimate the no observed effect concentration (NOEC) of a facility's effluent. The NOEC is defined as the greatest effluent dilution at and below which toxicity (lethal or sub-lethal) that is statistically different from the control (0% effluent) at the 95% confidence level does not occur. This concentration will allow continued protection of normal propagation of fish and other aquatic life in the receiving waters.

Chronic toxicity tests are conducted for a period of seven days and utilize the Fathead minnow (*Pimephales promelas)* and the water flea (*Ceriodaphnia dubia).* The endpoints that are considered to determine adverse effects of toxicants for the Fathead minnow are survival and growth. The endpoints that are considered to determine adverse effects of toxicants for the water flea are survival and reproduction.

Acute toxicity tests are conducted for a period of 48 hours and utilize the Fathead minnow (*Pimephales promelas)* and the water flea (*Daphnia pulex).* The endpoint that is considered to determine adverse effects of toxicants for the Fathead minnow is survival. The endpoint that is considered to determine adverse effects of toxicants for the water flea is survival.

WET testing is included in the major and significant minor industrial NPDES permits. WET testing is also included in both major and some minor municipal NPDES permits and in one Federal permit.

When a facility's effluent experiences a certain number of toxic events, a Toxicity Reduction Evaluation (TRE) is required. A sub-lethal TRE is triggered based on one sub-lethal failure and sub-lethal failures in two out of three consecutive re-tests. A lethal TRE is triggered based on one lethal failure and lethal failure in one out of three consecutive tests. A TRE is an investigation intended to determine those actions necessary to achieve compliance with water quality-based effluent limits by reducing an effluent's toxicity to an acceptable level. A TRE is defined as a step-wise process which combines toxicity testing and analyses of the physical and chemical characteristics of a toxic effluent to identify the constituents causing effluent toxicity and/or treatment methods which will reduce the effluent toxicity. The goal of the TRE is to maximally reduce the toxic effects of effluent at the critical dilution. Depending on the results of the TREs, a facility will have either corrected treatment issues, relocated the effluent discharge, improved treatment capabilities, or WET limits in their NPDES permits.

The NPDES General Permit number ARG790000, Groundwater Clean-Up Located within the State of Arkansas, authorizes the discharge of treated groundwater/surface water that may have been contaminated with petroleum fuels. Determinations of coverage under this general permit are issued for short duration discharges, which sometimes only last for several months. The initial general permit was first issued on April 10, 1990. The initial general permit contained monthly acute WET testing requirements for all treated groundwater discharges, which included all permittees covered by the general permit. The monthly acute WET testing for one year requirements were continued with the effective date of the renewal permit on March 1, 1995; February 1, 2001; April 1, 2006; April 1, 2011; and April 1, 2016.

Accreditation of Monitoring Data

Pursuant to the provisions of Act 322 of 1993, the Commission established mandatory certification for certain environmental testing laboratories. This Act clarifies the Division's ability to refuse to accept invalid test results and expands enforcement powers over environmental testing. Regulation No. 13 establishes the fee system for laboratory certification. The number of environmental testing laboratories which have received certification from the State of Arkansas is tabulated by year are listed in Table II-1.

Table II-1: Environmental Testing Labs certified by the state of Arkansas

Time Frame	Total of Labs Certified	Number of Labs Located in AR
January 1, 2012-December 31, 2012	78	24
January 1, 2013-December 31, 2013	76	26
January 1, 2014-December 31, 2014	79	27
January 1, 2015-December 31, 2015	73	27
January 1, 2016-December 31, 2016	75	28
January 1, 2017-July 10, 2017	46	18

Enforcement

The Enforcement Branch of the Office of Water Quality implements the NPDES enforcement program. The primary basis for enforcement is self-monitoring data submitted by permittees on discharge monitoring reports (DMRs). All DMR data are entered into the Integrated Compliance Information System (ICIS) national database and reviewed by enforcement staff. The State addresses all permit violations reported by permittees initially through informal enforcement action where feasible. An escalation of enforcement action occurs if the violation(s) are not resolved. Other violations are judged on their severity and actions are taken as necessary. Inspection Reports from the Office of Water Quality's Compliance Branch are also an important source of violation data and enforcement action is initiated in proportion to the severity of the violations noted by Division staff in the field. Some 220 formal enforcement actions with financial penalties were executed between April 1, 2012 and March 31, 2017.

Wastewater Licensing and Training

Wastewater treatment plant operator licensing and training continues to be a necessary and integral part of the overall scope of the point source pollution control program. The licensing and training verification program administered by the Wastewater Licensing Section, Office of Water Quality of DEQ, operates within the authority of Arkansas Act 211 of 1971, as amended, and Act 1103 of 1991. These Acts set the requirements by law that requires a licensed operator at most wastewater treatment facilities in Arkansas. Act 211 has required licensed operators at Publicly-Operated Treatment Works since 1971. Act 1103 of 1991 added the requirement for the licensing of industrial operators. There are currently approximately 2500 licensed operators in Arkansas, which includes both municipal and industrial operators. Classification of wastewater treatment plants by the unit processes determine the level of operator staffing and the licensing level of the plant operators.

Most training of wastewater treatment plant operators is accomplished by the Arkansas Environmental Training Academy, a branch of Southern Arkansas University located at Camden, Arkansas, and the Arkansas Rural Water Association, Lonoke, Arkansas. Over 60 training sessions and 700 license exams are accomplished annually with offerings in all phases of wastewater training at various state locations by the faculty and staff. Other sources of training are provided by private contractors, professional organizations, and other institutions of higher learning.

Nonpoint Source Control Program

In 1988, the Division conducted a nonpoint source (NPS) assessment and prepared a management plan pursuant to Section 319 of the CWA. This assessment and portions of the original management program were approved by EPA Region 6 personnel.

In 1996, the former Arkansas Soil and Water Conservation Commission, now the Arkansas Natural Resources Commission (ANRC), was designated as the Nonpoint Source Program Management Agency and the lead agency for the Agriculture nonpoint source category; the Arkansas Forestry Commission assumed the responsibilities for the silviculture category; the Division has retained the responsibility of assessing and reporting on nonpoint source pollution and the responsibilities associated with Resource Extraction (mining); and the University of Arkansas Division of Agriculture, Cooperative Extension Service for education outreach. The Division and ANRC share the responsibilities of the Surface Erosion, Urban Runoff, and Road Construction / Maintenance categories. The Nonpoint Source Management Task Force prioritizes watersheds by the use of a matrix approach. The 8-digit HUCs are further broken down into 12-digit HUCs to facilitate focus in implementing projects in critical areas. In addition, both of these entities and numerous other cooperators lend assistance and/or support to each of the priority watersheds.

Assessment

The initial Arkansas Nonpoint Source Pollution Assessment was completed in 1988. This assessment was updated in June 1997 using updated assessment criteria. The 1997 report assessed 8,700 stream miles and indicated that nonpoint source pollution was impacting (but not necessarily impairing) over 4,100 stream miles. Agricultural activities were identified as the major cause of impacts on 3,197 stream miles. Other impacts were related to silviculture activities, road construction/maintenance activities and unknown sources. The unknown source was mercury contamination of fish tissue.

To reduce the confusion between the Nonpoint Source Assessment Report and this document, the Division no longer publishes a separate nonpoint source assessment report. This document, updated every two years, serves as the nonpoint source assessment report.

Management Program

The Arkansas Nonpoint Source Pollution Management Plan is developed and implemented by ANRC. It provides for continued monitoring of water quality, demonstrations of the effectiveness of BMPs, and implementation strategies of BMPs to reduce nonpoint source pollutants. In 2006, and in each year since then, ANRC and its subsequent Nonpoint Source Management Program section have and continue to initiate annual meetings of the Nonpoint Source Management Task Force (Task Force). The Task Force utilizes new or updated information and data to incorporate into a 12-tiered risk matrix approach to adjust and/or allocate resources and support, when appropriate, to emerging or changing conditions. This approach also facilitates stakeholder participation. Although the Arkansas Nonpoint Source Management Plan is printed every five years, updates to the plan occur annually. Additional information regarding the Program including past projects can be accessed by visiting www.arkansaswater.org.

ANRC conducts in-stream water quality monitoring in various priority areas as defined by the NPS Program. Collected data are utilized to determine project effectiveness, to evaluate NPS contribution trends and to determine water quality improvement as related to best management practice implementation specifically to known NPS sources. Collected data are forward to DEQ for use and inclusion of the Water Quality Assessment reported when applicable.

No-Discharge State Permits

The No-Discharge Section of the Permits Branch issues individual permits relating to waste disposal systems under the guidance of 40 CFR §503 that do not discharge directly to the waters of the State. These systems are most commonly located at confined animal facilities, commercial facilities with septic tanks and leach fields, and centralized or decentralized wastewater treatment systems for residential developments. Individual permits are also issued for the land application of waste generated by different types of treatment facilities such as wastewater treatment plants, poultry processing plants, food-processing plants, and drilling fluids from oil and gas field exploration activities. General permit for Septic Tanks for Carwashes, One Time Land Application, Saltwater Disposal, and Land Application of Water Treatment Plant Residuals In addition, this Section administers the Underground Injection Control Program for Class I, III, and V wells (excluding bromine-related spent brine disposal wells), and in conjunction with the Arkansas Oil and Gas Commission, issues permits for salt-water disposal systems.

Groundwater

The Division is empowered to enforce and administer all laws and regulations relating to pollution of the waters of the state, including groundwater, per Ark. Code Ann. § 8-4-201, because “waters of the state” include “…all bodies or accumulations of water, surface *and* underground….”

The Office of Land Resources within the Division has regulations pertaining to groundwater protections. The Division's Brownfields Program uses the Region VI Human Health Media-Specific Screening Levels for purposes of evaluating risk to human health and the environment during site evaluation. Methodologies and standards for risk assessment at contaminated sites have been established. Risk assessments demonstrate the difficulty of simply establishing numerical standards for all contaminated sites, because groundwater quality standards must be established in a manner that will augment existing regulations, provide a uniform set of criteria for defining and addressing groundwater contamination, and fill existing gaps in groundwater protection. Chief among the issues are fundamental policy decisions such as a non-degradation policy versus a risk-based or numeric cleanup standard, the role of stakeholders, coordination among applicable state agencies, and legislative support. In the event that statewide groundwater standard development is undertaken, these policy decisions must be made by a multi-agency team and receive input from multiple levels of agency management.

Watershed Approach

The watershed approach for water quality management in Arkansas was initiated in the 1970s with the development of Water Quality Planning Segments. This approach provides a framework where local programs can make educated choices about managing their natural resources.

The Division promoted and supported many activities and programs within this period of record. From October 2016 to 2018, the education team consisted of a watershed outreach coordinator, an ecologist-educator specializing in Project WET (Water Education for Teachers) and wetlands management, and an ecologist-educator specializing in solid waste management and recycling. The following includes many of the activities and programs addressed within these goals during the past five years:

The education team provided services to formal and non-formal educators through our association with the international Project WET program. Project WET activities are multi-disciplinary, incorporating language arts, fine arts, health, math, and science to meet Arkansas's core curriculum standards, while bridging to the unifying theme of watersheds and water education. The team offered, on average, 24 Project WET workshops each year. Workshops offered by education team staff also include *Wonders of the Wetlands*, *Healthy Water and Healthy People*, as well as special topic workshops specifically tailored for Arkansas watersheds and their issues and concerns. Each May (four for this period of record, due to May 2016 rainout), the education team coordinated the Project WET Make a Splash water festival at different locations around the state. This event allows students from area schools to spend a full day engaging in interactive, interdisciplinary activities that help them learn about the hydrologic cycle, groundwater, spring water, wetlands, water management, water conservation, water properties and soils. In addition to the Project WET curriculum, the education section provided a variety of in-classroom presentations and demonstrations ranging from water- and science-related career orientation to local water quality stream assessment procedures. The staff averaged nearly 20 youth education presentations using Project WET curriculum each year, and delivered presentations for five partner-sponsored environmental education events each year during this period of record.

Staff also provided educational services to communities by hosting local public awareness events and policy and regulatory meetings in watersheds across the state. Averaging two outreach events per month, staff actively participated in local field days, educational fairs, state park events, 4H/Girl Scout/Boy Scout days, Earth Day activities, and stream cleanup events. Education team members also served as local science fair judges and held positions on various related boards and advisory councils. The education staff provided presentations (about ten per year) and workshops (about six per year) to local civic and citizen groups and organizations to teach about water quality, sustainable practices for the home and garden, and local impact on the environment. Previous workshop topics have included: general water quality (information, issues, concerns, and assessments), grant writing, recent legislation, watershed management, stormwater issues and mitigation methods, rain gardens and rain barrels, water quality and pharmaceuticals, and special focus workshops addressing issues specific to local watersheds and ecosystems.

Staff organized five DEQ sponsored volunteer river cleanups in this reporting period as part of an annual statewide litter campaign with Keep Arkansas Beautiful Commission, and assisted with planning and staffing ten additional volunteer cleanups hosted by partner organizations and agencies during this period.

Introduction

CWA section 305(b) (and associated sections) requires states to provide an estimate of the environmental, economic, and social costs and benefits needed to achieve CWA objectives and an estimate of the date of such achievement.

A true cost/benefit analysis (CBA) described above to fulfill CWA requirements would be burdensome and expensive. Therefore, EPA guidance (2005) suggests States include a brief narrative that includes as much of the following information as possible.

For costs, states may include "capital investments in municipal and industrial facilities, investments in nonpoint source measures, annual operation and maintenance costs of municipal and industrial facilities, total annual costs of municipal and industrial facilities, and annual costs to states and local governments to administer water pollution control activities."

For benefits, states may include "information on improvements in recreational and commercial fishing; extent of stream miles, lake acres, etc., improved from meeting WQSs; reduced costs of drinking water treatment due to cleaner intake water; and increase in use of beaches and recreational boating due to improved water quality."

Cost Information

Costs for implementing CWA regulations are summarized as agency programmatic implementation expenses, pollution abatement capital expenditures, and operating costs. Much of the water quality related budget is self-generated through permit fees; however, a portion is derived through federal grants. These grants include §106 grant money for water pollution control activities, §319 grant money for nonpoint source management issues, and §604(b) grant money for state ambient water quality analysis. Funds from these grants are divided throughout the appropriate water-quality related state programs as directed by each grant and provide funding for personnel, equipment, survey and research work, and ambient water quality monitoring.

State of Arkansas Budget for Water Quality Control Activities

The Division has primary responsibility for permitting and enforcement of CWA provisions in Arkansas, but the implementation of water quality control activities are distributed across several state agencies, including the Division, Arkansas Natural Resources Commission, Arkansas Department of Health, Rural Water Association of Arkansas, and the Arkansas Division of Agriculture, among others.

Federal CWA Section 604(b) Budget

The §604(b) grant program provides funding to E&E's Laboratory and Monitoring Services branch in the amount of approximately $100 thousand per fiscal year. The §604(b) funds are used to help defray expenses for analytical work performed in the E&E Laboratory and Monitoring Services Water Lab. Expenses include supplies and analysts' salaries in the chemical analyses of ambient river, stream, and lake water quality samples, and Compliance Sampling Inspection (CSI) samples. For this period of record, the Division received approximately $500 thousand in federal §604(b) grant funding for these activities.

Federal CWA Section 106 Budget

The §106 grant program provides funding for DEQ's general water pollution control/water quality management program. Activities funded under the §106 grant include ambient water quality monitoring, assessment of ambient water quality data, development of the Water Quality Inventory (now known as the Integrated Report), revision of Arkansas's Water Quality Management Plan, development and revision of surface water quality standards, development and issuance of waste water discharge permits (NPDES Program), compliance inspections, complaint investigations, and development of enforcement actions. For this period of record, the Division received approximately $10 million in federal §106 grant funding for these activities.

Federal CWA Section 319 Budget

The Clean Water Act §319 grant for nonpoint source management issues in Arkansas is implemented by the ANRC. The ANRC works with universities, city and regional officials, private industries, and the federal government to prevent, control, and remediate nonpoint source pollution throughout Arkansas. Part II, Chapter 2, Nonpoint Source Pollution Control has more information about the Nonpoint Source Program. For the period of record, ANRC received approximately $15.3 million in Federal funding for these activities.

Benefits Information

The benefits of implementing the CWA are numerous and obvious. Clean water means higher revenue from aquatic related tourism and recreation, decreased costs to treat drinking and waste water, and higher revenue from commercial fishing and aquaculture. Because economic reports are not specific to 305(b) reporting needs, as necessary, DEQ reports benefits as conservative estimates of ten percent of expenditures or revenue gains.

Tourism and Recreation

Arkansas has over 87,600 miles of streams and rivers, and 515,000 acres of lakes, reservoirs, and ponds; most of which are used for some sort of aquatic recreation: fishing, swimming, kayaking, scuba diving, canoeing, hunting, motor boating, and waterskiing. All of these activities benefit from clean water, as does Arkansas's tourism revenue (directly or indirectly).

The Arkansas tourism industry experienced a year of growth in 2016 (based on 2013 US Travel and Tourism Expenditure Impact Model). Travel expenditures increased from approximately $7.28 billion in 2015 to $7.66 billion in 2015, up 5.17% (https://www.arkansas.com/!userfiles/annual_report_2017/2017_annual_report.pdf). A conservative estimate for tourism revenue that directly benefited from implementation of the CWA (fishing, boating, canoeing, etc.) would be 10% or approximately $766 million. Using data from previous 305(b) reports, a conservative estimate of tourism revenue that directly benefited from implementation of the CWA, for the 2018 period of record, is over $3.36 billion dollars.

Table II-2: Conservative estimate of tourism revenue in AR that benefits from implementation of the CWA. (AR Parks and Tourism annual reports 2012-2017)

Year	Travel expenditures in Arkansas (in billions of dollars)	Estimated tourism revenue that directly benefited from implementation of the CWA (in millions of dollars)
2012	$5.77	$577
2013	$6.27	$627
2014	$6.70	$670
2015	$7.28	$728
2016	$7.66	$766
Total for Period of Record		**$3,368,000,000**

According to the United States Fish and Wildlife Service (USFWS) (http://www.fws.gov/southeast/arkansas/NationalSurvey_AR.pdf,) in 2011 (the most recent data available) $496 million was realized in Arkansas for fishing related expenditures. If we assume a conservative 10% benefit from the CWA that would be almost $50 million.

Drinking Water

Arkansas has 70 surface water intake systems that produce (collectively) an average of 284 million gallons per day (Department of Health personal communication). Cost to treat drinking water due to diminished water quality varies by contaminant and is dependent on multiple variables. Dearmont et al. (1998) conducted a case study in Texas and found that costs of treatment increased by $95 per million gallons when contamination is present. If we extrapolate this to Arkansas, this translates to a cost of nearly $27,000 per day or $9.8 million annually. They also found that a 1% increase in turbidity increased chemical treatment costs by 0.25%.

Aquaculture

According to the University of Arkansas at Pine Bluff aquaculture/fisheries center of excellence, Arkansas has a $61 million aquaculture industry (http://www.uapb.edu/academics/school_of_agriculture_fisheries_and_human_sciences/aquaculture_fisheries/aquaculture_fisheries.aspx).

Warm-water (smallmouth bass, striped bass, and walleye) and cold-water (trout) fisheries is another economically important industry for Arkansas. Arkansas has six hatcheries operated by the Arkansas Game and Fish Commission (AGFC) and three National Fish Hatcheries (NFH). According to the USFWS, for each $1 spent of budget expenditures at the Norfork NFH, $5.86 in tax revenue is generated. (https://www.fws.gov/norfork/) For every tax dollar spent for recreational fish production at Mammoth Spring NFH $12 of net economic value is created resulting in a total economic output of more than $1.5 million every year by way of taxes, jobs, and sales. (https://www.fws.gov/mammothspring/). Based on 2017 economic data, for every $1 of hatchery operational budget Greers Ferry hatchery spends, $44 is put back into the economy (https://www.fws.gov/greersferry/documents/Economics-2017Greers_factsheetrev4-3-2018.pdf).

PART III SURFACE WATER ASSESSMENT

Chapter One SURFACE WATER MONITORING PROGRAM

Water Quality Monitoring Program

Arkansas has more than 150 permanent surface water monitoring sites (Figure III-1). The current monitoring program operates under four goals: 1) to better assess the effects of point source discharges upon water quality; 2) to observe nonpoint source contributions over time; 3) to continue monitoring the major rivers due to their basic importance to the State; and 4) to monitor high quality (least impaired) streams to provide long term chemical data by physiographic region for use in future water quality standards revisions. The Division's monitoring program is thoroughly outlined in, State of Arkansas Water Quality Monitoring and Assessment Program, Revision 5 (ADEQ 2013).

If a waterbody is assessed as impaired or needing more information using the data collected from the permanent stations, a special or intensive survey may be implemented. Table III-1 lists Water Planning projects within this period of record. These surveys are usually on a watershed or site specific scale and can include biological and/or special needs data collection dependent upon the impairment or type of information needed. Figure III-2 shows Water Planning sites within this period of record.

Biological Testing Program

The Division maintains a monitoring system to evaluate the environmental impacts of pollutants on aquatic life and human health. Monitoring programs include macroinvertebrate and fish community assessments; fish tissue analyses for contaminants, which may be harmful for human consumption; sediment testing for pesticides, toxic chemicals, and heavy metals; EPA Ambient Toxicity Monitoring Program (results available at http://www.epa.gov/earth1r6/6wq/ecopro/watershd/monitrng/toxnet/index.htm); and bacteriological analyses. These techniques are used either as stand-alone methods or in conjunction with other biological or chemical analyses to monitor the biological health of waters throughout the State.

Macroinvertebrate and Fish Community Assessment

One of the best ways to monitor the health of a stream or other waterbody is to examine its biological inhabitants. The Division has conducted biological community monitoring throughout the state since the 1970s. Current biological collection methods are based on EPA's Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour 1999).

Figure III-1: DEQ Water Quality Monitoring Stations

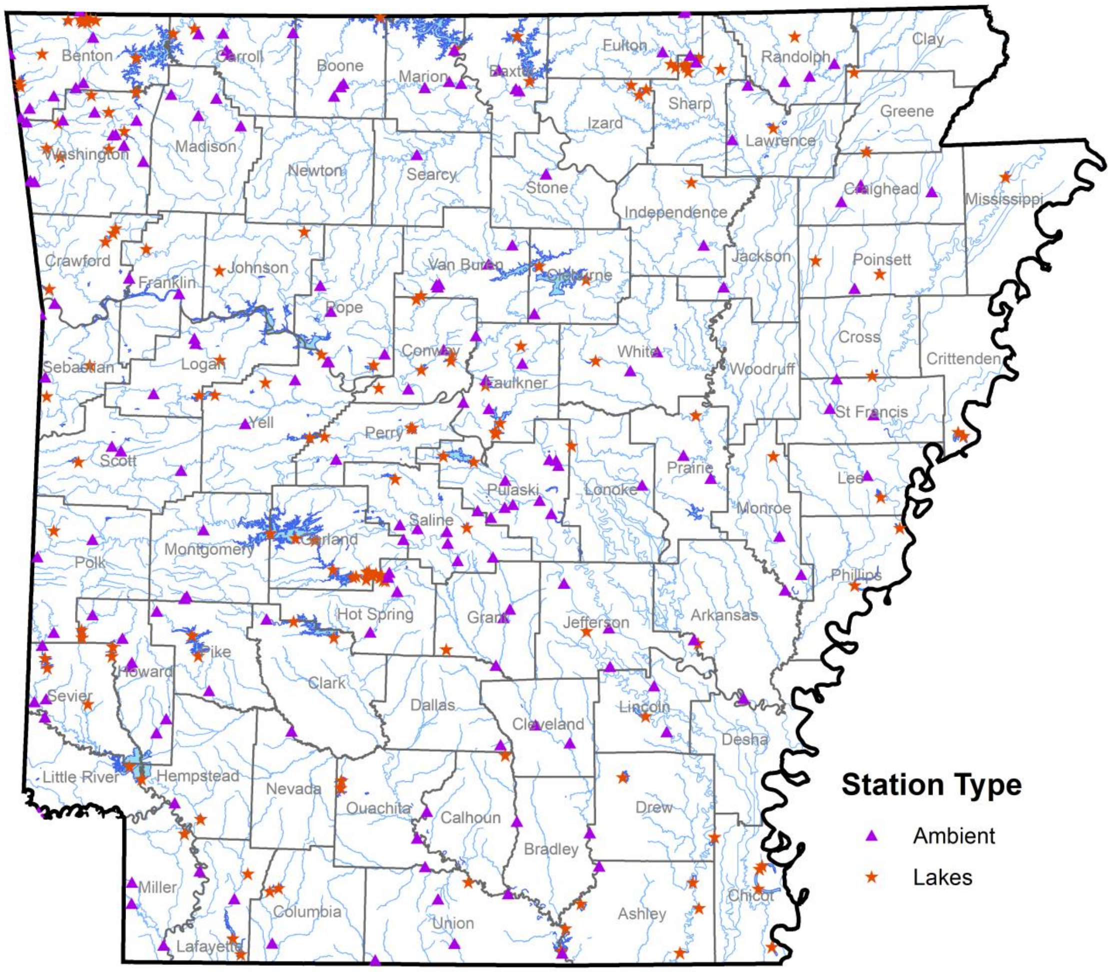


Figure III-2: Water Planning Monitoring Waters

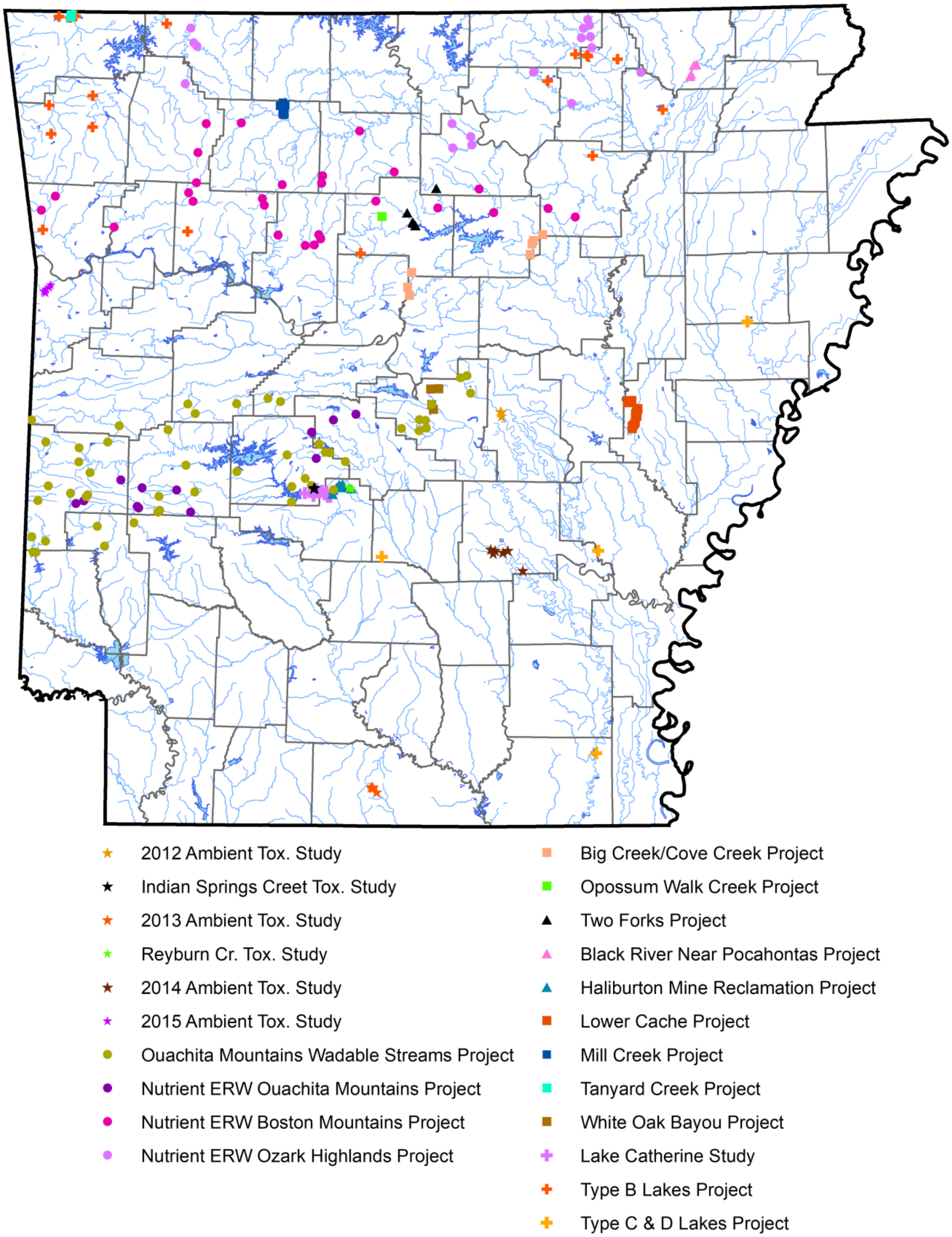


Table III-1: Water Planning Projects (April 1, 2012 to March 31, 2017)

Name	Project Year(s)
Type B Reference Lake Identification	2010 to 2015
White Oak Bayou	2010 to 2015
Type C and D Reference Lakes Data Collection	2009 to 2015
Inventory of Aquatic Species of Big and Cove Creek Natural Areas	2011-2012
Halliburton Mine Reclamation Project	2011-present
2012 Ambient Toxicity Study	2012
Excavation Activities in and near the Opossum Walk Creek, Van Buren County, Arkansas	2012
Indian Springs Creek Toxicity Study	2012-2013
Lake Catherine Study	2012-2013
Lower Cache River Restoration Project	2012-2016
Two Forks Restoration- Biological Monitoring Program	2012-2016
2013 Ambient Toxicity Study	2013
Stream Restoration of Tanyard Creek in the Little Sugar Watershed	2013-2016
Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Ozark Highland Ecoregion of Arkansas	2012-2015
Reyburn Creek Toxicity Study	2013-2015
2014 Ambient Toxicity Study	2014
Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Boston Mountain Ecoregion of Arkansas	2013-2016
Preliminary Evaluation of Designated Use Attainment for the Black River near Pocahontas, Arkansas	2014-present
2015 Ambient Toxicity Study	2015
Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Water Bodies in the Ouachita Mountain Ecoregion	2016-present
Biotic and Abiotic Sampling at Select Wadeable Locations Within the Ouachita Mountain Ecoregion	2016-present

Name	Project Year(s)
Evaluation of *Escherichia coli* (*E. coli*) Concentrations in Mill Creek, Newton Co., Arkansas	2016-2017

Bacteriological Program

The bacteriological monitoring network has been substantially modified during the past several years. Because of the incompatibility of current network monitoring strategies and bacteriological sample holding times, a separate sampling scheme was developed. Technicians perform the sampling and analyses in the field to comply with the holding time of the methodology.

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Arkansas strives to achieve comprehensive assessments by utilizing both DEQ data and data from outside sources.

DEQ Data

Arkansas's water quality monitoring network is discussed in the previous chapter. DEQ's ambient network is facilitated by regionally located field personnel and personnel from the central office (Figure III-1).

Site specific and parameter specific intensive surveys are conducted to better assess streams (Figure III-2 and Table III-1) in areas outside the ambient network.

Data from Outside DEQ

In accordance with the CWA under Section 303(d) and implementing regulations in 40 C.F.R. §130.7, DEQ actively solicits existing and readily available water quality data from around Arkansas and neighboring states. Data solicitation by DEQ is conducted via postal correspondence to various agencies, municipalities, universities, and other entities who may have collected water quality data within the period of record. For the 2018 cycle, 137 entities were contacted via a June 8, 2017 letter. In response, data were received and evaluated from entities listed in Table III-2. Figure III-3 shows where data were collected by each entity.

In order to be considered for assessment and attainment purposes, outside data must first pass all Phase I requirements:

- Be characteristic of the main water mass or distinct hydrologic areas. For example, not taken within a mixing zone, side channel, tributary, or stagnant back water.
- Be reported in standard units recommended in the relevant approved method and that conform to APC&EC Regulation No. 2 or can be directly compared or converted to units within APC&EC Regulation No. 2.
- Have been collected and analyzed under a QA/QC protocol equivalent to or more stringent than that of DEQ or the USGS. Data collection protocols should either be readily available or accompany the data.
- All laboratory analyzed parameters (not *in situ*) must be analyzed pursuant to the rules outlined in the State Environmental Laboratory Certification Program Act, Ark. Code Ann. § 8-2-201 *et seq.* The name and location of the laboratory should either be readily available or accompany the data.

- Be accompanied by precise collection metadata such as time, date, stream name, parameters sampled, chain of custody, and sample site location(s), preferably latitude and longitude in either decimal degrees or degrees, minutes, seconds.
- Be received in either an Excel spreadsheet or compatible format not requiring excessive formatting by DEQ.
- Have been collected within the period of record.

Once data passes Phase I requirements, they are then evaluated against Phase II requirements as a set. Phase II requirements are specific to each parameter, but generally consist of temporal, quantity, distribution, and spatial requirements. See the Assessment Methodology (Appendix B) for specifics of Phase II requirements for each parameter.

Data sets that pass Phase I requirements may be assessed individually if no other data are available for that AU, and that set also passes Phase II. Or data sets that pass Phase I requirements may be aggregated into larger data sets if more than one data set exists for an AU. In this case, the aggregate data set must pass Phase II requirements to be considered for use in assessments.

Data Not Used

In general, and as described in the Assessment Methodology (Appendix B), some existing and readily available data were evaluated, but not used for assessments during the 2018 assessment cycle if they were

- unable to meet all Phase I requirements (see above)
- unable to meet Phase II quantity, temporal, distribution, or spatial requirements on their own, or were unable to be aggregated with other data sets to meet Phase II requirements
- duplicates within the same AU on the same day (most protective value was used for assessment purposes)
- taken outside of applicable watershed size requirements. For example, primary contact recreation is not assessed in watersheds less than ten square miles unless primary contact is verified.
- taken within springs or other groundwater sources
- taken in non-stream or lake areas such as roadside ditches, puddles, etc.
- preliminary or provisional

Specific existing and readily available data or data sets not used during the 2018 assessment cycle are described below.

Arkansas Department of Health (ADH) pathogen (*E. coli*) data were unable to be used for assessment due to holding times exceeding the eight hour maximum set forth in Standard Methods for ambient waters. ADH used holding times consistent with source water analytical methods set forth in 40 C.F.R. § 141.704 (b)(1) which are as high as thirty hours. Communications with ADH confirmed that samples were shipped next day and were likely to violate the eight hour holding time required by DEQ per Standard Methods 9060 B Preservation and Storage(1.)(c.).

Arkansas State University (ASU) metals data were unable to be used for assessment due to quality control (QC) issues. Metals values were listed that were below the practical quantitation limit (PQL) and dissolved concentrations were greater than total concentrations.

Any USGS data marked as "preliminary" or "provisional" were not used for assessments. These data have not been verified by USGS that they meet QA/QC procedures. Various parameters were marked as "preliminary" across the state.

Some USGS long-term continuous data was not used to make long-term continuous assessments as it did not meet quantity and distribution requirements.

Some National Park Service (NPS) and DEQ short-term continuous data was not used for various reasons. Most commonly, short-term data issues were only one deployment, either one or both deployments were not long enough, one or both deployments did not meet seasonal temperature requirements, or the two deployments were not separated by at least two weeks. These issues were found in several AUs in both lakes and streams.

Some DEQ and Arkansas Water Resource Center (AWRC) pathogen data (*E. coli*) was not assessed for primary contact recreation because data were collected in watersheds less than 10 square miles and primary contact recreation use was not verified. Some NPS and Buffalo River Watershed Association (BRWA) *E. coli* data were not used because data were collected in springs or otherwise not on the mainstem of the waterbody.

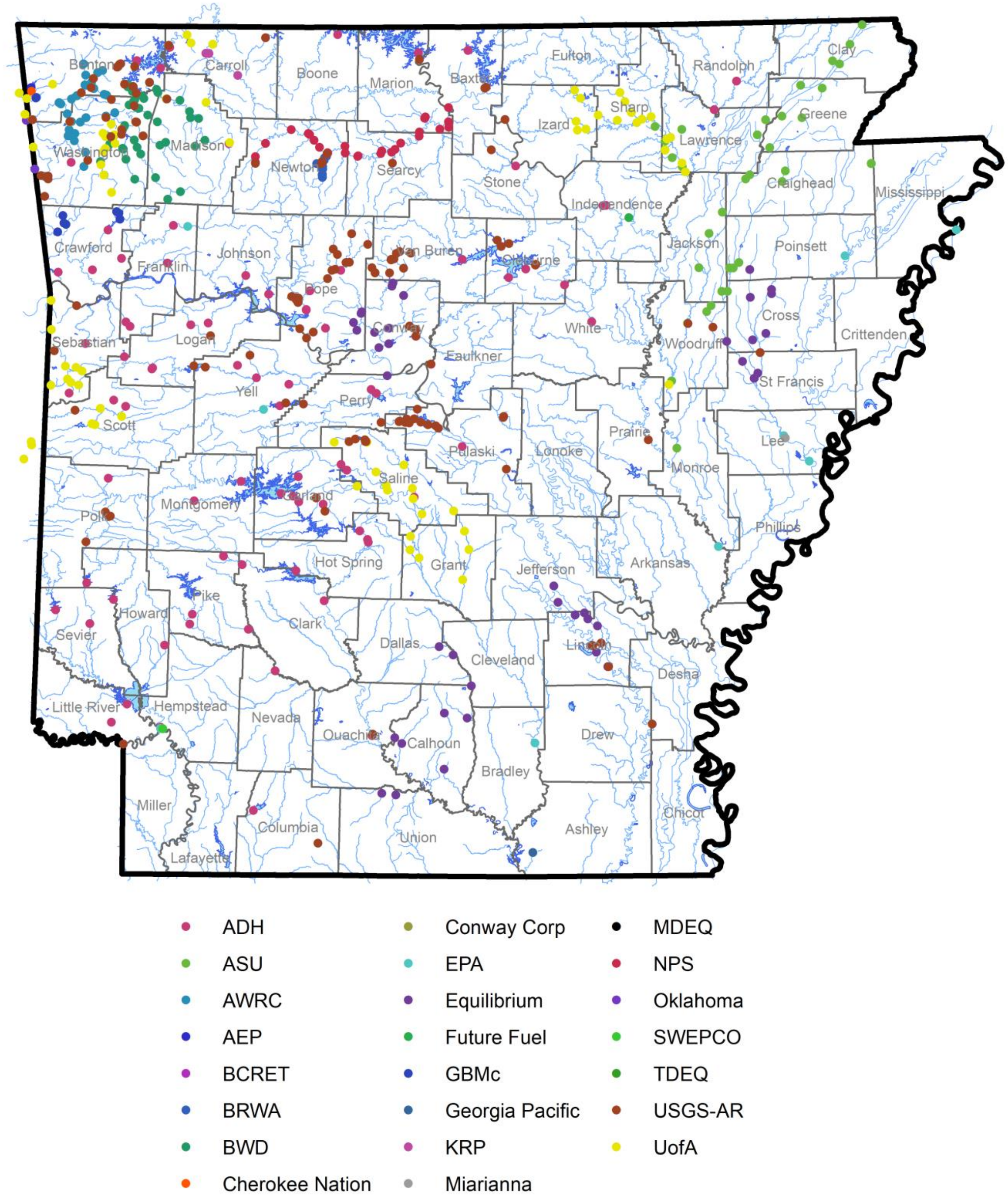
One of UMETCO's monitoring stations, EWCL is not characteristic of the main water mass. During the period of record, depressed pH readings at this station were attributed to temporary conditions occurring due to active remediation activities during the time samples were taken.

Numerous data points provided by EPA contained the same sample date and collection time with varying results.

Table III-2: Entities Submitting Outside Data for the 2018 Cycle

Name	Map Title
Arkansas Department of Health	ADH
Arkansas State University	ASU
Arkansas Water Resources Center	AWRC
American Electric Power	AEP
Big Creek Research Extension Team	BCRET
Buffalo River Watershed Alliance	BRWA
Beaver Water District	BWD
Cherokee Nation	Cherokee Nation
Conway Corp.	Conway Corp.
U.S. Environmental Protection Agency	EPA
Equilibrium	Equilibrium
Future Fuel Chemical	Future Fuel
GBMc and Associates	GBMc
Georgia Pacific	Georgia Pacific
Kings River Partnership	KRP
Marianna, City of	Marianna
Mississippi Department of Environmental Quality	MDEQ
National Parks Service	NPS
Oklahoma	Oklahoma
Southwestern Electric Power Company	SWEPCO
Tennessee Department of Environmental Quality	TDEQ
Umetco Minerals Corporation	UMETCO
United States Geological Survey - Arkansas	USGS - AR
University of Arkansas	UofA

Figure III-3: Data from Outside Sources



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Physical and Chemical Parameters

Tables III-3 through III-6 summarize the designated use support and water quality standards attainment status of the State's river and stream waterbodies. Non-support encompasses categories 5, 5-alt, 4a, and 4b. Tables III 3-6 can have overlapping mileage, for example, if the same stream segment that is 10 miles long is listed as non-support for both primary and secondary contact recreation, it would appear as 20 miles, not 10.

Table III-3: Designated Use and Water Quality Standards Support in Arkansas

Degree of Use Support	Assessed Total (miles)
Supporting all assessed uses	7,420
Not supporting a use	4,011
Total Waters Assessed	11,430

Table III-4: Designated Use Support of Assessed Waters by Use Type

Use Type	Support (miles)	Non-Support (miles)
Agri & Industrial Water Supply	11,399	31
Aquatic Life	8,231	3,199
Domestic Water Supply	11,167	263
Primary contact	10,801	629
Secondary contact	11,430	0

Table III-5: Total Sizes of Waters Listed as Not Supporting Water Quality Standards and/or Designated Use(s) by Various Source Categories

Source Categories	Stream Miles
Agriculture	166
Industrial point sources	349
Municipal point sources	63
Resource extraction	37
Surface erosion	405
Urban run-off	48
Unknown	3,005

Table III-6: Total Sizes of Waters Listed Not Attaining Water Quality Standards by Various Cause Categories

Cause Categories	Stream Miles
Ammonia	15
Aluminum	3
Beryllium	3
Cadmium	0
Copper	33
Chlorides	428
Dissolved Oxygen	2,120
Lead	822
Mercury	413
Nickel	0
Nitrogen	80
Pathogen Indicators	684
pH	774
Phosphorus	35
Priority Organics	57
Selenium	9
Siltation/Turbidity	1,755
Sulfates	315
Temperature	155
Total Dissolved Solids	437
Toxicity	6
Zinc	141

Biological Parameters

Aquatic life designated use assessment is a tool used to better characterize the health of the aquatic biota based on macroinvertebrate and fish community structures. Short-term water quality impairments either from point and/or nonpoint source inputs or from short-term seasonal and/or storm events may not be detected using water quality data from grab samples. Individual short-term events most likely do not have a significant effect on the biological communities within a stream; however, these communities may be affected by frequent short-term events that limit full recovery between episodes. Therefore, biological data, when available, will be the ultimate deciding factor of the attainment of the aquatic life designated use, regardless of chemical conditions.

Between April 1, 2012 and March 31, 2017, over 230 aquatic biota samples were collected for the purpose of watershed assessment surveys or the establishment of ecoregion based indices of biotic integrity, as well as use support determination. Data are accessible on line: www.adeq.state.ar.us/compsvs/webmaster/databases.htm. Some samples were part of the special project surveys listed in Part III, Chapter 1. Tables III-7 through III-17 provide information on biological samples for various projects throughout this period of record.

Table III-7: White Oak Bayou Biology (2012)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
White Oak Bayou	ARK0162	AR_11110207_912	3C	BM	X	X
White Oak Bayou	ARK0162B	AR_11110207_912	3C	BM	X	X
White Oak Bayou	ARK0162D	AR_11110207_912	3C	BM	X	X

BM = Boston Mountains

Table III-8: Inventory of Aquatic Species of Big and Cove Creek Natural Areas (2011-2012)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
Big Creek	UWBCK01	AR_11010014_013	4E	BM	X	X
Big Creek	UWBCK02	AR_11010014_013	4E	BM	X	X
Big Creek	UWBCK03	AR_11010014_013	4E	BM	X	X
Big Creek	UWBCK04	AR_11010014_013	4E	BM	X	X
Cove Creek	ARK0171	AR_11110205_016	3D	BM	X	X
Cove Creek	ARK0172	AR_11110205_016	3D	BM	X	X

BM = Boston Mountains

Table III-9: Excavation Activities in and near the Opossum Walk Creek, Van Buren County, Arkansas (2012)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
Opossum Walk Creek	OWC01	AR_11010014_039	4E	BM	X	
Opossum Walk Creek	OWC02	AR_11010015_039	4E	BM	X	
Opossum Walk Creek	OWC03	AR_11010016_039	4E	BM	X	

BM = Boston Mountains

Table III-10: Lower Cache River Restoration Project (2012). All stations located on Cache River

Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
N1	AR_8020302_016	4B	D	X	X
N2	AR_8020302_016	4B	D	X	X
N3	AR_8020302_016	4B	D		X
N4	AR_8020302_016	4B	D		X
N5	AR_8020302_016	4B	D		X
WD01	AR_8020302_001	4B	D	X	X
WD02	AR_8020302_001	4B	D	X	X
WD03	AR_8020302_001	4B	D	X	X
WD04	AR_8020302_001	4B	D		X
WD05	AR_8020302_001	4B	D		X
WN01	AR_8020302_001	4B	D	X	X
WN02	AR_8020302_001	4B	D	X	X

Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
WN03	AR_8020302_001	4B	D	X	X
WN04	AR_8020302_001	4B	D		X
WN05	AR_8020302_001	4B	D		X
D1	AR_8020302_001	4B	D	X	X
D2	AR_8020302_001	4B	D	X	X
D3	AR_8020302_001	4B	D		X
D4	AR_8020302_001	4B	D		X
D5	AR_8020302_001	4B	D		X

D = Delta

Table III-11: Two Forks Restoration-Biological Monitoring Program (2012)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
Archey Fork	AF-P1	AR_11010014_037	4E	BM	X	X
Archey Fork	AF-P2	AR_11010014_037	4E	BM	X	X
Archey Fork	AF-P3	AR_11010014_037	4E	BM	X	X
Archey Fork	WHI0194	AR_11010014_037	4E	BM	X	X
Middle Fork	MF01	AR_11010014_028	4E	BM	X	X
Beech Fork	WHI0188	AR_11010014_025	4E	BM		X

BM = Boston Mountains

Table III-12: Stream Restoration of Tanyard Creek in the Little Sugar Watershed (2013)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
Tanyard Creek	TC01	AR_11070208	3J	OH	X	
Tanyard Creek	TC02	AR_11070208	3J	OH	X	
Tanyard Creek	TC03	AR_11070208	3J	OH	X	
Tanyard Creek	TC-CON	AR_11070208	3J	OH	X	

OH = Ozark Highlands

Table III-13: Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Ozark Highlands Ecoregion of Arkansas (2013)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Periphyton Community Collected
Big Creek	WHI0142J	AR_11010010_908	4H	OH	X	X
English Creek	WHI0142H	AR_11010010_009	4H	OH	X	X
Field Creek	WHI0142I	AR_11010010_909	4H	OH	X	X
Gut Creek	WHI0142K	AR_11010010_906	4H	OH	X	X
Kings River	WHI0009A	AR_11010001_037	4K	OH	X	X
Kings River	WHI0123	AR_11010001_042	4K	OH	X	X
Myatt Creek	WHI0171	AR_11010010_010	4H	OH	X	X
North Sylamore Creek	WHI0144A	AR_11010004_009	4F	OH	X	X
North Sylamore Creek	WHI0202	AR_11010004_009	4F	OH	X	X
Osage Creek	WHI0068	AR_11010001_045	4K	OH	X	X
Osage Creek	WHI0069	AR_11010001_045	4K	OH	X	X
Roasting Ear Creek	WHI0144F	AR_11010004_910	4F	OH	X	X
South Fork Spring	WHI0023	AR_11010010_012	4H	OH	X	X
South Sylamore Creek	WHI0145B	AR_11010004_010	4F	OH	X	X
Spring River at Hardy	WHI0022	AR_11010010_003	4H	OH	X	X

Table III-13: Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Ozark Highlands Ecoregion of Arkansas (2013)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Periphyton Community Collected
Spring River at Ravenden	WHI0021	AR_11010010_006	4H	OH	X	X
Strawberry River	UWSBR01	AR_11010012_011	4G	OH	X	X
Strawberry River	UWSBR02	AR_11010012_009	4G	OH	X	X

OH = Ozark Highlands

Table III-14 Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Boston Mountain Ecoregion of Arkansas (2014-2015)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected	Periphyton Collected
Archey Creek	WHI0195	AR_11010014_937	4E	BM	X	X	X
Beech Fork Little Red River	UWBHC01	AR_11010014_023	4E	BM	X	X	X
Big Piney Creek	ARK0113	AR_11110202_919	3H	BM	X	X	X
Big Piney Creek	ARK0118	AR_11110202_021	3H	BM	X	X	X
Hurricane Creek	ARK0119	AR_11110202_022	3H	BM	X	X	X
Hurricane Creek	ARK0145	AR_11110202_022	3H	BM	X	X	X
North Fork Illinois Bayou	ARK0149	AR_11110202_015	3H	BM	X	X	X

Table III-14 Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Boston Mountain Ecoregion of Arkansas (2014-2015)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected	Periphyton Collected
Illinois Bayou	ARK0150	AR_11110202_012	3H	BM	X	X	X
Middle Fork Illinois Bayou	ARK0176	AR_11110202_014	3H	BM	X	X	X
East Fork Illinois Bayou	ARK0177	AR_11110202_013	3H	BM	X	X	X
Kings River	BUFET004	AR_11010001_042	4K	BM	X	X	X
Buffalo River	BUFR02	AR_11010005_012	4J	BM	X	X	X
Falling Water Creek	BUFT903	AR_11010005_924	4J	BM	X	X	X
Richland Creek	LRC0001	AR_11010005_024	4J	BM	X	X	X
Beech Fork Little Red River	UWBHC01	AR_11010014_023	4E	BM	X	X	X
Lee Creek	UWLCK01	AR_11110104_006	3H	BM	X	X	X
Middle Fork Little Red River	UWMFK01	AR_11010014_030	4E	BM	X	X	X
Middle Fork Little Red River	WHI0043	AR_11010014_028	4E	BM	X	X	X
Buffalo River	WHI0049A	AR_11010005_005	4J	BM	X	X	X

Table III-14 Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Boston Mountain Ecoregion of Arkansas (2014-2015)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected	Periphyton Collected
Salado Creek	WHI0151	AR_11010004_012	4F	BM	X	X	X
Turkey Creek	WHI0187	AR_11010014_925	4E	BM	X	X	X
Archey Creek	WHI0195	AR_11010014_937	4E	BM	X	X	X
Salado Creek	WHI0201	AR_11010004_012	4F	BM	X	X	X
Kings River	WHI0203	AR_11010001_042	4K	BM	X	X	X

BM = Boston Mountains

Table III-15: Preliminary Evaluation of Designated Use Attainment for the Black River near Pocahontas, Arkansas (2015)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
Black River	WHI0025	AR_11010009_005	4G	Delta	X	X
Black River	WHI0025A	AR_11010009_005	4G	Delta	X	X
Black River	WHI0025B	AR_11010009_005	4G	Delta	X	X
Black River	WHI0025C	AR_11010009_005	4G	Delta	X	X

Table III-16: Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies in the Ouachita Mountain Ecoregion of Arkansas (2016-2017)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
Middle Fork Saline River	MFS0005	AR_08040203_019	2C	Ouachita	X	X
North Fork Saline River	NFS0001	AR_08040203_011	2C	Ouachita	X	X
Little Missouri River	OUA0190, 193	AR_08040103_023	2G	Ouachita	X	X
South Fork Caddo River	OUA0044, 187	AR_08040102_023	2F	Ouachita	X	X
Caddo River	OUA0188, 189	AR_08040102_721	2F	Ouachita	X	X
Caney Creek	OUA0069	AR_11140109_921	1C	Ouachita	X	X
Cossatot River	OUA0070	AR_11140109_019	1C	Ouachita	X	X
South Fork Saline River	SFS0002	AR_08040203_020	2C	Ouachita	X	X
Big Fork Creek	OUA0161	AR_08040101_636	2F	Ouachita	X	X
Alum Fork Creek	OUA0216	AR_08040203_014	2C	Ouachita	X	X

Table III-17: Establishment of the Arkansas Department of Energy and Environment, Division of Environmental Quality's Biological Monitoring Network (BMN) and Data Collection for Selected Ouachita Mountain Ecoregion Sites (2016-2018)

Site Name	Station ID	Assessment Unit	Planning Segment	Ecoregion	Macro-Invertebrates Collected	Fish Community Collected
Rock Creek	ARK0194, 196	AR_11110207_929	3C	Ouachita	X	X
McHenry Creek	ARK0195	AR_11110207_022	3C	Ouachita	X	X
Fourche Creek	ARK0197	AR_11110207_922	3C	Ouachita	X	X
Fiddlers Creek	OUA0141	AR_08040101_032	2F	Ouachita	X	X
Irons Fork	OUA0142	AR_08040101_938	2F	Ouachita	X	X
Collier Creek	OUA0162	AR_08040101_821	2F	Ouachita	X	X
Polk Creek	OUA0163	AR_08040101_925	2F	Ouachita	X	X
Board Camp Creek	OUA0186	AR_08040101_836	2F	Ouachita	X	X
Cedar Creek	OUA196	AR_08040203_022	2C	Ouachita	X	X
Lockett Creek	OUA0197	AR_08040203_922	2C	Ouachita	X	X
Gulpha Creek	OUA0199	AR_08040203_501	2C	Ouachita	X	X
Walnut Creek	OUA0204	AR_08040101_920	2F	Ouachita	X	X
Fourche a Loupe Creek	OUA0206	AR_08040101_906	2F	Ouachita	X	X
Brushy Creek	RED0053	AR_11140109_020	1C	Ouachita	X	X
Short Creek	RED0071	AR_11140109_719	1C	Ouachita	X	X
South Fork Ouachita River	UWSFO01	AR_08040101_043	2F	Ouachita	X	X

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Background

Although selected lakes have had some historic, long-term assessments, the water quality data from the majority of Arkansas's lakes are sparse. Some have only specific purpose data, e.g., bacteria sampling from swimming areas. A few lakes have been investigated as a short term project when a specific or potential problem was identified. Such studies were associated with the Clean Lakes Section of the Water Quality Act, or municipal water supply reservoirs with treatment related concerns. In contrast, the Corps' lakes of the Little Rock District have a relatively large amount of historic, multi-parameter and multi-site water quality data. Additionally, DeGray Reservoir probably has the most extensive historic water quality database of any reservoir in this region of the country.

Arkansas currently has identified 79 significant publicly-owned lakes (Figure III-5) ranging in size from 60 to over 45,000 acres; totaling 357,896 acres. The lakes are categorized into five "Types" (ADEQ 2000) by ecoregion, primary construction purpose, and certain morphometric features such as size and average depth (Table III-18). In 2007, construction was completed on the Lake Fort Smith dam in Crawford County in northwest Arkansas which combined Lake Shepherd Springs and the original Lake Fort Smith. The new Lake Fort Smith is 1390 surface acres, 422 surface acres larger than the original two lakes combined.

Lake Water Quality Assessment

Since 1989, four lake water quality assessments have been completed on Arkansas's significant publicly-owned lakes. Water quality samples, metals, pesticides, and pathogens, as well as dissolved oxygen and temperature profiles were collected from most of these lakes between mid-July and the end of August in 1989, 1994, 1999, and 2004. Sediment samples were collected in 1994 and plankton samples were collected in 1999 and 2004.

In 2011, ADEQ initiated a sampling program on 16 Type A lakes (described below). Water quality and profile samples are collected quarterly on each lake.

Using lake morphology, ecoregion, and purpose of construction, all lakes are grouped in the following manner:

Type A

These are larger lakes, usually of several thousand acres in size. They have average depths of 30 to 60 feet and are located in the mountain areas of the State in the Ozark Highlands, Ouachita Mountains, and Boston Mountains. The watersheds of most are forest dominated, and the primary purpose of most of these lakes is hydropower and/or flood control. The watershed-to-lake area ratio (W/A) is relatively large for these impoundments, but the large reservoir volume lengthens the water residence time.

Type B

These are smaller lakes of uplands or steeper terrains of the mountainous regions and are probably the most heterogeneous group of lakes. Most are 500 acres or less in size and are located in the Ozark Highlands, Ouachita Mountains and Boston Mountains. Several are located in more mountainous areas of the Arkansas River Valley. Average depths range from 10 to 25 feet and watersheds are normally dominated by forest lands. The W/A ratios are normally high which results in a high flushing rate and low water retention time for these smaller lakes.

Type C

This group is composed of smaller lakes of lowlands or flat terrain areas. Sizes range from 300 to 1,000 acres with average depths of normally less than 10 feet. These lakes are located in the Arkansas River Valley, Gulf Coastal Plains, and Delta ecoregions. Delta lakes within this group are generally associated with the Crowley's Ridge region. Watersheds of these lakes include timberlands of both lowland hardwoods and pines, but some are broken by pasture land and small farms. These lakes have relatively small storage volumes due to shallow average depths and those with higher W/A ratios have high flushing rates.

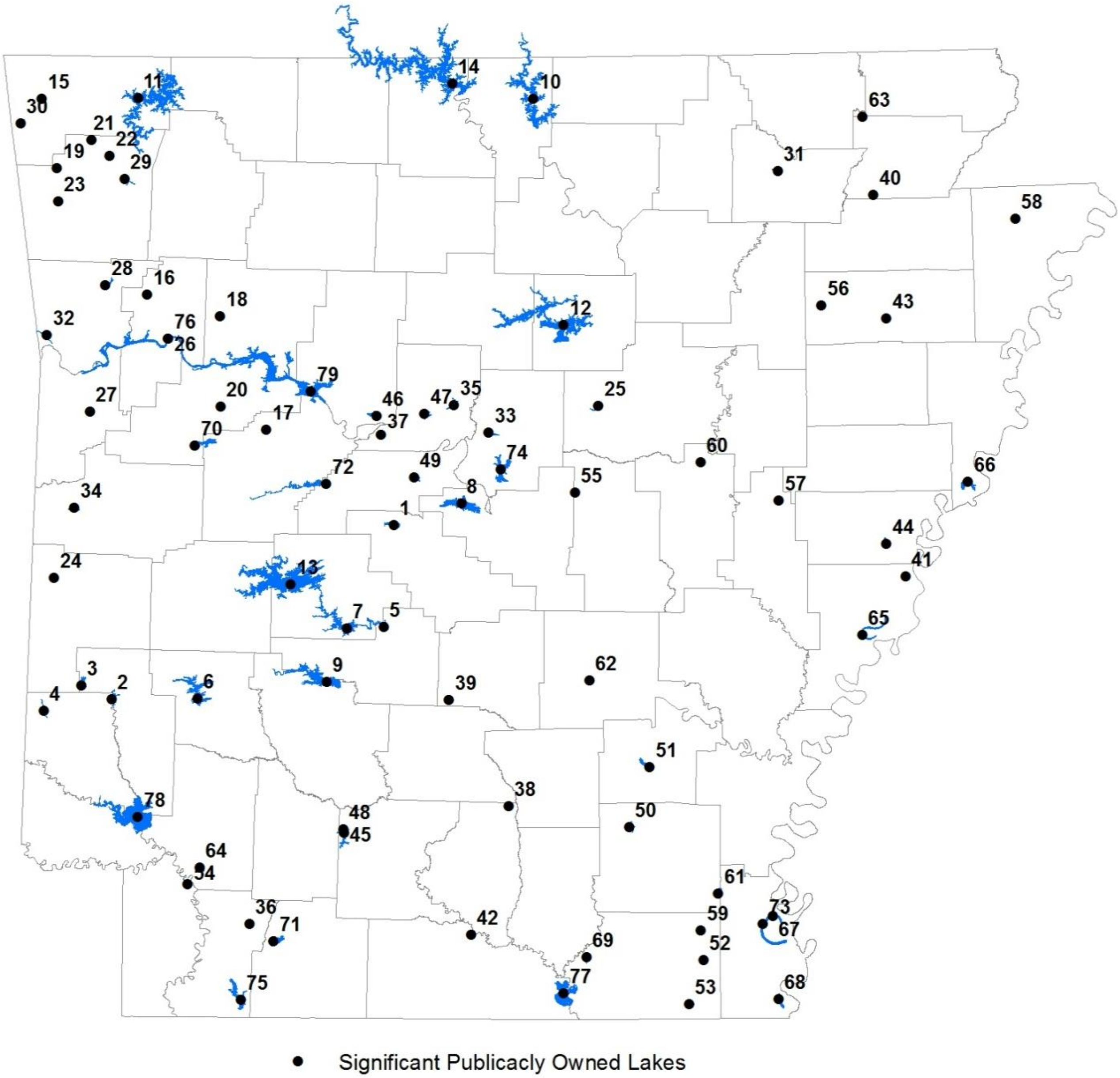
Type D

These are small impoundments of the Delta area of the State, but include two similar type lakes from the large river alluvium of the Gulf Coastal Plains Ecoregion. These lakes are generally 200 to 500 acres in size with average depths of approximately five feet. This group includes several natural, oxbow cutoff lakes which have been modified by a water control structure to increase their isolation from the parent stream and maintain higher dry season water levels. These lakes are only occasionally flooded by the parent stream and generally have very small direct runoff watersheds. The other lakes of this type are man-made, but they are almost totally isolated from their watershed by levees. Water levels are maintained through occasional pumping from adjacent waterways. In this group, runoff from watersheds that discharge directly into oxbow lakes is primarily from row crop agriculture.

Type E

These are large lowland lakes of the Delta, Gulf Coastal Plains, and the large alluvial areas of the Arkansas River Valley Ecoregion. They range from several thousand to over 30,000 acres in size, but average depth is usually less than 10 feet. This group also includes four large, oxbow cutoff lakes which have been substantially modified by construction of drainage ditches, levees and other water control structures. Watershed types include mixtures of intensive row crop agriculture, small farms and pastures (with increasing amounts of confined animal production) and timberlands.

Figure III-5: Significant Publicly-Owned Lakes



See Table III-50 for lake information corresponding to numbers on map.

Table III-18: Significant Publicly-Owned Lakes

No.	Lake	County	Acres	Ave. Depth	Water Shed (mi^2)	W/A[#]	Eco-region[*]	Primary Purpose[+]	Type
1	Winona	Saline	1240	30	44.4	22.9	OM	W	A
2	Dierks	Howard	1360	22	114	53.6	OM	F	A
3	Gillham	Howard	1370	21	271	126.6	OM	F	A
4	DeQueen	Sevier	1680	21	169	64.4	OM	F	A
5	Catherine	Hot Spring	1940	18	1516	500.1	OM	H	A
6	Greeson	Pike	7200	39	237	21.1	OM	H	A
7	Hamilton	Garland	7300	26	1441	126.3	OM	H	A
8	Maumelle	Pulaski	8900	23	137	9.9	OM	W	A
9	DeGray	Clark	13200	49	453	22	OM	H	A
10	Norfork	Baxter	22000	57	1806	52.5	OH	H	A
11	Beaver	Benton	28200	58	1186	26.9	OH	H	A
12	Greers Ferry	Cleburne	31500	60	1153	23.4	BM	H	A
13	Ouachita	Garland	40100	51	1105	17.6	OM	H	A
14	Bull Shoals	Marion	45440	67	6036	85	OH	H	A
15	Crystal	Benton	60	12	4.5	48	OH	A	B
16	Shores	Franklin	82	10	26	202.9	BM	R	B
17	Spring	Yell	82	23	10.5	82	ARV	R	B
18	Horsehead	Johnson	100	16	17.3	110.7	BM	R	B
19	Wedington	Washington	102	16	3	18.8	OH	R	B
20	Cove	Logan	160	10	8.5	34	ARV	R	B
21	Elmdale	Washington	180	8	6	21.3	OH	A	B
22	Fayetteville	Washington	196	15	6	19.6	OH	R	B
23	Bobb Kidd	Washington	200	13	4	12.8	OH	A	B
24	Wilhelmina	Polk	200	10	13.5	43.2	OM	A	B
25	Barnett	White	245	27	37.5	98	ARV	A	B
26	Sugarloaf	Sebastian	250	12	5	12.8	ARV	A	B
27	Nolan (Wright)	Sebastian	350	9	3.1	5.7	ARV	A	B
28	Ft. Smith	Crawford	1390	---	73	33.6	BM	W	B
29	Sequoyah	Washington	500	8	275	352	OH	R	B
30	SWEPCO	Benton	531	17	14	16.9	OH	W	B
31	Charles	Lawrence	562	8	18	20.5	OH	A	B
32	Lee Creek	Crawford	634	11	465	469.4	BM	W	B
33	Beaver Fork	Faulkner	900	10	11.5	8.2	ARV	R	B
34	Hinkle	Scott	965	15	27.5	18.2	ARV	A	B
35	Brewer	Conway	1165	20	36.4	20	ARV	W	B
36	June	Lafayette	60	5	4	42.7	GCP	A	C
37	Bailey	Conway	124	8	7.5	38.7	ARV	R	C

Table III-18: Significant Publicly-Owned Lakes

No.	Lake	County	Acres	Ave. Depth	Water Shed (mi^2)	W/A#	Eco-region*	Primary Purpose+	Type
38	Tricounty	Calhoun	280	7	11.5	26.3	GCP	A	C
39	Cox Creek	Grant	300	6	17	36.3	GCP	A	C
40	Frierson	Greene	335	8	7.3	13.9	D	A	C
41	Storm Creek	Phillips	420	7	8	12.2	D	R	C
42	Calion	Union	510	6	6.7	8.4	GCP	A	C
43	Poinsett	Poinsett	550	7	4.5	5.2	D	A	C
44	Bear Creek	Lee	625	10	6	6.1	D	R	C
45	Upr White Oak	Ouachita	630	8	20.7	21	GCP	A	C
46	Atkins	Pope	750	6	10.2	8.7	ARV	A	C
47	Overcup	Conway	1025	4	17.2	10.7	ARV	A	C
48	Lwr White Oak	Ouachita	1080	8	42.5	25.2	GCP	A	C
49	Harris Brake	Perry	1300	6	11.2	5.5	ARV	A	C
50	Monticello	Drew	1520	12.5	6.8	2.9	GCP	A	C
51	Cane Creek	Lincoln	1620	6	24	9.5	GCP	A	C
52	Wilson	Ashley	150	5	1	4.3	D	A	D
53	Enterprise	Ashley	200	5	2	6.4	D	A	D
54	First Old River	Miller	200	4	2	6.4	GCP	A	D
55	Pickthorne	Lonoke	207	5	13.2	40.8	D	A	D
56	Hogue	Poinsett	280	4	2	4.6	D	A	D
57	Greenlee	Monroe	300	6	0.5	1.1	D	A	D
58	Mallard	Mississippi	300	6	0.5	1.1	D	A	D
59	Grampus	Ashley	334	6	2	3.8	D	A	D
60	Des Arc	Prairie	350	6	1	1.8	D	A	D
61	Wallace	Drew	362	5	1	1.8	D	A	D
62	Pine Bluff	Jefferson	500	6	4	5.1	D	A	D
63	Ashbaugh	Greene	500	5	1	1.3	D	A	D
64	Bois D'Arc	Hempstead	750	4	4	3.4	GCP	A	D
65	Old Town	Phillips	900	4	23	16.4	D	R	D
66	Horseshoe	Crittenden	1200	10	13.5	7.2	D	R	E
67	Upper Chicot	Chicot	1270	15	14	7.1	D	R	E
68	Grand	Chicot	1400	7	5.5	2.5	D	A	E
69	Georgia Pacific	Ashley	1700	4	4	1.5	GCP	W	E
70	Blue Mountain	Logan	2900	9	488	107.7	ARV	F	E
71	Columbia	Columbia	2950	11	48	10.4	GCP	W	E
72	Nimrod	Yell	3600	8	680	120.9	ARV	F	E
73	Lower Chicot	Chicot	4030	15	350	55.6	D	R	E
74	Conway	Faulkner	6700	5	136	13	ARV	A	E

Table III-18: Significant Publicly-Owned Lakes

No.	Lake	County	Acres	Ave. Depth	Water Shed (mi^2)	W/A[#]	Eco-region[*]	Primary Purpose[+]	Type
75	Erling	Lafayette	7000	7	400	36.6	GCP	W	E
76	Ozark	Franklin	10600	14	151801	9165.3	ARV	N	E
77	Felsenthal	Bradley	14000	7	10852	496.1	GCP	R	E
78	Millwood	Little River	29500	5	4144	89.9	GCP	F	E
79	Dardanelle	Pope	34300	14	153666	2867.2	ARV	N	E
		Total Acres	**357896**						

[#] Watershed (Acres)/Area of Lake

* OM=Ouachita Mountains; BM=Boston Mountains; OH=Ozark Highlands; ARV=Arkansas River Valley; GCP=Gulf Coastal Plain; D=Delta

+ Primary purpose corresponds with lake creation needs. This does not correspond with Designated Use(s) for the lake. W=Water Supply; F=Flood Control; H=Hydropower; A=Angling (Public Fishing); N=Navigation; R=Recreation

Water Quality Standards Development

In cooperation with the Little Rock office of the USGS, the Division coordinated projects to develop water quality standards for publicly-owned lakes. The first phase was to identify reference lakes for each of the lake types and different lake purposes within each of the State's ecoregions. The goals of the first phase were to develop a process for identifying potential reference lakes, identify these lakes, and collect water quality data from these lakes to verify reference conditions. The second phase included intensive, multi-year water quality sampling to support the reference lake determination; establish a database that can be used to help determine water quality trends and criteria; determine the similarities and differences between and among the lakes; and establish a more precise classification of the lakes.

Phase I and Phase II projects have been completed for the smaller impoundments of the Gulf Coastal, Mississippi Alluvial Plains, Boston Mountains, and Ozark Highlands ecoregions. Data produced from these projects have indicated that three to four reference lakes per ecoregion is inadequate because of the vast differences within each ecoregion. The approach outlined in the original projects is being revised to better identify least-disturbed ecoregion lakes.

Lakes on the List of Impaired Waterbodies

Part IV of this report (Table IV-6) lists lakes that have had TMDLs completed (Category 4a). The majority of the TMDLs completed involving lakes have been for mercury contamination of edible fish tissue. Other TMDLs have been completed for either nutrients or turbidity.

Impaired Uses of Lakes

Table III-19: Lakes Use Support

Degree of Use Support	Total Assessed (acres)
Size Fully Supporting	253,432
Size Not Supporting	25,304
Total Assessed (acres)	278,736

Table III-20: Designated Use Support of Assessed Lakes by Use Type

Designated Use Type	Support (Lake acres)	Non-Support (Lake acres)
Fish consumption	246,539	6,893
Aquatic Life	242,552	10,880
Primary Contact Recreation	249,947	3,485
Secondary Contact Recreation	253,432	0
Domestic Water Supply	253,432	0
Agricultural & Industrial Water Supply	253,432	0

+Total surface acres of the oxbow lakes in the Ouachita River basin are unknown.

Table III-21: Total Sizes of Lakes Listed Not Supporting Uses by Various Source Categories

Source Categories	Number of Lake Assessment Units	Lake Acres
Industrial Point Source	1	467
Surface erosion	4	5,337
Unknown	22	14,990

Table III-22: Total Sizes of Lakes Listed Not Supporting Uses by Various Cause Categories

Cause Categories	Number of Lake Assessment Units	Lake Acres
Dissolved Oxygen	3	3,784
pH	6	2,417
Nutrients (nitrogen & phosphorus)	6	6,428
Siltation/Turbidity	5	5,680
Pathogens	3	3,485
PCBs	1	467
Copper	1	343
Mercury	35	6,426
Unknown	1	325

+Total surface acres of the oxbow lakes in the Ouachita River basin are unknown.

National Aquatic Resource Surveys (NARS)

The National Aquatic Resource Surveys (NARS) are statistical surveys designed to assess the status of and changes in quality of the nation's lakes and reservoirs, rivers and streams, and wetlands. Using sample sites selected at random, these surveys provide a snapshot of the overall condition of the nation's water. Because the surveys use standardized field and lab methods, we can compare results from different parts of the country and between years. EPA works with state, tribal and federal partners to design and implement the National Aquatic Resource Surveys.

These surveys are providing critical, groundbreaking, and nationally-consistent water quality information. Additionally, the national surveys are helping to build stronger water quality monitoring programs across the country by fostering collaboration on new methods, new indicators and new research.

In Arkansas, NARS consists of individual surveys to evaluate rivers and streams and lakes that are implemented on a rotating basis.

Rivers and Streams

Wadeable Stream Assessment (WSA)

Wadeable Stream Assessment (2004) randomly selected 1,392 sites across the United States, of which 24 sites were in Arkansas. Arkansas's streams were better than the national condition for benthic macroinvertebrate taxa loss. Nationally, only 42% of stream retained more than 90% of the expected taxa, whereas Arkansas had 52%. The expected taxa at individual sites are predicted from a modeled developed from data collected at least-disturbed reference sites. By comparing the list of observed at a site to what is expected to occur, the proportion of expected taxa that have been lost can be quantified.

National Rivers and Streams Assessment (NRSA)

The Division, at the request of U.S. EPA Region VI, reviewed EPA's National Rivers and Streams Assessment 2008-2009 (2013). The National Rivers and Streams Assessment (NRSA) was designed to study all rivers and streams of the United States from the largest rivers to the smallest streams following a statistically validated approach. DEQ review was initiated to address discrepancies brought forth by U.S EPA Region VI regarding the percentage of impaired waters on Arkansas's 2008 and draft 2010, 2012 303(d) listings and the percentage of impaired waters described from the 2008-2009 NRSA. In short, the 2008-2009 NRSA classifies 57% of the State's river miles sampled as "Poor" condition due to total nitrogen, total phosphorous, and/or salinity. Arkansas's 2008 303(d) list classifies 41% of State assessed waters as impaired for all parameters, including nutrients, while the State's draft 2010 and 2012 303(d) list identifies 38% and 37% as impaired, respectively.

Furthermore, 2008-2009 NRSA data indicate biological impairment at approximately 89% of stations sampled. Impairments of periphyton, macroinvertebrate, and/or fish assemblages were determined using metrics derived from a large-scale dataset and the assemblage derivation from least-disturbed reference conditions. Due to concerns of longitudinal shifts in assemblage structure associated with stream order, planning staff only assesses biocriteria scores for fishes collected from wadeable streams. Multi-metric indices to evaluate macroinvertebrate or periphyton assemblages in Arkansas have yet to be established; therefore, comparisons were only made regarding fish collections. Planning staff thoroughly reviewed fish assemblage data and are in disagreement on the proportion of site identified as "Poor" condition (43% or 30 of 69). Planning staff analyzed fish assemblages using DEQ's CSI and determined only 14 of 69 stations had less than comparable fish assemblages. However, there were discrepancies between specific sites characterized by DEQ and NRSA as having a poor fish assemblage. Additionally, 10 of ADEQ's 14 stations were considered as either intermittent or canal/ditch by NHD. A disproportionate amount of headwater streams may be influencing results and interpretation of water quality and biological impairment for several key reasons. A one-time site visit to headwater streams, without regard to duration of flow, cannot be expected to portray an accurate depiction of biotic and abiotic conditions. As mentioned, a number of stations sampled were actually agricultural ditches. These waterbodies should not be included when interpreting the state of our waters.

The NRSA study design was specifically geared for uneven selection of sites among stream orders for wadeable and non-wadeable. Distribution of 2008-2009 NRSA sites indicated 52% had watershed areas < 10 mi^2. Arkansas streams with watershed sizes of <10 mi^2 and of 1st-3rd order are most likely intermittent, at best. A total of 39 % of NRSA stations were identified as intermittent using NHD, and 6 sites were classified as canal/ditch. Arkansas's Reg. 2 establishes a seasonal aquatic life use for watersheds <10 mi^2 during the primary season. Of the 43 <10 mi^2 NRSA sites, 93% were sampled during the critical season, May through September, when sites are not expected to support aquatic life. The Division's water quality monitoring stations have been more orientated towards larger watersheds to fully assess waters of the State. In 2008, distribution of DEQ's water quality monitoring stations was weighted more heavily towards streams and rivers with watersheds >100mi^2. From 2008 to 2011, there was a 9% increase of streams with <10 mi^2 and a 243% increase in total number of stations. Despite marked increase of sampling stations between 2008 and 2011, there was a reduction of 2078 impaired miles between Arkansas's 2008 303(d) list and draft 2012 303(d) list.

The EPA has collected data for 2013-2014, but is processing data and evaluating data quality. The next scheduled assessment will be 2018-2019.

Lakes and Reservoirs

National Lakes Assessment (NLA)

As of 2018, the National Lakes Assessment (NLA) has been conducted three times since the beginning of the NARS program. The NLA assesses the condition of the nation's lakes by randomly selecting sites using a probability-based design, which represents lake population among ecoregions. There were 10 lakes selected to represent Arkansas. Results from the 2007 survey indicated that 56% of lakes nationally were in good biological condition and 22% were in poor condition. Biological condition was based on observed vs expected results using a combined phytoplankton-zooplankton index. From the lakes sampled in Arkansas, 78% were in good biological condition, and none were assessed as poor. Two sites in Arkansas were most disturbed for phosphorus, and 40% were intermediately disturbed. None of the selected lakes had high levels of nitrogen, but the lakes with intermediate disturbance were also 40%. Nationally, nitrogen and phosphorus levels were high in 20% of lakes. The algal toxin microcystin was detected at low levels at two sites in Arkansas, but all other locations had levels below detection limits. Similar results were seen nationally with 31% detection, but at low levels.

The NLA was conducted again in 2012 and also included small lakes (1 – 4 acres) in addition to lake size criteria that had been used in the previous assessment. When comparing indicators from each assessment, little had changed within 5 years. However, there was a noticeable increase in lakes with microcystin presence (↑ 8%) and nutrient pollution (nitrogen ↑16%, phosphorus ↑22%). Eight lakes were selected to represent Arkansas for the 2012 assessment. Instead of using the observed/expected ratio that was calculated in the 2007 assessment, benthic macroinvertebrate and zooplankton represented biological condition. Benthic macroinvertebrate condition was poor in 63% of Arkansas lakes as was 25% of zooplankton condition. National condition for benthic macroinvertebrates and zooplankton were 31% and 33%, respectively. Like national results, lakes representing Arkansas saw increased amounts of microcystin (↑5%) and nutrients (nitrogen ↑38%, phosphorus ↑18%). Trophic status was based on chlorophyll as a proxy for primary productivity. Lakes throughout the nation were determined to be 21% hypereutrophic and 34% eutrophic, and Arkansas representatives were 38% and 25%, respectively.

The most recent NLA was conducted in summer 2017 by ADEQ staff. Eight lakes were chosen based on criteria laid out throughout the program, which included >1000 m^2 open water, > 1 m depth, and physically accessible. Additional variables were added to the analysis which include eDNA and air/dissolved gas samples. Results of this survey will not be completed until 2020.

Nutrient Criteria Development for Ozark Highland Extraordinary Resource Waterbodies (ERWs)

In 2013, the Division began physical, chemical, and biological evaluation of Ozark Highland ecoregion Tier III waterbodies (herein Extraordinary Resource Waterbody, ERWs) for the purpose of nutrient criteria development. Objectives of this project were twofold; evaluate biological integrity of ERWs as well as evaluate causal-response relationships. For the latter objective, DEQ entered into a Nutrient Scientific Technical Exchange Partnership and Support (N-STEPS) partnership with EPA. DEQ and N-STEPS analyses of the Ozark Highland ERW data indicate relatively low nutrient concentrations among these waterbodies. For the 2013-2015 study period, median total phosphorus and total nitrogen concentrations for ERWs were generally at or below 25th percentile for all water chemistry data collected between 2004 and 2015 from the entire Ozark Highland ecoregion. Among Ozark Highland ERWs, 67% had median total nitrogen below ecoregion 25th percentile and 33% of sites had median total phosphorus concentrations below ecoregion 25th percentile. DEQ and N-STEPS evaluated three biological assemblages representative of increasing trophic functions as response variables to increasing nutrients. Dissolved oxygen was not strongly correlated to densities of benthic periphyton. However, benthic periphyton biomass and benthic chlorophyll-α were strongly correlated to total nitrogen with weaker correlations with total phosphorus. Fall macroinvertebrate measures, specifically Ephemeroptera, Plecoptera, and Trichoptera (EPT) abundance, taxa richness, and EPT richness, demonstrated strongest negative relationship with total phosphorus. Decreases of EPT taxa were also correlated with increased benthic periphyton.

Nutrient Criteria Development for Boston Mountain Extraordinary Resource Waterbodies (ERWs)

DEQ began an investigation and subsequent classification and validation of site-specific nutrient criteria for the Extraordinary Resource Water Bodies within the Boston Mountains. The goal of this study was to develop site-specific criteria for Boston Mountain ERW's as a whole or individually, based on findings of the study. As this is not a stressor-response study it is not imperative for a nutrient gradient to be present. This study began with a priori classification of streams based upon historical nutrient concentrations. Classification of streams by nutrient concentrations were based upon standard methodologies (EPA 2000). Upon site selection, DEQ scientists conducted intensive sampling of each stream's water quality, macroinvertebrate assemblages, fish community, and periphyton biomass.

Evaluation of Boston Mountain ERWs resulted in total phosphorus and total nitrogen distributional statistics near or below that of EPA's 2002 recommended values for nutrient ecoregion XI. EPA's recommended values for the Interior Highlands (Ozark Highland, Boston Mountain, and Ouachita Mountain ecoregions) are 0.01 mg/L TP and 0.31 mg/L TN. Measures of central tendency, both median and mean, indicate relatively low concentrations of total phosphorus and total nitrogen. However, one potentially limiting factor is that E&E's Laboratory Services has a 0.01 mg/L detection limit for total phosphorus. Therein lies potential for actual values to be much lower than reported and requires a thorough evaluation of censored data prior to additional analyses of distributional statistics. Nutrient enrichment and impacts were evaluated with measures of photosynthetic productivity and aquatic life. During this study, significant negative relationships were detected among sensitive macroinvertebrate taxa (i.e. percent intolerant and percent intermediate tolerance) with increasing total nitrogen. Results of the Ozark Highland NSTEPS project indicated similar responses to nitrogen among higher trophic groups, however strong relationships were not observed among total nitrogen and measures of productivity. A possible and unexplored alternative is that phosphorus is assimilated so quickly and is present at such low concentrations that relationships are difficult to detect. Other strong correlations among macroinvertebrates were observed among major ions, particularly chloride and TDS. Further investigation of potential spurious correlations should be pursued to evaluate the influence of point source discharges, if any, particularly if least-disturbed conditions are applied. DEQ is currently focusing efforts on developing numeric nutrient criteria for the Ozark Highlands, for the ecoregion as a whole or applicable just to ERWs within the ecoregion. As study design and monitoring efforts in the Ozark Highlands were replicated in the Boston Mountains, DEQ intends to take the same approach determining magnitude, frequency, and duration of the Boston's as was done for the Ozark's. Additional data is necessary for the State to proceed with numeric nutrient criteria development in the Boston Mountain ecoregion. The current study represents a very limited dataset from a two year period. DEQ will mirror efforts of NSTEPS in exploring other existing paired chemical and biological data collected throughout the entirety of the ecoregion to define least disturbed condition and explore magnitudes derived from reference condition approach. Ideally, interpretation of values derived from this approach will be supplemented with paired data collected outside the scope of this project so that testing of stressor response relationships can be used to further support determination of appropriate magnitudes for the ecoregion as a whole. It is acknowledged that additional water chemistry may need to be collected at all existing ERW locations and/or potentially least-disturbed locations in order to achieve a more defensible sample size. Additionally, appropriate frequency and duration components must be evaluated for future proposed criteria. These criteria attributes will reflect conditions under which magnitude components were developed and will appropriately account for spatial and temporal variability.

Data Collection for the Development of Nutrient Criteria for Extraordinary Resource Waterbodies (ERW) in the Ouachita Mountains Ecoregion of Arkansas

DEQ began an investigation and subsequent classification and validation of site-specific nutrient criteria for the Extraordinary Resource Waterbodies within the Ouachita Mountains. The goal of this study was to develop site-specific criteria for Ouachita Mountain ERW's as a whole or individually, based on findings of the study. As this is not a stressor-response study it is not imperative for a nutrient gradient to be present. This study began with a priori classification of streams based upon historical nutrient concentrations. Classification of streams by nutrient concentrations were based upon standard methodologies (EPA 2000). Upon site selection, DEQ scientists conducted intensive sampling of each stream's water quality, macroinvertebrate assemblages, fish community, and periphyton biomass.

Nutrient concentrations at all of the sites were relatively low, close to the EPA recommended levels for the Ouachita Mountains ecoregion of 0.01 mg/L TP and 0.31 mg/L TN (these values were reported in another report to EPA, No. I000F87601-0). For context, average TP was ≤0.05 mg/L in 11 out of the 12 sites, and average TN was ≤0.33 mg/L for all 12 sites. Correlations with nutrients revealed statistically significant negative relationships between both TN and TP and average %EPT for fall samples. For the spring samples there was still a negative relationship for TN and TP and average %EPT, but the relationship was only significant for TN. Percent intolerant macroinvertebrates had a significant negative correlation with TN, while % tolerant macroinvertebrates had significant positive correlations with average TN for both spring and fall, and a significant positive correlation with average TP in spring.

Fish communities showed no significant relationships with average TN or TP; but there were significant relationships between other nutrient parameters. Percent Key Individuals had a significant negative relationship with average inorganic nitrogen. There were significant positive correlations between average TKN and % centrarchidae and richness; while there was a significant negative correlation between average TKN and % percidae.

Background

The 1994 Water Quality Inventory report contained an in-depth look at bioaccumulative compounds and trace metals in Arkansas's lakes and streams. It was the culmination of a cooperative effort with the AGFC to collect, analyze, and evaluate data on compounds that could affect public health or aquatic life. The report contained data collected from numerous streams, rivers, and lakes. Overall, data collected and/or analyzed during the 1994 reporting period were much more extensive than usual. Since that report, the collection and analysis of data has been concentrated on evaluating the mercury problems discussed in the 1994 report.

During the 1996 reporting period, the Division's monitoring program concentrated on mercury and its effects on public health. Edible fish tissue (fillets), usually from predatory fishes, was analyzed for metals and pesticides from 32 lakes and numerous stream segments. These results are documented in the ADEQ (1996) *Integrated Water Quality Monitoring and Assessment Report*.

Since the 1996 reporting period, fish tissue has only been collected from those areas of the State with the greatest risk and highest concentrations of mercury and/or other fish tissue contaminants.

Public Health and Aquatic Life Impacts

Fish Consumption Advisories

Table III-23 lists the current fish consumption advisories for the State. The most significant health advisory changes in the State over the last several years have been the reduction in the total number of stream miles with dioxin advisories.

The Arkansas Department of Health (ADH) is responsible for issuing fish consumption advisories. Few waters have been added to the fish consumption advisory list since the 1996 report. Some advisories concerning the consumption of fish tissue with mercury contamination have been better defined and some dioxin advisories have been removed and/or scaled back. It is important to contact DEQ, ADH, or AGFC for the latest advisories.

<table>
<tr><th colspan="8">Table III-23: Fish Consumption Advisories in Place as of September, 2017</th></tr>
<tr><th rowspan="3">Waterbody /Reach No.</th><th rowspan="3">Type</th><th rowspan="3">Size Affected</th><th colspan="4">Type Fish Consumption Restricted</th><th rowspan="3">Pollutant of Concern</th></tr>
<tr><th colspan="2">No Consumption</th><th colspan="2">Lim. Consumption</th></tr>
<tr><th>Gen Pop</th><th>High Risk</th><th>Gen Pop</th><th>High Risk</th></tr>
<tr><td rowspan="2">Bayou Bartholomew
08040205–002
08040205–012</td><td>River</td><td>~48 miles</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat flathead catfish, gar, bowfin, pickerel, or blue catfish (20 inches or longer), largemouth bass (12 inches or longer) or buffalo (18 inches or longer) from this bayou.
The general public should eat no more than 2 meals per month of flathead catfish, gar, pickerel, bowfin, blue catfish (20 inches or longer), largemouth bass (12 inches or longer) or buffalo (18 inches or longer) from this bayou.</td></tr>
<tr><td rowspan="2">Bayou Meto
08020402–007</td><td>Stream</td><td>~48 miles</td><td>X</td><td>X</td><td></td><td></td><td>Dioxin</td></tr>
<tr><td colspan="7">Should not eat any fish from this stream due to dioxin contamination. This applies to all risk groups.</td></tr>
<tr><td rowspan="2">Big Cr Tributary
11140203–XXX</td><td>Stream</td><td>~2 miles</td><td>X</td><td>X</td><td></td><td></td><td>PCBs</td></tr>
<tr><td colspan="7">This stream is closed to fishing due to polychlorinated biphenyl contamination.</td></tr>
<tr><td rowspan="2">Big Johnson Lake
(Calhoun County)</td><td>Lake</td><td>80 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups have no restrictions on consumption of crappie or buffalo. They should not eat all other predators and non-predators.
The general public has no restrictions on the consumption of crappie or buffalo. They should not eat more than two meals per month of all other predators. There is no restriction on consumption of non-predator fish.</td></tr>
<tr><td rowspan="2">Champagnolle
08040201–003
L. Champagnolle
08040201–903</td><td>Stream</td><td>~20 miles</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat flathead catfish, gar, bowfin, drum, pickerel or largemouth bass (13 inches in length or longer) from this creek.
The general public should eat no more than 2 meals per month of flathead catfish, gar, pickerel, bowfin or largemouth bass (13 inches or longer) from this creek.</td></tr>
<tr><td rowspan="2">Lake Columbia</td><td>Lake</td><td>2,950 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat pickerel, flathead catfish, gar, bowfin or largemouth bass (16 inches or longer) from this lake.
The general public should not eat flathead catfish, gar, pickerel or bowfin. No more than 2 meals a month of largemouth bass (16 inches or longer) from this lake.</td></tr>
<tr><td rowspan="2">Cove Creek Lake
(Perry County)</td><td>Lake</td><td>46 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (12 inches or longer) from this lake.
The general public should not largemouth bass (over 16 inches in length). No more than 2 meals per month of largemouth bass (12-16 inches in length) should be eaten from this lake.</td></tr>
<tr><td rowspan="2">Cut-Off Creek
08040205–007</td><td>Stream</td><td>16.8 miles</td><td></td><td>X</td><td>X</td><td></td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat any fish from this creek.
The general public should not eat drum, buffalo, redhorse or suckers. No more than 2 meals per month of largemouth bass, catfish, crappie, gar, pickerel and bowfin from this creek.</td></tr>
</table>

<table>
<tr><th colspan="8">Table III-23: Fish Consumption Advisories in Place as of September, 2017</th></tr>
<tr><th rowspan="3">Waterbody /Reach No.</th><th rowspan="3">Type</th><th rowspan="3">Size Affected</th><th colspan="4">Type Fish Consumption Restricted</th><th rowspan="3">Pollutant of Concern</th></tr>
<tr><th colspan="2">No Consumption</th><th colspan="2">Lim. Consumption</th></tr>
<tr><th>Gen Pop</th><th>High Risk</th><th>Gen Pop</th><th>High Risk</th></tr>
<tr><td rowspan="2">Dorcheat Bayou
11140203–020
11140203–022
11140203–024
11140203–026</td><td>Stream</td><td>50.6 miles</td><td></td><td>X</td><td>X</td><td></td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat any fish from this bayou.
The general public should not eat largemouth bass (16 inches or longer). No more than 2 meals per month of catfish, crappie, gar, pickerel, bowfin or largemouth bass (under 16 inches in length) should be eaten from this lake.</td></tr>
<tr><td rowspan="2">Dry Fork Lake
(Perry County)</td><td>Lake</td><td>104 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (16 inches or longer) from this lake.
The general public should eat no more than 2 meals per month of largemouth bass (16 inches or longer) from this lake.</td></tr>
<tr><td rowspan="2">Dupree Lake</td><td>Lake</td><td><10 acres</td><td>X</td><td>X</td><td></td><td></td><td>Dioxin</td></tr>
<tr><td colspan="7">Should not eat any fish from this stream due to dioxin contamination. This applies to all risk groups.</td></tr>
<tr><td rowspan="2">Felsenthal Wildlife Refuge</td><td>Lake</td><td>14,000 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (13 inches or longer), flathead or blue catfish, pickerel, gar, bowfin or drum from this refuge.
The general public should not eat flathead catfish, gar, bowfin, drum, pickerel or largemouth bass (16 inches in length or longer). No more than 2 meals per month of blue catfish and largemouth bass (13-16 inches in length) should be eaten from this refuge.</td></tr>
<tr><td rowspan="2">Fourche La Fave River
11110206–002</td><td>River</td><td>8.7 miles</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (16 inches or longer) from this river.
The general public should eat no more than 2 meals per month of largemouth bass (16 inches or longer) from this river.</td></tr>
<tr><td rowspan="2">Grays Lake
(Cleveland County)</td><td>Lake</td><td>22 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat flathead catfish (26 inches or longer), largemouth bass (13 inches or longer), gar, bowfin or pickerel.
The general public should not eat largemouth bass over 16 inches in length. No more than 2 meals per month of gar, bowfin, pickerel, flathead catfish (26 inches or longer) or largemouth bass (13-16 inches in length) from this lake.</td></tr>
<tr><td rowspan="2">Johnson Hole
(Van Buren County)</td><td>Lake</td><td>~50 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (16 inches or longer) from this river area.
The general public should not eat largemouth bass (16 inches or longer) from this river area.</td></tr>
<tr><td rowspan="2">Moro Bay Creek
08040201–001</td><td>Stream</td><td>~12 miles</td><td></td><td>X</td><td>X</td><td></td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat any fish from this creek.
The general public should not eat largemouth bass, catfish, crappie, gar, pickerel or bowfin. No more than 2 meals per month of bream, drum, buffalo, redhorse and suckers from this creek.</td></tr>
</table>

<table>
<tr><th colspan="8">Table III-23: Fish Consumption Advisories in Place as of September, 2017</th></tr>
<tr><th rowspan="3">Waterbody /Reach No.</th><th rowspan="3">Type</th><th rowspan="3">Size Affected</th><th colspan="4">Type Fish Consumption Restricted</th><th rowspan="3">Pollutant of Concern</th></tr>
<tr><th colspan="2">No Consumption</th><th colspan="2">Lim. Consumption</th></tr>
<tr><th>Gen Pop</th><th>High Risk</th><th>Gen Pop</th><th>High Risk</th></tr>
<tr><td rowspan="2">Nimrod Lake</td><td>Lake</td><td>3,600 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (16 inches or longer) from this lake.
The general public should eat no more than 2 meals per month of largemouth bass (16 inches or longer) from this lake.</td></tr>
<tr><td rowspan="2">Lake Ouachita</td><td>Lake</td><td>40,100 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (13 inches or longer), white bass (13 inches or longer), or striped bass (25 inches or longer) from this lake.
The general public should eat no more than 2 meals per month of largemouth bass (13 inches or longer), white bass (13 inches or longer), or striped bass (25 inches or longer) from this lake.</td></tr>
<tr><td rowspan="2">Ouachita River
08040201–002
08040201–004
08040202–002
08040202–003
08040202–004</td><td>River</td><td>66.3 miles</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass, flathead catfish, pickerel, gar or bowfin from this river.
The general public should not eat largemouth bass, flathead catfish, pickerel, gar or bowfin from this river.</td></tr>
<tr><td rowspan="2">Saline River
08040204–001
08040204–002</td><td>River</td><td>55.8 miles</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (13 inches or longer), flathead or blue catfish, pickerel, gar, bowfin or drum from this refuge.
The general public should not eat flathead catfish, gar, bowfin, drum, pickerel or largemouth bass (16 inches in length or longer). No more than 2 meals per month of blue catfish and largemouth bass (13-16 inches in length) should be eaten from this refuge.</td></tr>
<tr><td rowspan="2">Saline River
08040204–004
08040204–006</td><td>River</td><td>33.9 miles</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat blue catfish, flathead catfish, gar, bowfin, drum, pickerel or largemouth bass (13 inches or longer) or redhorse (20 inches or longer) from this river.
The general public should not eat blue catfish, flathead catfish, gar, bowfin, drum, pickerel, largemouth bass (over 16 inches in length) or redhorse (20 inches or longer). No more than 2 meals per month of largemouth bass (13-16 inches in length) should be eaten from this river.</td></tr>
<tr><td rowspan="2">Lake Saracen (Jefferson County)</td><td>Lake</td><td>500 acres</td><td></td><td></td><td>X</td><td>X</td><td>PCBs</td></tr>
<tr><td colspan="7">High risk groups should not eat buffalo fish from this lake.
The general public should not eat buffalo fish from this lake.</td></tr>
<tr><td rowspan="2">Lake Fort Smith
Formerly Shepherd Springs Lake Area (Crawford County)</td><td>Lake</td><td>1,390 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat black bass (16 inches or longer) from this lake.
The general public should not eat black bass (over 20 inches in length). No more than 2 meals per month of black bass (16-20 inches in length) should be eaten from this lake.</td></tr>
</table>

<table>
<tr><th colspan="9">Table III-23: Fish Consumption Advisories in Place as of September, 2017</th></tr>
<tr><th rowspan="3">Waterbody /Reach No.</th><th rowspan="3">Type</th><th rowspan="3">Size Affected</th><th colspan="4">Type Fish Consumption Restricted</th><th rowspan="3">Pollutant of Concern</th></tr>
<tr><th colspan="2">No Consumption</th><th colspan="2">Lim. Consumption</th></tr>
<tr><th>Gen Pop</th><th>High Risk</th><th>Gen Pop</th><th>High Risk</th></tr>
<tr><td rowspan="2">South Fork Little Red River 11010014–036</td><td>River</td><td>2.0 miles</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (16 inches or longer) from this area.
The general public should not eat largemouth bass (16 inches or longer) from this area.</td></tr>
<tr><td rowspan="2">Lake Winona (Saline County)</td><td>Lake</td><td>1,240 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat black bass (16 inches or longer) from this lake.
The general public should eat no more than 2 meals per month of black bass (16 inches or longer) from this lake.</td></tr>
<tr><td rowspan="2">Oxbow Lakes</td><td>All types</td><td>1,240 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">There is an advisory on all oxbow lakes, backwaters, overflow lakes and bar ditches formed by the Ouachita River below Camden.
High risk groups should not eat largemouth bass, flathead catfish, pickerel, gar or bowfin from this river.
The general public should not eat largemouth bass, flathead catfish, pickerel, gar or bowfin from this river.</td></tr>
<tr><td rowspan="2">Spring Lake (Yell County)</td><td>Lake</td><td>Total Area not known</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (16 inches or longer) from this lake.
The general public should eat no more than 2 meals per month of largemouth bass (16 inches or longer).</td></tr>
<tr><td rowspan="2">Lake Sylvia (Perry County)</td><td>Lake</td><td>82 acres</td><td></td><td></td><td>X</td><td>X</td><td>Mercury</td></tr>
<tr><td colspan="7">High risk groups should not eat largemouth bass (16 inches or longer) from this lake.
The general public should eat no more than 2 meals per month of largemouth bass (16 inches or longer).</td></tr>
</table>

Domestic Water Supply Use

The ambient monitoring network provided monthly data from all stations for nitrate and minerals (chlorides, sulfates, and total dissolved solids) which were compared against the domestic water supply criteria to assess the protection of the domestic water supply designated use. Of the more than 11,430.6 miles assessed for these parameters for domestic water supply use support, approximately 408.4 miles were not meeting the use. Most of the exceedances were caused by excess mineral concentrations. In addition, approximately 607 stream miles have had the domestic water supply designated use removed through site specific amendments to the water quality standards, to date (not just this period of record).

Source Water Protection Program, Arkansas Department of Health

Arkansas's Source Water Protection Program (SWAP) is an EPA program mandated by the 1996 amendments to the Safe Drinking Water Act that required each state to assess all public drinking water sources for vulnerability to contamination. Responsibility for the development of the SWAP plan and for conducting the vulnerability assessments was given to the Engineering Division at the ADH, now the Engineering Section at the ADH.

Vulnerability assessment is a multi-step process consisting of accurate mapping of drinking water source locations, delineation of source water "assessment" areas where the water is likely derived from, mapping of potential contaminant locations within the assessment areas, and producing a susceptibility analysis using a Geographical Information System. The purpose of the SWAP is to establish a viable method for assessing vulnerability and for producing accurate maps intended to serve as the basis for source water protection planning by public water systems, their customers, and other interested parties. Source protection programs help to ensure a continued safe drinking water supply, provide for monitoring flexibility, and limit capital expenditures for treatment. The results of the assessments can also be used by other government entities and conservation groups to better understand the cumulative effects of various human activities; they also help to determine where the most critical problems are located within a watershed. Arkansas's SWAP was approved by EPA Region 6 in November 1999, and the original assessments were completed in May 2003 using ArcView 3.2. Currently, USGS is under contract to ADH to update the SWAP model so that it will support ArcGIS 10.x, with a scheduled completion date of July, 2016. ADH's Source Water Protection team—continues to provide technical assistance for the development of source water protection plans—and produces program report elements as required, for new water systems or new drinking water sources. More information about the SWAP and source water protection planning can be accessed on the Arkansas Department of Health's Engineering Section website at: http://www.healthy.arkansas.gov/programsServices/environmentalHealth/Engineering/sourceWaterProtection/Pages/default.aspx.

PART IV WATER QUALITY LIMITED WATERBODIES LIST: 303(d) LIST

Introduction

Clean Water Act Section 303(d) requires states to identify waters which do not meet or are not expected to meet applicable water quality standards. These waterbodies are compiled into a list known as the 303(d) list or list of impaired waterbodies. The 2018 list of impaired waterbodies (303(d) list) (Tables IV-5 through IV-11) contained in this report has not yet been approved by the U. S. Environmental Protection Agency.

Methodology

The methodology used for the 2018 assessment cycle can be found in Appendix B of this document.

Deviations from Methodology

For a number of reasons, deviations from strict interpretation of the assessment methodology can occur and still be protective of water quality. These deviations can result in an assessment of support/attainment (not impaired) or non-support/non-attainment (impaired). Such deviations are performed on a case by case basis using a weight of evidence approach. For example, if an exceedance rate was surpassed for a data set, but the magnitude of the exceedance(s) was low, the AU may have been assessed as not impaired because the weight of evidence suggests there is no impairment. Similarly, if the minimum number of samples is not met, but there are a large percentage of exceedances in the samples provided, the AU may be assessed as impaired.

Table IV-1describes deviations and justifications for assessment units assessed as not impaired. While Table IV-2 describes deviations and justifications for assessment units assessed as impaired.

Table IV-1: Deviations that resulted in an assessment of not impaired.				
AU	**Waterbody Name**	**Parameter**	**Deviation**	**Justification**
AR_08040203_021	Cedar Creek	Dissolved oxygen	10% Exceedance rate surpassed.	Site OUA0196 is less than a mile downstream of a dam. Site is not representative of the main waterbody.
AR_08040101_4063	Lake Ouachita-lower	Temperature	Not assessed as trout waters.	Use no longer exists. Lake no longer managed as trout fishery.
AR_11010014_4021	Greers Ferry Lake near Dam	Temperature	Not assessed as trout waters.	Use no longer exists. Lake no longer managed as trout fishery.
AR_11010003_4011	Bull Shoals Lake near Dam	Temperature	Not assessed as trout waters.	Use no longer exists. Lake no longer managed as trout fishery.
AR_11110207_4071	Maumelle Lake	pH	10% Exceedance rate surpassed.	Magnitude of each exceedance low.
AR_11140109_921	Caney Creek	Temperature, pH, DO	Short term deployment duration not met.	Deployment was 2 hours short, but few, if any, exceedances.
AR_11110202_919	Big Piney Creek	Temperature, pH, DO	Short term deployment duration not met.	Deployment was 1 hour short, but no exceedances.
AR_1010004_XXX	Dodd Creek	Temperature, pH, DO	Short term deployment duration not met.	Deployment was 4 hours short, but no exceedances.
AR_11010004_015	Hicks Creek	Temperature, pH, DO	Short term deployment duration not met.	Deployment was 4 hours short, but no exceedances.

Table IV-1: Deviations that resulted in an assessment of not impaired.				
AU	**Waterbody Name**	**Parameter**	**Deviation**	**Justification**
AR_11010009_4020	Lake Kimberly	Temperature, pH, DO	Additional short term deployments at different locations.	Second deployment had two sondes in different locations, but there were no exceedances.
AR_11010001_042	Kings River	Temperature, pH, DO	Short term deployments not 2 weeks apart.	Deployments in 2012 just short of 2 weeks apart. 3 deployments in 2013. All were used and low exceedance rate.
AR_11010004_015	Big Creek	Temperature, pH, DO	Additional short term deployments.	Four deployments in one year. All data used.
AR_11110202_022	Hurricane Creek	Temperature, pH, DO	Additional short term deployments.	Four deployments in one year. All data used.
AR_11110207_023	Rock Creek	Temperature, pH, DO	Additional short term deployments. Multiple sites in same AU.	Three deployments in one year. All data used. Multiple sites in same AU.
AR_11110103_021	Cincinnatti Creek	DO	10% Exceedance rate surpassed.	Magnitude of exceedances low.
AR_11140104_005, and others	Lee Creek	pH	10% Exceedance rate surpassed.	Magnitude of exceedances low.
AR_11110201_006, 008, 009, 010, 011, 012, 014, 912, 913, and others	Mulberry River and its tributaries	pH	10% Exceedance rate surpassed.	Natural conditions create lower pH conditions.
AR_11110201_007	Mulberry River	pH	10% Exceedance rate surpassed.	Magnitude of exceedances low.
AR_11110201_008	Mulberry River	pH	10% Exceedance rate surpassed.	Magnitude of exceedances low.
AR_11110201_009	Mulberry River	pH	10% Exceedance rate surpassed.	Magnitude of exceedances low.

Table IV-1: Deviations that resulted in an assessment of not impaired.				
AU	**Waterbody Name**	**Parameter**	**Deviation**	**Justification**
AR_11110201_012	Little Mulberry River	pH	10% Exceedance rate surpassed.	Magnitude of exceedances low.
AR_11110201_912	Friley Creek	pH	10% Exceedance rate surpassed.	Magnitude of exceedances low.

Table IV-2: Deviations that resulted in an assessment of non-attainment.				
AU	**Waterbody Name**	**Parameter**	**Deviation**	**Justification**
AR_08040203_011	North Fork Saline River	DO	Short term deployment duration not met.	Deployment was 2 hours short, but high exceedance rate showed impairment.
AR_08040101_838	Irons Fork	DO	Short term deployment duration not met.	Deployment spanned critical season.
AR_08040203_021	Cedar Creek	DO	Short term deployment duration not met.	Deployment was 30 minutes short but high exceedance rate showed impairment.
AR_08040203_922	Lockett Creek	DO	Short term deployment duration not met.	Deployment was 4 hours short but high exceedance rate showed impairment.
AR_11010010_009	English Creek	Temperature, DO	Short term deployment duration not met.	Deployment was >4 hours short but high exceedance rate showed impairment.
AR_11010005_020	Big Creek	DO	Additional short term deployments.	More short term deployments than necessary used and 46% exceedance rate

AR_11010001_542	Kings River	DO	Short term deployments not 2 weeks apart.	Deployments in 2012 just short of 2 weeks apart. 3 deployments in 2014. All were used.
AR_11010001_916	Leatherwood Creek	DO	Short term deployments not 2 weeks apart.	Deployments were not 2 weeks apart but high rate of exceedance of very low DO.
AR_08040101_902	Indian Springs Creek	DO	Minimum number of samples not met.	Only 8 samples taken; however all 8 samples were below criteria.

Assessment Categories

AUs are placed into categories upon assessment. AUs may be placed into more than one category if different parameters assess differently (Example: pH could attain and be placed in Category 1 while temperature does not attain and is placed in Category 5 for the same AU). Categories are listed below. Categories 4 and 5 contain AUs that do not attain their water quality standard. Categories 1 and 2 contain AUs that do attain water quality standards. Category 1b contain AUs that attain water quality standards, but have a TMDL already in place. Category 3 AUs need more data or information to make an attainment decision.

Waterbodies listed on the 2018 list of impaired waterbodies are depicted on Figures IV-1 (Category 1b and 4a listings) and Figure IV-2 (Category 5, 5alt, and 4b listings). The 2018 list of impaired waterbody segments is divided into four tables: a list of stream segments (Table IV-5) and a list of lakes (Table IV-6) not currently meeting water quality standards but have completed TMDLs (Category 4a); a list of stream segments (Table IV-7) and lakes (Table IV-8) listed in Category 5; a list of stream segments (Table IV-9) and lakes (Table IV-10) listed in Category 5-alt; a list of stream segments (Table IV-11) listed in Category 4b; as described below.

Category 1. Attains all water quality criteria and supports all designated uses; categorized by existence of a TMDL or not for one or more constituents.

1a. Attaining all water quality criteria and supporting all designated uses, no use is threatened. No TMDL exists for any constituents.

1b. Attaining all water quality criteria and supporting all designated uses; however, a TMDL remains in place for one or more constituents.

Category 2. Available data and/or information indicate that some, but not all of the designated uses are supported.

Category 3. Insufficient data and/or information are available to make a use support determination.

3a. No data available.

3b. Insufficient data available.

- Data do not meet all quality requirements outlined in this assessment methodology;
- Waters in which the data are questionable because of Quality Assurance and/or Quality Control (QA/QC) procedures and/or the AU requires confirmation of impairment before a TMDL is scheduled.
- Where limited available data and/or information indicate potential impacts or downward trends in water quality, the following waterbodies in Category 3 will be prioritized (on a case-by-case basis) for additional investigation: waters designated as ERW, ESW, or NSW; domestic water supplies; and waters located in known karst areas.

Category 4. Water quality standards are not attained for one or more designated uses but the development of a TMDL is not required because:

4a. A TMDL has been completed for the listed parameter(s); or

4b. Other management alternatives are expected to result in the attainment of the water quality standard; or

4c. Non-support of the water quality standard is not caused by a pollutant.

Category 5. The waterbody is impaired, or one or more water quality standards are not attained. Waterbodies in Category 5 will be prioritized as:

High

- Truly impaired; develop a TMDL or other corrective action(s) for the listed parameter(s).

Medium

- Waters currently not attaining standards, but may be de-listed with future revisions to APC&EC Regulation No. 2, the state water quality standards; or
- Waters which are impaired by point source discharges and future permit restrictions are expected to correct the problem(s).

Low

- Waters currently not attaining one or more water quality standards, but assessed designated uses are determined to be supported; or
- There is insufficient data to make a scientifically defensible decision concerning designated use attainment. Where more data and/or information are needed to verify the need for TMDL development or other corrective action(s) for the listed parameter(s), the following waterbodies in Category 5 will be prioritized (on a case-by-case basis) for additional investigation: waters designated as ERW, ESW, or NSW; domestic water supplies; and waters located in known karst areas; or

- Waters DEQ assessed as unimpaired, but were assessed as impaired by EPA.

Alternative (Alt)

- Waters currently not attaining one or more water quality standards, but alternative restoration approaches may be more immediately beneficial or practicable in achieving water quality standards than pursuing a TMDL approach in the near term.

TMDL Prioritization

Current TMDL prioritization focuses on revising existing TMDLs, particularly those written as part of the May, 2000 Consent Decree. These TMDLs often do not include room for future growth and waste load allocations (WLAs) need to be revised.

In 2015, the Division created a "Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act (CWA) 303(d) Program" (4/17/2015) in accordance with the new measures set forth by the United States Environmental Protection Agency (EPA). https://www.adeq.state.ar.us/water/planning/integrated/pdfs/long-term-vision-for-arkansas-20150417.pdf

DEQ has been working in conjunction with the Arkansas Natural Resources Commission (ANRC) to target resources for water quality improvements within the state. The ANRC is responsible for developing and implementing Arkansas's Nonpoint Source Pollution Management Program. ANRC prioritized ten basins in Arkansas using stakeholder involvement coupled with a science-based process. For TMDL prioritization, nine of the ten ANRC basins were chosen because they have impairments that carry from ADEQ's 2008 303(d) list to the Draft 2014 303(d) list. The Division is currently working to finish one of these TMDLs.

Figure IV-1: Arkansas's Waterbodies with Completed TMDLs (Categories 4a and 1b)

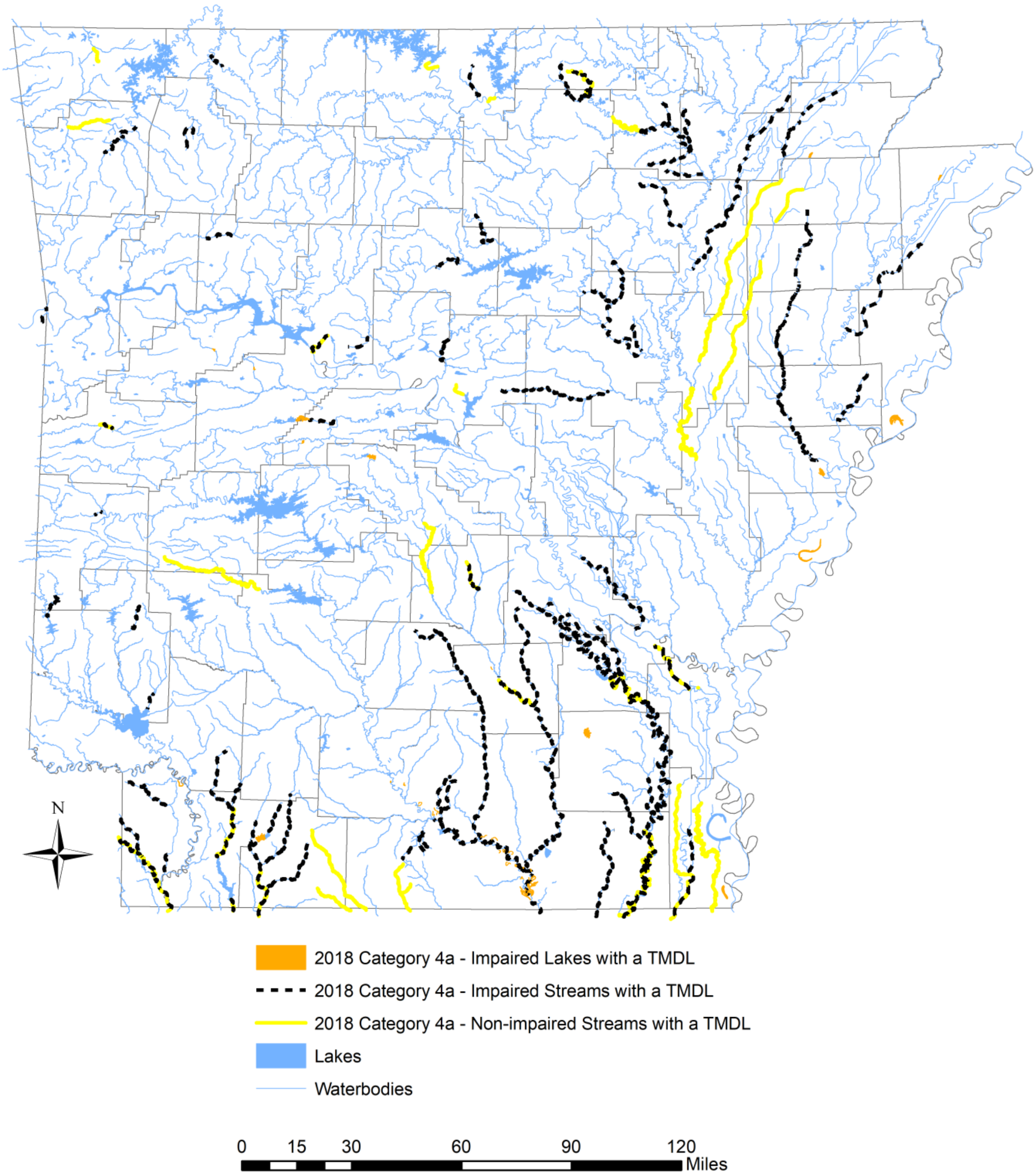
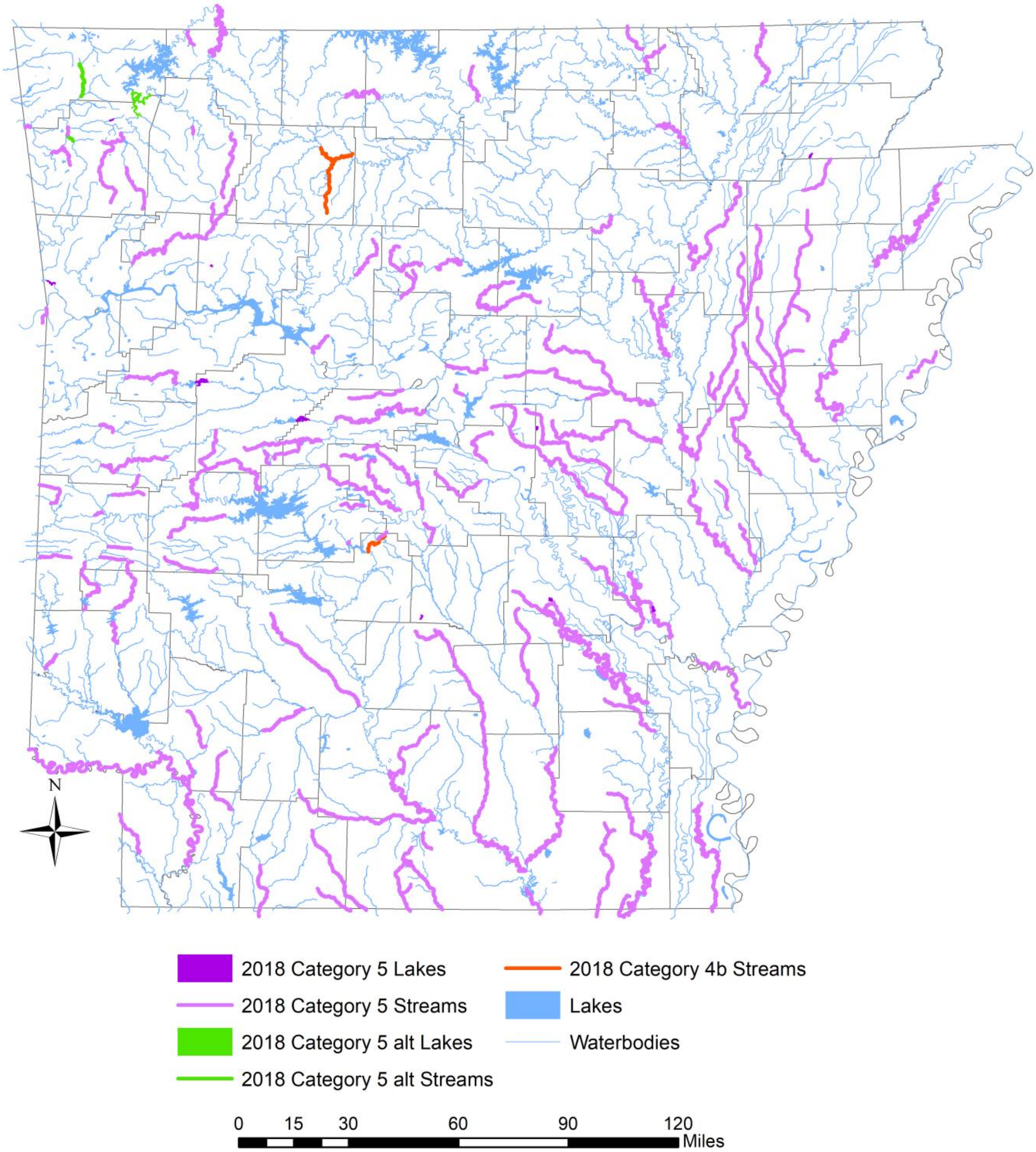


Figure IV-2: Arkansas's Impaired Waterbodies without Completed TMDLs (Category 5, 5-alt, and 4b)



New and Removed Listings

Most of Arkansas's water quality standards were developed after the completion of the ecoregions of Arkansas survey (reference). Least-disturbed waterbodies, approximately six, in each of the ecoregions were studied; the data compiled; average concentrations of water quality constituents were calculated, and standards were set based on those averages. On occasion, water quality standards for certain constituents, such as dissolved oxygen, temperature, and pH, will not be attained simply because of weather related conditions. As a result, some waterbodies will be evaluated as impaired during one period of record, only to be evaluated as fully supporting the next.

In addition, some waterbodies have been evaluated as impaired for a constituent simply because the natural background characteristics of the waterbody are significantly different than the ecoregion average. This occurs mostly with the water quality standards for pH, dissolved oxygen, and temperature. The table below lists the number of pollutant pairs that have been listed and delisted for the 2016 period of record. A pollutant pair is one waterbody and one water constituent. One waterbody may have more than one constituent not meeting water quality standards, such as pH and temperature. In this case, that would equal two pollutant pairs.

The implementation of nonpoint source best management practices has been effective in reducing pollutants entering three of Arkansas's rivers. Turbidity concentrations in the Illinois River, the St. Francis River, and Days Creek have been reduced and the waterbodies are now meeting turbidity standards. In addition, portions of Bayou DeView, listed for excessive lead concentrations, have also been removed from the impaired waterbodies list. The Arkansas Natural Resources Commission partnered with land owners within these watersheds and provided education, demonstration, expertise, and financial assistance to implement and install best management practices. These success stories can be read on the EPA website: http://www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-success-stories.

Table IV-1: Waterbody pollutant pairs added and removed for the 2018 period of record

Added Pollutant Pairs (99)		Removed Pollutant Pairs (52)	
Pollutant	**Number of Pairs**	**Pollutant**	**Number of Pairs**
Dissolved Oxygen	28	Dissolved Oxygen	10
Metals (Cu, Pb, Zn, Se)	14	Metals (Cu, Pb, Zn, Se)	3
Minerals (Cl, SO_4, TDS)	0	Minerals (Cl, SO_4, TDS)	22
Nitrate	0	Nitrate	1
Pathogens (*E. coli*)	3	Pathogens (*E. coli*)	3
pH	35	pH	1
Temperature	4	Temperature	3
Turbidity	15	Turbidity	9

Notable Waterbodies in Category 3

Assessment units placed in Category 3 are assessed as having insufficient data and/or information available to make a use support determination. Many assessment units not specifically listed here were placed in Category 3 for insufficient or no information. In this report we highlight Category 3 attainment decisions for statewide nutrients, Illinois River basin total phosphorus, and Lake Ouachita mercury advisory—fish consumption.

Category 3 Illinois Basin Total Phosphorus

Table IV-2: Category 3 – Illinois Basin – Total Phosphorus

Water Body	Assessment Unit	Parameter
Muddy Fork Illinois River	(AR_11110103_027)	Total Phosphorus
Osage Creek	(AR_11110103_030)	Total Phosphorus
Osage Creek	(AR_11110103_930)	Total Phosphorus
Spring Creek	(AR_11110103_931)	Total Phosphorus

DEQ utilized a weight of evidence approach and placed Illinois Basin AUs AR_11110103_027, AR_11110103_030, AR_11110103_930, and AR_11110103_931 in Category 3 for total phosphorus using the following lines of evidence.

- Assessment Units (AUs) Muddy Fork, 2 segments of Osage Creek, and Spring Creek were listed as impaired for Total Phosphorus and placed in Category 5 in 2008 by EPA.
- The 2016 Record of Decision (ROD), Section III C. Waters requiring no further action included these 4 AU's and recommended: "Rather than add these waters to Category 5, EPA sees it appropriate for Arkansas to designate them as Category 4b, because other pollution controls are in place to bring the water in to attainment with the water quality standards."
- DEQ assesses only "wadeable" streams for nutrients which are defined as 4th order streams with generally have a watershed of <100 mi2
- The approved 2016 Assessment Methodology nutrient discrete data screening requirement is 10 or more samples per monitoring station and data are representative of at least 3 astronomical seasons (not years – seasons).
- Figure 3: Nutrient assessment flowchart for wadeable streams and rivers. (page 68 of 79 of the Assessment Methodology) compares the mean concentration of the data for a monitoring segment with the 75th % of the ecoregion value during the period of record. Next - the chart asks "Does the monitoring segment have paired biological collections AND continuous DO data that meets quality requirements set forth in Section 6.4."

- Neither Muddy Fork, the upper AU of Osage, nor Spring Creek data meet these criteria which, according to the chart is deemed “Insufficient data, Place in Category 3”. Actually there is no data in this assessment cycle which brings up No. 9, below, and
- The lower AU of Osage is >100 mi2   (5th order) and is, therefore, not wadeable and not assessed.
- Since the 2016 ROD included these AUs in Section III C and took no further action, they are technically still in Category 5 from EPA action in 2008,
- Further, Section 3.2.1 No New Data of the Assessment Methodology says “if no new qualifying water quality data have been generated for an AU during the current period of record…….the attainment decision from the preceding assessment period will be carried forward....” i.e. still Category 5. However there is conflicting historical data in this regard. One set from EPA contractor and another set from cities’ contractor that EPA rejected on the basis of fisheries index.
- OWQ planning staff placed these AUs in Category 4b because the 2016 EPA ROD “sees it as appropriate”.
- In accordance with the approved 2016 Assessment Methodology the 3 assessable AU’s (i.e. not Osage Creek segments) should be in Category 3.

Category 3 Lake Ouachita Mercury Advisory – Fish Consumption

EPA’s TSD for the 2016 303(d) list (dated July 19, 2017, revised August 16, 2017) notes deferred action for Lake Ouachita (HUC8 08040101) for Mercury in Fish.

DEQ utilized a weight of evidence approach and placed Lake Ouachita AUs AR_08040101_4060, AR_08040101_4061, AR_08040101_4062, and AR_08040101_4063 in Category 3 using the following lines of evidence.

- ADH’s August 11, 2014 Fish Consumption Advisory Issued for Lake Ouachita does not exclude all persons from consuming all species of all size classes. It is a limited consumption advisory:

  “High Risk Groups (women of childbearing age, pregnant women, breastfeeding women, and children under the age of seven years): Should not eat largemouth bass (13 inches or longer), white bass (13 inches or longer), or striped bass (25 inches or longer) from this lake.

  General Public (men, women, and children seven years and older): Eat no more than 2 meals per month of largemouth bass (13 inches or longer), white bass (13 inches or longer), or striped bass (25 inches or longer) from this lake.”

EPA guidance does not state mandatory listing of an AU based on limited consumption advisories. Additionally, EPA's April 2010 Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion Section 5.4.1 states: "…These advisories are non-regulatory and inform the public that high concentrations of chemical contaminants, such as mercury, have been found in local fish…"

- EPA's April 2010 Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion Section 4.3 states:

  "States and authorized tribes determine attainment of water quality standards by comparing ambient concentrations to the numeric and narrative AWQC (40 CFR 130.7 (b)(3)). Where a fish tissue criterion has been adopted, states and tribes should consider observed concentrations in fish tissue in comparison to the criterion. Where a water column translation of the fish tissue criterion has been developed and is adopted as part of the state's or tribe's water quality standards, states and tribes should consider ambient water concentrations in comparison to the translation."

  APC&EC Regulation (Rule) No. 2 has not adopted a fish tissue criterion nor does it include a designated use for fish consumption.

Waterbodies in Category 4b

Assessment units placed in Category 4b are assessed as not meeting water quality standards; however, required control measures, other than a TMDL, are expected to result in the attainment of water quality standards in a reasonable amount of time. EPA IR Guidance (2006) outlines six elements that that should be included in the State's rationale to place AUs in Category 4b:

1. Identification of assessment units and a statement of the problem causing the impairment,
2. a description of the proposed implementation strategy and supporting pollution controls necessary to achieve water quality standards, including the identification of point and nonpoint source loadings that when implemented assure the attainment of all applicable water quality standards,
3. an estimate or projection of the time when water quality standards will be met,
4. a reasonable schedule for implementing the necessary pollution measures,
5. a description of, and schedule for, monitoring milestones for tracking and reporting progress to EPA on the implementation of the pollution controls, and
6. a commitment to revise as necessary the implementation strategy and corresponding pollution controls if progress towards meeting water quality standards in not being shown.

For the 2018 assessment cycle, seven AUs consisting of sixteen pollutant pairs were placed in category 4b for multiple parameters (Table IV-3). Rationale for including Big Creek and Buffalo River AUs in Category 4b can be found in Appendix C. Rationale for including Chamberlain Creek, Cove Creek, and Lucinda Creek AUs in Category 4b can be found in Appendix D.

Table IV-3 Assessment units placed in Category 4b

Waterbody	Assessment Unit	Parameter
Big Creek	AR_11010003_022	Pathogens
Big Creek	AR_11010003_020	Dissolved Oxygen
Buffalo River	AR_11010005_011	Pathogens
Buffalo River	AR_11010005_010	Pathogens
Chamberlain Creek	AR_08040102_971	pH
Chamberlain Creek	AR_08040102_971	Sulfates
Chamberlain Creek	AR_08040102_971	Total Dissolved Solids
Chamberlain Creek	AR_08040102_971	Al, Be, Cu, Zn
Chamberlain Creek	AR_08040102_971	Toxicity
Cove Creek	AR_08040102_970	pH
Cove Creek	AR_08040102_970	Zn
Cove Creek	AR_08040102_970	Toxicity
Lucinda Creek	AR_08040102_975	pH

Waterbodies in Category 5-Alt

Assessment units placed in Category 5-Alt are assessed as not meeting water quality standards; however, alternate restoration approaches may be more immediately beneficial or practical in achieving WQS than pursuing a TMDL in the near-term. EPA IR Guidance (2016) outlines eight (8) elements that that should be included in the State's rationale to place AUs in Category 5-Alt:

1. Identification of specific impaired water segments or waters addressed by the alternative restoration approach, and identification of all sources contributing to the impairment.
2. Analysis to support why the State believes the implementation of the alternative restoration approach is expected to achieve WQS.
3. An Action Plan of Implementation Plan to document:

a) The actions to address all sources—both point and nonpoint sources, as appropriate—necessary to achieve WQS (this may include e.g., commitments to adjust permit limits when permits are re-issued or a list of nonpoint source conservation practices of BMPs to be implemented, as part of the alternative restoration approach); and,
b) A schedule of actions designed to meet WQS with clear milestones and dates, which includes interim milestones and target dates with clear deliverables.

4. Identification of available funding opportunities to implement the alternative restoration plan.
5. Identification of all parties committed, and/or additional parties needed, to take actions that are expected to meet WQS.
6. An estimate of projection of the time when WQS will be met.
7. Plans for effectiveness monitoring to: demonstrate progress made toward achieving WQS following implementation; identify needed improvement for adaptive management as the project progresses; and evaluate the success of actions and outcome.
8. Commitment to periodically evaluate the alternative restoration approach to determine if it is on track to be more immediately beneficial or practicable in achieving WQS than pursuing a TMDL in the near-term, and if the impaired water should be assigned a higher priority for TMDL development.

For the 2018 assessment cycle, eight AUs consisting of twelve pollutant pairs were placed in category 5-Alt for multiple parameters (Table IV-4. Rationale for including these AUs in Category 5-Alt can be found in Appendices E and F.

Table IV-4 Assessment units placed in Category 5-Alt

Waterbody	Assessment Unit	Parameter
Moores Creek	AR_11110103-026	Pathogens
Muddy Fork Illinois River	AR_11110103_027	Pathogens
Illinois River	AR_11110103-028	Pathogens
Little Osage Creek	AR_11110103_630	Pathogens
Little Osage Creek	AR_11110103_933	Pathogens
Beaver Lake	AR_11010001_4040	Pathogens
Beaver Lake	AR_11010001_4040	Turbidity
Beaver Lake	AR_11010001_4041	Pathogens
Beaver Lake	AR_11010001_4041	Turbidity
Beaver Lake	AR_11010001_4041	pH

Waterbody	Assessment Unit	Parameter
Beaver Lake	AR_11010001_4042	Pathogens
Beaver Lake	AR_11010001_4042	Turbidity

Key to Tables IV-5 through IV-11:

Assessment Unit – Assessment Units (AUs) are the stream segment or area of lake that is assessed. AUs are coded as AR_8 digit HUC_ reach number. Within this code, AR stands for Arkansas, the 8 digit HUC is the 8 digit hydrologic unit the AU is within, and the reach number is a three or four digit code assigned to stream reaches and lake areas by DEQ Planning staff.

Lake Type – Lakes are classified into Types using lake morphology, ecoregion, and purpose of construction. Information describing Lake Type is located in Part III Chapter Five of this report.

Planning Segment – Two-digit alpha-numeric code to identify in which DEQ Planning Segment a waterbody is located. Figure II-3 is a map of DEQ's Planning Segments. DEQ's 38 water quality planning segments are based on hydrological characteristics, human activities, geographic characteristics, and other factors.

Miles - the total length (in miles) of a specific stream reach.

Acres – total surface acreage for lake.

Monitoring Station:

DEQ surface water monitoring stations are named in a variety of ways as shown in the following examples:

RED0015A = DEQ stream monitoring stations in the ambient and roving networks typically follow this format where the first three letters represent the drainage basin (RED = Red River, WHI = White River, FRA = St. Francis River, OUA = Ouachita River, and ARK = Arkansas River) and the numbers, sometimes followed by a letter, represent the unique station ID within that basin.

UWAFK01 = DEQ stream monitoring stations not on the ambient network. These stations were named when initially established, before being used for assessments. UW = Unassessed Waters. The next series of letters represents the stream (AFK = Archey Fork Creek) and the numbers are a unique identifier for that stream.

MIN0001 = DEQ stream monitoring stations that are originally used in special studies.

LRED002A = DEQ lake monitoring station. These typically start with "L" and the next three letters represent the drainage basin like with streams. The three digit numeric code, sometimes followed by a letter, represents the unique identifier for that lake.

e = evaluated assessment. Used when there is not a station on the actual reach but a monitoring station on an adjacent segment may be used for assessment. The “e” may be stand alone in the cell or may precede a monitoring station ID.

ANRC = Data received from the Arkansas Natural Resource Commission.

UAA = Use Attainability Analysis. Data for this assessment was attained via a UAA, not a monitoring station.

USGS = Data received from U. S. Geological Society.

Ark G&F = Data received from Arkansas Game and Fish Commission.

BWD = Data received from Beaver Water District.

Report = Data received from third party report.

Toxicity Samples = DEQ data from ambient toxicity project.

Assessment Method

M = monitored assessment

Designated Use Not Supported: uses specified in Reg. 2 for each waterbody or stream segment which are not being supported.

AL = aquatic life

PC = primary contact

SC = secondary contact

DW = domestic water supply

AI = agricultural and/or industrial water supply

Water Quality Standard Non-Attainment: contaminant identified as the cause of impairment.

Al = aluminum

AM = ammonia

Be = beryllium

Cl = chlorides

Cu = copper

DO = dissolved oxygen

Hg = mercury

NO3 = nitrate nitrogen

PA = pathogen indicator bacteria

Pb = lead

PCB = Polychlorinated biphenyl

pH = pH

PO = priority organics

Se = Selenium

SO4 = sulfates

Tb = turbidity

TDS = total dissolved solids

Tm = temperature

Tox = Toxicity

TP = total phosphorus

UN = Unknown

Zn = zinc

Sources of Contamination or Source- the probable source of the contaminant causing impairment.

AG = agriculture activities

HP = hydropower

IP = industrial point source

MP = municipal point source

SE[1] = surface erosion

UN = unknown

UR = urban runoff

RE = resource extraction (mining; oil and gas extraction)

Cause:
HG = Mercury
NU = nutrients[2]
SI = Siltation

Priority Rank - A ranking of waters in order of need for corrective action taking into account the severity of the pollution and designated uses of the waters.

H = High priority: highest risk of affecting public health or welfare; substantial impact on aquatic life.

M = Medium priority: moderate risk to public health, welfare or to aquatic life.

L = Low priority: lowest risk to public health or welfare; secondary impact on aquatic life.

Notes:
[1] Surface Erosion – This category includes erosion from agriculture activities, unpaved road surfaces, in-stream erosion, mainly from unstable stream banks, and any other land surface disturbing activity.
[2] This listing was used in previous 303(d) lists. TMDLs are currently being developed for these listings.

Table IV-5: Water Quality Limited Waters – Streams (Category 4a) – 303(d) List

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination					
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other
Dorcheat Bayou	AR_11140203_020	1A	11.4	e - RED0015A	Hg	Pb, Hg			Pb			x								x		Hg						UN
Dorcheat Bayou	AR_11140203_022	1A	11.5	RED0015A	Hg	Pb, Hg			Pb			x								x		Hg						UN
Dorcheat Bayou	AR_11140203_024	1A	7.6	RED0065	Hg							x										Hg						UN
Dorcheat Bayou	AR_11140203_026	1A	9.6	UWBDT02	Hg	Pb, Hg			Pb			x								x		Hg						UN
Little Bodcau Creek	AR_11140205_010	1A	33.1	RED0056		Pb			Pb											x								UN
Bodcau Creek	AR_11140205_007	1A	11.7	RED0057		Pb			Pb											x								UN
Bodcau Creek	AR_11140205_006	1A	23.3	RED0027		Pb			Pb			x		x						x					x			UN
Bodcau Creek	AR_11140205_002	1A	5.1	e-RED0027		Pb			Pb			x		x						x					x			UN
Beech Creek	AR_11140203_025	1A	21.1	UWBCH01		DO, Pb			Pb		x			x						x					x			
Big Creek	AR_11140203_923	1A	35.1	UWBIG01		Pb			Pb			x								x								UN
Big Creek	AR_11140203_023	1A	4.4	UWBIG02		Pb			Cl, SO4, TDS, Pb	Cl, SO4, TDS					x	x	x			x								UN
Horsehead Creek	AR_11140203_021	1A	31.1	UWHHC01		Pb			Pb			x								x								UN
Days Creek	AR_11140302_003	1B	17.6	RED0004A					NO3													NO3		x		x		
Sulphur River	AR_11140302_008	1B	3.0	e - RED0005										x											x			
Sulphur River	AR_11140302_006	1B	8.2	RED0005										x											x			
Sulphur River	AR_11140302_004	1B	0.2	e - RED0005										x											x			
Sulphur River	AR_11140302_002	1B	10.4	e - RED0005										x											x			
Sulphur River	AR_11140302_001	1B	7.9	e - RED0005										x											x			
Red River	AR_11140201_003	1B	8.5	RED0009										x											x			
McKinney Bayou	AR_11140201_014	1B	27.0	RED0055												x	x											UN
McKinney Bayou	AR_11140201_012	1B	17.8	RED0054											x	x	x											UN

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination					
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other
Rolling Fork	AR_11140109_919	1C	7.3	RED0058																		TP, NO3	x	x				
Rolling Fork	AR_11140109_927	1C	13.0	RED0030																		TP, NO3	x	x				
Holly Creek	AR_11140109_913	1C	11.2	RED0034B			PA											x						x				
Mine Creek	AR_11140109_033	1C	6.6	MIN0002			PA											x						x				
Oak Bayou	AR_08050002_910	2A	24.0	OUA0179					TDS	TDS				x			x								x			UN
Boeuf River	AR_08050001_018	2A	16.4	OUA0015A										x											x			
Boeuf River	AR_08050001_019	2A	15.6	UWBFR01										x	x	x	x								x			UN
Bayou Bartholomew	AR_08040205_001	2B	54.0	OUA0013										x											x			
Bayou Bartholomew	AR_08040205_002	2B	17.5	UWBYB01	Hg	Hg								x	x	x	x					Hg			x			UN
Melton's Creek	AR_08040205_903	2B	5.4	OUA0148			PA											x										UN
Harding Creek	AR_08040205_902	2B	4.3	OUA0145			PA											x									x	
Deep Bayou	AR_08040205_005	2B	33.2	OUA0151			PA							x				x							x			UN
Bayou Bartholomew	AR_08040205_006	2B	97.0	OUA0033										x											x			UN
Cutoff Creek	AR_08040205_007	2B	19.4	UWCOC01	Hg	Hg								x								Hg			x			UN
Bayou Bartholomew	AR_08040205_912	2B	47.1	UWBYB02										x	x	x	x								x			UN
Cross Bayou	AR_08040205_905	2B	2.5	OUA0152			PA											x										UN
Bayou Bartholomew	AR_08040205_013	2B	34.4	UWBYB03			PA							x				x							x			UN
Bayou Bartholomew	AR_08040205_012	2B	49.4	UWBYB02	Hg	Hg								x								Hg			x			UN
Chemin-A-Haut Cr.	AR_08040205_907	2B	51.2	OUA0012			PA											x										UN
Bearhouse Creek	AR_08040205_901	2B	34.5	OUA0155			PA											x										UN
Jack's Bayou	AR_08040205_904	2B	7.4	OUA0150			PA											x										UN
Big Creek	AR_08040203_904	2C	15.6	OUA0018										x											x			

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination							
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other
Saline River	AR_08040203_001	2C	1.5	OUA0010A,117	Hg	Hg																Hg						UN
Saline River	AR_08040204_001	2C	3.8		Hg	Hg																Hg						UN
Saline River	AR_08040204_002	2C	60.1		Hg	Hg																Hg						UN
Saline River	AR_08040204_004	2C	20.6		Hg	Hg																Hg						UN
Big Creek	AR_08040204_005	2C	48.7	OUA0043										x											x			
Saline River	AR_08040204_006	2C	17.3	OUA0118	Hg	Hg																Hg						UN
Ouachita River	AR_08040202_002	2D	10.3	OUA008B	Hg	Hg																Hg						UN
Ouachita River	AR_08040202_003	2D	9.0	e	Hg	Hg																Hg						UN
Ouachita River	AR_08040202_004	2D	32.5	OUA0124B	Hg	Hg																Hg						UN
Moro Creek	AR_08040201_001	2D	56.4	OUA0028	Hg	Hg								x								Hg			x			UN
Moro Creek	AR_08040201_901	2D	57.0	e - OUA0028										x											x			
Ouachita River	AR_08040201_002	2D	23.4	OUA008B	Hg	Hg																Hg						UN
Ouachita River	AR_08040201_004	2D	2.8	OUA0037	Hg	Hg																Hg						UN
L. Champagnolle Cr.	AR_08040201_903	2D	14.6	e	Hg	Hg																Hg						UN
Champagnolle	AR_08040201_003	2D	19.7	UWCHC01	Hg	Hg																Hg						UN
ECC Tributary	AR_08040201_606	2D	5.2	OUA0137A+		AM									x	x	x					AM	x					
ECC Tributary	AR_08040201_616	2D	5.2	OUA0137A+		AM									x	x	x					AM	x					
ECC Tributary	AR_08040201_626	2D	5.2	OUA0137A+		AM									x	x	x					AM	x					
Flat Creek	AR_08040201_706	2D	9.9	OUA0137C											x	x	x						x					
Salt Creek	AR_08040201_806	2D	7.2	OUA0137D					TDS						x		x						x					
Prairie Creek	AR_08040101_048	2F	2.8	OUA0040										x											x			
Wabbaseka Bayou	AR_08020401_003	3A	42.3	UWWSB01										x											x			
Cadron Creek	AR_11110205_011	3D	2.8	UWCCR01										x											x			
Cadron Creek	AR_11110205_012	3D	13.0	UWCCR01										x											x			
Fourche LaFave	AR_11110206_002	3E	10.1	e	Hg	Hg																Hg						
White Oak Creek	AR_11110203_927	3F	7.6	ARK0053										x														
Whig Creek	AR_11110203_931	3F	10.1	ARK0067					NO3													NO3		x		x		
Mulberry River	AR_11110201_009	3H	9.8	ARK0138								x																

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination					
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other
Poteau River	AR_11110105_001	3I	4.9	ARK0014										x													x	
Poteau River near Waldron	AR_11110105_031	3I	6.7	ARK0055		TP																TP	x					
Cache River Ditch	AR_08020302_032	4B	11.0	e - UWCHR04										x											x			
Cache River	AR_08020302_031	4B	2.9	e - UWCHR04										x											x			
Cache River	AR_08020302_029	4B	5.4	e - UWCHR04										x											x			
Cache River	AR_08020302_028	4B	6.0	UWCHR04										x											x			
Cache River	AR_08020302_027	4B	2.2	e - UWCHR04										x											x			
Village Creek	AR_11010013_006	4C	29.1	UWVGC01; UWVGC03										x											x			
Village Creek	AR_11010013_007	4C	1.2	e										x											x			
Village Creek	AR_11010013_008	4C	12.2	e										x											x			
Village Creek	AR_11010013_012	4C	7.7	e										x											x			
Village Creek	AR_11010013_014	4C	25.7	UWVGC02										x											x			
Cypress Bayou	AR_08020301_010	4D	7.8	UWCPB01			PA											x										UN
Cypress Bayou	AR_08020301_011	4D	11.3	e - UWCPB01			PA											x										UN
Cypress Bayou	AR_08020301_012	4D	28.2	e - UWCPB02			PA											x										UN
S. Fk. L. Red River	AR_11010014_036	4E	4.0	e	Hg	Hg																Hg						UN
M. Fk. Little Red	AR_11010014_028	4E	14.1	e			PA											x										UN
M. Fk. Little Red	AR_11010014_027	4E	3.4	WHI0043			PA											x										UN
Ten Mile Creek	AR_11010014_009	4E	23.5	UWTMC01			PA							x				x							x			UN
Little Red River	AR_11010014_007	4E	22.0	WHI0059			PA											x										UN
Little Red River	AR_11010014_008	4E	8.4	e - WHI0059			PA											x										UN
Little Red River	AR_11010014_010	4E	3.7	e - WHI0059			PA											x										UN
Little Red River	AR_11010014_012	4E	8.4	e - WHI0059			PA											x										UN
Overflow Creek	AR_11010014_004	4E	0.9	e - UWOFC01			PA											x										UN
Overflow Creek	AR_11010014_006	4E	12.0	UWOFC01			PA											x										UN

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination					
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other
South Fork Little Red River	AR_11010014_038	4E	9.7	UWSRR01; UWSRR02; WHI0190			PA											x										UN
Hicks Creek	AR_11010004_015	4F	13.2	WHI0065			PA											x				NO3		x				
Strawberry River	AR_11010012_011	4G	27.1	UWSBR01			PA							x				x							x	x		
L. Strawberry River	AR_11010012_010	4G	19.5	WHI0143H+			PA											x								x		
Strawberry River	AR_11010012_008	4G	12.4	e-WHI0024			PA							x				x							x			
Strawberry River	AR_11010012_006	4G	20.3	WHI0024, outside data										x											x			
Strawberry River	AR_11010012_005	4G	1.8	e - UWSBR03										x											x			
Strawberry River	AR_11010012_004	4G	0.1	e - UWSBR03										x											x			
Caney Creek	AR_11010012_015	4G	12.4	other data			PA											x								x		
Cooper Creek	AR_11010012_003	4G	20.2	WHI0143S			PA											x								x		
Dota Creek	AR_11010009_902	4G	25.3	WHI0165			PA											x								x		
Mill Creek	AR_11010012_016	4G	7.3	WHI00143N			PA											x								x		
Reeds' Creek	AR_11010012_014	4G	17.8	UWRDC01			PA											x								x		
West Fork White River	AR_11010001_024	4K	10.7	WHI0051										x														UN
White River	AR_11010001_023	4K	1.9	e-WHI0052										x														UN
White River	AR_11010001_923	4K	0.4	e-WHI0052										x														UN
White River	AR_11010001_823	4K	5.1	WHI0052										x														UN
Town Branch	AR_11010001_959	4K	2.6	WHI0093		*																NO3		x				
Holman Creek	AR_11010001_059	4K	10.6	WHI0070		*																NO3		x				
Osage Creek Near Berryville	AR_11010001_945	4K	7.8	BUFET008; WHI0065; WHI0069; WHI0130		*																TP		x				
Blackfish Bayou	AR_08020203_003	5A	2.1	e - FRA0027										x											x			
Blackfish Bayou	AR_08020203_005	5A	2.6	e - FRA0027										x											x			

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination					
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other
Blackfish Bayou	AR_08020203_007	5A	16.8	FRA0027										x											x			
Tyronza River	AR_08020203_012	5A	35.4	FRA0033										x											x			
Tyronza River	AR_08020203_909	5A	30.3	e-FRA0033										x											x			
Tyronza River	AR_08020203_912	5A	4.7	e-FRA0033										x											x			
L'Anguille River	AR_08020205_001	5B	17.2	FRA0010										x											x			
L'Anguille River	AR_08020205_002	5B	23.0	e - FRA0010										x											x			
L'Anguille River	AR_08020205_003	5B	2.9	e - FRA0011										x											x			
L'Anguille River	AR_08020205_004	5B	17.0	UWLGR01			PA							x				x							x			x
L'Anguille River	AR_08020205_005	5B	53.4	UWLGR02			PA							x				x							x			x

Table IV-6: Water Quality Limited Waters –Lakes (Category 4a) – 303(d) List

Lake Name	Assessment Unit	Monitoring Station	Planning Segment	Acres	County(s)	Assessment Method	Designated Use Not Supported						Source of Contamination			CAUSE			TMDLDATE	Year Listed
							FC*	AL	PC	SC	DW	AI	1	2	3	1	2	3		
Columbia - Lower	AR_11140203_4011	LRED002A	1A	1692	Columbia	M	Hg						UN			Hg			2002	2002
First Old River	AR_11140201_4020	LRED006A	1B	220	Miller	M		NU					UN			NU			2007	2004
Grand	AR_08050002_4020	LOUA001A	2A	1192	Chicot	M		NU					UN			NU			2007	2004
Grays	AR_08040203_4090	none	2C	25	Cleveland	M	Hg						UN			Hg			2004	2002
Monticello	AR_08040204_4020	LOUA022A	2C	1476	Drew	M	Hg						UN			Hg			2004	2002
Winona - Lower	AR_08040203_4101	LOUA011A	2C	843	Saline	M	Hg						UN			Hg			2002	2002
Ouachita River Oxbows below Camden	AR_08040202_xxxx	none	2D	UN	Ashley Calhoun Union Bradley Ouachita	M	Hg						UN			Hg			2002	2002
Ouachita River Oxbows below Camden	AR_08040201_xxxx	none	2D	UN	Ashley Calhoun Union Bradley Ouachita	M	Hg						UN			Hg			2002	2002
Big Johnson	AR_08040201_4040	none	2D	39	Calhoun	M	Hg						UN			Hg			2004	2002
Felsenthal	AR_08040202_ALL	LOUA002A	2D	UN	Union, Ashley	M	Hg						UN			Hg			2004	2002
Nimrod - Lower	AR_11110206_4052	LARK030A	3E	1370	Yell	M	Hg						UN			Hg			2002	2002
Dry Fork	AR_11110206_4060	none	3E	165	Perry	M	Hg						UN			Hg			2002	2002
Spring	AR_11110204_4070	LARK016A	3G	82	Yell	M	Hg						UN			Hg			2004	2002
Cove Creek	AR_11110202_4030	LARK013A	3H	126	Perry	M	Hg						UN			Hg			2002	2002
Old Town	AR_08020303_4010	LWHI003A	4A	2135	Phillips	M		NU					UN			NU			2007	2004
Frierson	AR_08020302_4020	LWHI002A	4B	343	Greene	M							UN			SI			2007	2004
Horseshoe	AR_08020203_4060	LMIS001A	5A	2388	Crittenden	M		NU					UN			NU			2007	2004
Bear Creek	AR_08020203_4020	LMIS003A	5A	493	Lee	M		NU					UN			NU			2007	2004
Mallard	AR_08020204_4010	LMIS005A	5C	318	Mississippi	M		NU					UN			NU			2007	2004

*FC - This is not a designated use.

Table IV-7: Water Quality Limited Waters – Streams (Category 5) – 303(d) List

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
Dorcheat Bayou	AR_11140203_022	1A	11.6	RED0015A										x											x				L
Dorcheat Bayou	AR_11140203_020	1A	9.8	e - RED0015A										x											x				L
Little Bodcau Creek	AR_11140205_010	1A	26.5	RED0056		DO					x																	UN	L
Red River	AR_11140106_025	1B	5.5	e - RED0025										x											x				L
Red River	AR_11140106_005	1B	20.8	RED0025										x											x				L
Red River	AR_11140106_003	1B	17.0	e - RED0025										x											x				L
Red River	AR_11140106_001	1B	36.5	e - RED0025										x											x				L
Red River	AR_11140201_007	1B	41.0	RED0045										x											x				L
Red River	AR_11140201_011	1B	14.9	RED0046										x											x				L
Bois D'Arc Creek	AR_11140201_008	1B	10.0	UWBDK02		DO					x																	UN	L
Bois D'Arc Creek	AR_11140201_009	1B	18.7	UWBDK01		DO					x																	UN	L
Days Creek	AR_11140302_003	1B	17.6	RED0004A		Pb			Pb											x			x						M
Bear Creek	AR_11140109_025	1C	11.3	RED0033		Cu			Cu										x				x						M
Little River	AR_11140109_001	1C	4.9	report		*							x															UN	L
Short Creek	AR_11140109_819	1C	7.1	RED0071								x																UN	L
Caney Creek	AR_11140109_921	1C	8.2	RED0069								x																UN	L
Cossatot River	AR_11140109_018	1C	18.5	RED0031		DO					x																	UN	M
Saline River	AR_11140109_014	1C	33.7	RED0032		DO					x																	UN	M
Mill Creek	AR_11140108_019	1D	12.3	RED0083								x																UN	L
Barren Creek	AR_11140108_907	1D	11.7	RED0078								x																UN	L
Bayou Macon	AR_08050002_003	2A	23.3	UWBYM01											x													UN	L
Bayou Macon	AR_08050002_006	2A	37.8	e - UWBYM01											x													UN	L
Bayou Bartholomew	AR_08040205_001	2B	54.0	OUA0013		DO, Pb			Pb		x									x								UN	L
Chemin-A-Haut Cr.	AR_08040205_907	2B	51.3	OUA0012		DO					x																	UN	L
Main Street Ditch	AR_08040205_909	2B	3.3	OUA0146		DO, Pb			Pb		x									x							x	UN	L

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	Al	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
Harding Creek	AR_08040205_902	2B	4.3	OUA0145		Pb			Pb											x							x		L
Bayou Imbeau	AR_08040205_910	2B	5.3	OUA0147		DO, Pb	PA		Pb		x							x		x							x		H
Able's Creek	AR_08040205_911	2B	28.0	OUA0158										x											x				L
Bearhouse Creek	AR_08040205_901	2B	34.6	OUA0155		DO					x																	UN	L
Bayou Bartholomew	AR_08040205_013	2B	34.4	UWBYB03, BB2, BB3, USGS07364 133		DO					x																	UN	L
Bayou Bartholomew	AR_08040205_006	2B	97.0	OUA0033, OUA0160, BB1		Pb			Pb											x								UN	L
Cross Bayou	AR_08040205_905	2B	2.5	OUA0152		DO					x																	UN	L
Overflow Creek	AR_08040205_908	2B	8.3	OUA0012A										x	x										x				L
Alum Fk. Saline River	AR_08040203_018	2C	7.7	USGS								x																UN	M
Alum Fork Saline River	AR_08040203_014	2C	19.3	OUA0216		DO					x	x																UN	M
Saline River	AR_08040203_913	2C	10.2	OUA0041, SAL-16										x											x			UN	M
North Fork Saline River	AR_08040203_011	2C	37.5	NFS0001A NFS04		DO					x																	UN	M
Middle Fork Saline River	AR_08040203_019	2C	37.1	MFS0005		DO					x																	UN	M
Lockett Creek	AR_08040203_922	2C	8.8	OUA0197		**					x																	UN	L
Saline River	AR_08040204_002	2C	60.2	OUA0010A OUA0117		*							x															UN	M
Big Creek	AR_08040204_005	2C	48.7	OUA0043 OUA0099		Pb			Pb			x								x								UN	L
Moro Creek	AR_08040201_001	2D	56.4	OUA0028 OUA0050 SAL-U3A		DO, Pb			Pb		x			x						x								UN	L
Moro Creek	AR_08040201_901	2D	57.0	e - OUA0028		DO, Pb			Pb		x									x								UN	L

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
E. Two Bayou	AR_08040201_905	2D	35.7	OUA0052B			PA					x						x										UN	H
Smackover Creek	AR_08040201_007	2D	49.8	e - OUA0027		DO, Pb			Pb		x	x		x						x			x					UN	L
Smackover Creek	AR_08040201_006	2D	4.7	e - OUA0027		DO, Pb			Pb		x	x		x						x			x					UN	L
Smackover Creek	AR_08040201_406	2D	17.5	OUA0027		DO, Pb			Pb		x	x		x						x			x						L
Salt Creek	AR_08040201_806	2D	7.2	OUA0137D								x																UN	L
ECC Tributary	AR_08040201_606	2D	5.2	OUA0137A		Cu, NO3						x							x			NO3	x						H
Ouachita River	AR_08040202_002	2D	10.3	OUA008B		Pb			Pb											x								UN	M
Ouachita River	AR_08040201_005	2D	2.8	OUA0037		Pb			Pb											x								UN	M
Bayou De L'outre	AR_08040202_008	2D	5.8	e - OUA0005, UAA		Pb, Zn, Se						x		x						x	x	Se	x						H
Bayou De L'outre	AR_08040202_007	2D	4.0	e - OUA0005		Pb, Zn,						x		x						x	x		x						H
Bayou De L'outre	AR_08040202_006	2D	13.2	OUA0005		Pb, Zn,						x		x						x	x		x						H
Loutre Creek	AR_08040202_909	2D	3.3	OUA0138, UAA		SE‡			Cl, SO4, TDS, SE	SO4, TDS					x	x	x					Se	x						H
Ouachita River	AR_08040202_004	2D	32.5	OUA0134, OUA0124B		DO					x																	UN	M
Cornie Bayou	AR_08040206_015	2E	55.1	OUA0002		Pb			Pb			x		x						x			x					UN	L
Little Cornie Creek	AR_08040206_016	2E	18.5	e-OUA0002		Pb			Pb											x			x						L
Little Cornie Creek	AR_08040206_716	2E	16.4	e-OUA0002		Pb			Pb											x			x						L
Little Cornie Creek	AR_08040206_816	2E	3.3	e-OUA0002		Pb			Pb											x			x						L
Walker Branch	AR_08040206_916	2E	4.5	e-OUA0002		Pb			Pb											x			x						L
Cove Creek	AR_08040102_976	2F	3.3	OUA0171C		DO					x	x																UN	M

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
Indian Springs Creek	AR_08040101_902	2F	0.7	OUA0184A; B; C; UAA		DO			SO4, TDS	SO4	x					x	x											UN	M
Prairie Creek	AR_08040101_048	2F	2.8	OUA0040		DO					x																	UN	H
Fiddlers Creek	AR_08040101_032	2F	12.8	OUA0141		DO					x	x																UN	L
Irons Fork Creek	AR_08040101_838	2F	10.4	OUA0142		**					x	x																UN	L
South Fk. Ouachita River	AR_08040101_043	2F	25.7	UWSFO01		DO					x																	UN	L
Irons Fork Creek	AR_08040101_929	2F	28.4	OUA0194								x																UN	L
‡ Loutre Creek has a perennial aquatic life use.																													
South Fork Caddo	AR_08040102_023	2F	18.6	OUA0187		DO					x																	UN	L
Ouachita River	AR_08040101_033	2F	12.1	OUA0021		DO					x																	UN	L
Terre Noir Creek	AR_08040103_003	2G	23.5	UWTNO01								x																UN	L
Terre Noir Creek	AR_08040103_002	2G	38.9	UWTNR02								x																UN	L
Terre Rouge Creek	AR_08040103_031	2G	26.0	UWTRC01										x											x				L
Arkansas River	AR_08020401_001	3A	28.6	ARK0020		DO					x																	UN	L
Wabbaseka Bayou	AR_08020401_003	3A	42.3	UWWSB01		DO					x																	UN	L
Bayou Meto	AR_08020402_001	3B	5.8	e - ARK0023		DO					x																	UN	L
Bayou Meto	AR_08020402_003	3B	41.4	ARK0023		DO					x																	UN	L
Bayou Two Prairie	AR_08020402_006	3B	5.2	e - ARK0097		DO					x																	UN	L
Bayou Two Prairie	AR_08020402_106	3B	1.9	e - ARK0097		DO					x																	UN	L
Bayou Two Prairie	AR_08020402_206	3B	11.1	ARK0097		DO					x																	UN	L
Bayou Two Prairie	AR_08020402_306	3B	43.3	ARK0021		DO					x																	UN	L
Bayou Two Prairie	AR_08020402_806	3B	6.7	e-ARK0097		DO					x																	UN	L
Bayou Meto	AR_08020402_907	3B	25.8	ARK0060		DO					x																	UN	L
Bayou Meto	AR_08020402_007	3B	56.5	ARK0050	PO												x					PO	x					UN	L

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
Fourche Creek	AR_11110207_024	3C	22.1	ARK0130; ARK0159; ARK0147E, F, ARK0147G, H		DO					x			x											x		x	UN	M
White Oak Bayou	AR_11110207_912	3C	19.5	ARK0162B		DO					x																	UN	L
N. Fork Cadron Creek	AR_11110205_015	3D	30.1	UWNCC02		DO					x																	UN	L
Cadron Creek	AR_11110205_014	3D	20.0	ARK0164		DO					x																	UN	L
E. Fork Cadron Creek	AR_11110205_002	3D	19.6	ARK0158; UWEFC01										x											x			UN	L
Dry Fork Creek	AR_11110206_914	3E	12.2	ARK0190								x																UN	L
Turner Creek	AR_11110206_808	3E	4.8	ARK0182								x																UN	L
Negro Branch	AR_11110206_514	3E	5.0	ARK0187								x																UN	L
West Gafford Creek	AR_11110206_012	3E	14.6	ARK0208								x																UN	L
Fourche LaFave R.	AR_11110206_008	3E	28.3	UWFLR01		DO, TM					x	x	x															UN	L
Fourche LaFave R.	AR_11110206_001	3E	51.6	ARK0036		DO					x																	UN	L
S. Fourche LaFave R.	AR_11110206_014	3E	30.2	ARK0052		DO					x																	UN	L
Stone Dam Creek	AR_11110203_904	3F	4.8	ARK0051		DO					x																	UN	L
Trimble Creek	AR_11110203_918	3F	3.5	ARK0168								x																UN	L
W. Fk. Point Remove	AR_11110203_018	3F	11.1	ARK0167 ARK0169								x																UN	L
Whig Creek	AR_11110203_931	3F	10.1	ARK0067		DO, AM					x											Am	x					UN	L
Rock Cypress Creek	AR_11110203_033	3F	19.9	CYP										x											x				L
Petit Jean River	AR_11110204_011	3G	24.1	ARK0034										x											x				L
E. Fk. Illinois Bayou	AR_11110202_013	3H	16.5	ARK0177		DO					x																	UN	M
Mulberry River	AR_11110201_007	3H	7.2	ARK0061								x																UN	H
Mulberry River	AR_11110201_008	3H	30.0	ARK0139								x																UN	H
Little Mulberry Creek	AR_11110201_012	3H	19.3	ARK0143								x																UN	H
Friley Creek	AR_11110201_912	3H	7.2	ARK0144								x																UN	H
Poteau River	AR_11110105_001	3I	4.9	ARK0014		DO					x																	UN	M

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
Poteau River	AR_11110105_031	3I	6.7	ARK0055, UAA										x		x							x	x	x				M
Unnamed Tributary to Poteau	AR_11110105_831	3I	1.1	UAA											x		x											UN	L
Illinois River	AR_11110103_020	3J	1.6	ARK006A, ILL0007, UofA IR59, USGS_0719 5430											x	x												UN	M
Illinois River	AR_11110103_024	3J	2.8	ARK0040, ARK0066, UofA_Savoy, USGS_0719 4800, AWRCIR024 A											x	x												UN	M
Moores Creek	AR_11110103_026	3J	4.8	e -ARK0040												x												UN	M
Illinois River, Muddy Fork	AR_11110103_027	3J	7.1	e -ARK0040												x												UN	M
Big Creek	AR_08020304_010	4A	40.7	UWBGC03											x		x											UN	L
Prairie Cypress	AR_08020304_014	4A	14.1	WHI0073		DO, Cu			Cu		x								x									UN	L
Boat Gunwale Slash	AR_08020303_914	4A	10.0	WHI0074		DO					x																	UN	L
White River	AR_08020303_005	4A	50.7	WHI0036; WHI0086		DO					x																	UN	L
Cache River	AR_08020302_016	4B	25.0	WHI0032		DO, Pb			Pb		x									x						x			L
Bayou DeView (Cow Ditch)	AR_08020302_012	4B	18.2	ANRC		DO					x																	UN	L
Flag Slough Ditch	AR_08020302_011	4B	16.3	ASUERF-FSDI		DO					x																	UN	L
Bayou DeView	AR_08020302_007	4B	6.2	e - UWBDV02		DO					x					x										x		UN	L
Bayou DeView	AR_08020302_006	4B	10.2	e - UWBDV02		DO					x					x										x		UN	L
Bayou DeView	AR_08020302_005	4B	8.3	e - UWBDV02		DO					x					x										x		UN	L
Bayou DeView	AR_08020302_004	4B	25.3	UWBDV02		DO					x					x										x		UN	L
Bayou DeView	AR_08020302_002	4B	15.8	WHI0033		DO					x																	UN	L
Buffalo Creek	AR_08020302_014	4B	10.5	ANRC		DO					x																	UN	L

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
Caney Creek	AR_08020302_903	4B	18.0	ANRC		DO					x																	UN	L
Lost Creek Ditch	AR_08020302_909	4B	14.1	WHI0172		Cl									x								x	x					L
Departee Creek	AR_11010013_020	4C	21.9	UWDTC01		Zn					x										x					x		UN	L
Glaise Creek	AR_11010013_021	4C	43.1	UWGSC01		DO,Zn					x										x					x		UN	L
Village Creek	AR_11010013_008	4C	12.2	e - UWVGC01; UWVGC03		DO					x																	UN	L
Village Creek	AR_11010013_007	4C	1.2	e - UWVGC01; UWVGC03		DO					x																	UN	L
Village Creek	AR_11010013_006	4C	29.2	UWVGC01, UWVGC03		DO					x																	UN	L
White River	AR_11010013_017	4C	12.8	WHI0060		*							x															UN	L
Wattensaw Bayou	AR_08020301_015	4D	69.5	WHI0072		DO					x																	UN	L
Cypress Bayou	AR_08020301_010	4D	7.8	UWCPB01		DO					x																	UN	L
Bull Creek	AR_08020301_009	4D	46.8	UWBLB01		DO, Zn			Zn		x										x							UN	L
Bayou Des Arc	AR_08020301_007	4D	50.1	UWBDA01		DO, Pb			Pb		x									x								UN	L
Bayou Des Arc	AR_08020301_006	4D	22.7	WHI0056		DO, TM					x		x	x											x			UN	L
S. Fk Little Red River	AR_11010014_038	4E	9.7	UWSRR01, UWSRR02, WHI0190								x																UN	L
S. Fk Little Red River	AR_11010014_040	4E	7.7	USGS		DO					x																	UN	L
S. Fk Little Red River	AR_11010014_940	4E	13.8	USGS								x																UN	L
S. Fk Little Red River	AR_11010014_036	4E	4.0	UWAFK01, WHI0185, WHI0194								x																UN	L
Greenbrier Creek	AR_11010004_017	4F	13.1	WHI0167		DO					x																	UN	L
Hicks Creek	AR_11010004_015	4F	13.3	WHI0065			PA											x						x			x	UN	H

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	Al	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
Strawberry River	AR11010012_006	4G	20.3	WHI0024, WHI0143P, STR-S1, STR-10								x																UN	L
Fourche River	AR_11010009_008	4G	31.4	WHI0170										x											x				L
English Creek	AR_11010010_009	4H	9.6	WHI0142H		DO					x																	UN	L
Gut Creek	AR_11010010_906	4H	9.4	WHI0142K		DO					x																	UN	L
Spring River	AR_11010010_006	4H	5.2	WHI0022		Tem p							x															UN	L
Crooked Creek	AR_11010003_049	4I	20.6	UWCKC01, WHI0048		*							x															UN	L
Leatherwood Creek	AR_11010001_916	4K	5.5	LC02		DO					x																	UN	M
Town Branch	AR_11010001_959	4K	2.6	UAA					TDS								x						x	x					L
Kings River	AR_11010001_037	4K	38.2	WHI0009A		++											x											UN	L
Kings River	AR_11010001_542	4K	23.0	BUFET004		DO					x																	UN	M
White River	AR_11010001_023	4K	7.4	WHI0052, WHI0151A, WHI0151B, WR45, Banks farm, Wyman Bridge		*										x												UN	L
Town Branch	AR_11010001_824	4K	3.0	TB62, TBN01, TB										x											x				L
Middle Fork White River	AR_11010001_926	4K	15.5	WHI0101 MFW01		DO					x																	UN	M
West Fork White River	AR_11010001_024	4K	10.7	WHI0051, WHI0100, Tilly Willy, Dead Horse, Molly Wagon, Harvey Dowell, Stonebridge, UAA, WHW03, 04, 05										x		x	x											UN	L
West Fork White River	AR_11010001_624	4K	19.2	WHI0097, WHI0098, Airport		DO					x					x												UN	M

Stream Name	Assessment Unit	PLNG SEG	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority
St. Francis River	AR_08020203_009	5A	13.7	e - FRA0013		DO					x				x													UN	L
St. Francis River	AR_08020203_008	5A	42.9	FRA0013		DO					x				x													UN	L
Ten Mile Bayou	AR_08020203_906	5A	10.7	FRA0029		DO					x																	UN	L
Caney Creek	AR_08020205_901	5B	7.1	FRA0034		DO					x																	UN	L
Second Creek	AR_08020205_008	5B	26.0	FRA0012		DO					x																	UN	L
L' Anguille River	AR_08020205_005	5B	53.4	UWLGR02		DO					x				x	x	x											UN	L
L' Anguille River	AR_08020205_004	5B	17.0	UWLGR01, USGS_0704 7942		DO					x				x													UN	L
First Creek	AR_08020205_007	5B	31.2	FRA0030		DO					x																	UN	L
L' Anguille River	AR_08020205_003	5B	2.9	e - FRA0010		DO					x				x		x											UN	L
L' Anguille River	AR_08020205_002	5B	23.1	e - FRA0010		DO					x				x		x											UN	L
L' Anguille River	AR_08020205_001	5B	17.2	FRA0010		DO					x				x		x											UN	L
Prairie Creek	AR_08020205_902	5B	8.4	FRA0035					TDS								x											UN	L
Little River, Left	AR_08020204_001	5C	17.6	FRA0037		DO					x																	UN	L
Little River, Left	AR_08020204_002	5C	51.0	e - FRA0037		DO					x																	UN	L

Table IV-8: Water Quality Limited Waters –Lakes (Category 5) – 303(d) List

Lake Name	Assessment Unit	Monitoring Station	Planning Segment	Acres	County(s)	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
						FC*	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	UN	Priority
Cox Creek	AR_08040203_4110	LOUA021A	2C	245	Grant								x																x	L
Pickthorne	AR_08020402_4010	Ark G&F	3B	325	Lonoke		UN																UN						x	L
Rodgers	AR_08020402_4020	LARK027A	3B	562	Arkansas		DO					x																	x	L
Saracen	AR_11110207_4010	LARK026A	3C	467	Jefferson	PCB																	PCB	x						L
Nimrod - Lower	AR_11110206_4052	LARK030A	3E	1370	Perry		DO					x																		L
Driver	AR_11110203_4020	LARK041	3F	28	Van Buren								x																	L
Blue Mountain - Lower	AR_11110204_4061	LARK028A	3G	1852	Yell		DO					x			x											x				L
Horsehead	AR_11110202_4050	LARK017A	3H	109	Johnson								x																	L
Lee Creek	AR_11110104_4020	LARK024A	3H	582	Crawford								x																	L
Fayetteville	AR_11110103_4080	LARK015A	3J	171	Washington								x																	M
Frierson	AR_08020302_4020	LWHI002A	4B	343	Greene		Cu													x									x	L

Table IV-9: Water Quality Limited Waters – Streams (Category 5 alt) – 303(d) List

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Station	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other	Priority*
Illinois River, Muddy Fork	AR_11110103_027	3J	7.1	MFI0002B			PA											x					x	x	x	x			L
Moores Creek	AR_11110103_026	3J	4.8	ARK0096			PA											x					x	x	x	x			L
Illinois River	AR_11110103_028	3J	2.9	IR028D			PA											x					x	x	x	x			L
Little Osage Creek	AR_11110103_630	3J	7.2	LO933B			PA											x					x	x	x	x			L
Little Osage Creek	AR_11110103_933	3J	4.3	LO933C			PA											x					x	x	x	x			L

Table IV-10: Water Quality Limited Waters –Lakes (Category 5 alt) – 303(d) List

Lake Name	Assessment Unit	Monitoring Station	Planning Segment	Acres	County(s)	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination						
						FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	UN	Priority*
Beaver Reservoir - White River Arm previously part of area known as Beaver Lake upper	AR_11010001_4040	LWHI013B	4K	1338	Benton Washington			PA							x				x							x				L
Beaver Lake - War Eagle Arm previously part of area known as Beaver Lake upper	AR_11010001_4041	USGS-07049160	4K	1282	Benton Washington			PA					x		x				x							x			x	L
Beaver Reservoir at Hickory Creek - previously part of area known as Beaver Lake upper	AR_11010001_4042	USGS-07049187	4K	865	Benton			PA							x				x							x				L

* Low priority for TMDL development due to an alternative plan being in place.

Table IV - 11: Water Quality Limited Waterbodies – Streams (Category 4b) - 303(d) List

Stream Name	Assessment Unit	Planning Segment	Miles	Monitoring Stations	Designated Use Not Supported						Water Quality Criteria Non-Attainment												Source of Contamination					
					FC	AL	PC	SC	DW	AI	DO	pH	Tm	Tb	Cl	SO4	TDS	PA	Cu	Pb	Zn	Other	IP	MP	SE	AG	UR	Other
Chamberlain Creek	AR_08040102_971	2F	2.5	OUA0104, OUA0171A		pH, Cu, Zn, Al, Be, Tox			SO4, TDS, Cu, Zn, Al, Be	SO4, TDS		x				x	x		x		x	Al, Be, Tox	x					RE
Cove Creek	AR_08040102_970	2F	3.7	Toxicity samples		pH, Zn, Tox			Zn			x									x	Tox						RE
Lucinda Creek	AR_08040102_975	2F	2.3	OUA0171B		pH						x																RE
Big Creek	AR_11010005_020	4J	3.7	USGS , BUFT06		DO					x																	UN
Big Creek	AR_11010005_022	4J	15.1	BRWA, BCRET			PA											x										UN
Buffalo River	AR_11010005_011	4J	7.5	BUFR04, BUFR0414			PA											x										UN
Buffalo River	AR_11010005_010	4J	10.7	BUFR0415			PA											x										UN

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PART V GROUNDWATER ASSESSMENT

Introduction

Section 106(e) of the CWA specifies that each state monitor the quality of its groundwater resources and report results to Congress on a biennial basis in its state 305(b) report. The Division has sampled all major fresh-water aquifers per the EPA goal of reporting groundwater quality for specific aquifers or hydrologic setting. This section of the report consists of (1) a summary of State groundwater protection programs and (2) a listing of the major sources of groundwater contamination in the State.

The following is a combination of information from the previous report and new information since the last publication of the Arkansas Water Quality Inventory Report. Specifically, activities from April 1, 2012 to March 31, 2017 are included; activities prior to that period have been omitted. Due to the three-year rotational period for the monitoring areas, and for completeness of major program changes in other areas in the last five years, the present report may include information also provided in the last report.

Overview

Shallow fresh water aquifer systems are found throughout Arkansas, and supply high quality groundwater for a wide range of uses including industrial, municipal, agricultural, and domestic. Groundwater is one of the most important water supply sources in Arkansas and accounts for approximately 60 percent of the total water use in the state. Most all of the surficial aquifers supply water of good to very good quality, ranging from calcium-bicarbonate to sodium-bicarbonate water types. Localized areas of poor water quality result from both natural and anthropogenic effects. Natural sources of contamination are typically regional in extent and are related to water-rock interactions, whereas the anthropogenic effects are more localized, including both point and nonpoint sources of contamination. Nonpoint sources do affect larger areas, but contaminant concentrations are typically much lower than those resulting from point sources and the contaminants are normally soluble, non-reactive constituents. Point sources of contamination often result in elevated concentrations of contaminants above federal Maximum Contaminant Level (MCL); however, the extent of contamination normally is confined to a small area with little to no offsite migration or contact with receptors.

Groundwater in Arkansas occurs in two general geologic settings, distributed among five major physiographic regions of the State: Ozark Plateaus, Arkansas River Valley, Ouachita Mountains, West Gulf Coastal Plain, and Mississippi River Alluvial Plain. The aquifer systems in eastern Arkansas (West Gulf Coastal Plain and the Mississippi River Alluvial Plain) are mainly composed of alternating sequences of gravel, sand, silt, and clay, which form both confining layers and aquifers. The main aquifer systems are located in the Quaternary deposits (the Alluvial aquifer), the Cockfield Formation, the Sparta Formation, the Wilcox Group, the

Nacatoch Sand, and the Tokio Formation (Table V-1). The Alluvial aquifer and the Sparta aquifer supply most of the groundwater used in the state. The thickness of the alluvial aquifer ranges from approximately 50 to 150 feet, and is used mainly for irrigation. It is often able to yield up to 1700 gallons per minute (gpm) to a well. The Sparta aquifer is used mainly for municipal and industrial supply, although declining levels in the alluvial aquifer in some areas have resulted in increasing exploitation of the underlying Sparta aquifer for irrigation.

Three aquifers which comprise the Ozark Plateaus Aquifer System are located in northern Arkansas (Table V-2). The Springfield Plateau aquifer is generally under unconfined conditions, with groundwater movement occurring through solution cavities and fractures enlarged by dissolution of carbonate rock. Local discharge is to springs and streams. The Ozark aquifer is generally under confined conditions, especially where overlain by the units of the Ozark Confining Unit (Chattanooga Shale). Most wells in the Springfield Plateau and upper units in the Ozark aquifer yield 5-10 gpm on the average, with yields greater than 25 gpm in rare cases. The Roubidoux Formation and the Gunter Sandstone Member of the Gasconade Formation in northern Arkansas constitute the only significant deep aquifer system in the Ozarks. They are used mainly for municipal supply systems where surface water sources are unavailable or unreliable. These units may yield up to 500 gpm to wells that are completed in both zones.

Table V-1: Generalized Stratigraphic Column of the Gulf Coastal Plain of Southern and Eastern Arkansas (modified from Haley et al., 1993).

ERA	SYSTEM	SERIES	GROUP	FORMATION
Cenozoic	Quaternary	Holocene & Pleistocene		Alluvium & Terrace Deposits *
	Tertiary	Eocene	Jackson	Undifferentiated
			Claiborne	Cockfield Formation *
				Cook Mountain Formation
				Sparta and Memphis Sand *
				Cane River Formation
				Carrizo Sand
		Eocene / Paleocene	Wilcox	Undifferentiated *
		Paleocene	Midway	Undifferentiated
Mesozoic	Cretaceous	Upper Cretaceous		Arkadelphia Marl
				Nacatoch Sand *
				Tokio Formation *
				Undifferentiated
Paleozoic	Undifferentiated	Undifferentiated		Undifferentiated

(* denotes major aquifers)

Table V-2: Generalized Stratigraphic Units in Northern Arkansas with Corresponding Geohydrologic Units (modified from Imes and Emmett, 1994).

ERA	SYSTEM	FORMATION	GEOHYDROLOGIC UNIT	GEOHYDROLOGIC SYSTEM
Paleozoic	Pennsylvanian	Atoka Formation Bloyd Formation Hale Formation		Western Interior Plains Confining System
	Mississippian	Pitkin Limestone Fayetteville Shale Batesville Sandstone Moorefield Formation		
		Boone Formation St. Joe Limestone Member	Springfield Plateau Aquifer	Ozark Plateaus Aquifer System
	Devonian	Chattanooga Shale	Ozark Confining Unit	
		Clifty Limestone Penters Chert	Ozark Aquifer	
	Silurian	Lafferty Limestone St.Clair Limestone Brassfield Limestone		
	Ordovician	Cason Shale Fernvale Limestone Kimmswick Limestone Plattin Limestone Joachim Dolomite St. Peter Sandstone Everton Formation Smithville Formation Powell Dolomite Cotter Dolomite Jefferson City Dolomite Roubidoux Formation Gasconade Dolomite Van Buren Formation Gunter Sandstone Member		
	Cambrian	Eminence Dolomite Potosi Dolomite		
		Doe Run Dolomite Derby Dolomite Davis Formation	St. Francois Confining Unit	
		Bonneterre Dolomite Regan Sandstone Lamotte Sandstone	St. Francois Aquifer	

The Western Interior Highlands (Arkansas River Valley and Ouachita Mountains) are underlain by thick sequences of consolidated rocks of mostly Paleozoic age consisting generally of sandstones, shale, and novaculite (Table V-3). Groundwater in these units occurs primarily in fractures and joints, and is used both for domestic and municipal supplies. Wells throughout western Arkansas average about 150 feet in depth and normally produce less than 10 gpm.

Table V-3: Generalized Stratigraphic Column of the Arkansas River Valley and Ouachita Mountain Region. (modified from Haley et al., 1993)

<table>
<tr><th>ERA</th><th>SYSTEM</th><th>FORMATION</th></tr>
<tr><td>Cenozoic</td><td>Quaternary</td><td>Alluvium & Terrace Deposits</td></tr>
<tr><td rowspan="6">Paleozoic</td><td>Pennsylvanian</td><td>Boggy Formation
Savanna Formation
McAlester Formation
Hartshorne Sandstone
Atoka Formation
Johns Valley Shale
Jackfork Sandstone</td></tr>
<tr><td rowspan="2">Mississippian</td><td>Stanley Shale</td></tr>
<tr><td rowspan="2">Arkansas Novaculite</td></tr>
<tr><td>Devonian</td></tr>
<tr><td>Silurian</td><td>Missouri Mountain Shale
Blaylock Sandstone</td></tr>
<tr><td>Ordovician</td><td>Polk Creek Shale
Big Fork Chert
Womble Shale
Blakely Sandstone
Mazarn Shale
Crystal Mountain Sandstone
Collier Shale</td></tr>
</table>

Groundwater Availability and Use

Groundwater use in Arkansas has more than doubled since 1985; the increased demand has resulted in water-level declines in many areas of the State. Act 154 of 1991, allows designation of “critical” groundwater areas based on indicators of groundwater depletion, and authorizes regulation of usage. Recent policy changes place an increased emphasis on the achievement of sustainable yield of all the State’s aquifers. Determination of sustainable yield is established by the ANRC as part of a joint project with the USGS Arkansas Water Science Center in Little Rock.

Beginning in 1995, the Sparta aquifer beneath a five-county area in south Arkansas was designated as a critical groundwater area by the ANRC, then in 1998, they designated a second area in eastern and central Arkansas for the Alluvial and Sparta aquifers. Priority study areas for present and future analyses include the Alluvial and Sparta aquifers in parts of northeastern and southeastern Arkansas, including the Cache and St. Francis study areas in northeast Arkansas and the Boeuf-Tensas study area in southeast Arkansas.

Information used to evaluate water-level trends in the various aquifers is based on a water-level monitoring measurement network maintained under cooperative agreements between the ANRC, USGS, the Arkansas Geological Survey (AGS), and the Natural Resources Conservation Service (NRCS). Through this process, over 1500 measurements are collected annually, and trends in water-level changes are used in evaluating potential critical use areas within the State.

Water use registration for all wells capable of producing 50,000 gallons per day has been required since 1985 along with an annual water use registration fee. Arkansas Act 1426 was promulgated in 2001 for the purpose of requiring a properly functioning metering device for any well constructed after September 30, 2001, which withdraws groundwater from a sustaining aquifer. Domestic wells are specifically exempt from the metering requirement. After September 30, 2006 all wells withdrawing groundwater from a sustaining aquifer were required to have a properly functioning meter. Sustaining aquifers include the Sparta, Memphis, Cockfield, Cane River, Carrizo, Wilcox, Nacatoch, Roubidoux and the Gunter aquifers. The Alluvial aquifer is not considered a sustaining aquifer. Based on sustainable yield estimates produced by groundwater modeling at the USGS Water Science Center in Little Rock, the ANRC is considering formal recommendation of sustainable yield for the Sparta/Memphis Aquifer in eastern and southern Arkansas.

The greatest water quantity issue in Arkansas is the extensive use of the Alluvial aquifer (primarily for irrigation purposes) and the Sparta aquifer (primarily for municipal and industrial supply) in eastern Arkansas. While both have historically provided abundant water, neither can sustain the current withdrawal rates indefinitely. Although the amount of water withdrawn annually from the Sparta aquifer is much less than what is withdrawn from the Alluvial aquifer, its coefficient of storage (or "storativity" that describes the amount of water released from an aquifer per unit volume) is several orders of magnitude smaller than that of the Alluvial aquifer. Thus, a much larger volume of the Sparta is dewatered compared to the alluvial aquifer in obtaining an equal volume of water. The alluvial aquiver yields around 3000 times more water per unit volume than the Sparta does, thus the drawdown from pumping at a given rate from the Sparta aquifer extends much farther than pumping at the same rate from the alluvial aquifer does.

In response to high usage rates, water levels have declined substantially in both aquifers. Large "cones of depression" have developed across broad areas. Individual cones of depression have coalesced into larger cones, eventually forming depressions of regional scale. In this way, extensive water-level declines have occurred in the Sparta, due to water being withdrawn at higher rates than the lateral recharge replenishes it. The Sparta cannot sustain the current rates of withdrawals, and certainly not the accelerating rates of withdrawal observed in many areas. The effect of increased pumping will be especially evident where high-volume agricultural users tap the Sparta as a supplemental water source. Where pumping from the Alluvial and Sparta aquifers continues to exceed sustainable rates, water levels will continue to decline and eventually reach a physical limit at which water cannot be produced at the desired rates.

Groundwater - Surface Water Interactions

The subject of interaction of ground and surface water, exemplified by losing and gaining streams, encompasses regulatory, pollution-prevention, and research programs among others. It is considered during development of policies and regulations regarding groundwater, and in groundwater remediation projects. For example, standards for remediation of groundwater contamination at a site (say, treating to the applicable MCLs for drinking water) may be acceptable for the local groundwater use requirements; however, the same concentrations that are acceptable at the remediated site may nevertheless exceed stream standards locally if the groundwater seeps into a stream. Another example is over pumping of groundwater leading to development of a persistent cone of depression, which may then reduce base flow to streams in the area.

Many U of A investigations have addressed surface/groundwater interaction occurring on karst. Many of the flow paths discharge as springs and seeps into nearby streams, and movement of contaminants within the karst aquifer system has a more pronounced effect on both surface and subsurface water quality because of the rapidity and higher degree of groundwater - surface water interaction relative to other geologic settings.

Chapter One PRINCIPAL SOURCES OF CONTAMINATION

Most potential and actual sources of groundwater contamination in the State are common to many states, i.e. anthropogenic and natural sources of contamination. Each source varies in its areal extent and in its effect on water quality, making it difficult to state which sources have the greatest effect. For example, a hazardous waste site may severely affect groundwater, with numerous organic contaminants exceeding drinking water standards. However, the areal extent of the contaminant plume may be small, with no known receptors at risk. Conversely, contamination from various land use activities may be widespread, impacting numerous receptors but possibly exhibiting few discernible effects on the usability of the water.

Potential point sources of contamination from disposal sites, underground storage tanks (UST), mining operations, and other activities are regulated under various DEQ programs; whereas agriculture, urbanization, and other wide-ranging land-use activities commonly are addressed by voluntary activities like education and implementation of BMPs for protection of groundwater. These activities are described in more detail in the section titled "Groundwater Protection Programs."

Nonpoint sources of contamination range from elevated nutrients and bacteria in shallow aquifers in northern Arkansas associated with animal production and septic systems, to low-level pesticide detections in eastern Arkansas associated with row-crop agriculture. Point sources of contamination include landfills, USTs, leaking waste- and process-water storage ponds, industrial facilities, military installations and petroleum storage and transfer sites. Although these sources are responsible for numerous localized groundwater contamination instances, offsite migration of contaminants is infrequent because the flow behavior of organic constituents in the subsurface differs from that of groundwater; plumes stop expanding after the release of contaminants is stopped. However, costs for procuring an alternate water supply for impacted users and total contamination remediation costs can exceed several million dollars at a single site, thus contamination prevention remains the best approach.

In addition to anthropogenic sources of contamination, water quality degradation resulting from natural water-rock interaction ranges from simple TDS and hardness issues due to high concentrations of dissolved calcium and magnesium, to high concentrations of iron caused by dissolution of iron-oxide coatings from the aquifer sediments. For the same reason, elevated manganese (above the 50 µg/L MCL is frequently noted. Other areas of concern from natural sources include areas of saltwater intrusion (chloride as high as 1000 mg/L) predominantly in southeast Arkansas, though isolated areas of elevated chloride are also found in several locations throughout the Alluvial aquifer in east central Arkansas, probably related to heavy drawdown and/or the depositional environments and local hydrogeologic variables.

Also, naturally-occurring radionuclides (radium) and fluoride above MCLs exist in localized areas of deeper Paleozoic aquifer systems in north central Arkansas; strong reducing conditions that allow mobilization and concentration of these constituents is the putative cause. This situation is encountered occasionally during development of deep public water supply wells in the area, but due to a paucity of foregoing research and background data, it is difficult to predict and avoid.

Elevated iron and manganese concentrations are ubiquitous throughout the State in the Alluvial aquifer in eastern Arkansas and in the Paleozoic strata in north central Arkansas because subsurface conditions are predominantly reducing (with the exception of the carbonate aquifers that tend to be oxic). Dissolved iron and manganese do not present a health hazard, but do cause aesthetic problems (staining, taste, etc.) and can also interfere with industrial applications where high-quality water is often required. Naturally-occurring arsenic concentrations as high as 70 µg/L have been documented in isolated areas of the alluvial aquifer. These excursions are the result of reductive dissolution of iron oxides that were originally co-precipitated along with arsenic and trace metals; these then remobilize when the redox condition of the aquifer becomes reducing.

Nitrate concentrations appear to be increasing in groundwater in northwest and northern Arkansas due to the combination of the predominant land use (e.g. poultry production) and Karst terrain that is more vulnerable to surface water influence. In the Coastal Plain area of the State, groundwater quality monitoring has indicated low concentrations of pesticides due to row-crop agriculture. Finally, brine contamination can also occur due to leaky surface impoundments, corroded well casings, leaking brine pipelines, or pre-law disposal to the land surface.

The Safe Drinking Water Act has focused attention on minimizing microbial contaminants in public water supplies; also waterborne disease outbreaks and chemical spills upstream of public water intakes have been a cause of national concern. These incidents emphasize the need for effective local source water protection measures, and reinforce the value of adherence to the proven “multiple barrier” approach in water production and treatment.

The DEQ Office of Water Quality has increased groundwater monitoring requirements during permitting of facilities with potential sources of groundwater contamination. This assists in weighing the effects of sludge application, manure spreading, earthen lagoons, and other potential sources of groundwater contaminants. Office of Water Quality geologists review these permits as required, to ensure that groundwater is protected beneath these facilities.

Groundwater Quality Protection and Restoration

There are many groundwater protection programs within the State that include both regulatory and voluntary groundwater contamination prevention activities from both point sources and nonpoint sources. Point source prevention programs are almost entirely regulatory programs and are administered by the Division, while the majority of nonpoint sources are related to agriculture and other land-use activities and commonly include joint efforts by several agencies.

Petroleum Tank Program and Enforcement Branch (DEQ)

The Petroleum Tank Program and Enforcement Branch (Previously Regulated Storage Tanks (RST) Division) within the Office of Land Resources at the Division has program responsibility for implementing the federal underground storage tank (UST) program in Arkansas, and for the cleanup of releases from both regulated USTs and aboveground storage tanks (AST).

During this reporting period, the Petroleum Tank Program and Enforcement Branch experienced significant developments including the following:

> Petroleum Tank Program and Enforcement Branch staff trained and certified over 2075 UST operators between April 1, 2012 and March 31, 2017.
>
> Petroleum Tank Program and Enforcement Branch has completed its third three-year inspection cycle on all UST facilities. The total compliance inspections completed during the reporting period of April 1, 2012 through March 31, 2017 is 6,232. There were 207 confirmed releases reported between April 1, 2012 and March 31, 2017.The division recorded a significant operational compliance rate for UST owners of 58 percent as of March 31, 2017.
>
> Petroleum Tank Program and Enforcement Branch initiated 194 corrective action cleanups at petroleum contaminated sites between April 1, 2012 and March 31, 2017. Remediation was completed on 230 sites during the reporting period.
>
> Claims for reimbursement of corrective action costs from the Arkansas Petroleum Storage Tank Trust Fund totaled 482 between April 1, 2012 and March 31, 2017. The trust fund balance as of March 31, 2017, was approximately $25.5 million, with total estimated obligations (corrective action and third-party) of approximately $11.6 million.

Underground Injection Control Program (DEQ)

The Underground Injection Control (UIC) Program regulates disposal of waste waters into appropriate underground reservoirs under authority of Part C of the federal Safe Drinking Water

Act (SDWA). Congress passed the SDWA in 1974, requiring the Environmental Protection Agency (EPA) to establish a system of regulations for injection activities. The regulations are designed to establish minimum requirements for controlling all injection activities, to provide mechanisms for implementation and authorization of enforcement authority, and to provide protection of underground sources of drinking water (USDW).

Arkansas was given authority to administer the UIC program as a primacy state in 1982 and is seventy-five percent funded by a grant from EPA and twenty-five percent funded by DEQ. This primacy authority (primary enforcement authority) allows the Division to regulate Class I, Class III, Class IV, Class V (excluding bromine-related spent brine disposal wells), and Class VI UIC wells. The Arkansas Oil and Gas Commission (AOGC) regulates the Class II UIC wells and Class V bromine-related spent-brine disposal UIC wells as outlined in the 1982 Memorandum of Understanding revised in 1996. Protecting USDWs is accomplished through the issuance of permits, conducting inspections, performing annual, quinquennial, and as-needed testing, continuous monitoring, and on-going enforcement of the regulations in 40 CFR Parts 124, 144, 145, 146, and 147 and in Arkansas Pollution Control and Ecology Commission (ADP&EC) Regulation 17.

Class I UIC Wells

Presently there are 12 Class I waste disposal UIC wells in the State of Arkansas covered under seven permits. These wells were constructed to inject hazardous and non-hazardous industrial waste water into underground saline fluid-containing formations at depths ranging from 3,181 feet to 8,991 feet below ground surface. There are currently four hazardous waste injection wells and eight non-hazardous waste Class I injection wells in Arkansas. Two of these wells (one hazardous and one non-hazardous) are “shut-in” or temporarily abandoned and not injecting. All Class I wells, with the exception of the Red River Aluminum well WDW-1, passed the annual and quinquennial mechanical integrity testing (MIT) requirements during the time frame of April 1, 2012 to March 31, 2017.

The following permits are active at the time of this report except for 0008-U:

- 0004-UR-3: Albemarle South Plant in Magnolia, Columbia County. The two non-hazardous waste disposal UIC wells, WDW-3 and WDW-13, are operating and two more, WDW-4 and WDW-5, are permitted for future construction. The hazardous waste disposal UIC well, WDW-2, has had a temporary abandonment status since 2006. Albemarle has submitted a letter of intent and a revised well closure plan and plans to plug and abandon this well in October 2017.
- 0008-U (expired): former Red River Aluminum Plant in Stamps, Lafayette County. The one non-hazardous waste disposal UIC well, WDW-1, has been shut in since December

1998 and has not been tested since before that time. The City of Stamps along with the DEQ Office of Water Quality is exploring options for closure of this well.

- 0009-UR-1: Great Lakes Chemical Corporation (Lanxess) West Plant in Marysville, Union County. The one non-hazardous waste disposal UIC well, WDW-14M, is operating. The non-hazardous waste disposal UIC well, WDW-1M, was plugged and abandoned according to 40 CFR § 146.10 requirements in September 2012.
- 0010-UR-3: Great Lakes Chemical Corporation (Lanxess) South Plant in El Dorado, Union County. The two non-hazardous waste disposal UIC wells, WDW-6S and WDW-7S, are operating. The non-hazardous waste disposal UIC well, WDW-5S, was plugged and abandoned according to 40 CFR § 146.10 requirements in April 2014.
- 0011-UR-1: Great Lakes Chemical Corporation (Lanxess) Central Plant in El Dorado, Union County. The two hazardous waste disposal UIC wells, WDW-5C and WDW-6C, are operating. This permit is currently being modified for the existing wells and to permit the installation of one more hazardous waste disposal UIC well, WDW-7C.
- 0015-UR-3: Great Lakes Chemical Corporation (Lanxess) Newell Plant in Newell, Union County. The two non-hazardous waste disposal UIC wells, WDW-7N and WDW-8N, are operating.
- 0017-UR-2: Dow Chemical Company, Albemarle West Plant in Magnolia, Columbia County. The one hazardous waste disposal UIC well, DWD-1, is operating.

Class V UIC Wells

Since most shallow aquifer Class V UIC wells are permitted by rule according to 40 CFR § 144.84, DEQ issues authorizations for infrequent injection activity for activities including dye trace studies and aquifer remediation. During the time frame of April 1, 2012 to March 31, 2017, DEQ issued fifty-two (52) authorizations for aquifer remediation and dye trace studies.

DEQ issues general permits for shallow subsurface non-hazardous injection of carwash waste fluid. During the time frame of April 1, 2012 to March 31, 2017, DEQ had an average of 150 of these facilities covered under active permits.

DEQ issues individual permits for subsurface wastewater disposal for domestic wastewater systems serving twenty or more people per day and permits for subsurface disposal of industrial wastewater. The Arkansas Department of Health has authority over domestic wastewater systems serving less than twenty people per day.

Other Classes of UIC Wells

DEQ is also authorized to regulate Class III, Class IV, Class V (excluding bromine-related spent brine disposal wells), and Class VI UIC wells. Since there are no Class III, IV, or VI UIC wells in Arkansas, no permits have been issued for these categories. In 1984, EPA banned the use of

Class IV injection wells. These wells may only operate as part of an EPA- or state-authorized ground water clean-up action.

Solid Waste Management (DEQ)

The Division's Solid Waste Management program is within the Office of Land Resources. The program works to ensure that solid waste is handled, processed, recycled, and disposed of in ways that protect the environment and in accordance with federal and state regulations.

Arkansans are provided with environmentally safe options for solid waste collection and disposal through municipal solid waste landfills, construction landfills, industrial landfills, transfer stations, waste-tire collection facilities, composting facilities and material recycling centers. Solid Waste Management staff oversees implementation of Regulation No. 22 solid waste management rules. This regulation governs the State's municipal, industrial, and commercial solid waste programs and was established to protect human health and the environment.

The Post-Closure Trust Fund provides financing for corrective actions at landfills that developed problems creating environmental threats after closure.

The program also takes the lead in updating the Statewide Solid Waste Management Plan every ten years. This plan, made in cooperation with Arkansas's 18 solid waste management districts, anticipates future needs and addresses ways to reduce landfill disposal and provide appropriate solid waste management service to all Arkansas residents.

Landfills are a potential point source for groundwater contamination. To reduce groundwater contamination potential, Arkansas regulations require all landfills to:

1) Be built five feet above the seasonal high groundwater level and
2) Have liners to reduce or stop leachate from percolating through the bottom and sides of the landfill.

In addition, landfills which are considered to have a higher potential to impact the environment are required to:

1) Collect their leachate and treat it prior to discharge and
2) Perform groundwater monitoring around the landfill.

These landfills include all municipal solid waste landfills (Class 1) and certain private industrial landfills, depending on the type of waste that is disposed at the private facility. If groundwater around the landfill exceeds Groundwater Protection Standards then corrective action is required. During the current period of record (April 1, 2012 – March 31, 2017):

- 43 landfills performed regular, ongoing groundwater monitoring
- 6 landfills performed nature and extent of release investigations

- 4 landfills performed assessment of corrective measures
- 2 landfills performed formal groundwater corrective action

Hazardous Waste Management (DEQ)

The following items are regulatory or policy changes that may impact sites within the State requiring groundwater monitoring, groundwater investigations, and groundwater remediation under the Division's Regulated Waste Operations of the Office of Land Resources.

Regulation No. 23

Regulation No. 23, Hazardous Waste Management, was updated, effective August 12, 2012, to include revisions to the following: 1) Add Conditional Exclusions for Solvent Contaminated Wipes, 2) Add Conditional Exclusion for Carbon Dioxide (CO_2) Streams in Geologic Sequestration Activities, 3) Add authorization to use a Hazardous Waste Electronic Manifest System, 4) Revisions to the Export Provisions of the Cathode Ray Tube (CRT) Rule, 5) Notice to Terminate the National Environmental Performance Track Program as EPA no longer offers this program, 6)Technical corrections to include deletion of all references to Comparable Fuels/Syngas Fuels, amended to update Federal regulations adopted or incorporated by reference, revise Monitoring/Inspection Fees to charge a set fee of $500 to Large Quantity Generators, Definitions is amended to add the definition of Carbon Dioxide stream, CRT exporter, Electronic manifest (or e-Manifest), Electronic manifest system (or e-Manifest system,), No free liquids, Solvent-contaminated wipe, User of the electronic manifest system, Wipe, and to delete the definition of Performance Track member facility, § 261.3 (a)(2)(iv)(A) adds benzene to the list of solvents, Editorial Corrections and Miscellaneous Corrections and language changes.

Regulation No. 30

Regulation No. 30, The Arkansas Remedial Action Trust Fund Hazardous Substance Site Priority List, was proposed to be updated in August 2014. Four sites were proposed for deletion and two sites for listing on the State Priority List. The changes were effective December 2014.

Sites Delisted from the State Priority List:
Arkansas Waste to – Energy Warehouse Site, Osceola, Mississippi County
I Can Inc., Lonoke, Lonoke County
Norphlet Chemical Co., Norphlet, Union County
Thompson Scientific Industries, Scranton, Logan

Site Added to the State Priority List:
49ers Resource Recovery and Forty-Niner Metals Management LLC, Paragould, Greene County

Macmillan Ring Free Oil, Norphlet, Union County was finalized to the National Priority List on May 12, 2014.

Regulation No. 32

Regulation 32 was amended to establish cleanup standards for clandestine drug laboratories on April 25, 2008; effective May 26, 2008. No additional changes have been proposed for this regulation.

Groundwater Remediation Level Interim Policy and Technical Guidance

The Division has developed an interim Policy for the establishment of groundwater remediation requirements for contaminated sites. This policy will apply to Divisions responsible for the oversight of groundwater remediation within the Division. The purpose of this policy is to establish consistent methods for establishing groundwater remediation levels regardless of the media Division having principal responsibility for the action.

Until a final regulation is promulgated by the Arkansas Pollution Control and Ecology Commission that is specific to the establishment of groundwater remediation levels, such levels will be established on a case-by-case basis.

Elective Site Cleanup Program

The Division administers an Elective Site Cleanup Program that allows responsible parties to enter into an agreement with the Division to govern the cleanup of sites. The Elective Site Cleanup Program does not offer a release of liability but does offer participants a means to address historic contamination on their site without penalty and with known objectives. The Division is working to promote the Elective Site Cleanup Program in order to maximize cleanups of sites within the State.

Groundwater Contamination Prevention Programs

Wellhead Protection Program (Arkansas Department of Health)

The Arkansas Wellhead Protection Program (WHPP) is designed to help Public Water Suppliers (PWS) prevent contamination of underground sources of water they use. The WHPP was authorized in the 1986 Amendments to the federal SDWA and assigned to the Public Water Supply Supervision Program (PWSSP) in the Engineering Division of ADH. It is a voluntary program maintained by Public Water Systems and local communities with technical assistance and guidance provided by ADH. A WHPP minimizes the potential for contamination by: 1) identifying the probable area that contributes water to municipal water supply wells, i.e., the Wellhead Protection Area (WHPA)) and 2) implementing protection strategies within each WHPA that will help prevent release of contaminants.

A WHP program consists of three steps: 1) delineating a WHPA for each well or wellhead; 2) identifying and mapping the locations of all potential sources of contaminants (PSOCs) within each WHPA; and 3) developing strategies to manage the WHPA to protect the groundwater resource from contamination. The more successful WHP Programs include public outreach activities to increase awareness and coordinate local pollution prevention efforts. Emphasis is placed on public participation and local control of the plan.

Integration of the WHPP with the Source Water Assessment Program (SWAP), a similar program authorized in the 1996 amendments to the SDWA began in about 2003. The SWAP applied consistent metrics to assess all sources of Public Water Supply (surface water supplies as well as groundwater sources) for their vulnerability to contamination. The SWAP, partly modeled after the WHPP, extended its emphasis on contamination prevention to all drinking water sources. Like the WHPP, the SWAP reports sent to each PWS were intended to serve as the basis for protection planning efforts. In keeping with long-term planning goals and guidance from EPA, Arkansas has been combining the functions of the WHPP and SWAP programs.

Another source water protection activity coordinated by the Arkansas SWAP program is technical review of permitting actions at other agencies to assess potential adverse effects on drinking water sources. This involves review and tracking of permitting activities including NPDES permits, land application permits, and permits associated with oil and gas drilling and disposal of drilling fluids.

Technical assistance with proper siting and design of public water supply wells is another important feature of the WHPP. WHPP geologists analyze drill cuttings and produce detailed construction recommendations for proposed PWS wells as required.

PWS well construction information and other data are maintained in a database that also supports other aspects of ADH’s PWSSP. Comprehensive hydrologic information is presently available for most PWS wells and is available for use by other agencies and organizations in achieving their missions.

The success of the source water protection program is measured by the number of Community Water Systems (CWSs) and the populations served by those CWSs that have met the criteria of the state’s definition of “Substantial Implementation,” defined as any CWS with a Source Water Program (SWP) in place that includes a management team, a SWAP or WHPP delineation, a PSOC inventory, and one of the following control measures/management strategies: (1) SWP/WHPP ordinance/resolution, or (2) any two of the following: SWP Emergency/Contingency plan, public outreach program, drinking water protection road signs, or other qualifying control measure/management strategy.

Water Well Construction Commission

Act 641 of 1969 created the Arkansas Water Well Construction Commission (AWWCC), which provides for safe, sanitary and orderly water well development. Standards ensure proper well construction and pump installation. Administration of the licensing and registration of drillers and pump installers, as well as technical assistance, is provided by the ANRC, which includes field inspectors, management, and technical support personnel. Act 297, effective July 1, 2003, authorized the AWWCC to develop a training program for drillers and pump installers and added a continuing education requirement for drillers and pump installers. It also increased the amount of civil penalties the Commission may seek from $500 to $2,500, and required contractors to obtain a bond of $10,000 rather than $2,000 to protect customers.

The AWWCC maintains a water-well construction report database. The database contains well-construction details such as depth to static water level, water-producing formations encountered, well yield, pump-setting information, and the geologic setting of each well. It is linked to the USGS water use database and is searchable online.

Act 855 of 2003, effective March 31, 2003, requires proper training and licensing for water well drillers and specifies minimum bond amounts to protect well owners. Water well contractors who repeatedly violate Arkansas law regarding proper registration and training may find their property subject to forfeiture and sale at public auction. Sale proceeds and other monies forfeited are applied to entities in the order listed.

Chapter Three GROUNDWATER QUALITY MONITORING

Groundwater quality monitoring data are available from ongoing ambient monitoring; short-term research-oriented monitoring, and mandated monitoring at regulated sites. The types of data available depend on the goals and range from hard-copy reports to publicly accessible online databases such as the EPA's STORET database. It is important to consider the sources of water quality data when investigating groundwater conditions. For example, contaminants in a water supply system, domestic or municipal, may simply be derived from the treatment process, the distribution lines, or household plumbing. As such, they would be an artifact of treatment and/or distribution rather than groundwater (source) problems. Comparison of quality information from various time periods and data collectors is problematic because of the differences in monitoring goals, reporting requirements, and continuing evolution of laboratory instrumentation and methods that provide ever lower quantification levels.

Ambient Groundwater Quality Monitoring

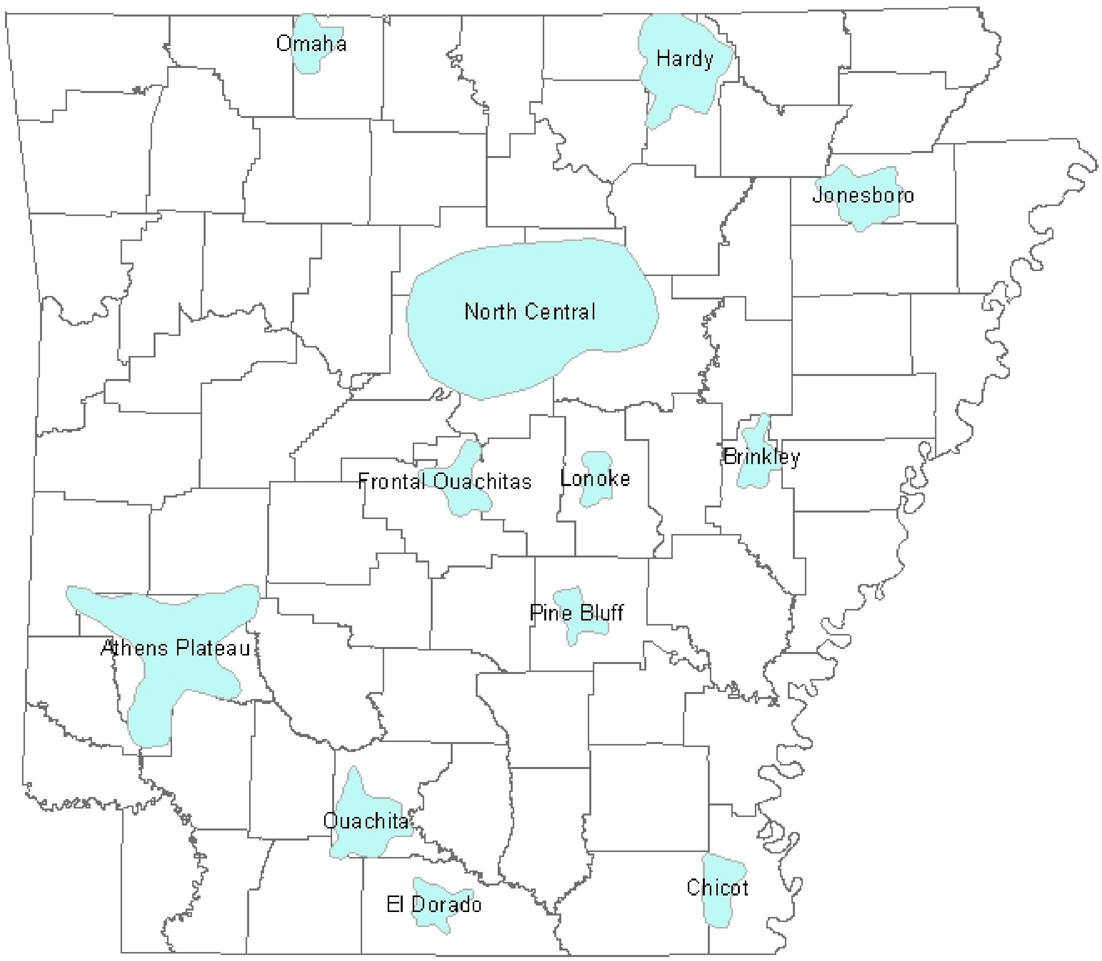
Groundwater quality data have been collected in numerous investigations primarily by the U of A at Fayetteville, the USGS, and the Division. However, much of this information is available in hard-copy only in the form of reports and publications. Data from regulated sites with known sources of contamination can be useful but may not represent background water quality.

Arkansas Department of Energy and Environment, Division of Environmental Quality

The principal goal of the Division's ambient water quality monitoring program is to document existing conditions in the various aquifers of the state and any changes in the quality of groundwater over time; to determine whether known areas of contamination (i.e., areas of saltwater intrusion) are expanding; and to assist in water quality planning efforts at the Division and other state and federal agencies with groundwater quality protection responsibilities. To that end, the Ambient Groundwater Monitoring Program (Program) was begun in 1986. The Program currently consists of 12 monitoring areas throughout Arkansas (Figure V-1). Each area was selected to monitor various aquifers in representative areas of the State and evaluate potential effects of multiple land uses. Monitoring is conducted on an approximate three-year basis.

All of the monitoring events include field pH, conductivity, Oxidation-Reduction Potential, and temperature, laboratory analysis of nutrients, major cations and anions, Total Dissolved Solids (TDS) and trace metals. Selected sites in areas potentially impacted by industrial or other point sources are analyzed for volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC), and likewise samples from areas potentially impacted by agricultural activities are analyzed for pesticides. The current and proposed monitoring areas are described individually below.

Figure V-1: Arkansas's Groundwater Monitoring Areas



Athens Plateau Monitoring Area

The Athens Plateau Monitoring Area encompasses Paleozoic rocks of the Ouachita Mountains physiographic region and Cretaceous rocks and Quaternary deposits of the West Gulf Coastal Plain physiographic province. This monitoring area, first sampled in 2004, and comprised of 23 water wells and 1 spring in Howard and Pike Counties, provides baseline groundwater quality data including potential effects on groundwater from the extensive swine, poultry, and cattle operations in this region.

The sites in the northern part of the study area (along the southern margin of the Ouachita Mountains) are in the Devonian to Pennsylvanian Arkansas Novaculite, Stanley Shale and Jackfork Sandstone. The southern part of the study area (within the northern part of the West

Gulf Coastal Plain) is in the Cretaceous Tokio Formation and Quaternary (Pleistocene and Holocene) deposits comprising the Alluvial aquifer. Most towns within the area utilize surface water sources, thus few municipal wells are available. However, many domestic and livestock wells exist in the Cretaceous formations within the subject area.

Water quality in the study area is generally good. TDS concentrations exceed the Secondary Maximum Contaminant Level (SMCL) of 500 mg/L in one deep well, as higher mineralization is expected at greater depth. One well in the Stanley Shale and one spring exceed the MCL for nitrate (10 mg/L) but the well has exhibited a noticeable decline after the onsite poultry operation ceased some years ago. Two other wells in the Stanley Shale had somewhat elevated nitrate. Nitrate concentrations in the remainder of the samples are well below 1.0 mg/L. Chloride is highest in the Alluvial aquifer, particularly the Quaternary alluvium, ranging up to 131 mg/L in this interval. Dissolved iron concentrations often exceed the EPA Secondary MCLs (which address aesthetics like taste and odor rather than health concerns) and can range as high as 3.8 mg/L. Logically, many of the exceedances occur in samples from the Stanley Shale; manganese is also frequently detected in the Athens Plateau samples, reaching a maximum of slightly more than 0.55 mg/L. Low concentrations of Arsenic occur in three wells, but well below the MCL of 0.01 mg/L. Mobilization of naturally-occurring iron, manganese, and other multivalent ions like Arsenic is a common occurrence in aquifers across the state, due to reducing conditions that develop in response to the presence of organic matter concentrated in some parts of the formations.

Brinkley Monitoring Area

The Brinkley Monitoring Area encompasses the town of Brinkley and surrounding areas in northern Monroe County in the Mississippi River Alluvial Plain. The Alluvial and Sparta aquifers provide all community water needs: drinking water and crop irrigation. Monitoring in this area was initiated in 1989 to characterize chloride levels and assess potential presence of pesticides in the Alluvial aquifer.

Historic sampling shows that Chloride concentrations ranged from 13.8 to 619 mg/L, with concentrations in seven wells exceeding the SMCL (250 mg/L). Iron concentrations exceeded the SMCL of 0.3 mg/L in 27 of 29 wells, and manganese concentrations exceeded the SMCL of 0.05 mg/L in 28 wells. TDS concentrations exceeded the SMCL of 500 mg/L in 22 of the 29 wells. Arsenic was detectable in all samples at concentrations ranging from 0.00088 mg/L to 0.00790 mg/L, though with no exceedances of the MCL (0.01 mg/L).

El Dorado Monitoring Area

The El Dorado Monitoring Area centers on El Dorado in Union County, in the West Gulf Coast Plain physiographic region. Three aquifers, the Cockfield, Upper Sparta (Greensand), and Lower Sparta (El Dorado) are sampled in this area. The Cockfield is used primarily as a domestic drinking water supply. The Greensand aquifer is used for domestic and industrial purposes. The El Dorado aquifer is used for industrial and municipal purposes. This area has oil and gas production; bromine extraction, production, and refining; light manufacturing; and food processing; all of which are potential threats to the shallow Cockfield aquifer. Monitoring in the El Dorado Monitoring Area began in 1987.

Iron and manganese exceed the SMCL in about 20 percent of the wells. Selected samples (from the Cockfield aquifer) are also analyzed for VOCs, SVOCs, Pesticides and PCBs. Pesticides and PCBs have not been detected in any of the El Dorado groundwater samples.

Omaha Monitoring Area

The Omaha Monitoring Area encompasses the northwest quarter of Boone County in the Ozark Plateaus physiographic region. Groundwater is from the Springfield Plateau and Ozark aquifers, which are primarily limestone and dolostone formations, respectively. The monitoring area documents existing conditions in karst terrain. Potential contaminant sources include livestock, poultry houses, and USTs. The monitoring sites consist of 10 springs and 18 wells, depending on accessibility and flow conditions. The springs discharge from the Springfield Plateau aquifer, and all but one of the wells penetrates the Ozark aquifer.

Overall, groundwater quality is good. Iron is not detectable in any of the Springfield Plateau aquifer samples due mainly to the type of geology and the oxidative state of the aquifers; this also limits manganese concentrations, ranging from mostly non-detectable to just over 0.002 mg/L, well below the SMCL of 0.05 mg/L. Nitrate is present in all Springfield Plateau aquifer samples, ranging up to almost 7 mg/L. Arsenic has been detected in some samples, but well below the MCL of 0.01 mg/L, also due to the general oxidizing state of the groundwater, which limits arsenic mobility.

Hardy Monitoring Area

The Hardy Monitoring Area is located in northeast Arkansas in Sharp and Fulton counties. The standard sampling round includes 24 wells ranging in depth from 150 to 1200 feet and 2 springs. The area was originally chosen to address the lack of water quality data from the Lower Ordovician aquifers along the eastern end of the Ozark Plateaus physiographic region. The wells produce water from various formations including the Cotter and Jefferson City Dolomites and the Roubidoux Formation.

The groundwater quality in the Hardy monitoring area is generally good. Water type is calcium or magnesium bicarbonate, in which concentrations of magnesium and calcium, expressed as equivalent weights, are approximately equal. Sodium concentrations are generally less than 5 mg/L. TDS concentrations are generally below 500 mg/L in all wells and springs including four wells exceeding 1000 feet in depth. The average TDS concentration is approximately 300 mg/L. As expected, the deeper wells have very low nitrate concentrations relative to the overall mean for all wells, which is also low (0.845 mg/L). Average TDS, nitrogen and other parameters resemble the Ozark aquifer samples from the Omaha Monitoring Area. Iron is rarely detected and the maximum manganese concentration is quite low as well (0.0026 mg/L), well below the SMCL (0.05 mg/L).

Jonesboro Monitoring Area

The Jonesboro Monitoring Area includes Jonesboro and surrounding areas in central Craighead County and northern Poinsett County, in the Mississippi River Alluvial Plain region. The Alluvial aquifer and the Memphis aquifer (northern extension of the Sparta) are the primary groundwater sources. The monitoring area was chosen because it has large populations using groundwater that is vulnerable to surface contaminants and is subject to intensive pumping from the Alluvial aquifer. A cone of depression coinciding with drawdown in the underlying Memphis aquifer indicates minimal physical (hydraulic) separation between the two aquifers. Potential contaminant sources in the area include pesticides, solvents, landfill leachate, and septic systems. One sampling site is in the deeper Wilcox Formation.

Groundwater ranges from a calcium-bicarbonate to a strongly sodium-bicarbonate water type, with an intermediate “mixed” type containing approximately equal portions of calcium, sodium and magnesium. This reflects a gradual chemical evolution from a calcium-dominated water type in the shallow Alluvial aquifer to sodium-dominated water at depth within the Memphis aquifer due to natural ion-exchange processes. TDS concentrations range from less than 100 mg/L, to just over 1110 mg/L in one well. High dissolved iron is common, ranging up to 7 mg/L. About one third of wells exceed the SMCL of 0.3 mg/L. Manganese is detectable in all wells at concentrations ranging from less than 0.001 to over 1.2 mg/L, and about one third exceed the SMCL of 0.05 mg/L. Nitrate is present in almost 50 percent of wells, ranging from very low to just above 2 mg/L.

Lonoke Monitoring Area

The Lonoke Monitoring Area includes Lonoke and surrounding areas in central Lonoke County and is located in the Mississippi River Alluvial Plain physiographic region. Groundwater is from the Alluvial and Sparta aquifers, for agricultural, domestic and municipal use. This monitoring area was selected to represent a rural, agricultural area that relies entirely on groundwater for water. Pesticides are the primary potential contaminants in the area.

Elevated iron and manganese are common, ranging from 1.49 to 30 mg/L, due to reducing conditions that result from a high proportion of disseminated organic debris in the aquifer. TDS concentrations range from 140 to almost 500 mg/L, with no exceedances of the SMCL.

Frontal Ouachita Monitoring Area

The Frontal Ouachita Monitoring Area is located in central Arkansas in Pulaski and Saline counties in the Ouachita Mountains region. Strata within this monitoring area consist of intensely folded and faulted Paleozoic sandstones, shales, novaculites and cherts, deformed during the late Paleozoic era into generally east-west trending anticlines and synclines. Strata exposed at the surface include formations ranging in age from Ordovician through Mississippian. The more resistant novaculite or sandstone persists to form ridge tops, while valleys develop above the less resistant shale intervals. Sixteen wells and three springs comprise the current monitoring sites. Laboratory analyses include inorganic chemistry and nutrients.

Most wells are completed in bedrock with minimal surface casing and thus likely producing water from multiple horizons. Twelve are in the Ordovician Womble Shale, two in the Ordovician Bigfork Chert, one in the Devonian to Mississippian Arkansas Novaculite, one from the Mississippian Stanley Shale, one from the Bigfork Chert/Arkansas Novaculite contact, and one from a spring at the Ordovician Bigfork Chert/Polk Creek Shale contact. The remaining two wells are completed in Quaternary terrace deposits of the Alluvial aquifer.

Generally, the groundwater quality is good. Owing to a higher than normal amount of silica in many of the formations in the Ouachitas (related to their depositional history), very low "neutralizing potential" (i.e. calcium carbonate) is present in the bedrock. Consequently, some shallow wells (especially ones developed in certain geologic units like the Arkansas Novaculate) exhibit pH values as low as 4.0. This is the result of rainfall with a fairly low initial pH passing through soil that imparts carbonic acid and organic acids, further lowering the pH. Due to the lack of the usual neutralization process involving water-rock interactions (e.g. dissolution of calcium carbonate in the bedrock), the pH remains quite low as the groundwater resides in the silica-rich bedrock. Some well owners in the monitoring area employ alkalinity-producing systems to counter this phenomenon. Other constituents of note are dissolved iron and manganese. Iron exists in about one third of the wells at concentrations up to 1.54 mg/L. Manganese is present in many of the wells, at concentrations ranging up to 0.15 mg/L, with several exceeding the SMCL (0.05 mg/L). Due to reducing conditions, arsenic is present in concentrations ranging up to almost 0.004 mg/L but still below the MCL of 0.01 mg/L. Nitrate is present in about half the wells, at concentrations ranging from 0.060 to 8.15 mg/L. Most of the nitrate detections correlate to the presence of septic systems, livestock, or poultry houses.

Ouachita Monitoring Area

The Ouachita Monitoring Area is located in Ouachita County and includes the city of Camden. This area is located in the West Gulf Coast Plain physiographic region, chosen because it is in the recharge area of the Sparta aquifer; in addition, a portion of the Cockfield aquifer recharge area is present in the southwestern portion of this monitoring area. Groundwater is the primary water source in the area. Most wells penetrate the Sparta aquifer; however, several potentially tap the underlying Cane River Formation, which is the lower confining unit of the Sparta. However, some minor water-bearing zones exist within the Cane River, sufficient for domestic water supplies.

Generally, groundwater quality in this area is good, with TDS concentrations ranging from 31 to just over 150 mg/L. Water type ranges from a calcium-bicarbonate water type at shallow depths to a sodium-bicarbonate water type in the deeper portions of the aquifer where natural ion exchange processes have neared completion along the flow path. Iron is elevated in about half of the wells, at concentrations ranging to 3.35 mg/L. Manganese is ubiquitous in the area at concentrations ranging up to 0.0546 mg/L. Nitrate is present in moderate amounts but currently there are no exceedances of the MCL with the highest at just above 0.005 mg/L. Arsenic is generally not present in the sites within this monitoring area.

Pine Bluff Monitoring Area

The Pine Bluff Monitoring Area includes the town of Pine Bluff and environs, in central Jefferson County. The monitoring area spans the boundary between the West Gulf Coast Plain and the Mississippi River Alluvial Plain regions. Groundwater in the area is produced from the Alluvial, Cockfield, and Sparta aquifers, the only sources of water for the community. The Alluvial and Cockfield aquifers are used primarily for irrigation and domestic purposes, while the Sparta is used for municipal and industrial purposes.

The groundwater quality is generally good. The Alluvial aquifer produces a calcium-bicarbonate water type and the Cockfield and Sparta aquifers produce a sodium-bicarbonate water type, similar to its composition elsewhere. Iron is detectable in all the wells at concentrations ranging from 0.01 to 38.5 mg/L, with many exceeding the SMCL (0.3 mg/L). Manganese is also nearly always present, in concentration ranging from 0.015 to 2.6 mg/L, with many exceeding the SMCL (0.05 mg/L). In association with the iron and manganese, arsenic is detectable in several wells, but well below the MCL. Nitrate has only been detected in one well at a concentration of 0.060 mg/L, well below the MCL. Four alluvial wells are sampled for VOCs, but only a very small concentration of Methylene Chloride (MC), a common laboratory contaminant, has been detected and is attributed to the presence of MC within the instrument.

North Central Monitoring Area

The North Central Monitoring Area a new ambient groundwater monitoring area, in the shale gas development “boom” area It was initially sampled in May through November 2010, with limited repeat sampling in 2015; it includes portions of Conway, Van Buren, Cleburne, White, and Faulkner Counties in the Arkansas River Valley physiographic region. Groundwater in the area is from the Pennsylvanian Atoka Formation or Hale Formation which lie well above the Fayetteville Shale. Historically, public water supply wells in the area were beset by iron problems, hydrogen sulfide and limited supply and thus were all abandoned decades ago after a regional surface water supply (from Greer's Ferry Lake) became available. The majority of the area is served by surface water from Greer's Ferry, but there are still a small fraction of domestic wells in use, mainly as backup supplies for livestock and home gardens, though a small percentage are used as primary (drinking water) supply. A total of 64 springs and wells were sampled during the initial sampling event. During subsequent sampling events, some of the shallow springs were discontinued and some new wells were added. Over the long term, the North Central monitoring area will be reduced to a small subset of sites similar to the other monitoring areas.

The groundwater quality was generally good, though iron was detected in about two thirds of the sites and was above SMCLs in about half of them. Manganese was detected in all 64 sample locations at concentration ranging from 0.00091 to 2.8 mg/L, with 45 detections exceeding the SMCL (0.05 mg/L). Arsenic, commonly co-existent with iron, and mobilized by similar geochemical conditions, was detected in 17 of the 64 samples at concentrations ranging from 0.00051 to 0.0181 mg/L (one detection above the MCL). Nitrate was detected in about 30 percent of the samples at concentrations ranging from 0.020 to 6.40 mg/L, all below the MCL. Chloride and TDS, primary indicators of potential impacts from deeper groundwater zones and gas drilling were within normal ranges; chloride was detected in all 64 samples at concentrations ranging from 1.1 to 105 mg/L. TDS ranged from 10 to 644 mg/L. Three exceedances of the SMCL for TDS were noted in the mineral springs located in Heber Springs Park, assumed to originate from deeper groundwater zones. One other exceedance was a domestic well with artesian flow and also interpreted to connect to a deeper, more mineralized groundwater horizon. Based upon the analyses conducted, no quality effects from the gas drilling or hydraulic fracturing of the underlying shale were evident.

Other Monitoring Efforts

Some ambient monitoring is also performed by other divisions within DEQ and the USGS, at numerous Division-regulated facilities throughout Arkansas. However, because the purpose of the monitoring is to evaluate potential and actual anthropogenic impacts, the parameter list is limited, and thus is not as useful for interpretation of natural or background quality. However, in the absence of other data, monitoring results from these sites, especially up gradient "background" wells, can be a useful source of information.

Arkansas Department of Health

Monitoring of public water supply wells by the ADH under the SDWA provides another source of groundwater data. The ADH monitors approximately 1200 wells every three years for inorganic and organic (pesticide, herbicide, SVOCs, VOCs) contaminants, and radionuclides. The Total Coliform Rule requires sampling monthly, with the number of samples dependent on the population size. Nitrate monitoring is conducted yearly unless a sample greater than or equal to 50 percent of the MCL triggers the need for increased frequency. Additionally, the

Disinfection Byproduct Rule requires monitoring for trihalomethanes and haloacetic acids, byproducts of the disinfection process, on a quarterly or annual basis, with the number of samples dependent on the type of source and population served by the system.

Raw water sampling is conducted for selected wells in "hydrologically sensitive" aquifers (i.e. those which may be at risk for contamination per the Groundwater Rule) to assess whether they are influenced by surface water pathogens; this sampling includes frequent raw water bacteriological testing during the evaluation period, and may include water temperature variations and Microscopic Particulate Analysis to detect insects, organic debris, large diameter pathogens, and algae and other microorganisms. Raw water sampling for *E. coli* is conducted monthly for at least 12 months to establish baseline conditions, including analysis for *E. coli* and/or cryptosporidium oocysts.

Short Term Water Quality Monitoring (Special Investigations)

Arkansas Department of Environmental Quality

Special groundwater investigations are occasionally undertaken, normally upon request by management, as a result of general interest in an area, or to address an identified or incipient groundwater problem that warrants examination. Recent examples of such projects range from occasional complaint investigations in conjunction with Inspection or Enforcement duties of the Office of Water Quality or other agency divisions, to comprehensive investigations of groundwater conditions associated with land uses at permitted facilities. The establishment of the North Central ambient monitoring area falls into this category of activities. However, these projects are intentionally limited in scope and duration so as to minimize the diversion of the groundwater section's staff time and budget, which is primarily dedicated to the operation of the ongoing long-term ambient monitoring network.

United States Geological Survey

The USGS, in cooperation with the Arkansas Natural Resources Commission, has 45 master wells throughout the State that are sampled every five years. Additionally, 150 wells in the Sparta-Memphis aquifer and 150 wells in the Mississippi River Valley Alluvial aquifer are sampled for specific conductance, pH, temperature, chloride, and bromide on alternating years. Although limited in the number of constituents, the relatively large number of wells provides a means of documenting general water-quality trends over time, through the plotting and comparison of isopleth maps and the use of statistical programs. Other wells are utilized for water quality sampling, but are sampled for special investigations and do not provide long-term data for trend analyses. The data derived from water quality investigations are presented in reports, which are easily obtainable at the local or national level or online at http://ar.water.usgs.gov/; data also are available in downloadable tabular or graphic format on the USGS NWISWeb, see http://waterdata.usgs.gov/ar/nwis/qw/.

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PART VI PUBLIC PARTICIPATION (REGULATION NO. 8)

The Public Participation Program (Regulation No. 8) at the Division is designed to be an active program that seeks out individuals and/or organizations that may provide useful input and those who will be affected by Division activities. The program includes provisions for disseminating information to the public through easily accessible avenues. These avenues include, but are not limited to, local media, internet access, and information depositories located throughout the State. Additional avenues include the publication and distribution of newsletters, informational pamphlets, and activity reports; and the participation of Division representatives at public meeting, hearings, and citizen group gatherings.

The purpose of the public participation program at the Division is to inform affected Arkansans, organizations, and public officials of the factors involved in, and of decisions contemplated in, Division activities. It is also used to incorporate public thinking into planning decisions and to provide all citizens and organizations an equal opportunity to influence the design of alternatives and selection of choices. This process will produce activities that have substantial community support.

The current Public Participation Program at the Division complies with all applicable regulations and guidelines of the Federal Water Pollution Control Act amendments of 1979 40 CFR, Parts 25 and 35.

For additional information concerning the Public Participation Program at the Division, visit the Office of Water Quality website http://www.adeq.state.ar.us/water/reports_data.htm and go to the State of Arkansas Continuing Planning Process document.

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APPENDIX A MAP INFORMATION

Maps depicting the impaired waterbodies by county are now available via an online interactive map.

http://arkansasdeq.maps.arcgis.com/apps/MapJournal/index.html?appid=edf6259f9c8840e7b686287bc2c29799

APPENDIX B ASSESSMENT METHODOLOGY

1.0 ASSESSMENT BACKGROUND

Section 305(b) of the Federal Water Pollution Control Act (hereinafter “Clean Water Act”) requires states to perform a comprehensive assessment of the State’s water quality to be reported to the U.S. Environmental Protection Agency (EPA) every two years. The report provides information on the quality of the state’s waters; the extent to which state waters provide for the protection and propagation of a balanced population of fish, shellfish, and wildlife, and allow recreational activities in and on the water; and how pollution control measures are leading to water quality standards attainment.

In addition, Section 303(d) of the Clean Water Act requires each state to identify waters where existing pollution controls are not stringent enough to achieve state water quality standards and establish a priority ranking of these waters. States must develop Total Maximum Daily Loads (TMDLs) or other corrective actions for the identified waters. TMDLs describe the amount of each pollutant a waterbody can receive and not violate water quality standards. States submit the list of impaired waters (303(d) list) to EPA. EPA has the option to approve, disapprove, or take no action on the list within 30 days of submission.

DEQ follows the specific requirements of 40 C.F.R. § 130.7-130.8 and EPA’s most current 305(b) reporting and 303(d) listing requirements and guidance when developing this assessment methodology. Current EPA guidance recommends producing one report combining requirements of the Clean Water Act for Sections 305(b) reporting and 303(d) submissions. This is, in general, referred to as the Integrated Report (IR).

Arkansas’s combined report is the *Integrated Water Quality Monitoring and Assessment Report* (305(b) Report). The 305(b) Report describes the quality of all of the surface waters of the state that were evaluated for a specified assessment period (period of record). This report is prepared using the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act (EPA 2005)* which is supplemented by memoranda regarding development of the 2008, 2010, 2012, 2014, and 2016 305(b) Reports (EPA 2006, 2009, 2011, 2013, and 2015 respectively). Arkansas’s waters are evaluated in terms of whether their assigned water quality standards and designated uses, as delineated in the Arkansas Pollution Control and Ecology Commission’s (APC&EC) Regulation No. 2 *Water Quality Standards for Surface Waters of the State of Arkansas* (Reg. 2) (APC&EC 2017), are being attained.

Reg. 2 provides the foundation for the 305(b) Report, establishing water quality standards for surface waters of the State of Arkansas; designated uses associated with those water quality standards; and criteria and policies established to protect, maintain, and restore designated uses. Water quality data are assessed for compliance with Reg. 2 to determine impairment and designated use support, based upon the frequency, duration, and/or magnitude of water quality standard exceedances as delineated in Division of Environmental Quality’s (DEQ) assessment methodology.

2.0 INTEGRATED REPORTING CATEGORIES

Arkansas's waters are assessed based on water quality criteria and designated use support, as adopted in Reg. 2 and this assessment methodology. Water quality standard attainment is determined based on support of designated uses and/or criteria in place to protect those designated uses. An assessment unit (AU), previously referred to as a monitoring segment, is the basic unit of record for conducting and reporting water quality assessments. AUs are individual stream reaches, lakes, or other defined waterbodies and are grouped by planning segments and 8-digit hydrologic unit codes (HUC). AUs are delineated using GIS layers and several real world considerations such as tributaries, land use boundaries, point source dischargers, monitoring stations, physical breaks, and other factors.

Arkansas's assessments are formatted to reflect EPA's most current 305(b)/303(d) Integrated Report (IR) guidance (EPA 2015) which suggests placing AUs into the following five integrated reporting categories upon assessment. AUs will be assessed as Category 1, 'support' if all water quality criteria and designated uses, for which data are available, are attained. AUs will be assessed as 'non-support' if any water quality standard or designated use is not attained; and will be placed in Category 4 or 5, as appropriate. AUs will be placed in Category 3 if there is not enough information to make an attainment decision. Historically, Category 2 is rarely used in Arkansas.

Waters not attaining one or more water quality criteria, or not supporting one or more designated uses will be placed in Category 4 or 5. Some impaired AUs will be distinguished between pollutant causes currently without a TMDL (Category 5) and pollutant causes for which TMDLs have already been approved (Category 4a). In some instances, a regulatory response outside of a TMDL is permissible and the AU/pollutant pair is assigned to Category 4b (alternative pollution control). In instances where non-attainment is not caused by a pollutant, AUs will be placed in Category 4c. Examples of this would be naturally occurring deviations from current criteria where site specific criteria would be more appropriate but are yet to be developed. Note that Category 4 waters are not part of the 303(d) list of impaired waterbodies; however, a list of Category 4 waters are public noticed along with the 303(d) list (Category 5).

The 303(d) list of impaired waterbodies (Category 5) consists of AUs not supporting one or more designated use and/or not meeting water quality criteria. Category 5 is prioritized by DEQ for planning and management purposes in accordance with 40 § CFR 130.7 (b)(4) which states: "The list required under §§ 130.7(b)(1) and 130.7(b)(2) of this section shall include a priority ranking for all listed water quality-limited segments still requiring TMDLs, taking into account the severity of the pollution and the uses to be made of such waters and shall identify the pollutants causing or expected to cause violations of the applicable water quality standards. The priority ranking shall specifically include the identification of waters targeted for TMDL development in the next two years." Therefore, any waterbody ranked as "high" within Category 5 will be targeted for TMDL development.

Category 1. Attains all water quality criteria and supports all designated uses; categorized by existence of a TMDL or not for one or more constituents.

1a. Attaining all water quality criteria and supporting all designated uses, no use is threatened. No TMDL exists for any constituents.

1b. Attaining all water quality criteria and supporting all designated uses; however, a TMDL remains in place for one or more constituents.

Category 2. Available data and/or information indicate that some, but not all of the designated uses are supported.

Category 3. Insufficient data and/or information are available to make a use support determination.

3a. No data available.

3b. Insufficient data available.

- Data do not meet all quality requirements outlined in this assessment methodology;
- Waters in which the data are questionable because of Quality Assurance and/or Quality Control (QA/QC) procedures and/or the AU requires confirmation of impairment before a TMDL is scheduled.
- Where limited available data and/or information indicate potential impacts or downward trends in water quality, the following waterbodies in Category 3 will be prioritized (on a case-by-case basis) for additional investigation: waters designated as ERW, ESW, or NSW; domestic water supplies; and waters located in known karst areas.

Category 4. Water quality standards are not attained for one or more designated uses but the development of a TMDL is not required because:

4a. A TMDL has been completed for the listed parameter(s); or

4b. Other management alternatives are expected to result in the attainment of the water quality standard; or

4c. Non-support of the water quality standard is not caused by a pollutant.

Category 5. The waterbody is impaired, or one or more water quality standards are not attained. Waterbodies in Category 5 will be prioritized as:

High

- Truly impaired; develop a TMDL or other corrective action(s) for the listed parameter(s).

Medium

- Waters currently not attaining standards, but may be de-listed with future revisions to APC&EC Regulation No. 2, the state water quality standards; or

- Waters which are impaired by point source discharges and future permit restrictions are expected to correct the problem(s).

Low

- Waters currently not attaining one or more water quality standards, but assessed designated uses are determined to be supported; or
- There is insufficient data to make a scientifically defensible decision concerning designated use attainment. Where more data and/or information are needed to verify the need for TMDL development or other corrective action(s) for the listed parameter(s), the following waterbodies in Category 5 will be prioritized (on a case-by-case basis) for additional investigation: waters designated as ERW, ESW, or NSW; domestic water supplies; and waters located in known karst areas; or
- Waters DEQ assessed as unimpaired, but were assessed as impaired by EPA.
-

3.0 DATA MANAGEMENT

Data assessment forms the basis of water quality standard attainment decisions. In order to conduct accurate assessments, evaluated data must reflect current ambient surface water quality conditions, adhere to robust quality and quantity considerations, and represent accurate temporal and spatial requirements. Data are assessed based on the current EPA-approved water quality standards for the State of Arkansas (APC&EC 2017) and this assessment methodology. In some cases, a weight of evidence approach will be used to supersede a preliminary assessment. When this occurs, justification will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. A more robust discussion of how final attainment decisions are determined can be found in Section 3.11 Final Attainment Determination Process.

3.1 Water Quality Data Types and conditions

3.1.1 Data Types

Water quality data are collected in a variety of ways in Arkansas and are utilized differently for assessment purposes. Data sets are generally classified as discrete, continuous, or profile. Unless otherwise specified, assessment methodologies are designed for use with discrete data sets. When continuous data are used for assessment purposes, assessment methodologies will be identified as such. Different data types will not be combined for assessment purposes. If multiple data types exist for one AU the most appropriate set will be used for assessments based on robustness, scientific soundness, and representativeness. A weight of evidence approach will be applied when making decisions about which data set to use.

3.1.1.1 Discrete Data

Discrete data are generally characterized as data generated from samples taken at the same location with a significant amount of time passing, or a significant event (such as a storm event) occurring between each sample such that potential changes in water chemistry can be noted.

These samples can be *in situ* measurements (pH, temperature, etc.) or grab samples to be taken to a lab for analysis (metals, toxics, etc.). An example of a discrete data set would be DEQ's ambient monitoring network where samples are collected from the same locations on a monthly basis. Discrete sampling works well when resources are limited, allowing entities to sample a larger area over time.

3.1.1.2 Continuous Data

Continuous data are generally characterized data generated from as a series of discrete *in situ* samples taken at frequent, regular intervals at the same location over time. Generally, these data are collected using a continuous logging meter taking measurements in regular time increments from once every second up to once an hour. Water quality parameters typical of this collection are pH, dissolved oxygen, and temperature.

For assessment purposes, DEQ considers two types of continuous data: long-term and short-term. Long-term continuous data spans long time periods, from several weeks to years. USGS gages can yield long-term continuous monitoring data. Long-term continuous data are typically collected at minute to hourly intervals. Long-term continuous data taken in less than hourly readings (example: data recorded every fifteen minutes) will be calculated into an hourly average reading. Short-term continuous data spans a much shorter time frame, typically a 72 – 96 hour period. These time periods target diurnal shifts in certain water quality parameters and readings are typically collected every few seconds or minutes.

3.1.1.3 Profile Data

Profile data are typically gathered in lakes, reservoirs, or other deep bodies of water. These data reveal a top to bottom examination of waterbody temperature, dissolved oxygen, pH, and other *in situ* parameters. Profile data are typically used in the identification of thermal stratification depths and dissolved oxygen concentrations within each thermal layer; and are not directly used for assessments. Measurements are typically collected in rapid succession, such as every second or every few seconds.

3.1.2 Data Conditions

At times, data results are "censored," meaning they are reported as less than some value, greater than some value, or as an interval or range of numbers. This is a common and standard occurrence. DEQ will handle these data in the following ways.

3.1.2.1 Data below detection limits

Data that are lower than detection limits of laboratory methods or equipment are typically represented as less than the numerical detection limit (example: <0.05 mg/L). In these cases, DEQ will use one-half the detection limit and assign that value as the numeric result for that data point (Clarke 1998, Scott et al. 2016, Croghan and Egeghy 2003, and Dixon 2005). In the example, the data point would be 0.025 mg/L. This is done so that the result can be used, as an actual number, in assessment calculations and data management. Numbers with symbols cannot be easily sorted or managed, thus the need to be converted into a usable number.

3.1.2.2 Other data conditions

Some data are represented as approximate. This is common for bacteria data as it is common to extrapolate to a larger sample size than what is analyzed (EPA 2014). Approximate data (Example: ~125 cfu) will be used in assessments by dropping the approximate sign and using the whole number value. In the example, the data point would be 125 cfu. This is done so that the result can be used, as an actual number, in assessment calculations and data management. Numbers with symbols cannot be easily sorted or managed, thus the need to be converted into a usable number.

3.2 Data Assembly

Pursuant to 40 C.F.R. § 130.7(b)(5), DEQ assembles and evaluates all existing and readily available water quality data and information, from DEQ and outside entities, to make water quality standard attainment decisions. Data are evaluated for use by determining adherence (or not) to data quality considerations outlined in this document (Sections 3.3 and 6.0 and subsections thereof).

The primary data used in the assessment of Arkansas's water quality are generated as part of DEQ's water quality monitoring activities, described in the *State of Arkansas's Water Quality Monitoring and Assessment Program, Revision 5* (ADEQ 2013). Additionally, local, state, and federal agencies, and other entities are solicited by DEQ to provide water quality data that meets or exceeds DEQ's or USGS' QA/QC protocols.

Any entity may submit water quality data to DEQ without solicitation. All data received will be evaluated for use. The 305(b) report will include a list of all outside entities who provided data as well as a map of where data were collected that were used in assessments.

Period of record for the 2018 305(b) Report:

Metals and ammonia toxicity analysis: *April 1, 2014 through March 31, 2017*

Beaver Lake site specific nutrient criteria: *January 1, 2012 through December 31, 2016*

All other analyses: *April 1, 2012 through March 31, 2017*

3.2.1 No New Data

If no new qualifying water quality data have been generated for an AU during the current period of record, water quality standard and designated use attainment decisions from the preceding assessment period will be carried forward unless a substantial change in water quality standards or assessment methodology has occurred. If substantial changes in water quality standards or assessment methodology has occurred since the preceding assessment period, and those changes would affect previous assessment decisions, the data from the preceding period of record will be re-assessed using newly-adopted water quality standards and newly defined methodology to determine current water quality standard attainment.

3.2.2 Absence of Data

AUs may be “monitored” or “non-monitored.” A monitored AU contains a water quality monitoring station within its delineated boundaries. A non-monitored AU does not contain a water quality monitoring station within its delineated boundaries. Water quality standard attainment assessments can be made for AUs in the absence of data if it can be reasonably established that non-monitored AUs are similar in watershed characteristic and condition to contiguous monitored AUs.

DEQ will consider land use practices, tributary location, impoundments, point sources, and other hydrological features that could impact the water quality between the station site and the contiguous non-monitored AU. If similarity in watershed characteristic and/or condition cannot be established, contiguous non-monitored AUs will remain unassessed.

Water quality standard non-attainment assessments, in the absence of data, can be made for non-monitored stream segments if it can be reasonably established that the segment is similar with respect to the cause and magnitude of impairment to contiguous monitored waters. However, an evaluation of non-attainment will not be made for non-monitored AUs when the source or the origin of the impairment in contiguous monitored waters is unknown, and/or when the magnitude or frequency of the impairment is such that contiguous segments may not be impacted.

Non-monitored AUs that are evaluated using data from monitored AUs will be noted as such in the Impaired Waterbodies 303(d) list.

3.3 Data Quality Considerations

DEQ maintains a strong commitment to the collection and use of high quality data to support environmental decisions and regulatory programs. DEQ uses data submitted by various entities in different ways, depending on the quality and quantity of the data; however, all data submitted to DEQ will be evaluated for use. Although all existing and readily available water quality data are “evaluated,” not all data can be used to make assessments or attainment decisions. Data sets must first be evaluated for adherence to data quality requirements as defined below.

Data quality requirements are categorized into Phase I and Phase II. Phase I requirements are general to all parameters; whereas Phase II requirements are specific to the parameter being assessed. Phase II requirements are explained in more detail in Section 6.0 and subsections thereof.

Certain Phase I data quality requirements are considered “essential.” These requirements are essential for data to be considered scientifically valid for any purpose. Essential data requirements are listed below along with other Phase I requirements.

Data sets that meet all Phase I and Phase II data quality requirements can be used for attainment decisions. Data sets that fail to meet all quality requirements may be used for screening purposes. However, failure to meet essential quality requirements will exempt those data from use in screening or assessment purposes altogether. This is explained in detail in section 3.4 Tiered Approach to Qualifying Data.

Each individual data set presented for consideration will be evaluated against Phase I data quality requirements. If the data set meets essential Phase I data quality requirements, it will then be evaluated against the remaining Phase I and Phase II data quality requirements. If the data set does not meet essential Phase I data quality requirements it will not be evaluated further.

Phase I Data Quality Requirements

Essential data requirements:

- Be characteristic of the main water mass or distinct hydrologic areas. For example, not taken within a mixing zone, side channel, tributary, or stagnant back water, etc.
- Be reported in standard units recommended in the relevant approved method and that conform to Reg. 2 or can be directly compared or converted to units within Reg. 2.
- Have been collected and analyzed under a QA/QC protocol equivalent to or more stringent than that of DEQ or the USGS. Data collection protocols should either be readily available or accompany the data. This includes *in situ* data.
- All laboratory analyzed parameters (not *in situ*) must be analyzed pursuant to the rules outlined in the Environmental Laboratory Accreditation Program Act, Ark. Code Ann. § 8-2-201 *et seq.* The name and location of the laboratory should either be readily available or accompany the data.

Other data requirements:

- Be accompanied by precise collection metadata such as time, date, stream name, parameters sampled, chain of custody, and sample site location(s), preferably latitude and longitude in either decimal degrees or degrees, minutes, seconds.
- Be received in either an Excel spreadsheet or compatible format not requiring excessive formatting by DEQ.
- Have been collected within the period of record for the current assessment cycle.

Phase II Data Quality Requirements

Phase II data quality requirements will be specific for each parameter and will be detailed in the appropriate subsection of section 6.0 Specific Standards.

If multiple data sets pass Phase I data quality requirements for the same AU, they may be combined and considered as an aggregate data set for Phase II data quality requirements (see section 3.3.2 Aggregate Data Sets for more information). If only one data set for a given AU passes Phase I data quality requirements it will be considered as a standalone data set for Phase II data quality requirements.

These requirements apply to the entire data set for a given AU, whether individual or aggregate, that will be considered for assessment.

- Meet sampling temporal conditions described for each parameter or designated use being assessed. These conditions include season (time of year) such as “critical season,” “secondary contact season,” or “primary season,” each defined within the applicable parameter.
- Meet data quantity requirements for each parameter or designated use being assessed. If quantity requirements are not met, but all other data quality considerations are met, AUs may be assessed as Category 3b. Insufficient data available.
- Meet data distribution throughout the appropriate season(s) or overall time frame appropriate for each parameter or designated use being assessed. Samples should always be “evenly distributed” for the temporal conditions outlined for each parameter. “Evenly distributed” is defined in Section 6.0. AUs that do not meet specific distribution requirements may be assessed as Category 3b. Insufficient data available.
- Meet sample spatial requirements described for each parameter or designated use being assessed. These can include lake sampling depth, specific sampling locations, or other spatial requirements.

3.3.1 Individual Data Sets

Individual data sets must first meet the Phase I data quality requirements outlined in Section 3.2 above to be considered for assessment purposes. If an individual data set is the only data set for a given AU, then that data set must also meet the Phase II data quality requirements outlined above to be used for attainment purposes.

When more than one individual data set exists for a given AU, each data set will be independently evaluated for use. If water quality data indicate that an AU is not homogenous, resulting in conflicting attainment conclusions, the AU will warrant further examination. The assessor will evaluate data from each station individually to confirm impairments and determine whether or not it would be more appropriate to split an AU. If data indicate that it is more appropriate to split an AU, the resulting AUs will be re-assessed based on data within the newly-defined boundaries for the applicable period of record.

3.3.2 Aggregate Data Sets

AUs are delineated to represent homogenous waters with regard to water quality. Therefore, it follows that any independent sample taken from an AU is representative of conditions within that AU. Occasionally more than one monitoring station with available data exists within an AU or several entities may provide data for the same monitoring location. Since each independent sample is considered to be representative of the AU at the time of collection, aggregation of independent samples into one data set within an AU may be appropriate. Aggregation can occur for data from the same entity or from different entities. Aggregation of data sets will be evaluated on a case by case basis.

Data sets of different types (e.g. discrete vs. continuous) will not be combined into an aggregate data set. Different data types will always be assessed independently, if available.

Aggregation of data sets may be full or partial. Fully aggregated data sets will use all data points from all available data sets (that meet data requirements) from an AU. Partially aggregated data sets will use a subset of available data points for the AU. These scenarios are described below.

3.3.2.1 Fully aggregating data sets

Individual data sets of the same type (e.g. discrete data) that pass Phase I quality requirements may be combined into a single aggregate data set for that AU. Individual data sets that do not pass Phase II quality requirements on their own may still be used for assessments if, when combined with another data set of the same type, pass Phase II quality requirements as an aggregate set.

3.3.2.2 Partially aggregating data sets

For certain conditions, explained below for both streams and lakes, data sets may be partially aggregated. Partial aggregation of data sets may be appropriate in order to not weight data toward temporal or spatial conditions.

For streams, data sets taken within the same AU on the same day will be partially aggregated. Data sets will be aggregated and duplicate data points per day will be omitted, retaining only the most protective data point per day. This will prevent weighting limited data sets temporally.

For lakes, samples taken at multiple site locations within the same AU, and on the same day may be aggregated if they are taken at different depths. If multiple data sets exist for a single lake AU on the same day, the most protective data point for each depth will be used (provided Phase II depth requirements are met). This will prevent weighting data spatially.

3.4 Tiered Approach to Qualifying Data

Data received by DEQ may be used in assessments and for attainment decisions, may be used for screening purposes only, or may not be used at all depending on the level of data quality. Data sets are evaluated and placed into one of three tiers depending on adherence Phase I and Phase II data quality requirements. Tiers are described below and a visual representation of how the data are used is provided in Table 1.

Tier I data fail to meet "essential" data quality requirements. Essential data quality requirements are 1.) characteristic of main water mass, 2.) reported in proper units, 3.) collected using proper QC protocols, and 4.) analyzed according to Ark. Code Ann. § 8-2-201 *et seq.* (see Phase I data quality requirements (Section 3.3) for full descriptions). These data cannot be used for attainment decisions and cannot be used for screening purposes. No other data quality requirements will be evaluated as the data are unusable.

Tier II data must pass "essential" (as described above) Phase I data quality requirements; however, they may pass or fail other Phase I or Phase II requirements. These data fail to meet requirements that are necessary for attainment decisions, but may be used for other applications such as screening purposes. Examples of this would be data that fail to meet minimum quantity or distribution requirements outlined in Phase II requirements. AUs with Tier II data may be assessed as Category 3b. Insufficient data available.

Tier III data meet all Phase I and Phase II data quality requirements. These data are suitable for assessments and attainment decisions.

Table 1: Data tiers based on adherence to Phase I and Phase II data quality requirements.

		Phase I							Phase II
		Characteristic of main water mass	Have been collected and analyzed under a QA/QC protocol equivalent to or more stringent than that of DEQ or the USGS.	Have been analyzed pursuant to the rules outlined in the State Environmental Laboratory Certification Program Act, Ark. Code Ann. § 8-2-201 et seq.	Be accompanied by proper metadata (location, date, etc.)	Reported in standard units consistent with or compatible with Reg. 2.	Be received in either an Excel spreadsheet or compatible format not requiring excessive formatting;	Have been collected within the period of record	Meet temporal, spatial, frequency, and quantity requirements for each parameter it is assessed for.
Tier 3	Data meets all quality considerations outlined in Section 3.2 as well as specific requirements for each parameter. Used for attainment decisions.	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Tier 2	Data fail to meet some specific quality considerations, but can be used for screening.	Pass	Pass	Pass	Pass	Pass/ Fail	Pass/ Fail	Pass/ Fail	Pass/ Fail
Tier 1	Data fail to meet essential quality considerations. Not used for assessment or screening purposes.	Fail	Fail	Fail	Fail	---	---	---	---

3.5 Data Quantity Considerations

DEQ strives to follow EPA guidance, which encourages collection of adequate data to make well-grounded attainment determinations (EPA 2005). Use of limited data is acceptable to EPA as limited financial, field, and laboratory resources often dictate the number of samples that can be collected and analyzed (EPA 2002). EPA has not established, required, nor encouraged the establishment of rigid minimum sample set size requirements in the water quality standards attainment status determination process (EPA 2005). As such, EPA discourages the use of target sample sizes applied in an assessment methodology as absolute exclusionary rules (EPA 2005).

However, EPA recognizes that assessments based on larger sample sets are more likely to yield accurate conclusions than assessments based on smaller sample sets, and that it may be appropriate to identify an initial sample size screen, but also provide for a further assessment of sample sets that do not meet the target sample size (EPA 2005).

DEQ strives for a minimum of ten (10) water quality samples to make water quality standard and designated use attainment decisions for most physical and chemical parameters. The primary goal of obtaining ten (10) data points is to protect against the occurrence of Type I and Type II errors. A Type I error would result in assessing an assessment unit as non-support when it is actually fully supporting its standards and uses. A Type II error occurs when an assessment unit is assessed as support despite it actually not meeting its standards or uses.

For water quality and designated use attainment decisions, data sets containing fewer than ten (10) ($n<10$) data points will be used as a screening sample, unless fewer than ten (10) samples is appropriate for the parameter, such as primary contact season bacteria, or if non-attainment is reached in only one (1) or two (2) samples such as radioactivity, toxics, and ammonia. Surface water AUs with fewer than 10 ($n<10$) data points and two or more ($n\geq2$) exceedances will warrant additional monitoring and may be placed into Category 3 for further investigation. Impairments based on this limited data set may be assessed on a case-by-case basis. Once the sample size reaches ten (10) data points or greater ($n\geq10$) the appropriate rate of exceedance applies.

Specific data quantity requirements are described for each parameter within Section 6.0 and subsections thereof. AUs that fail to meet the Phase II data quantity requirement may be categorized as Category 3, insufficient data to determine attainment.

3.6 Data Representativeness Considerations

Spatial and temporal representativeness of data and information must be considered when characterizing annual ambient conditions for a given AU. Specifics of spatial and temporal distribution will be discussed within each parameter in Section 6.0 and subsections thereof of this document.

Spatial and temporal representativeness of a grab sample is a qualitative assessment addressed primarily in sample design through selection of sampling sites and use of procedures that reflect project goals and environment being sampled (i.e., monitoring the presence and magnitude of toxicity at specific sites for potential impacts on aquatic life may require specialized parameter sampling). For assessment purposes, grab samples from a given monitoring site are considered representative of the waterbody for that distance upstream and downstream in which there are no significant influences to the waterbody that might cause a change in water quality (e.g., point source discharges, confluence with another stream, etc.) or when there is an absence of contextual information indicating unstable hydrologic conditions, such as: 1) precipitation, 2) streamflow, 3) differing land use patterns, or 4) historic patterns of pollutant concentrations in the monitoring segment.

3.7 Statistical Confidence

Past EPA guidelines (EPA 1996 and 2002) have recommended listing waterbody segments as impaired (for conventional pollutants) when “10% of measurements exceed the water quality criterion.” Making attainment decisions by simply applying a literal percent exceedance rate (10 exceedances out of 100 equals 10%) is referred to as a “raw score” assessment method. While this “raw score” assessment method can be applied, it errs significantly toward making false positive listings (Washington State Department of Ecology 2002).

In an effort to limit or reduce false positive (Type 1 error) listings, DEQ utilizes binomial distribution methodology for certain parameters, as appropriate. It will not be used on parameters where only one or two excursions of the criteria will result in an assessment of non-attainment such as toxics, radioactivity, and ammonia. Additionally, binomial distribution method will not be applied to bacteria data due of assessment language established in Reg. 2.507. Binomial distribution method will be applied to the following parameters: temperature, turbidity, pH, dissolved oxygen, and minerals.

When the binomial distribution method is not applied, the specific method used for each parameter is described within applicable Sections 6.1- 6.12.

The binomial distribution method is a non-parametric, robust, and well known method for characterizing the probability of proportions. In this case, the percent a data set exceeds a predetermined constant. Statistical analysis methods, such as the binomial distribution method, are used to increase the confidence level of the final decision of attainment of water quality criteria.

Use of the binomial distribution method also allows DEQ to statistically consider the waterbody as a whole rather than just the available sample set. The “raw score” method only determines exceedances in the available sample set, which are only a representation of the whole waterbody. The binomial distribution method allows for a margin of safety to statistically declare, with a set degree of confidence, that the sample set accurately represent the waterbody as a whole. This is more effective, from an environmental standpoint, than simply determining whether or not the sample set exceed standards.

The EPA suggests that states determine the level of error they are willing to accept during the decision making process. Statistical methods should be employed to help achieve the state’s acceptable level of error. DEQ strives to attain a greater than ninety percent (>90%) confidence level when determining the water quality attainment status of an AU. Table 2 specifies the minimum number of exceedances required per sample size to list an AU on the 303(d) list of impaired waterbodies. Conversely, Table 3 specifies the maximum number of exceedances allowed per sample size to de-list a listed AU. Each table assumes >90% confidence level for a decision with exceedance rates of ten (10), twenty (20), and twenty-five (25) percent using the binomial distribution method.

Utilizing the mathematical functions in Microsoft Excel, the exceedance rates were calculated using the following formula:

BINOM.INV(X,Y,Z)

Where:

X = number of samples in the data set (Trials)
Y = percent exceedance rate expressed as a decimal, (Probability_s); 10%=0.10, 20%=0.20, 25%=0.25
Z = confidence level to be attained, expressed as a decimal, (Alpha) 90%=0.9

Text above in parentheses is language input for Microsoft Excel arguments.

Thus, for a data set that contains 10 samples, to be assessed on a 10% exceedance rate and attain a 90% confidence level in the final decision, the formula would be:

BINOM.INV(10,0.1,0.9)

Table 2: Minimum number of sample exceedances required to assess as non-attaining (list) water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the waterbody is greater than or equal to 10%, 20%, or 25%.

10% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10-11	2
12-18	3
19-25	4
26-32	5
33-40	6
41-47	7
48-55	8
56-63	9
64-71	10
72-79	11
80-88	12
89-96	13
97-100	14

20% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10-13	4
14-16	5
17-20	6
21-24	7
25-28	8
29-32	9
33-36	10
37-40	11
41-45	12
46-49	13
50-53	14
54-57	15
58-62	16
63-66	17
67-70	18
71-75	19
76-79	20
80-83	21
84-88	22
89-92	23
93-96	24
97-100	25

25% Exceedance Rate	
Sample Size	Minimum Number of Exceedances Needed to Assess as Non-Attains
10	4
11-13	5
14-16	6
17-19	7
20-23	8
24-26	9
27-29	10
30-33	11
34-36	12
37-39	13
40-43	14
44-46	15
47-50	16
51-53	17
54-57	18
58-60	19
61-64	20
65-67	21
68-71	22
72-74	23
75-78	24
79-81	25
82-85	26
86-88	27
89-92	28
93-96	29
97-99	30
100	31

Table 3: Maximum number of sample exceedances allowed in order to assess as attaining (de-list) water quality standards, using binomial distribution, with 90% confidence that the true exceedance percentage in the waterbody is greater than or equal to 10%, 20%, 25%.

10% Exceedance Rate	
Sample Size	Maximum Number of Exceedances Needed to Assess as Attains
10-11	1
12-18	2
19-25	3
26-32	4
33-40	5
41-47	6
48-55	7
56-63	8
64-71	9
72-79	10
80-88	11
89-96	12
97-100	13

20% Exceedance Rate	
Sample Size	Maximum Number of Exceedances Needed to Assess as Attains
10-13	3
14-16	4
17-20	5
21-24	6
25-28	7
29-32	8
33-36	9
37-40	10
41-45	11
46-49	12
50-53	13
54-57	14
58-62	15
63-66	16
67-70	17
71-75	18
76-79	19
80-83	20
84-88	21
89-92	22
93-96	23
97-100	24

25% Exceedance Rate	
Sample Size	Maximum Number of Exceedances Needed to Assess as Attains
10	3
11-13	4
14-16	5
17-19	6
20-23	7
24-26	8
27-29	9
30-33	10
34-36	11
37-39	12
40-43	13
44-46	14
47-50	15
51-53	16
54-57	17
58-60	18
61-64	19
65-67	20
68-71	21
72-74	22
75-78	23
79-81	24
82-85	25
86-88	26
89-92	27
93-96	28
97-99	29
100	30

3.8 Internal Data Assessment Method

Data generated by DEQ will be analyzed using the Water Quality Analysis Reporter (WQAR). WQAR is a data analysis program developed in partnership by DEQ and Windsor Solutions and was created to calculate, store, and organize the attainment results obtained from DEQ's water quality data. Attainment results are calculated using the water quality standards in Reg. 2 and the processes outlined in DEQ's Assessment Methodology.

Station IDs are assigned to AUs where applicable. AUs with assigned stations are identified as "monitored." AUs without stations, where data from another contiguous segment is used for evaluating attainment, are identified as "evaluated" and the AU containing the station data is linked to the unit without the data for tracking purposes. AUs are identified as "unassessed" when there are no water quality data available with which to evaluate attainment.

Water quality standards and methodology processes have been entered into the WQAR system as standard sets. Standard sets contain specific water quality criteria for parameters that apply to waters. For instance, the "Boston Mountains Less than 10 sqmi" standard set contains specific criteria that apply to Boston Mountain streams with watershed areas of less than 10 square miles for temperature, primary and critical season dissolved oxygen, and turbidity all flows and base flows. The "Boston Mountains Less than 10 sqmi" standard set can then be applied to all AUs in the Boston Mountains ecoregion that have watershed areas of less than 10 square miles. Other standard sets that apply more broadly include parameters such as pH, metals, bacteria, and minerals.

WQAR automatically calculates attainment of each standard using station data pulled directly from E&E's internal Laboratory Information Management System (LIMS). Attainment is calculated for each standard applied to the monitoring segment for the period of record. The integrated reporting category (Section 2.0) for each parameter is examined and an integrated reporting category is recommended for the monitoring segment.

Any internal data incapable of being assessed by WQAR for any reason will be assessed following the same protocols described below for external data.

3.9 External Data Assessment Method

Readily available data not generated by DEQ is considered "external data." Because WQAR was created for use with DEQ internal data formatting only, extracted directly from LIMS, external data must be assessed through traditional means. Typically, external data are presented in Excel or Excel compatible format and are evaluated using tools available through the Excel program.

3.10 Impairment Source Determination

For any monitored surface water segment where a water quality standard has been evaluated as non-support, the source(s) of impairment will be identified using available information (field observation, land use maps, point source location, nonpoint source assessment reports, special studies, and knowledge of field personnel familiar with the waterbody).

3.11 Final Attainment decision process

For parameters that allow for both discrete and continuous data (pH, temperature, and dissolved oxygen), data types will not be combined. Discrete data and continuous data will be evaluated separately. Attainment decisions will be based on the most appropriate and protective decision for the AU. Factors that could determine which data set will be used for attainment decisions could include quantity of data, quality of data sets, and time of year data were collected. A weight of evidence approach will be used to make the final attainment decision. When multiple data types meet all quality requirements for a given AU, final attainment decisions will be justified within the 305(b) report and any supporting documentation will be provided.

Occasionally DEQ will make final attainment decisions that differ from the initial attainment result produced from strict adherence to the methods contained within this assessment methodology. These differences in attainment results are made using a weight of evidence approach. Factors that may influence the decision to provide a differing final attainment decision could include, but are not limited to, magnitude, frequency, and duration of data; reports or peer reviewed literature; and DEQ personnel's unique understanding of a particular AU (such as ecoregion transitional zones and anthropogenic modifications within the AU).

Final attainment decisions that differ from initial attainment decisions reached using WQAR (for internal data) or Excel (or similar software for external data, biological data, WET data, etc.) will be justified within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided.

4.0 WATER QUALITY STANDARDS

Water quality standards are comprised of: 1) an antidegradation policy; 2) designated uses; and 3) narrative and numeric criteria, which work in concert to protect water quality.

4.1 Antidegradation

An antidegradation policy is a requirement of the federal Clean Water Act, which is designed to prevent or limit future degradation of the nation's waters. Reg. 2 contains an antidegradation policy that applies to all surface waters of the state. Per Reg. 2.201 existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. Arkansas's High Quality Waters as described in Reg. 2.202 and Outstanding Resource Waters, as described in Reg. 2.203 are to be protected and maintained for those beneficial uses and water quality for which the outstanding resource designation was granted. These waterbodies will be listed as non-support if the chemical, physical, and/or biological characteristics for which the waterbody was designated have been determined to be impaired or absent, as defined by the following assessment criteria. Per Reg. 2.204, in those cases where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act, 33 U.S.C. § 1326.

4.2 Designated Uses

The primary purpose of the 303(d) list of impaired waterbodies is to identify those waters that are not currently meeting water quality standards. The support/non-support status of designated uses is most often determined utilizing water quality criteria or other water quality indicators. EPA guidance (2005) makes suggestions as to which water quality constituents are protective of which designated uses to determine the support status of those designated uses. DEQ has developed Table 4 to illustrate which water quality criteria may be used to determine the support status of each designated use. The designated use "Other Uses" Reg. 2.302(J) is typically not dependent upon current water quality standards so it is not included in Table 4. Fish Consumption is not a designated use in Reg. 2; however it can be used to list a waterbody on the 303(d) list. Fish advisories are issued by the Epidemiology Branch of the Arkansas Department of Health (ADH). Parameters (regulations) for which no assessment methodology exists in this document were not included within this table.

Table 4: Designated Uses for Arkansas's surface waters and regulations used for assessment.

	Extraordinary Resource Waters, Ecologically Sensitive Waterbody, and Natural and Scenic Waterways Reg. 2.302 (A), (B), and (C)	Primary and Secondary Contact Reg. 2.302 (D) & (E)	Aquatic Life Reg. 2.302 (F)	Domestic Water Supply Reg. 2.302 (G)	Industrial & Agriculture Water Supply Reg. 2.302 (H) & (I)
Biological Integrity Reg. 2.405	•		•		
Temperature Reg. 2.502	•		•		
Turbidity Reg. 2.503	•		•		
pH Reg. 2.504	•		•		
Dissolved Oxygen Reg. 2.505	•		•		
Radioactivity Reg. 2.506	•	•	•	•	•
Bacteria Reg. 2.507	•	•			
Toxic Substances Reg. 2.508	•		•	•	
Nutrients Reg. 2.509	•		•		
Site Specific Minerals Reg. 2.511(A)	•		•		
Minerals Reg. 2.511(C)	•			•	•
Ammonia Reg. 2.512	•		•		

4.3 Water Quality Criteria

4.3.1 Narrative Criteria

Reg. 2 contains narrative criteria (written descriptions) that apply to all waters of the state and are used to evaluate support of applicable designated uses. Narrative criteria include general descriptions, such as the existence of nuisance species, biological integrity, taste and odor producing substances, visible globules on surface waters, nutrients, and toxins.

When listing and delisting methodologies are not specified for a particular narrative criterion within the assessment methodology, the following general methods will be used. Narrative criteria are evaluated by using screening levels established by EPA or other scientific literature, if they are available, as well as other information, including water quality studies, documentation of fish kills or contaminant spills, and photographic evidence. A weight of evidence approach will be used and final attainment decisions will be justified within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided.

4.3.2 Numeric Criteria

Numeric criteria are values established in Reg. 2 that provide a quantitative basis for assessing designated use support, developing permit limitations, and for managing point and nonpoint loadings in Arkansas's surface waters. Listing and delisting methodologies for instream water quality against numerical criteria are outlined in Section 6.0 and subsections thereof.

5.0 BIOLOGICAL INTEGRITY

This section establishes the protocol for assessment of biological integrity for Arkansas's surface waters, per APC&EC Reg. 2.405:

> *For all waters with specific aquatic life use designated in Appendix A, aquatic biota should not be impacted. Aquatic biota should be representative of streams that have the ability to support the designated fishery, taking into consideration the seasonal and natural variability of the aquatic biota community under naturally varying habitat and hydrological conditions; the technical and economic feasibility of the options available to address the relevant conditions; and other factors.*
>
> *An aquatic biota assessment should compare biota communities that are similar in habitat and hydrologic condition, based upon either an in-stream study including an upstream and downstream comparison, a comparison to a reference water body within the same ecoregion, or a comparison to community characteristics from a composite of reference waters. Such a comparison should consider the seasonal and natural variability of the aquatic biota community. It is the responsibility of the Department to evaluate the data for an aquatic biota assessment to protect aquatic life uses designated in Appendix A. Such data may be used to develop permit effluent limitations or conditions.*

ASSESSMENT METHODOLOGY FOR BIOLOGICAL INTEGRITY

Biological integrity is evaluated using macroinvertebrate and/or fish communities collected within the waterbody. At a minimum, paired biological and physical data must be collected over two seasons using methods outlined in a Quality Assurance Project Plan with requirements equal to or more stringent than that of DEQ or USGS. Chemical data for biological integrity analysis should be collected as per methods outlined within Section 6.1 - 6.12 of this document. Results from acute and chronic toxicity tests of vertebrates and invertebrates will also be evaluated, when available, but are not required to make a use determination.

MACROINVERTEBRATE COMMUNITY ANALYSIS

Modified metrics set forth in *Rapid Bioassessment Protocols for Use in Stream and Rivers* (Plafkin et al. 1989) are used in analysis of macroinvertebrate community samples. Each site will have a Rapid Bioassessment score derived from a multi-metric analysis, which includes: 1) Taxa Richness, 2) Ephemeroptera-Plecoptera-Trichoptera Index (EPT Index), 3) Hilsenhoff Biotic Index (HBI), 4) Percent Contribution of Dominant Taxa5) Community Loss Index, 6) Ratio of EPT to Chironomid Taxa, and 7) Ratio of Scrapers to Filter-Collectors. See *Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan* (ADEQ 2016) at the DEQ website: http://adeq.state.ar.us for more information. DEQ's metric modification or deviation from Plafkin et al. (1989) includes removal of the ratio of shedders to total taxa metrics. DEQ field sampling methodologies do not include the collection of coarse particulate organic matter (CPOM) (i.e. leaf packs) to evaluate macroinvertebrate communities. Collection of CPOM is required to calculate the ratio of shredders to total taxa.

Macroinvertebrate community analysis is as follows. Using raw data, calculate all seven Metric Values for each study site and reference site. Instructions for these calculations are found in Plafkin et al. (1989). Metric values from each study site are compared to metric values from a reference site for five of the seven metrics to calculate a Percent Comparison to Reference value. Community loss index is already a comparison of study site to reference so there is no need for additional comparison in this step. Percent contribution of dominant taxa is not a comparison to reference value, but rather actual percent contribution for the given site. Using the Percent Comparison to Reference values for all seven metrics, a bioassessment score (6, 4, 2, or 0) is assigned for each metric (Table 5). Bioassessment scores for each metric per site (study and reference) are summed to create a single Biological Condition Score for that site. The ratio of scores between the sample site to reference site provides the percent comparable estimate for each study site (Table 6). The percent comparable estimate score is then used to determine attainment status of "Support" or "non-support" (Table 6). See Figures 1 and 2 below for an overview on how aquatic life designated use is determined.

Table 5: Macroinvertebrate bioassessment metrics and scoring criteria[1].

Metric	Biological Condition Scoring Criteria			
	6	4	2	0
Taxa Richness[2]	≥80%	<80-60%	<60-40%	<40%
Hilsenhoff Biotic Index[3]	≥85%	<85-70%	<70-50%	<50%
Ratio of EPT to Chironomid Abundances[2]	≥75%	<75-50%	<50-25%	<25%
% Contribution of Dominant Taxa[4]	<20%	20-<30%	30-<40%	≥40%
EPT Index[2]	≥90%	<90-80%	<80%-70	<70%
Community Loss Index[5]	<0.5	0.5-<1.5	1.5-<4.0	≥4.0
Ratio of Scrapers to Filter-Collectors[2]	≥50%	<50-35%	<35-20%	<20%

[1] Modified from Plafkin, J.L. M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington D.C. EPA 440-4-89-001.

[2] Score is a ratio of study site to reference site X 100.

[3] Score is a ratio of reference site to study site X 100.

[4] Scoring criteria evaluate actual percent contribution, not percent comparability to reference site.

[5] Range of values obtained. A comparison to the reference site is incorporated in these indices.

Table 6: Scoring criteria for macroinvertebrate community attainment decisions (modified from Plafkin et al. 1989).

	Biological Condition Category	% Comparable Estimate	Attribute
Support	Comparable to reference	≥83%	Comparable to the best situation in an ecoregion.
	Supporting	54-79%	Community structure less than reference site. Taxa richness lower and tolerant forms are more prevalent.
Non-Support	Partially Supporting	21-50%	Obvious decline in community structure with loss of intolerant forms. EPT index reduced.
	Non-supporting	<20%	Community dominated by 1 or 2 taxa, few taxa present.

If the percent comparable estimates fall between the 50-54% cutoff for support vs non-support a weight of evidence approach will be utilized to make a final support or non-support decision using available physical, chemical, and biological data and information.

FISH COMMUNTIY ANALYSIS

DEQ's Community Structure Index (CSI) (Table 7) will be used in the analysis of fish communities. The CSI was established utilizing information from the 1987 ecoregion survey (APC&EC 1987) and supplemented with data from additional least-disturbed streams identified by DEQ personnel. A group of Arkansas ichthyologists reviewed the data. The current metric scores and similarity ranking categories were established utilizing the prevailing deviations in the ecoregion survey data set and employ best professional judgment. Ecoregion specific metric scores for watersheds (>10mi^2) outlined in *Arkansas's Water Quality and Compliance Monitoring Quality Assurance Project Plan* (ADEQ 2016), available at the DEQ website: http://adeq.state.ar.us, will be calculated for each site and total scores will be evaluated and assessed as follows:

Table 7: Fish Community Structure Index (CSI) ecoregion values.

Ecoregion	Total Score	Category	Attribute
Ozark Highlands Boston Mountains Ouachita Mountains AR River Valley Typical Gulf Coastal Spring-Influenced Gulf Coastal	**25-32**	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	24-17	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	16-9	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.
	0-8	Not Similar	Few taxa present and normally dominated by one (1) or two (2) taxa.
Channel Altered Delta Least-Disturbed Delta	**22-28**	Mostly Similar	Comparable to the best situation to be expected. Balanced trophic structure and optimum community structure present.
	21-15	Generally Similar	Community structure less than expected. Taxa richness lower than expected. Some intolerant taxa loss. Percent contribution of tolerant forms may increase.
	14-8	Somewhat Similar	Obvious decline in taxa richness due to the loss of tolerant forms. Loss of Key and Indicator taxa.
	0-8	Not Similar	Few taxa present and normally dominated by one (1) or two (2) taxa.

Results from fish and macroinvertebrate community analysis, along with evaluation of chemical and physical data, and toxicity test date if available, will be used to determine support or non-support of the aquatic life designated use.

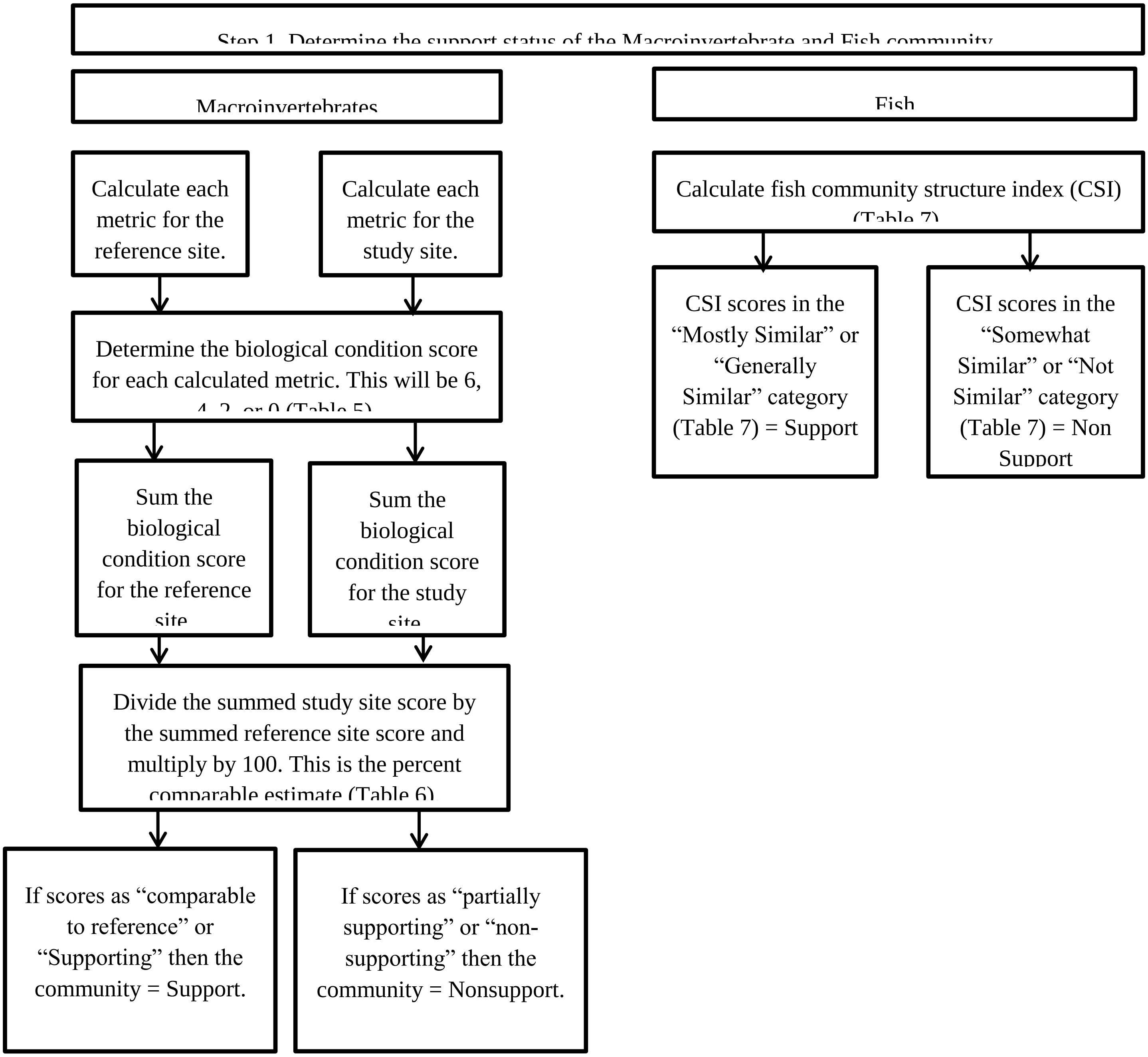


Figure 1: Determining Aquatic Life Use designated use attainment Step 1.

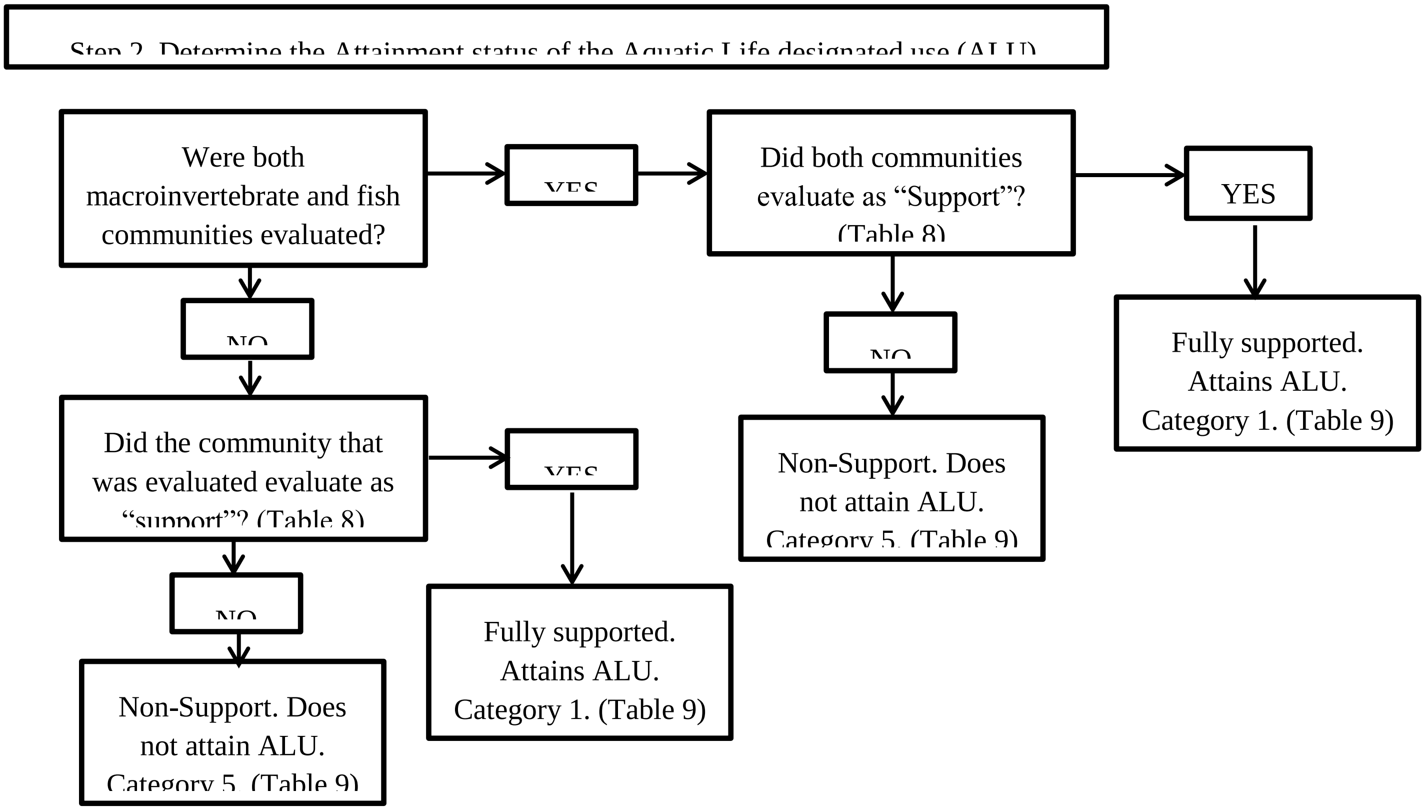


Figure 2: Determining Aquatic Life Use designated use attainment Step 2.

AQUATIC LIFE USE ATTAINMENT DETERMINATION

LISTING METHODOLOGY:

AUs will be listed as non-support when one or both of the evaluated biological communities (macroinvertebrates and/or fish) indicate perturbation/degradation (Table 9), or when one or both of the toxicity test organisms (vertebrate and/or invertebrate) fail more than one ambient toxicity study acute or chronic toxicity test in a three-year period (Table 10).

Aquatic life designated use attainment can be assessed using both biological integrity data and water chemistry data. When only water chemistry data are available for an AU and assessment results indicate water quality impairment for pH, temperature, dissolved oxygen, turbidity, ammonia, radioactivity, site specific minerals, or toxic substances it will be assumed that aquatic life designated use is not attained. However, if physical and biological data are collected post-assessment which indicate aquatic life designated use is attained, the water quality impairment will remain, but it will be noted that the aquatic life designated use is being attained in the subsequent assessment cycle.

DELISTING METHODOLOGY:

AUs will be listed as support when evaluated biological communities (macroinvertebrates and/or fish, which ever community led to the impaired attainment decision) do not indicate perturbation/degradation (Table 9) and when there have been no ambient toxicity test failures, acute or chronic, in a three-year period (Table 10).

Table 8: Biological community assessment determination.

Data Type	Support	Non-Support
Macroinvertebrate Community Data Available	Macroinvertebrate community structure analysis (Table 6) indicates comparable to reference or supporting	Macroinvertebrate community structure analysis (Table 6) indicates partially supporting or non-supporting*
Fish Community Data Available	Community Structure Index score (Table 7) is either mostly or generally similar; general presence of sensitive and indicator species	Community Structure Index score (Table 7) is either somewhat or not similar; absence of sensitive and indicator species*

* The aquatic life designated use may be assessed as support, despite an initial evaluation of non-support, if it is demonstrated that the non-support assessment is due to unrepresentative biological community data and not an environmental factor (low dissolved oxygen, low pH, toxicity); based on acceptable variances in ecoregion community structures. Under certain conditions, biological community data can be skewed due to an unrepresentative sample, which includes but is not limited to:

- Collection of irruptive species (e.g., large percentage of young-of-year in an isolated area that is not representative of the entire reach), which could trigger an inaccurate ‘non-support’ determination.
- Transitional areas between ecoregions.

A weight of evidence approach is used in these circumstances to prevent the inappropriate listing of waters. If a support determination is made due to an unrepresentative sample, it will be explained in detail in the 305(b) Report and supporting documentation will be provided.

Table 9: Aquatic life designated use listing protocol.

Type of Data Present	Evaluation Result		Final Assessment	Listing Category
	Fish Community	Macroinvertebrate Community		
Fish Community and/or Macroinvertebrate Community	S	S	FS	1
	S	NS	NS	5
	NS	S	NS	5
	NS	NS	NS	5
At Least One Biological Community	S	NA	FS	1
	NA	S	FS	1
	S	S	FS	1
	NA	NA	UA	3
	NS	NA	NS	5
	NA	NS	NS	5

S = Support NS = Non-Support FS = Fully Supporting NA = No Available Data UA = Unassessed

Table 10: Ambient toxicity listing protocol.

Type of Test	Evaluation Result		Final Assessment	Listing Category
	Vertebrate	Invertebrate		
Acute Toxicity	S	S	FS	1
	S	NS	NS	5
	NS	S	NS	5
	NS	NS	NS	5
Chronic Toxicity	S	S	FS	1
	S	NS	NS	5
	NS	S	NS	5
	NS	NS	NS	5

S = Support NS = Non-Support FS = Fully Supporting

6.0 SPECIFIC STANDARDS

Per Reg. 2.501 (Applicability), unless otherwise indicated, the following specific standards shall apply to all surface waters of the state at all times except during periods when flows are less than the applicable critical flow. Streams with regulated flow will be addressed on a case-by-case basis to maintain designated instream uses. These standards apply outside the applicable mixing zone.

6.0.1 General Description of Phase II Data Quality Requirements

In general, Phase II requirements are categorized into temporal, distribution and quantity, and spatial categories. Phase II data quality requirements are discussed in detail for each parameter within their respective section (6.1 - 6.12). Each general category are described in general below.

Temporal requirements

Temporal requirements relate to time of year, season, or other time dependent sample collection considerations. If a parameter does not have a particular season, such as pH, temporal requirements many not be listed for this parameter; or the temporal requirement may read "taken year round." These parameters should be collected throughout the year without preference to any particular season or time of year. Conversely, a parameter with specific seasonal considerations, such as bacteria, will have temporal requirements listed for the particular sampling season(s)—for this example, primary and secondary contact season. "Season" will be defined within the parameter.

As per Phase I data quality requirements, data should be collected within the stated assessment cycle period of record for each parameter.

Distribution and quantity requirements

Distribution requirements are intended to be a guideline unless otherwise explicitly stated. If a parameter says "ten (10) samples evenly distributed over twelve (12) months," that is intended to be a guideline for minimum sample size and how those samples should be distributed. If more samples are taken over a longer time period, then DEQ would assess the data set for appropriate distribution.

"Evenly distributed" is meant to be a general guideline for sample distribution. It does not mean that monthly samples must be taken exactly thirty (30) days apart without exception or that an exact number of days must exist between each sample in a data set. There is no way to describe or predict every scenario for sample distribution, so "evenly distributed" is intended to be a general guide. "Evenly distributed" is also intended to guard against samples being clumped or concentrated toward one time of the year when the parameter should be collected year round. DEQ welcomes entities to ask about sample distribution prior to finalizing sampling plans for data intended to be submitted for assessment purposes.

Quantity requirements are intended to be minimum number of samples necessary to assess waters. This applies to both listing and delisting methodologies. Three exceptions exist to this minimum requirement: radioactivity (Section 6.5), toxic substances (Section 6.7), and ammonia (Section 6.12). For these three parameters, an assessment of non-attainment can be achieved before reaching ten (10) samples because these parameters are not assessed based on a percentage for non-attainment purposes; they are assessed as “not attained” whenever an absolute threshold is reached. A minimum of ten (10) samples are still required to delist or to assess as “attains” for these three parameters.

Spatial requirements

Spatial requirements relate to where samples should be taken within the waterbody, if any particular requirements exist beyond Phase I requirements or QAPP requirements. As per Phase I data requirements, all data must be characteristic of the main water mass or hydrologic area. Spatial requirements may also be spelled out in the QAPP accompanying the data. If no spatial requirements are listed in Phase II data requirements, then collection should adhere to Phase I and QAPP requirements.

Spatial requirements for lakes and reservoirs are intended to ensure assessment consistent with standards development. Primary contact recreation, secondary contact recreation, and the majority of lake aquatic life productivity occur in the epilimnion (uppermost stratified layer). For these reasons, Arkansas’s water quality standards for lakes and reservoirs were developed using data collected within the epilimnion. If no epilimnion exists—due to natural depth limitations or seasonal mixing—samples should be taken within two meters of the surface unless otherwise noted within the Phase II quality requirements for a parameter. Lake sampling depths, if any, will be specified for each parameter.

Where available, lake depth profiles containing temperature, dissolved oxygen, and pH data will be used to define epilimnion, metalimnion, and hypolimnion depths. If depth profile data do not exist for a lake or reservoir, or a metalimnion does not exist, surface samples will then be assessed. “Surface sample” is defined as any sample taken within two meters depth of a lake or reservoir unless a different sampling depth is specified within the spatial requirements for a parameter.

6.0.2 Continuous data

For assessment purposes, long-term continuous data taken in less than hourly readings (example: data recorded every fifteen minutes) will be averaged into an hourly average reading.

6.1 Temperature

This section establishes the protocol for determining attainment of temperature criteria within Arkansas's surface waters, per APC&EC Reg. 2.502:

> *Heat shall not be added to any waterbody in excess of the amount that will elevate the natural temperature, outside the mixing zone, by more than 5°F (2.8°C) based upon the monthly average of the maximum daily temperatures measured at mid-depth or three feet (whichever is less) in streams, lakes or reservoirs. The following standards are applicable:*

Waterbodies	***Limit °C (°F)***
Streams	
Ozark Highlands	*29 (84.2)*
Boston Mountains	*31 (87.8)*
Arkansas River Valley	*31 (87.8)*
Waterbodies	***Limit °C (°F)***
Ouachita Mountains	*30 (86.0)*
Springwater-influenced Gulf Coastal	*30 (86.0)*
Typical Gulf Coastal	*30 (86.0)*
Least-Altered Delta	*30 (86.0)*
Channel-Altered Delta	*32 (89.6)*
White River (Dam #1 to mouth)	*32 (89.6)*
St. Francis River	*32 (89.6)*
Mississippi River	*32 (89.6)*
Arkansas River	*32 (89.6)*
Ouachita River (L. Missouri to Louisiana state line)	*32 (89.6)*
Red River	*32 (89.6)*
Lakes and Reservoirs	*32 (89.6)*
Trout waters	*20 (68.0)*

> *Temperature requirements shall not apply to off-stream privately-owned reservoirs constructed primarily for industrial cooling purposes and financed in whole or in part by the entity or successor entity using the lake for cooling purposes.*

PHASE II DATA QUALITY REQUIREMENTS FOR TEMPERATURE

Both discrete and long-term continuous data can be considered for temperature assessment of all waters. Short-term data sets, such as 72-96 hour diel studies will be used for screening purposes only.

1. Temporal requirements
   - Discrete Data
     - Discrete data should be collected year round.
   - Long-Term Continuous Data
     - Long-term continuous data should be collected during the critical season.

- Critical season is defined, in Reg. 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
- Only data above 22 degrees Celsius will be utilized for assessments made using long-term continuous data.
- For Trout Waters long-term continuous data should be collected year round.

2. Minimum distribution and quantity requirements

- Discrete Data
  - Ten (10) discrete samples are required to make temperature attainment decisions.
  - Data must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter).
- Long-Term Continuous Data
  - Meter must be deployed and taking readings for no less than two-thirds of the critical season at no less than hourly readings.
  - For Trout Waters Long-term continuous data must cover ten (10) of the twelve (12) calendar months with continuous readings taken at least hourly. Individual days missing more than 10% of values do not meet minimum quantity requirements for that day.

3. Spatial requirements

- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR TEMPERATURE

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete and long-term continuous) will not be combined. Refer to Section 3.11 for information regarding final attainment decisions should both types of data exist for an AU. Assessments can be made using long-term continuous data measured for only one critical season; however; if multiple critical season data sets exist from different years, within the period of record, data sets will be combined. Binomial distribution method will be applied for temperature data assessments, per Section 3.7.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as non-support when, using the ten percent exceedance rate within Table 2, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable temperature standard listed in Reg. 2.502. This methodology applies to both discrete and long-term continuous data sets.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as support when, using the ten percent exceedance rate within Table 3, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable temperature standard listed in Reg. 2.502. This methodology applies to both discrete and long-term continuous data sets.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.2 Turbidity

This section establishes the protocol for determining attainment of turbidity criteria within Arkansas's surface waters, per APC&EC Reg. 2.503:

> *There shall be no distinctly visible increase in turbidity of receiving waters attributable to discharges or instream activities. The values below should not be exceeded during base flow (June to October) in more than 20% of samples. The values below should not be exceeded during storm flows in more than 25% of samples taken in not less than 24 monthly samples.*

Waterbodies	***Base Flows Values (NTU)***	***Storm Flow Values (NTU)***
Streams		
Ozark Highlands	*10*	*17*
Boston Mountains	*10*	*19*
Arkansas River Valley	*21*	*40*
Ouachita Mountains	*10*	*18*
Springwater-influenced Gulf Coastal	*21*	*32*
Typical Gulf Coastal	*21*	*32*
Least-Altered Delta	*45*	*84*
Channel-Altered Delta	*75*	*250*
Arkansas River	*50*	*52*
Mississippi River	*50*	*75*
Red River	*50*	*150*
St. Francis River	*75*	*100*
Trout	*10*	*15*
Lakes and Reservoirs	*25*	*45*

PHASE II DATA QUALITY REQUIREMENTS FOR TURBIDITY

Turbidity assessments can be made with discrete data collected in Nephelometric Turbidity Units (NTU) only. Data collected in Formazin Nephelometric Units (FNU) will be used for screening purposes only. Short-term and long-term continuous data will be used for screening purposes, if available.

Base Flows

1. Temporal requirements
   - Discrete data should be collected during base flows season.
   - Base flows season is defined, in Reg. 2, as June to October.
2. Minimum distribution and quantity requirements
   - Discrete Data
     - Ten (10) discrete samples are required to make turbidity attainment decisions for base flows.
     - Samples must be evenly distributed throughout the base flows season.
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present), sample depth shall not exceed two (2) meters.

Storm Flows

1. Data temporal requirements
   - Discrete data should be taken year round. This includes June to October (base flows season).
2. Minimum data distribution and quantity requirements
   - Discrete Data
     - Discrete samples must be taken in no less than twenty-four (24) monthly samples.
     - Samples must be evenly distributed throughout the time period sampled.
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR TURBIDITY

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Discrete samples from multiple base flows seasons within the period of record (if exist) will be combined for assessments. If an AU is assessed as not meeting either the base flows or storm flows values, or both, it will be listed as non-support for turbidity. Binomial distribution method will be applied to turbidity data, per Section 3.7.

BASE FLOWS LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as non-support when, using the twenty percent exceedance rate within Table 2, greater than or equal to the minimum number of samples for the entire qualifying data set from June to October exceed the applicable base flows values listed in APC&EC Reg. 2.503.

BASE FLOWS DELISTING METHODOLOGY:
Stream, river, reservoir, and lake AUs will be assessed as support when, using the twenty percent exceedance rate in Table 3, no more than the maximum number of samples allowed for the entire qualifying data set from June to October exceed the applicable base flows values listed in APC&EC Reg. 2.503.

STORM FLOWS LISTING METHODOLOGY:
Stream, river, reservoir, and lake AUs will be assessed as non-support when, using the twenty-five percent exceedance rate within Table 2, greater than or equal to the minimum number of samples for the entire qualifying data set (sample set not to be fewer than 24 data points) exceed the applicable storm flows values listed in APC&EC Reg. 2.503.

STORM FLOWS DELISTING METHODOLOGY:
Stream, river, reservoir, and lake AUs will be assessed as support when, using the twenty-five percent exceedance rate in Table 3, no more than the maximum number of samples allowed for the entire qualifying data set (sample set not to be fewer than 24 data points) exceed the applicable storm flows values listed in APC&EC Reg. 2.503.

6.3 pH

This section establishes the protocol for determining attainment of pH criteria within Arkansas's surface waters, per APC&EC Reg. 2.504:

> *pH between 6.0 and 9.0 standard units are the applicable standards for streams. As a result of waste discharges, the pH of water in streams or lakes must not fluctuate in excess of 1.0 standard unit over a period of 24 hours.*

PHASE II DATA QUALITY REQUIREMENTS FOR pH

pH assessments can be made using discrete data, short-term continuous data, or long-term continuous data.

1. Temporal requirements
   - pH data should be collected year round.
2. Minimum distribution and quantity requirements
   - Discrete Data
     - Ten (10) discrete samples are required to make pH attainment decisions.
     - Discrete data must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter).
   - Short-term Continuous data
     - Two (2) diel deployments of at least seventy-two (72) hours each with at least hourly readings are required for pH attainment decisions.
     - Diel deployments must be spaced at least two weeks (14 days) apart.
   - Long-term Continuous Data
     - Long-term continuous data must cover ten (10) of the twelve (12) calendar months with continuous readings taken at least hourly readings. Individual days missing more than 10% of values do not meet minimum quantity requirements.
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR pH

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined. Refer to Section 3.11 for information regarding final attainment decisions should more than one type of data set exist for an AU. Binomial distribution method will be applied to pH data, per Section 3.7.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as non-support when, using the ten percent exceedance rate in Table 2, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable pH standard listed in APC&EC Reg. 2.504. This methodology applies to discrete, short-term continuous, and long-term continuous data. AUs will not be listed as “non-attain” if the non-attainment decision is a result of data representing natural conditions (i.e., anthropogenic activities cannot be identified by DEQ as the source). If this occurs, the basis for determination of natural conditions will be noted in the 305(b) Report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as support when, using the ten percent exceedance rate within Table 3, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable pH standard listed in APC&EC Reg. 2.504. This methodology applies to discrete, short-term continuous, and long-term continuous data.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) Report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.4 Dissolved Oxygen

This section establishes the protocol for determining attainment of dissolved oxygen criteria within Arkansas's surface waters, per APC&EC Reg. 2.505:

Rivers and Streams

The following dissolved oxygen standards must be met:

Waterbodies	***Limit (mg/L)***	
Streams	*Primary*	*Critical*
Ozark Highlands		
<10 mi^2 watershed	*6*	*2*
10 to 100 mi^2	*6*	*5*
>100 mi^2 watershed	*6*	*6*
Boston Mountains		
<10 mi^2 watershed	*6*	*2*
>10 mi^2 watershed	*6*	*6*
Arkansas River Valley		
<10 mi^2 watershed	*5*	*2*
10 mi^2 to 150 mi^2	*5*	*3*
151 mi^2 to 400 mi^2	*5*	*4*
>400 mi^2 watershed	*5*	*5*
Ouachita Mountains		
<10 mi^2 watershed	*6*	*2*
>10 mi^2 watershed	*6*	*6*
Typical Gulf Coastal		
<10 mi^2 watershed	*5*	*2*
10 mi^2 to 500 mi^2	*5*	*3*
>500 mi^2 watershed	*5*	*5*
Springwater-influenced Gulf Coastal		
All size watersheds	*6*	*5*
Delta (least-altered and channel altered)		
<10 mi^2 watershed	*5*	*2*
10 mi^2 to 100 mi^2	*5*	*3*
>100 mi^2 watershed	*5*	*5*
Trout Waters		
All size watersheds	*6*	*6*

In streams with watersheds of less than 10 mi^2, it is assumed that insufficient water exists to support a fishery during the critical season. During this time, a dissolved oxygen standard of

2 mg/l will apply to prevent nuisance conditions. However, field verification is required in areas suspected of having significant groundwater flows or enduring pools which may support unique aquatic biota. In such waters the critical season standard for the next size category of stream shall apply.

All streams with watersheds of less than 10 mi^2 are expected to support aquatic life during the primary season when stream flows, including discharges, equal or exceed 1 cubic foot per second (cfs). However, when site verification indicates that aquatic life exists at flows below 1 cfs, such aquatic biota will be protected by the primary standard (refer to the State of Arkansas Continuing Planning Process for field verification requirements).

Also, in these streams with watersheds of less than 10 mi^2, where waste discharges are 1 cfs or more, they are assumed to provide sufficient water to support aquatic life and, therefore, must meet the dissolved oxygen standards of the next size category of streams.

Lakes and Reservoirs

Specific dissolved oxygen standards for lakes and reservoirs shall be 5 mg/L. Effluent limits for oxygen-demanding discharges into impounded waters are promulgated in Arkansas Pollution Control and Ecology Commission Regulation No. 6, Regulations for State Administration of the National Pollutant Discharge Elimination System (NPDES). However, the Commission may, after full satisfaction of the intergovernmental coordination and public participation provisions of the State of Arkansas Continuing Planning Process, establish alternative limits for dissolved oxygen in lakes and reservoirs where studies and other relevant information can demonstrate that predominant ecosystem conditions may be more accurately reflected by such alternate limits; provided that these limits shall be compatible with all designated beneficial uses of named lakes and reservoirs.

PHASE II DATA QUALITY REQUIREMENTS FOR DISSOLVED OXYGEN

Assessments for dissolved oxygen can be made using discrete data, short-term continuous data, or long-term continuous data depending on season. Concurrent temperature data must accompany dissolved oxygen data to be used for assessments.

Dissolved Oxygen- Trout Waters – Lakes and Streams

1. Temporal requirements
   - Discrete data and long-term continuous data
     - Year round.
   - Short-term continuous data
     - Mid-May to mid-September.
2. Minimum data distribution and quantity requirements
   - Discrete data
     - Ten (10) discrete samples are needed to make dissolved oxygen attainment decisions.
     - Discrete data must be evenly distributed throughout the year.
     - Discrete data must cover ten (10) of the twelve (12) calendar months.
   - Short-term continuous data
     - Two (2) diel deployments of no less than seventy-two (72) hours each with at least hourly readings are required for attainment decisions.
     - Diel deployments must be taken at least two weeks (14 days) apart during mid-May to mid-September.
     - The two diel deployments must be within the same year. You may have multiple years within the POR, but each year must have two deployments. Years need not be consecutive.
   - Long-term continuous data
     - Data must cover ten (10) of twelve (12) calendar months (January through December).
     - At least 80% of each month (as defined by 80% of readings) must be present for that month to be used.
     - Readings must be at least hourly. Data sets with sub-hourly readings (every 15 minutes, for example) will be calculated into an hourly average.
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

Dissolved Oxygen - Non-Trout Waters

Dissolved oxygen standards are divided into two (2) categories:

1) **Primary season:** Water temperatures are at or below 22 degrees Celsius (≤ 22 degrees Celsius).
2) **Critical season:** Water temperatures exceed 22 degrees Celsius (>22 degrees Celsius).

Dissolved Oxygen - Primary Season - Streams

1. Temporal requirements

- Discrete and long-term continuous data
  - Data must be collected during the primary season.
  - "Primary season" is defined as the time of year when water temperatures are less than or equal to 22 degrees Celsius.
- Long-term continuous data
  - Year round.

2. Minimum data distribution and quantity requirements

- Discrete data
  - Ten (10) discrete samples are needed to make dissolved oxygen attainment decisions.
  - Discrete data must be evenly distributed throughout the primary season.
  - Discrete data must be distributed over at least two primary seasons.
- Long-term continuous data
  - Data must cover ten (10) of twelve (12) calendar months
  - At least 80% of each month (as defined by 80% if readings) must be present for that month to be used.
  - Readings must be at least hourly. Data sets with sub-hourly readings (15 minutes, for example) will be combined in to hourly averages.
  -

3. Spatial requirements

- None that are not already covered in Phase I requirements.

Dissolved Oxygen - Critical Season – Streams

1. Temporal requirements
   - Discrete, Short-term, and Long-term continuous data
     - Data must be collected during the critical season.
     - "Critical season" is defined as the time of year when water temperatures are greater than 22 degrees Celsius.
   - Long-term continuous data
     - Year round.
2. Minimum data distribution and quantity requirements
   - Discrete data
     - Ten (10) discrete samples are needed to make dissolved oxygen attainment decisions.
     - Discrete data must be evenly distributed throughout the critical season.
     - Discrete data must be distributed over at least two seasons.
   - Short-term continuous data
     - Two (2) diel deployments of no less than seventy-two (72) hours each with at least hourly readings are required for attainment decisions.
     - Diel deployments must be taken at least two weeks (14 days) apart.
     - The two diel deployments must be within the same year. You may have multiple years within the POR, but each year must have two deployments. Years need not be consecutive.
   - Long-term continuous data

-
- Data must cover ten (10) calendar months (January through December).
- At least 80% of each month (as defined by 80% of readings) must be present for that month to be used.
- Readings must be at least hourly. Data sets with sub-hourly readings (every 15 minutes, for example) will be combined into an hourly average.

3. Spatial requirements

None that are not already covered in Phase I requirements.

Dissolved Oxygen - Lakes

1. Temporal requirements

- Discrete Data
  - Year round.
- Short-term continuous data
  - “Critical season” is defined as the time of year when water temperatures are greater than 22 degrees Celsius.

2. Minimum data distribution and quantity requirements

- Discrete data
  - Ten (10) discrete samples are needed to make dissolved oxygen attainment decisions.
  - Discrete data must be evenly distributed throughout the year.
  - Discrete data must cover ten (10) of the twelve (12) calendar months.
- Short-term continuous data
  - Two (2) diel deployments of no less than seventy-two (72) hours each with at least hourly readings are required for attainment decisions.
  - Diel deployments must be taken at least two weeks (14 days) apart when water temperatures are greater than 22 degrees Celsius.
  - The two diel deployments must be within the same year. You may have multiple years within the POR, but each year must have two deployments. Years need not be consecutive.

3. Spatial requirements

- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR DISSOLVED OXYGEN

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined. Refer to Section 3.11 for information regarding final attainment decisions should more than one type of data set exist for an AU. Concurrent temperature data must accompany dissolved oxygen data for attainment decisions. Binomial distribution method will be applied to all data types of dissolved oxygen data, per Section 3.7.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as non-support when, using the ten percent exceedance rate within Table 2, greater than or equal to the minimum number of samples for the entire qualifying data set fail to meet the minimum applicable dissolved oxygen standard listed in APC&EC Reg. 2.505 for either the primary or critical season, or year-round, as appropriate. This methodology applies to discrete, short-term continuous, and long-term continuous data.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as support when, using the ten percent exceedance rate within Table 3, no more than the maximum number of samples allowed for the entire qualifying data set fail to meet the applicable dissolved oxygen standard listed in APC&EC Reg. 2.505 for either the primary or critical season, or year-round as appropriate. This methodology applies to discrete, short-term continuous, and long-term continuous data.

In some instances, DEQ may use discrete data to delist AUs that were listed using continuous data, and vice versa. However, this will not be the rule, it will be the exception. When this occurs, justification of use of a different type of data for delisting will be provided within the 305(b) report as well as submitted with the 303(d) list for public notice and any supporting documentation will be provided. Justification for this methodology could include limited data availability, inability to acquire the same type of data that was used to list, or other special circumstances.

6.5 Radioactivity

This section establishes the protocol for determining attainment of radioactivity criteria within Arkansas's surface waters, per APC&EC Reg. 2.506:

> *The Rules and Regulations for the Control of Sources of Ionizing Radiation of the Division of Radiological Health, Arkansas Department of Health, limits the maximum permissible levels of radiation that may be present in effluents to surface waters in uncontrollable areas. These limits shall apply for the purposes of these standards, except that in no case shall the levels of dissolved radium-226 and strontium-90 exceed 3 and 10 picocuries/liter, respectively, in the receiving water after mixing, nor shall the gross beta concentration exceed 1000 picocuries/liter.*

PHASE II DATA QUALITY REQUIREMENTS FOR RADIOACTIVITY

Assessments for radioactivity will be made using discrete data only.

1. Data temporal requirements:
   - Discrete data should be collected year round.
2. Minimum Data distribution and quantity requirements:
   - Ten (10) samples are required to make attainment decisions for radioactivity; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
   - Samples must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter); unless an assessment of non-attainment can be reached in fewer than ten (10) samples.

ASSESSMENT METHODOLOGY FOR RADIOACTIVITY

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as non-support when a single sample within the period of record exceeds the concentration of 3 picocuries/Liter for radium-226, or the concentration of 10 picocuries/Liter for strontium-90, or if the gross beta concentration exceeds 1000 picocuries/liter per APC&EC Reg. 2.506, even if the minimum of ten (10) samples has not been reached.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as support when a no samples in the period of record exceed the concentration of 3 picocuries/Liter for radium-226, or the concentration of 10 picocuries/Liter for strontium-90, or if the gross beta concentration does not exceeds 1000 picocuries/liter per APC&EC Reg. 2.506. A minimum of ten (10) samples must be reached to make an assessment of attainment.

6.6 Bacteria

This section establishes the protocol for determining attainment of bacteria criteria within Arkansas's surface waters, per APC&EC Reg. 2.507:

> *For the purposes of this regulation, all streams with watersheds less than 10 mi^2 shall not be designated for primary contact unless and until site verification indicates that such use is attainable. No mixing zones are allowed for discharges of bacteria.*
>
> *For assessment of ambient waters as impaired by bacteria, the below listed applicable values for E. coli shall not be exceeded in more than 25% of samples in no less than eight (8) samples taken during the primary contact season or during the secondary contact season.*
>
> *The following standards are applicable:*

Contact Recreation Seasons	*Limit (col/100mL)*			
Primary Contact[1]	*E. coli*		*Fecal Coliform*	
	IS[3]	*GM*[4]	*IS*[3]	*GM*[4]
ERW, ESW, NSW, Reservoirs, Lakes	*298*	*126*	*400*	*200*
All Other Waters	*410*	*-*	*400*	*200*
Secondary Contact[5]				
ERW, ESW, NSW, Reservoirs, Lakes[2]	*1490*	*630*	*2000*	*1000*
All Other Waters	*2050*	*-*	*2000*	*1000*

[1] May 1 to September 30
[3] For assessment of Individual Sample Criteria– at least eight (8) data points
[4] For calculation and assessment of Geometric Mean – calculated on a minimum of five (5) samples spaced evenly and within a thirty (30)-day period.
[5] October 1 to April 30

> *The Arkansas Department of Health has the responsibility of approving or disapproving surface waters for public water supply and of approving or disapproving the suitability of specifically delineated outdoor bathing places for body contact recreation, and it has issued rules and regulations pertaining to such uses.*

PHASE II DATA QUALITY REQUIREMENTS FOR BACTERIA

Bacterial assessments are made with discrete *Escherichia coli* (*E. coli*) data. In the absence of *E. coli* data, discrete fecal coliform data may be utilized.

Primary Contact Season

1. Data temporal requirements
   - Discrete data must be collected during primary contact season.
     - Primary contact season is defined, in Reg. 2, as May 1 to September 30.
2. Minimum data distribution and quantity requirements
   - Individual Samples

    - A minimum of one (1) primary contact season is required.
    - Eight (8) discrete samples are required per primary contact season used for assessment.
    - Discrete data must be evenly spaced within the primary contact season (within the same calendar year).
- Geometric Mean
    - Five (5) discrete samples spaced evenly and within a thirty-day period are required to calculate geometric mean.

3. Spatial Requirements
- Individual Samples
    - Applicable for assessments in all waters.
- Geometric Mean
    - *E. coli* - Applicable for assessments only in ERW, ESW, NSW waters; lakes; and reservoirs. In all other waters, geometric mean is not applicable and individual samples must be used for assessment.
    - Fecal Coliform – Applicable for assessments in all waters.
- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

Secondary Contact Season

1. Data temporal requirements
- Discrete data must be collected during secondary contact season.
    - Secondary contact season is defined, in Reg. 2, as October 1 to April 30.

2. Minimum Data distribution and quantity requirements
- Individual Samples
    - A minimum of one (1) secondary contact season is required.
    - Eight (8) discrete samples are required per secondary contact season used for assessment.
    - Discrete data must be evenly spaced within the secondary contact season.
- Geometric Mean
    - Five (5) discrete samples spaced evenly and within a thirty-day period are required to calculate geometric mean.

3. Spatial Requirements
- Individual Samples
    - Applicable for assessments in all waters.
- Geometric Mean
    - *E. coli* - Applicable for assessments only in ERW, ESW, NSW waters; lakes; and reservoirs. In all other waters, geometric mean is not applicable and individual samples must be used for assessment.
    - Fecal Coliform – Applicable for assessments in all waters.
- For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR BACTERIA

Bacterial assessments are made with discrete *Escherichia coli* (*E. coli)* data. In the absence of *E. coli* bacteria data, fecal coliform bacteria data may be utilized for assessments. Bacterial assessments are made with discrete data only. Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Assessments can be made using individual samples or geometric mean (as appropriate per spatial requirements described above). If adequate data sets exist for both single sample and geometric mean assessment (within the same year), both methods will be assessed separately and the most protective result will be used as the final assessment decision. Raw score assessment methodology will be applied, not binomial distribution method, meaning a straight mathematical 25% exceedance rate will be used to assess attainment (Example: 2 exceedances in 8 samples equal 25%).

For assessment of ambient waters using bacteria:

- Primary Contact
  - Individual Samples - Assessments can be made using data from only one primary contact season within the period of record; however, if complete data sets exist for more than one primary contact season within the period of record, data sets will be combined for assessment. Each primary season must contain eight (8) evenly distributed samples (per Phase II requirements above). Primary contact seasons with fewer than eight (8) samples will not be combined with data from other primary contact seasons and will not be used for assessment purposes.
  - Geometric Mean - All geometric means calculated for any primary contact season within the period of record will be considered for assessment purposes. All samples within a thirty day period that meet the “evenly spaced” requirement must be used for geometric mean calculation. Example: If daily readings exist for a thirty day period, all thirty readings must be used, not just any five or more of those readings.

- Secondary Contact
  - Individual Samples - Assessments can be made using data from only one secondary contact season within the period of record; however, if complete data sets exist for more than one secondary contact season within the period of record, data sets will be combined for assessment. Each secondary season must contain eight (8) evenly distributed samples (per Phase II requirements above). Secondary contact seasons with fewer than eight (8) samples will not be combined with data from other secondary contact seasons and will not be used for assessment purposes.
  - Geometric Mean - All geometric means calculated for any secondary contact season within the period of record will be considered for assessment purposes. All samples within a thirty day period that meet the “evenly spaced” requirement must be used for geometric mean calculation. Example: If daily readings exist for a thirty day period, all thirty readings must be used, not just any five or more of those readings.

LISTING METHODOLOGY:

Individual Samples
Stream, river, reservoir, and lake AUs will be assessed as non-support when the applicable standard is exceeded in greater than 25 percent of samples collected during months within the applicable contact season (as described above).

If the assessment of non-support is based on only one (1) season of data (eight (8) discrete samples within one primary contact season, or within one secondary contact season), the AU will be placed in Category 3 and more data will be collected for re-assessment in a future assessment cycle.

If the assessment of non-support is based on more than one season of data, the AU will be placed in category 5, truly impaired.

Geometric Mean
Stream, river, reservoir, and lake AUs will be assessed as non-support when the geometric mean for the applicable contact season is exceeded. If one or more geometric mean calculations within the season exceed the criteria the AU will be assessed as non-support.

DELISTING METHODOLOGY:

Individual Samples
Stream, river, reservoir, and lake AUs will be assessed as support when the applicable standard is exceeded in 25 percent or less of samples collected during months within the applicable contact season (as described above). This assessment result will apply for single season and multi-season assessments.

Geometric Mean
Stream, river, reservoir, and lake AUs will be assessed as support when the geometric mean for the applicable contact season is not exceeded. If more than one geometric mean calculation exists, all must not exceed the criteria.

Table 11: Statewide bacteria assessment criteria.

	Escherichia coli	STANDARD	SUPPORT	NON-SUPPORT
PRIMARY CONTACT	ERW, ESW, and NSW Waters Lakes, Reservoirs	GM 126 col/100 mL*	≤ standard	> standard
		298 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
	All other waters	410 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
SECONDARY CONTACT	ERW, ESW, and NSW Waters Lakes, Reservoirs	GM 630 col/100 mL*	≤ standard	> standard
		1490 col/100 mL (anytime)	≤ 25% exceedance	>25% exceedance
	All other waters	2050 col/100 mL (anytime)	≤ 25% exceedance	>25% exceedance
FECAL COLIFORM		**STANDARD**	**SUPPORT**	**NON-SUPPORT**
PRIMARY CONTACT All Waters including ERW, ESW, NSW, Lakes, and Reservoirs		GM 200 col/100 mL*	≤ standard	> standard
		400 col/100 mL (May-Sept)	≤ 25% exceedance	>25% exceedance
SECONDARY CONTACT All Waters including ERW, ESW, NSW, Lakes, and Reservoirs		GM 1000 col/100 mL*	≤ standard	> standard
		2000 col/100 mL (anytime)	≤ 25% exceedance	>25% exceedance

ERW: Extraordinary Resource Water, **NSW**: Natural and Scenic Waterway, **ESW**: Ecologically Sensitive Water
*Geometric mean can be calculated for any 30-day period within a season (primary season May 1 through September 30; secondary season October 1 through April 30).

6.7 Toxic Substances

This section establishes the protocol for assessing attainment of toxic substances criteria within Arkansas's surface waters, per APC&EC Reg. 2.508:

> *Toxic substances shall not be present in receiving waters, after mixing, in such quantities as to be toxic to human, animal, plant or aquatic life or to interfere with the normal propagation, growth and survival of the indigenous aquatic biota. Acute toxicity standards apply outside the zone of initial dilution. Within the zone of initial dilution acute toxicity standards may be exceeded but acute toxicity may not occur. Chronic toxicity and chronic numeric toxicity standards apply at, or beyond, the edge of the mixing zone. Permitting of all toxic substances shall be in accordance with the toxic implementation strategy found in the State of Arkansas Continuing Planning Process. For non-permit issues and as a guideline for evaluating toxic substances not listed in the following tables, the Department may consider No Observed Effect Concentrations or other literature values as appropriate. For the substances listed below, the following standards shall apply:*

ALL WATERBODIES - AQUATIC LIFE CRITERIA

Substance	***Acute Values (µg/L)***	***Chronic Values (µg/L)*** **(24-hr Average)**
PCBs		*0.0140*
Aldrin	*3.0*	
Dieldrin	*2.5*	*0.0019*
DDT (& metabolites)	*1.1*	*0.0010*
*Endrin**	*0.18*	*0.0023*
Toxaphene	*0.73*	*0.0002*
Chlordane	*2.4*	*0.0043*
*Endosulfan**	*0.22*	*0.056*
Heptachlor	*0.52*	*0.0038*
*Hexachlorocyclohexane**	*2.0*	*0.080*
Pentachlorophenol	$e^{[1.005(pH)-4.869]}$	$e^{[1.005(pH)-5.134]}$
Chlorpyrifos	*0.083*	*0.041*

** Total of all isomers*

*DISSOLVED METALS**

Acute Criteria (CMC) - µg/L(ppb)			*Chronic Criteria (CCC) - µg/L(ppb)*	
Substance	***Formula***	***X Conversion***	***Formula***	***X Conversion***
Cadmium	$e^{[1.128(ln hardness)]-3.828}$	*(a)*	$e^{[0.7852(ln hardness)]-3.490}$	*(c)*
Chromium(III)	$e^{[0.819(ln hardness)]+3.688}$	*0.316*	$e^{[0.8190(ln hardness)]+1.561}$	*0.860*
Chromium (VI)	*16*	*0.982*	*11*	*0.962*
Copper	$e^{[0..9422(ln hardness)]-1.464}$	*0.960*	$e^{[0.8545(ln hardness)]-1.465}$	*0.960*
Lead	$e^{[1.273(ln hardness)]-1.460}$	*(b)*	$e^{[1.273(ln hardness)]-4.705}$	*(b)*
Mercury	*2.4*	*0.85*	*0.012***	*NONE*
Nickel	$e^{[0.8460(ln hardness)]+3.3612}$	*0.998*	$e^{[0.8460(ln hardness)]+1.1645}$	*0.997*
*Selenium***	*20*	*NONE*	*5*	*NONE*
Silver	$e^{[1.72(ln hardness)]-6.52}$	*0.85*	-------------	*NONE*
Zinc	$e^{[0.8473(ln hardness)]+0.8604}$	*0.978*	$e^{[0.8473(ln hardness)]+0.7614}$	*0.986*
*Cyanide***	*22.36*	*NONE*	*5.2*	*NONE*

**These values may be adjusted by a site specific Water Effects Ratio (WER) as defined in 40 CFR Part 131.36 (c).*

(a) Calculated as: 1.136672 - [(ln hardness)(0.041838)]
(b) Calculated as: 1.46203 - [(ln hardness)(0.145712)]
(c) Calculated as: 1.101672 - [(ln hardness)(0.041838)]

***Expressed as total recoverable. Mercury based on bioaccumulation of residues in aquatic organisms, rather than toxicity.*

ALL WATERBODIES - HUMAN HEALTH CRITERIA

Substance	***Criteria (ng/L)****
Dioxin (2,3,7,8 TCDD)	*0.001*
Chlordane	*5.0*
PCBs (polychlorinated biphenyls)	*0.4*
alpha Hexachlorocyclohexane	*37.3*
Beryllium	*4000***
Dieldrin	*1.2*
Toxaphene	*6.3*

** Criteria based on a lifetime risk factor of* 10^{-5}.

***4000 ng/l is also represented as 4.0 ug/l, which is the Maximum contaminant level (MCL) under the EPA Safe Drinking Water Act [40 U.S.C. s/s 300f et seq. (1974)]*

The permittee shall have the option to develop site-specific numerical standards for toxic substances using United States Environmental Protection Agency approved bioassay methodology and guidance. Such guidance may include but may not be limited to Water Quality Standards Handbook; Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses *(August, 1994);* Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms *(EPA 600/4-90/027F. 5th ed. December 2002);* Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms *(EPA/600/4-91/002. 4th ed. October 2002) or most recent update thereof.*

Only ambient water quality data for dissolved metals generated or approved by ADEQ after March 1, 1993 will be considered in the documentation of background concentrations for the purpose of developing permit limitations.

PHASE II DATA QUALITY REQUIREMENTS FOR TOXICS

Only discrete data will be used to make attainment decisions regarding toxicity. Concurrent instream hardness data must accompany metals data for metals toxicity attainment decisions.

1. Data temporal requirements:
   - Assessments can be made with discrete samples taken throughout the calendar year or period of record. There is no designated "season" for toxics.
2. Data distribution and quantity requirements:
   - Ten (10) samples are required to make toxic criteria attainment decisions; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
   - Data must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter); unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR TOXIC SUBSTANCES

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Metals toxicity will be evaluated based on instream hardness values at the time of sample collection. If the ambient hardness value is less than 25 mg/L, then a hardness value of 25 mg/L will be used to calculate metals toxicity.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as non-support when more than one (>1) exceedance of the criterion, per APC&EC Reg. 2.508, occurs during the period of record, even if the minimum of ten (10) samples has not been reached.

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as support when there are one or fewer (≤ 1) exceedances of the criterion, per APC&EC Reg. 2.508, during the period of record. A minimum of ten (10) samples must be reached to make an assessment of attainment.

6.8 Fish Consumption

This section establishes the protocol for determining attainment of fish consumption within Arkansas's surface waters.

ASSESSMENT METHODOLOGY FOR FISH CONSUMPTION

Fish consumption listings are based on fish consumption advisories issued by the Epidemiology Branch at Arkansas Department of Health.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be listed as non-support for fish consumption if a primary segment of the fish community (e.g., all predators or all largemouth bass) has restrictions for any group of people (e.g., general population or high risk groups).

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be listed as support if there are no fish consumption restrictions or only a *limited consumption* of fish is recommended (e.g., no more than 2 meals per month or no consumption of fish over 15 inches).

6.9 Nutrients

This section establishes the protocol for determining attainment of nutrients within Arkansas's surface water, per APC&EC Reg. 2.509:

(A) Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the waterbody. Impairment of a waterbody from excess nutrients is dependent on the natural waterbody characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use of waterbody, season of the year and ecoregion water chemistry. Because nutrient water column concentrations do not always correlate directly with stream impairments, impairments will be assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure and possibly others. However, when excess nutrients result in an impairment, based upon Department assessment methodology, by any Arkansas established numeric water quality standard, the waterbody will be determined to be impaired by nutrients.

(B) Site Specific Nutrient Standards

Lake	*Chlorophyll a (ug/L)***	*Secchi Transparency (m)****
*Beaver Lake**	*8*	*1.1*

**These standards are for measurement at the Hickory Creek site over the old thalweg, below the confluence of War Eagle Creek and the White River in Beaver Lake.*

***Growing season geometric mean (May - October)*

****Annual Average*

All point source discharges into the watershed of waters officially listed on Arkansas' impaired waterbody list (303d) with phosphorus as the major cause shall have monthly average discharge permit limits no greater than those listed below. Additionally, waters in nutrient surplus watersheds as determined by Act 1061 of 2003 Regular Session of the Arkansas 84th General Assembly and subsequently designated nutrient surplus watersheds may be included under this Reg. if point source discharges are shown to provide a significant phosphorus contribution to waters within the listed nutrient surplus watersheds.

Facility Design Flow – mgd	Total Phosphorus discharge limit – mg/L
= or > 15	Case by case
3 to <15	1.0
1 to <3	2.0
0.5 to <1.0	5.0
<0.5	Case by Case

For discharges from point sources which are greater than 15 mgd, reduction of phosphorus below 1 mg/L may be required based on the magnitude of the phosphorus load (mass) and the type of downstream waterbodies (e.g., reservoirs, Extraordinary Resource Waters). Additionally, any discharge limits listed above may be further reduced if it is determined that these values are causing impairments to special waters such as domestic water supplies, lakes or reservoirs or Extraordinary Resource Waters.

SCREENING REQUIREMENTS FOR NUTRIENTS

Total Nitrogen (TN) and Total Phosphorus (TP) data will be screened per respective ecoregion using the 75th percentile of TN and TP for the appropriate period of record. Data used in calculation of 75th percentiles must meet the following requirements:

- Discrete Data
    - Ten (10) or more discrete TN and TP samples per monitoring station, and
    - Data are representative of at least three (3) astronomical seasons.

Mean TN and mean TP concentrations for each assessment unit will then be compared to the 75th percentile screening values for the appropriate ecoregion and evaluated according to Figure 3.

PHASE II DATA QUALITY REQUIREMENTS FOR NUTRIENTS

Continuous and biological data requirements must be met for full nutrient assessment. The 75th percentile screening values are calculated from only discrete samples collected during the period of record. Nutrient screenings will be made by calculating the average concentration of each site for the period of record which will be compared to the 75th percentile for that ecoregion. For purposes of nutrient assessment, a "year" is defined as a calendar year.

Phase II Data Quality Requirements for Nutrients (Wadeable Streams/Rivers)

1. Temporal requirements:
    - o
- Short-term Continuous Data
    - Diel dissolved oxygen and pH deployments must be collected within the same critical season (same year) as discrete total nitrogen and total phosphorus samples.
    - Critical season is defined, in Reg. 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
- Long-term Continuous Data
    - Long-term dissolved oxygen and pH data must be collected within the same critical season (same year) as the discrete samples.
    - Critical season is defined, in Reg. 2, as that time of year when water temperatures naturally exceed 22 degrees Celsius for the given AU.
- Biological Communities
    - Fish communities must be collected during the same critical season as the diel dissolved oxygen and pH deployments.
    - Macroinvertebrate communities must be collected during the same year as fish collections, during either fall or spring base flow conditions. Fall macroinvertebrate collections are preferred.

2. Minimum distribution and quantity requirements
- Short-term Continuous Data
    - Two (2) diel deployments of at least 72 hours each with at least hourly readings are required.
    - Diel deployments must be spaced at least two weeks (14 days) apart within the same critical season.

- Long-term Continuous Data
  - Continuous data must cover consecutive months for at least two-thirds of critical season with at least hourly readings.
- Biological Communities
  - One (1) fish community and one (1) macroinvertebrate community data set are required per year.

3. Spatial and other requirements
- Biological Communities
  - Must be collected in representative habitats of the stream segments.
  - Must satisfy biological community sampling protocols.

Phase II Data Quality Requirements for Nutrients (Beaver Lake)

1. Temporal requirements
- Secchi Disk Transparency
  - Secchi disk transparency depths should be collected year round. Beaver Lake Secchi disk readings will be assessed on a calendar year.
- Growing Season Chlorophyll *a* Geometric Mean
  - Chlorophyll *a* should be collected during the growing season.
  - Growing season is defined as May – October per Reg. 2.509(B).

2. Minimum distribution and quantity requirements
- Secchi Disk Transparency
  - Ten (10) discrete samples evenly distributed over twelve (12) calendar months are required per year to calculate an annual average.
- Growing Season Chlorophyll *a* Geometric Mean
  - Five (5) evenly distributed discrete samples are required per growing season to calculate a geometric mean.

3. Spatial requirements
- Secchi Disk Transparency and Growing Season Chlorophyll *a* Geometric Mean
  - All data shall be collected at the Hickory Creek site over the old thalweg, below the confluence of War Eagle Creek and the White River in Beaver Lake.
- Chlorophyll *a* sample depth shall not exceed two (2) meters.
- All other parameter (DO, pH, temperature, etc.; excluding Secchi disk) samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR NUTRIENTS

To date, assessment methodologies for nutrients have only been developed for, and only apply to, wadeable streams (Figure 3) and Beaver Lake. Methodologies for wadeable streams were developed defining “wadeable” as fourth order streams and smaller using Strahler stream order (Strahler 1952). Site verification and best professional judgement was used to ensure safety at each location regarding actual wade-ability.

Nutrient assessment relies on “paired data.” This means that physical, chemical, and biological data must be collected within the same year or season. Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2; however, differing data types (discrete, short-term continuous, and long-term continuous) will not be combined.

Beaver Lake Secchi disk readings and growing season chlorophyll *a* concentrations will be assessed per calendar year. If multiple chlorophyll *a* samples exist on the same day, but at the different depths, the most protective sample at each depth will be used for assessments.

LISTING METHODOLOGY FOR WADEABLE STREAMS:

Wadeable stream and river AUs will be listed as non-support for nutrients when the following conditions occur:

- The mean total phosphorus or total nitrogen concentration of the monitoring segment is greater than the 75th percentile of the total phosphorus or total nitrogen data from wadeable stream and river AUs within an ecoregion, **and**
- When both of the 72-hour data sets indicate at least one of the two water quality translators, as listed in the flow chart, are exceeded, **and**
- One or both biological communities, as listed in the flow chart, are evaluated as impaired.

Water quality translators are dissolved oxygen and pH. Two separate, 72-hour data sets within the same critical season (when water temperatures are greater than 22°C) are required for evaluation.

The dissolved oxygen translator is a 10% exceedance of the water quality criteria as described in Section 6.4. The pH translator is considered to be exceeded when pH varies from the standard of between 6.0 and 9.0 standard units and assessment is described in Section 6.3.

Any wadeable stream or river segment that exceeds screening level criteria, but lacks adequate data to assess will be placed into Category 3b. Insufficient Data. Category 3 streams will be prioritized based on the magnitude of nutrient concentration, available data, and staff resources.

DELISTING METHODOLOGY FOR WADEABLE STREAMS:

Wadeable stream and river AUs will be listed as support for nutrients if there are fewer than two (<2) exceedances of nutrient translators for each 72-hour data set and biological communities are fully supported.

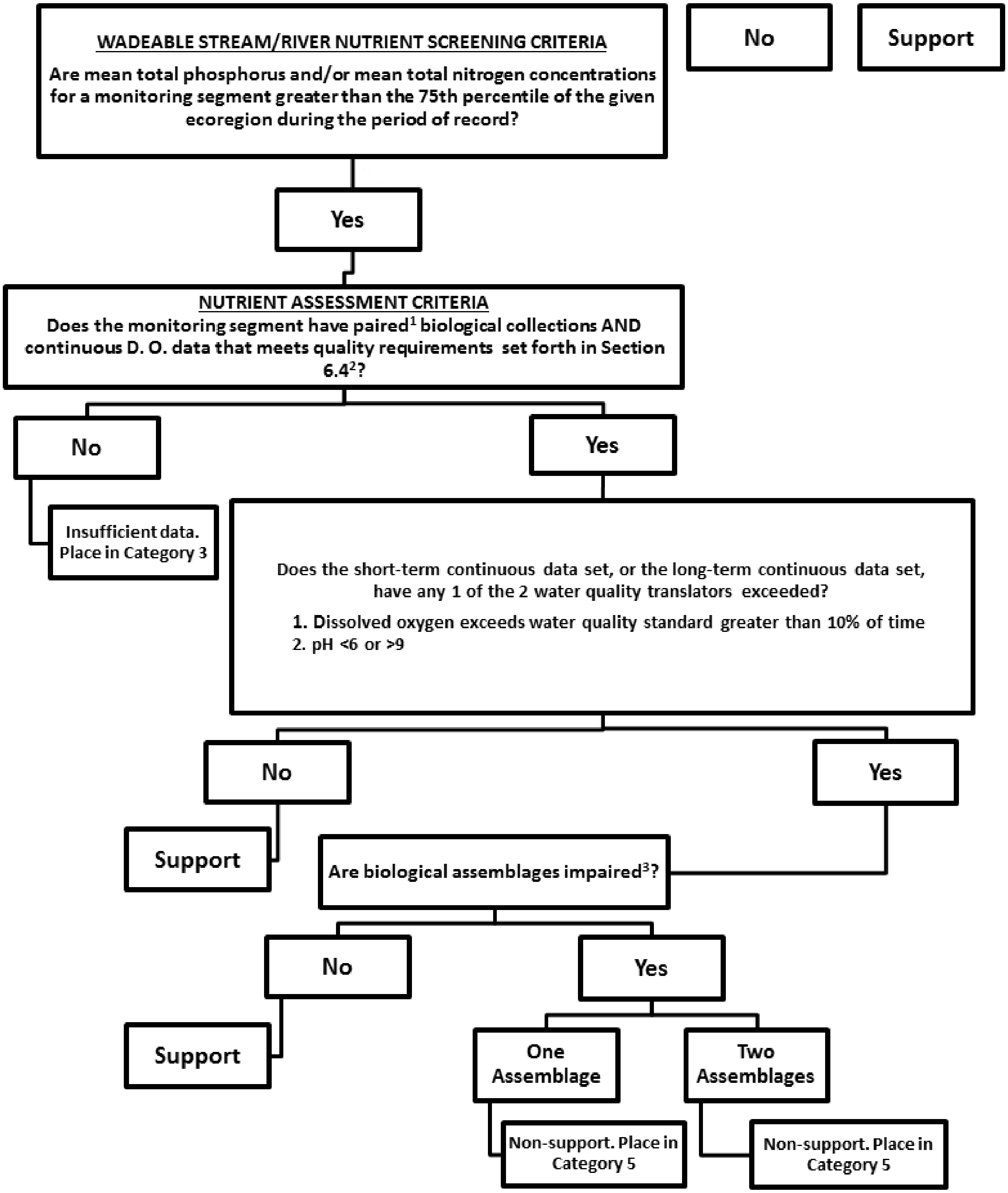
LISTING METHODOLOGY FOR BEAVER LAKE:

The Hickory Creek AU of Beaver Lake will be listed as non-support of its domestic water supply designated use when there are three or more (≥3) geometric mean exceedances of the chlorophyll *a* criteria within the five-year period of record.

The Hickory Creek AU of Beaver Lake will be listed as non-support of its domestic water supply designated use when there are three or more (≥3) annual average exceedances of the secchi transparency criteria within the five-year period of record.

DELISTING METHODOLOGY FOR BEAVER LAKE:

The Hickory Creek AU of Beaver Lake will be listed as supporting its domestic water supply designated use when there are no more than two (2) geometric mean exceedances of the chlorophyll *a* criteria *and* no more than two (2) annual averages exceedances of the secchi transparency criteria within the five-year period of record.



[1] Paired data/collections are defined as combined physical, chemical, and biological collections within the same calendar year and/or season.
[2] D. O. data must be continuous, either long-term or short-term.
[3] Section 5.0 discusses the determining factors for biological impairment.

Figure 3: Nutrient assessment flowchart for wadeable streams and rivers.

6.10 Site Specific Mineral Quality

This section establishes the protocol for determining attainment of site specific mineral criteria within Arkansas's waters, per APC&EC Reg. 2.511 (A):

> *(A) Site Specific Mineral Quality Criteria*
>
> *Mineral quality shall not be altered by municipal, industrial, other waste discharges or instream activities so as to interfere with designated uses. The following criteria apply to the streams indicated.*

PHASE II DATA QUALITY REQUIREMENTS FOR MINERALS

Only discrete data will be used to make assessments for minerals. All Phase II considerations apply to waters with site specific minerals criteria Reg. 2.511(A)).

1. Data temporal requirements
   - Discrete data should be collected year round.
2. Minimum data distribution and quantity requirements
   - Ten (10) discrete samples are required to make minerals attainment decisions.
   - Discrete samples must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter).

ASSESSMENT METHODOLOGY FOR SITE SPECIFIC MINERAL QUALITY

Waters with site specific mineral criteria are assessed according to site specific values for chlorides, sulfates, and/or TDS listed in APC&EC Reg. 2.511(A). Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Binomial distribution method will be applied to site specific mineral data, per Section 3.7.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs with site specific mineral criteria will be assessed as non-support when, using the twenty-five percent exceedance rate within Table 2, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable site specific mineral criteria listed in APC&EC Reg. 2.511(A).

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs with site specific mineral criteria will be assessed as support when, using the twenty-five percent exceedance rate within Table 3, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable site specific mineral criteria listed in APC&EC Reg. 2.511(A).

6.11 Non-Site Specific Mineral Quality; and Domestic, Agricultural, and Industrial Water Supply Uses

This section establishes the protocol for determining attainment of non-site specific mineral quality criteria and domestic water supply designated uses within Arkansas's surface waters, per APC&EC Reg. 2.511(C):

> *(C) Domestic Water Supply Criteria*
>
> *In no case shall discharges cause concentrations in any waterbody to exceed 250, 250 and 500 mg/L of chlorides, sulfates and total dissolved solids, respectively, or cause concentrations to exceed the applicable criteria, except in accordance with Regs. 2.306 and 2.308.*

This section is written in accordance with the Federal Safe Drinking Water Act (40 § C.F.R 143.3) and also establishes the protocol for assessing impairment due to exceedance of limits for agricultural and industrial water supplies.

PHASE II DATA QUALITY REQUIREMENTS FOR NON-SITE SPECIFIC MINERAL QUALITY; AND DOMESTIC, AGRICULTURAL, AND INDUSTRIAL WATER SUPPLY USES

Minerals data (chloride, sulfates, TDS) will be used to assess non-site specific minerals quality as well as Domestic, Agricultural, and Industrial Water Supply Uses. Only discrete data will be used.

1. Data temporal requirements
   - Discrete data should be collected year round.
2. Minimum data distribution and quantity requirements
   - Ten (10) discrete samples are required to make minerals attainment decisions.
   - Discrete samples must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter).
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR NON-SITE SPECIFIC MINERALS QUALITY; AND DOMESTIC, AGRICULTURAL, AND INDUSTRIAL WATER SUPPLY USE

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Binomial distribution method will be applied to non-site specific mineral data, as per Section 3.7.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as non-support when, using the ten percent exceedance rate within Table 2, greater than or equal to the minimum number of samples for the entire qualifying data set exceed the applicable mineral standards listed in APC&EC Reg. 2.511(C).

DELISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be assessed as support when, using the ten percent exceedance rate within Table 3, no more than the maximum number of samples allowed for the entire qualifying data set exceed the applicable mineral standards listed in APC&EC Reg. 2.511(C).

6.12 Ammonia

This section establishes the protocol for determining attainment of ammonia criteria in Arkansas's surface waters, per APC&EC Reg. 2.512:

The total ammonia nitrogen (N) criteria and the frequency of occurrence are as follows:

(A)The one-hour average concentration of total ammonia nitrogen shall not exceed, more than once every three years on the average, the acute criterion as shown in the following table:

pH-Dependent Values of the CMC (Acute Criterion)- mg/L

pH	*Salmonids* Present*	*Salmonids Absent*
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

** Family of fishes, which includes trout.*

(B) The monthly average concentration of total ammonia nitrogen shall not exceed those values shown as the chronic criterion in the following tables:

Temperature and pH-Dependent Values of the CCC (Chronic Criterion)
for Fish Early Life Stages Present – mg/L

	Temperature °C									
pH	**0**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

Temperature and pH-Dependent Values of the CCC (Chronic Criterion) for Fish Early Life Stages Absent – mg/L

	Temperature °C									
pH	***0-7***	***8***	***9***	***10***	***11***	***12***	***13***	***14***	***15****	***16****
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46	6.06
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36	5.97
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25	5.86
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.641	0.601
8.9	0.917	0.860	0.806	0.756	0.709	0.664	0.623	0.584	0.548	0.513
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471	0.442

**At 15^o C and above, the criterion for fish Early Life Stage absent is the same as the criterion for fish Early Life Stage present.*

(C) The highest four-day average within a 30-day period should not exceed 2.5 times the chronic values shown above.

(D) For permitted discharges, the daily maximum or seven-day average permit limit shall be calculated using the four-day average value described above as an instream value, after mixing and based on a season when fish early life stages are present and a season when fish early life stages are absent. Temperature values used will be 14^o C when fish early life stages are absent and the ecoregion temperature standard for the season when fish early life stages are present. The pH values will be the ecoregion mean value from least-disturbed stream data.

PHASE II DATA QUALITY REQUIREMENTS FOR AMMONIA:

Only discrete data will be used for ammonia assessments. Total ammonia nitrogen discrete samples must be paired with concurrently measured *in situ* pH and temperature data, as applicable.

Acute Criterion – Reg. 2.512(A)

1. Data temporal requirements
   - Discrete data should be collected year round.
2. Minimum data distribution and quantity requirements
   - Ten (10) discrete samples are required to make attainment decisions for ammonia; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
   - Discrete samples must be evenly distributed over at least two (2) years and three (3) seasons; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
3. Spatial requirements
   - Samples can be taken anywhere within the water column for lakes and reservoirs.

Chronic Criterion – Reg. 2.512(B) Fish Early Life Stage Present

1. Data temporal requirements
   - Assessments can be made with discrete samples collected when early life stage fishes are present. The actual months will vary for specific waterbodies.
2. Minimum data distribution and quantity requirements
   - Ten (10) discrete samples are required to make attainment decisions for ammonia; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
   - Data must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter); unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

Chronic Criterion – Reg. 2.512(C) Fish Early Life Stage Absent

1. Data temporal requirements
   - Assessments can be made with discrete samples collected when early life stage fish are absent. The actual months will vary for specific waterbodies.
2. Minimum data distribution and quantity requirements
   - Ten (10) discrete samples are required to make attainment decisions for ammonia; unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
   - Data must be evenly distributed over at least two (2) years and three (3) astronomical seasons (spring, summer, fall, winter); unless an assessment of non-attainment can be reached in fewer than ten (10) samples.
3. Spatial requirements
   - For lakes and reservoirs, samples are to be taken within the epilimnion (if present). Sample depth shall not exceed two (2) meters.

ASSESSMENT METHODOLOGY FOR AMMONIA:

Like data sets (e.g. discrete and discrete) from various sources may be combined into an aggregate data set as per Section 3.3.2. Total ammonia nitrogen will be evaluated based on concurrently measured instream pH and temperature, as applicable, at the time of sample collection using APC&EC Reg. 2.512(A)–(C) standards. The Chronic Criterion for fish early life stages present (Reg. 2.512(B)) apply when early life stage fishes are present in rivers and streams, or within the epilimnion of lakes and reservoirs. The criterion shall be applied as 1) the arithmetic mean of the analytical results of consecutive-day samples when available, or 2) the result of individual grab samples. In the event there is only one sample per month, that sample will serve as the "monthly average" for purposes of ammonia assessment.

LISTING METHODOLOGY:

Stream, river, reservoir, and lake AUs will be listed as non-support for ammonia toxicity if any one of the following standards are violated:

For Reg. 2.512(A) Acute Criterion - If more than one (>1) violation of the 1-hour average concentration of total ammonia nitrogen exceeds the calculated acute criterion within the period of record, even if the minimum of ten (10) samples has not been reached.

For Reg. 2.512(B) Chronic Criterion Fish Early Life Stage Present - If the monthly average concentration of total ammonia nitrogen exceeds the chronic criterion, even if the minimum of ten (10) samples has not been reached.

For Reg. 2.512(C) Chronic Criterion Fish Early Life Stage Absent - If the highest 4-day average within a 30-day period exceeds 2.5 times the chronic criterion, even if the minimum of ten (10) samples has not been reached.

DELISTING METHODOLOGY:

An AU can only be delisted by the same criterion that was used to list it. For example, if an AU was listed using the Reg. 2.512(A) acute criterion, it can only be delisted using the Reg. 2.512(A) acute criterion delisting methodology. Stream and river AUs, as well as lakes and reservoirs, will be listed as support for ammonia toxicity standards:

For Reg. 2.512(A) Acute Criterion - If no more than one violation of the 1-hour average concentration of total ammonia nitrogen exceeds the calculated acute criterion within the period of record. A minimum of ten (10) samples must be reached to make an assessment of attainment.

For Reg. 2.512(B) Chronic Criterion Fish Early Life Stage Present - If the monthly average concentration of total ammonia nitrogen does not exceed the chronic criterion. A minimum of ten (10) samples must be reached to make an assessment of attainment.

For Reg. 2.512(C) Chronic Criterion Fish Early Life Stage Absent - If the highest 4-day average within a 30-day period does not exceed 2.5 times the chronic criterion. A minimum of ten (10) samples must be reached to make an assessment of attainment.

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APPENDIX C CATEGORY 4B RATIONALE BUFFALO RIVER WATERSHED

Buffalo River Watershed 4b Plan for Pathogens and Dissolved Oxygen

1. Statement of the problem causing the impairment.

Two parameters were assessed as not attaining water quality criteria within the Buffalo River watershed—pathogens (*Escherichia coli (E. coli)*) and dissolved oxygen (DO).

1a. Pathogens

- AR_11010003_010 (Buffalo River) Use: Primary Contact - *E.coli*
- AR_11010003_011 (Buffalo River) Use: Primary Contact - *E.coli*
- AR_11010003_022 (Big Creek) Use: Primary Contact - *E.coli*

Concentration of *E. coli* in the stream segments listed above exceeded the water quality criteria. The percent exceedance rate of the data indicated that the segments were not supporting the primary contact designated use.

Sources and causes for elevated pathogen levels in Big Creek and the Buffalo River have not been specifically identified. In addition, because of the karst nature of the surrounding geology, it is unknown at this time if the conduit is subsurface and/or surface flows. Potential sources include manure application (hog and chicken), leaking septic tanks, tourism, and wildlife. Future surveys using Phylo-chip technology are planned for the watershed to help identify the sources.

1b. Dissolved Oxygen

- AR_11010003_020 (Big Creek)

The causes of the low DO in Big Creek have not been identified. Fluctuations in DO concentrations can be caused by chemical, physical and/or natural environmental processes. One such cause is the natural diurnal fluctuations in response to respiration and photosynthesis (Wetzel 2001). Other causes could be the physical habitat composition of the water body, bedrock or any other smooth streambed surface, and the chemical oxygen demand of water quality constituents found in the water.

2. Description of proposed implementation strategy and supporting pollution controls necessary to achieve water quality criteria, including the identification of point and nonpoint source loadings that when implemented assure the attainment of all applicable water quality standards.

In August 2016, Arkansas Governor Asa Hutchinson formed the Beautiful Buffalo River Action Committee (BBRAC) to establish an Arkansas-led approach to identify and address potential issues of concern in the Buffalo River watershed. BBRAC comprises the Arkansas Department of Environmental and Environment, Division of Environmental Quality (DEQ), Arkansas Department of Agriculture-Natural Resource Commission (NRC), Arkansas Game and Fish Commission, Arkansas Department of Transformation and Shared Services-Arkansas Geographic Information Systems, Arkansas Department of Health, and Arkansas Department of Parks, Heritage and Tourism. One of the most significant charges for BBRAC to date was to develop a non-regulatory management plan for the watershed. On January 15, 2018 the NRC finalized the Buffalo River Watershed Management Plan (WMP). It was accepted by EPA in June, 2018. The WMP outlines voluntary measures that may help to reduce nonpoint source runoff and makes recommendations for water quality monitoring and studies within the watershed. Stakeholders and BBRAC partners are necessary for successful strategy and milestone development. DEQ and BBRAC are committed to revising the strategy as necessary to work towards achieving attainment of water-quality standards for the Buffalo River.

The WMP contemplates implementing best management practices (BMPs) only after sources of pathogen, particularly *E.coli*, have been identified. This would allow for more effective BMPs to be used and a more efficient use of resources.

Non-point source controls:

- Animal manure application, rate, magnitude, location and conditions for application are controlled under a permit.
- Septic tank system state and federal aid
- All other sources currently have no regulatory controls.
- The WMP (Table 7.4) identifies numerous practices that may reduce storm-water runoff and thus typical water quality constituents.
- Unknown – Influence of karst. Controls on the surface, such as stream buffers, may be ineffective if the primary path is infiltration.

In September 2019, Arkansas Governor Asa Hutchinson formed the Buffalo River Conservation Committee (BRCC). BRCC is the next step in the process that began in 2016 with the Beautiful Buffalo River Action Committee (BBRAC), and members of the committee will utilize the Buffalo River Watershed Management Plan (WMP) to prioritize and fund projects in the most critical areas of the watershed. BRCC comprises the following Cabinet Secretaries or their designates: Wes Ward, Secretary of Agriculture – Chair, Becky Keogh, Secretary of Energy and Environment, Stacy Hurst, Secretary of Parks, Heritage, and Tourism, and Dr. Nathaniel Smith, Secretary of Health. $1 million in state general revenue funds and $1 million matched private funds will be allocated for conservation and water quality grants within the Buffalo River Watershed.

3. An estimate or projection of the time when water quality standards will be attained.

Pathogen criteria attainment in Big Creek is contingent upon source and cause identification and subsequent implementation of BMPs designed to address those sources and causes at the appropriate spatial and temporal scales.

Dissolved oxygen criteria attainment in Big Creek is contingent upon source and cause identification and subsequent implementation of BMPs designed to address those sources and causes at the appropriate spatial and temporal scales.

4. Reasonable schedule for implementing the necessary pollution controls.

Table ES.3 of the WMP provides a proposed schedule for implementation of the plan. The table includes clear milestones, dates, and responsible parties. Activities include monitoring, investigated studies, education and outreach, planning, additional management strategies, evaluation of the milestones, and a schedule to update the WMP as needed.

5. Description of, and schedule for, monitoring milestones for tracking and reporting progress to EPA on the implementation of the pollution controls.

Section 7.8 of the WMP discusses the evaluation schedule for meeting the milestones toward the implementation of pollution controls. It includes a well-defined structure identifying the responsible parties monitoring, the type of activities that will occur, and the indicators that will be used to determine the success of the program.

6. Commitment to revise, as necessary, the implementation strategy and corresponding pollution controls if progress towards meeting water quality standards is not attained.

Table ES.3 of the WMP specifies that the plan would be updated as needed starting in 2023 (or sooner). Section 7.9 of the WMP outlines the information that will be addressed or considered during the review of the plan.

Evaluation components of alternative restoration approaches would be very similar to those provided in Table ES.3 of the Buffalo River WMP. A key element that will be included is implementation tracking of BMPs in the Buffalo River watershed from 2018-2028. Indicators of this element would be measured through the linear feet/acres of BMPs implemented. The WMP also includes a proposed revision date of 2024-2025 utilizing data collected from the previous seven years. The WMP is intended to be a living document that reflects stakeholder interest and concerns related to the protection of the Buffalo River watershed.

Literature Cited

FTN Associates, Ltd. May 22, 2018. Buffalo River Watershed-Based Management Plan. FTN Associates, Ltd. 3 Innwood Circle Suite 220. Little Rock, AR. 72211. FTN No. R03015-005-031.

Wetzel, Robert G. 2001. Limnology, Lake and River Ecosystems. Third Edition. Academic Press. 525 B Street, Suite 1900, San Diego, California, 92101-4495.

APPENDIX D CATEGORY 4B RATIONALE COVE CREEK WATERSHED

In a letter dated November 6, 2018, Halliburton Energy Services, Inc. Project Manager, James McGinty presented DEQ with the following Category 4b rationale:

In response to DEQ's October 18, 2018 email request for additional site Category 4b qualification details, Halliburton Energy Services, Inc. (HESI) is providing the following references to further support the Dresser Industries-Magcobar former mine site ("DIM" Site) request to change the related stream segments in the draft 2018 303(d) from Category 5 to Category 4b.

The following stream segments associated with the former DIM mine site are listed in the Division of Environmental Quality (AEQ) draft 2018 303(d) listing:

- Cove Creek (AR_08040102_970) for pH, zinc and toxicity.
- Chamberlain Creek (AR_08040102_971) for dissolved oxygen, sulfate, TDS, copper, zinc, aluminum, beryllium, and toxicity.
- Lucinda Creek (AR_08040102_975) for pH.

HESI and DEQ have developed and initiated detailed corrective action plans for improving these 303(d) listed streams. As requested by DEQ, HESl has further detailed below the appropriate references to site improvement project documents that satisfy the six conditions for qualifying for the Category 4b designation.

1. Identification of segment and statement of problem causing the impairment.

Stream segment information for each reach is provided above. The cause for impairment is the same for all reaches listed. Halliburton, in cooperation with EPA and DEQ, performed an extensive site investigation for the site and receiving streams. The April 19, 2007 DIM Mine Site, Site Investigation (SI) Report identifies the stream segments and problems leading to the 303(d) listing of these stream segments. A complete version of the DIM SI report can be found on the Arkansas Pollution Control and Ecology Commission (APC&EC) in Docket 16-003-R at the following link: https://www.adeq.state.ar.us/regs/drafts/3rdParty/reg02/16-003-R/.

HESl is providing the following DIM Former Mine Site Environmental Improvement (EIP) Project Notice of Intent (NOI), Appendix A, SI Report references that identify the stream segments and statement of problems causing the impairment:

All Creeks

- SI, Executive Summary (pages ES-1 through ESC-10) gives an overview of the site conditions that are causing the stream segment water quality impairment. In general, the production of Acid Rock Drainage (ARD) and its subsequent migration to the streams resulting in elevated dissolved minerals, low pH and increased metals' mobility describes the stream reach impairment.

- SI, Sections 6.2 and 6.3 explains the persistence and migration of potential contaminants at the DIM site and how these contaminants are derived from naturally occurring geologic materials present prior to mining or other human activities in the area. The current environmental conditions have occurred because disturbance to the site from former mining activities accelerated weathering and ARD generation. Dissolved minerals and metals are leached from the site to surface waters related to the Site at concentrations above background levels.

- SI, Section 5.4.2.1 Cove Creek identifies the water quality impairments (metals, sulfates and TDS). Chamberlain Creek water flowing into Cove Creek is causing this impairment in Cove Creek.

Chamberlain Creek

- SI, Section 5.4.2.2 Chamberlain Creek identifies the water quality impairments. Chamberlain Creek flows directly from the DIM site Southwest Spoil Area. The DIM Former Mine Site stormwater run-off and shallow groundwater which contain ARD negatively affect Chamberlain Creek.

- SI, Section 2.1.1 Land Use In The Site Vicinity describes other mining operations and exploratory prospects that may also contribute contaminants to the listed streams (specifically the Christy Mine on Chamberlain Creek).

Lucinda Creek

- SI, Section 5.4.2.4 Lucinda and Rusher Creeks describes the impacts from ARD in these creeks. Rusher Creek flows into Lucinda Creek below Lucinda Lake.

2. Description of pollution controls and how they will achieve water quality standards.

The DEQ required pollution controls and site improvements to be implemented at the DIM former mining site per CAO LIS 16-043 (2016) are specifically described in the Remedial Action Decision Document (RADD) (ADEQ. 2016. RADD, DIM Former Mine Site). These pollution controls will, in combination, achieve applicable water quality standards for the reaches of Cove, Chamberlain, and Lucinda Creek noted above. A complete version of the RADD report can be found on the APC&EC website in Docket 16-003-R at the following link: https://www.adeq.state.ar.us/regs/drafts/3rdParty/reg02/16-003-R/.

Appendix C of the DIM Former Mine Site EIP NOI includes the RADD, which identifies pollution controls and how HESI will achieve water quality standards as follows:

- RADD, Section 9.0 Justification for Selections of Remedial Alternatives explains that the following pollution control combination would meet the Remedial Action Levels (RADD, Section 8.1) in off-site streams, would reduce identified risks to acceptable levels and is implementable at a reasonable cost. Thus, this Selected Remedial Alternative Combination (SRAC) provides overall protection of human health and the environment and high levels of short-term and long-term effectiveness. This SRAC will also promote the reduction of toxicity by reducing mobility of Site contaminants. The SRAC for the DIM Former Mine Site includes:

  - Pit Lake -PL2 modified -Operate Existing WTS, Maintain Pit Lake Water Level with temporary water quality standards for minerals as part of the EIP process;
  - SpoilPile-SP2-SelectiveRegrading,AugmentVegetation,andARDCapture;
  - Shallow Groundwater System -SGW3 -Expanded ARD Capture/Treatment System;
  - Bedrock Groundwater -BOW2 -Verify Connection to Municipal Water System;
  - SludgePonds-SLU2-SoilCover,Revegetate;
  - Chamberlain Creek -CHM2 -Source Control;
  - Tailings Impoundments -TI2 -Regrade, Stabilize Dams, Revegetate;
  - Affected Streams -AS2 -Source Control; and
  - Clearwater Lake -CWL2 -Source Control.

- RADD, Section 10 -Selected Remedy/Site Plan and Implementation Schedule are set forth in this section of the RADD. Pollution controls primarily consist of actions to prevent contact of precipitation with former spoils and/or collection and treatment of low pH water that remains affected by contact with disturbed areas of the site.

3. An estimate or projection of the time when WQS will be met.

A detailed schedule of the remedial actions detailed herein is included in Table 10 of the RADD (2016) and Section 7 of the DEQ approved EIP NOI. The project schedules reflect a long-term approach for compliance with remedial goals including Arkansas water quality standards at the site. Current versions of the DEQ DIM site RADD and EIP NOI reports can be found on the APC&EC website in Docket 16-003-R at the following link: https://www.adeq.state.ar.us/regs/drafts/3rdParty/reg02/16-003-R/.

Table 10 EIP NOI/RADD Implementation Schedule*

Schedule	**Activity**
Within 3 months of CAO effective date	Verification report for connection status of residents submitted to DEQ.
Within 9 months of CAO effective date	Draft remedial design for sludge ponds submitted to DEQ for review and approval.
Within 12 months of CAO effective date	Identified, unconnected residents connected to public water system if authorization is given.
Within 13 months of CAO effective date	Final remedial design for sludge ponds submitted to DEQ.
Within 18 months of CAO effective date	Remediation of sludge ponds completed.
Within 2 months of EIP approval	Draft EMP submitted to DEQ for review and approval.
Within 4 months of receipt of DEQ comments on draft EMP	Final EMP submitted to DEQ.
Within 6 months of DEQ approval of final EMP	Draft RDP submitted to DEQ for review and approval.
Within 4 months of receipt of DEQ comments on draft RDP	Final RDP submitted to DEQ.
Within 6 months of DEQ approval of final RDP	Draft RAIWP submitted to DEQ for review and approval.
Within 6 months of receipt of DEQ comments on draft RAIWP	Final RAIWP submitted to DEQ.
Within 48 months of DEQ approval of final RAIWP	Remediation construction activities completed.
Within 160 months of EIP approval**	Post-project water quality standards become effective.

*This schedule IS tentative and IS dependent on the effective date of the CAO or EIP (as noted). The schedule IS contingent on construction occurring during the summer months. The schedule also assumes that DEQ comments will be received within 2 months of each submittal.

**Basis for the total time frame is included in the EIP NOI.

4. Schedule for implementing pollution controls. See item 3 above.

5. Monitoring plan to track effectiveness of pollution controls.

The Effectiveness Monitoring Plan (EMP) (FTN Associates, Ltd. 2017. DIM Former Mine Site, EMP) addresses tracking of effectiveness of pollution controls at the DIM site. HESI and DEQ are is the process of finalizing the EMP and working through some of the DEQ comments relating to groundwater assessment (i.e. not surface water or waters related to 303(d) listing segments found above). The EMP is expected to be finalized in 2018 and implemented according to the project schedule and will satisfy the requirement that a monitoring plan track the effectiveness of pollution controls in the three waterbodies noted above.

6. Commitment to revise pollution controls, as necessary.

The DEQ RADD addresses monitoring and progress towards achieving site goals as well as evaluations of remedial alternatives as necessary during the RADD implementation. The DEQ DIM site RADD report Section 11 states:

> *"If compliance or progress toward compliance, to include obtaining the necessary access agreements and/or institutional controls, is not demonstrated, the RADD may be modified so that additional remedial alternatives can be considered, evaluated, and implemented in a reasonable timeframe."*

Additionally, the DIM CAO LIS 16-043 (2016) Section 20, page 10 explains that DEQ has the right to revise the RADD during the implementation of the RADD. Consequently, a mechanism exists to revise the pollution controls for the three waterbodies noted above if necessary.

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APPENDIX E CATEGORY 5-ALT RATIONALE BEAVER LAKE PATHOGENS, TURBIDITY, AND pH

Beaver Lake 5-Alt Plan for Turbidity, Pathogens, pH

1. **Assessment Units (AUs) in 5-alt, associated water quality criteria not in attainment, and identification of possible sources contributing to non-attainment**

    1. Beaver Lake - White River Arm previously part of area known as Beaver Lake upper (AR_11010001_4040) Turbidity and Pathogens
    2. Beaver Lake - War Eagle Arm previously part of area known as Beaver Lake upper (AR_11010001_4041) pH (> 9.0 standard units (s.u.)), Turbidity and Pathogens
    3. Beaver Lake at Hickory Creek - previously part of area known as Beaver Lake upper (AR_11010001_4042) Turbidity and Pathogens

<u>Turbidity</u>

The upper portion of Beaver Lake, that portion of the lake from near the community of Hickory Creek to the upstream portion in the White River and War Eagle Creek arms, has been listed as not attaining the turbidity criteria for many years. The source of the turbidity is identified as surface erosion. The May 2012 Revision of the Beaver Lake Watershed Protection Strategy (WPS) lists the following water quality threats and possible sources of sediment (turbidity): hydrologic modification resulting from land use change due to urbanization, runoff from new development, construction site runoff, streambank erosion, loss of stream buffers, inadequate pasture best management practices (BMPs), and unpaved roads.

<u>pH</u>

During the 2018 period of record used for the development of the list of impaired waterbodies, April 2012 through March 2017, at AR_11010001_4041, five (5) out of twenty-seven (27) pH samples were above 9.0 s.u., therefore the AU was listed as not-attaining the pH water quality criteria. It should be noted that these five (5) samples ranged from 9.1 to 9.2 s.u and were taken in May and July of 2012 and July of 2013 within the upper portion of the epilimnion. Beaver Watershed District's (BWD) 2013 report on lake water quality (Avery 2014) near the BWD intake structure notes that "In the months from June through September pH was above 8.0 s.u. near the surface."

2. **Analysis to support why the State believes the implementation of the alternative restoration approach is expected to achieve attainment of water quality criteria.**

The WPS has been in place prior to 2012 and is currently implemented with the support of the Beaver Watershed Alliance (BWA). https://www.beaverwatershedalliance.org/

BWA is an active steward group that "… works to proactively protect, enhance, and sustain the high water quality of Beaver Lake and its tributaries through voluntary BMP implementation, outreach and education, and scientific evaluation." According to BWA's website they had eight (8) activities from January 2019 thru April 2019, including trash pickup events, tree planting, rain garden installations, stewardship, Arkansas Native Seed Program, and a Forest and Wildfire Management Workshop. They also have other programs available, newsletters, and seventeen (17) educational brochures available for download.

3. **Action Plan**
   a. **Actions to address all sources**
   b. **Schedule of actions designed to meet WQS with**
      i. **Milestones**
      ii. **Dates**
      iii. **Interim milestones**
      iv. **Deliverables**

BWA is the primary entity for implementing the Beaver Lake WPS.

https://www.beaverwatershedalliance.org/strategy/watershed-protection-strategy.aspx

The WPS outlines five (5) components: Beaver Lake Watershed Council, Core BMPs, Developer and Contractor Lake Protection Certification Program, Education and Stewardship Program, and Monitoring and Adaptive Management. Refer to Section 4.2 and Table 5-1 for additional details.

Table 5-2 under Adaptive Management "Beaver Lake Watershed Protection Strategy Implementation Timeline: Assuming five-year Adaptive Management cycle beginning January 2012 or at hiring of Council Executive Director." outlines milestones for the WPS's five (5) components. The table also outlines a proposed implementation timeline for the WPS's.

4. **Identify funding to implement**

From 2011 to 2018, the total for all monetary grant awards to the BWA since the Beaver Lake WPS has been put in place is $1,751,225.

BWA has received funding for three (3) Section 319 non-point source projects in the Beaver Lake Watershed, totaling $922,194 which has $695,396 of associated match.

BWA has a contract to deliver watershed protection services to the Beaver Water District that has had a total value of $1,268,745.

Additionally, BWA receives contributions from local business, cities, counties and other water providers that have added more than $290,000 to the investment in watershed protection services.

Though BWD does not directly administer funds, the watershed benefits tremendously from the USDA NRCS Regional Conservation Partnership Program, which has brought $8.4 million ($4 million hard dollars) for stream restoration and watershed protection in the West Fork White River Watershed.

Table 5-1 under Adaptive Management provides potential funding sources, including but not limited to: tax credits, Conservation Reserve Program, Conservation Reserve Enhancement Program, Environmental Quality Incentives Program, Arkansas Stream Team, 319 Grants, land trusts, fees, and legislative appropriations.

5. **Identify all parties committed or needed to take actions that are expected to result in the attainment of water quality criteria**

Table 5-1 under Adaptive Management identifies the following responsible groups needed to implement the WPS: Beaver Watershed Alliance, County Farm Service agencies, NRCS, local governments, local water suppliers, AGFC, Arkansas Forestry Commission, Land Trusts, MS4s, DEQ, UA- Fayetteville Extension Service, US Army COE, Beaver Lake Watershed Council, Northwest Arkansas Council, UA- Fayetteville, Homebuilders Association, Illinois River Watershed Partnership, Ozark Water Watch, Kings River Watershed Partnership, conservation groups, landowners, and USGS.

6. **Estimate of time when water quality criteria are expected to be attained**

"Table 4-1 of the WPS list the estimated total reduction in sediment load, 23,450 tons/year that will be necessary to attain the turbidity water quality criterion. It is estimated that this goal will be attained by 2055.

7. **Plans for monitoring that:**
    a. **Demonstrate progress made toward achieving WQS following implementation**
    b. **Identify needed improvement for adaptive management as the project progresses**
    c. **Evaluate the success of actions and outcome**

Current sampling includes:

- DEQ currently collects quarterly samples in Beaver Lake and test for sixty-seven (67) water quality parameters at two (2) monitoring stations. One (1) monitoring station is sampled within the epilimnion. The other monitoring station is sampled within the epilimnion, metalimnion, and hypolimnion.

- BWD currently collects monthly samples on nine (9) Beaver Lake tributary sites and test for twenty-four (24) water quality parameters. All monitoring stations are sampled within the epilimnion.
- The annual Beaver Lake Secchi Day held in August is organized by the BWD. This event provides lake water transparency data as well as chlorophyll-a, total phosphorus, and total nitrogen. It is both a monitoring tool and community engagement event.
- In 2012, StreamSmart, a voluntary citizen science based monitoring program, was launched to increase the extent and frequency of water quality monitoring in the Beaver Lake Watershed. The StreamSmart program was developed by the Beaver Water District, Audubon Arkansas, and the Arkansas Water Resources Center (AWRC).

8. Commitment to periodically evaluate the alternative restoration approach to determine if it is on track to be more immediately beneficial or practicable in achieving WQS than pursuing a total maximum daily load (TMDL) in the near-term, and if the impaired water should be assigned as a higher priority for TMDL development.

Beaver Watershed Alliance states “The Beaver Watershed Alliance has adopted the document for revision and periodic updates with input from the original Policy and Technical Advisory Group organizations. The Protection Strategy will remain “evergreen” in that new and important issues, water quality data, and emerging pollutants will be addressed on a repeating cycle and in a timely manner.” (Beaver Watershed Alliance, 2019)

It should also be noted that the current May 2012 WPS is an update for the 2009 version. Dependent on funding, BWA aims to begin revision of the WPS in 2020 and have a final revised WPS by 2021.

Water quality in Beaver Lake is routinely monitored as part of the DEQ’s Ambient Water Quality Monitoring Network. Every two years the data are compiled and evaluated for water quality criteria attainment. This assessment will be used to determine if the alternative restoration approach is making progress toward addressing the water quality impairments.

Literature Cited

Avery, Ray. March 29, 2014. Beaver Lake and its Tributaries: 2013 Source Water Quality Report. Beaver Water District.

Beaver Watershed Alliance, 2012. Beaver Lake Watershed Protection Strategy, May 2012 Revision. Beaver Watershed Alliance. P.O. Box 319, Goshen AR. 72735.

Beaver Watershed Alliance, Watershed Protection Strategy. Accessed September 24, 2019). (https://www.beaverwatershedalliance.org/strategy/watershed-protection-strategy.aspx)

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APPENDIX F CATEGORY 5-ALT RATIONALE ILLINOIS RIVER WATERSHED PATHOGENS

Illinois River Watershed 5-Alt Plan for Pathogens

1. **Assessment Units (AUs) in 5-alt and identification of sources contributing to impairment per AU**

    1. Moores Creek (AR_11110103_026)
    2. Muddy Fork Illinois River (AR_11110103_025), (AR_11110103_027)
    3. Illinois River (AR_1110103_023) (AR_11110103_024), (AR_11110103_028)
    4. Little Osage Creek (AR_11110103_630), (AR_11110103_933)

    The 2012 EPA accepted Upper Illinois River Watershed Based Plan (WBP) lists possible sources of pathogens from urban contributions as failing septic systems, wildlife, illicit discharges, agriculture, urban runoff, and others. The possible agricultural pathogen sources identified were manure/litter application runoff, livestock access to streams, poultry litter storage, and animal feeding operations (FTN 2012).

2. **Analysis to support why the State believes the implementation of the alternative restoration approach is expected to achieve water quality standards (WQS).**

    An alternative restoration strategy is well-suited for the Illinois River Watershed because pathogen impairment sources are primarily from non-point source contributions. The WBP reports that rural land use in the pathogen-impaired stream reaches ranged from 58% forested with 34% pasture to 11% forested and 70% pasture. Discharges from point sources are regulated through the National Pollution Discharge Elimination System. Any corrective actions that may be needed will occur under the direction of this program.

    The Memorandum of Agreement (MOA) signed in November 2018 between the states of Arkansas and Oklahoma also supports the development and use of alternative restoration measures. The MOA outlines the formation of a Watershed Improvement Plan (WIP), which will include and update 319 projects, and a WIP Advisory Group. The WIP will identify possible water-quality improvement strategies for point and nonpoint sources outlined in each states watershed based management plans.

3. **Action Plan**
    a. **Actions to address all sources**
    b. **Schedule of actions designed to meet WQS with**

i. **Milestones**
ii. **Dates**
iii. **Interim milestones**
iv. **Deliverables**

The WBP includes a description of measurable milestones for education and outreach, best management practice implementation, and water quality monitoring. Since the completion and implementation of the WBP, many of the milestones and deliverables have been achieved. However, much work is still needed to bring the Illinois River and its tributaries into attainment for pathogens.

4. Identify funding sources to implement the Plan

To date, almost forty million dollars ($40,000,000) have been invested in nonpoint source controls in the Illinois River watershed through USDA and EPA programs. Over an eleven (11) year period (2000-2011), a total of fifty-eight (58) Section 319 non-point source projects were funded in the Illinois River watershed.

An informal survey of the mayors of Fayetteville, Springdale, Rogers, Bentonville and Siloam Springs was conducted to get an idea of the amount of capital investment that has occurred since 2000 to reduce the phosphorus loadings from the discharges of the wastewater treatment facilities. As a conservative amount, more than $225 million ($225,000,000) has been invested in the last two decades. This figure does not include any of the investments made for infrastructure improvements.

On September 10, 2018 the Arkansas Natural Resource Commission (ANRC) and the Illinois River Watershed Partnership (IRWP) announced a new agreement to improve water quality in the Illinois River. IRWP received a $1.4 million grant to assist landowners with implementing best management practices in the watershed. The Walton Foundation provided the necessary matching funds for the project. The goal will be to protect or restore twenty (20) miles of riparian area.

Additional potential funding sources include, but are not limited to: tax credits, Conservation Reserve Program, Conservation Reserve Enhancement Program, Environmental Quality Incentives Program, Arkansas Stream Team, 319 Grants, land trusts, fees, private entities, and legislative appropriations.

5. Identify potential partners to implement to Plan

Table 7.6 of the 2012 Upper Illinois River Watershed Based Management Plan identifies twenty-five (25) potential partners that may share common goals within the watershed. Potential partners include non-government organizations, city, state, and federal agencies, academia, and industries.

6. Estimate of time when WQS will be met

Implementation of effective nonpoint source best management practices (BMP) to address this issue is strictly on a voluntary basis. However, implementation of the BMPs could lead to timely attainment of the primary contact recreation designated use in the Illinois River watershed.

7. Plans for monitoring that:
   - **a. Demonstrate progress made toward achieving WQS following implementation**
   - **b. Identify needed improvement for adaptive management as the project progresses**
   - **c. Evaluate the success of actions and outcome**

In preparation of the draft 2018 303(d) list, data from thirty-six (36) water quality monitoring stations was used to assess seventeen (17) AUs, approximately 122 river miles, within the Illinois River watershed. A portion of those stations are operated by DEQ as part of the Ambient Water Quality Monitoring Network. Additional information was from stations operated by the Oklahoma Conservation Commission. Water quality samples collected on a monthly basis are analyzed for numerous water quality constituents including turbidity. It is widely accepted in scientific literature that storm water runoff mobilizes both pathogens and sediment, and there is a strong relationship between turbidity levels and pathogen concentrations (Irvine, et al. 2002). Therefore, decreasing the turbidity in the streams should result in the reduction of pathogens as well.

8. Commitment to periodically evaluate the alternative restoration approach to determine if it is on track to be more immediately beneficial or practicable in achieving WQS than pursuing a TMDL in the near-term, and if the impaired water should be assigned a higher priority for TMDL development.

Water quality in the Illinois River basin is routinely monitored as part of the DEQ Ambient Water Quality Monitoring Network. Every two years the data is compiled and evaluated for water quality criteria attainment. This assessment, and other readily available information, will aid in determining if the alternative restoration approach is making progress toward addressing the water quality issues.

The states of Arkansas and Oklahoma, through a Memorandum of Agreement (MOA) signed in November 2018, agreed to establish a Monitoring and Assessment Workgroup (MAW) and to develop a Watershed Improvement Plan (WIP) (Arkansas and Oklahoma, 2018).

A Technical Advisory Committee, a subcommittee of the MAW, was established and began meeting in early 2019. Their focus is to develop a monitoring and assessment program to ascertain progress toward meeting the total phosphorus criterion. Delegates from Arkansas and Oklahoma have convened on several occasions since January 2019. The determination of base flow, sampling methodologies, data quality objective and other factors are being developed.

The MOA outlines the formation of a Watershed Improvement Plan (WIP), which will include and update 319 projects, and a WIP Advisory Group. The WIP will identify possible water-quality improvement strategies for point and nonpoint sources outlined in each states watershed based management plans.

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Irvine, K. N., E.L. Somogye, and G.W. Pettibone. Turbidity, Suspended Solids, and Bacteria Relationships, in the Buffalo River Watershed. Department of Geography/Planning Department of Biology State University College at Buffalo 1300 Elmwood Ave. Buffalo, NY 14222