KANSAS INTEGRATED WATER QUALITY ASSESSMENT 2010

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EXECUTIVE SUMMARY

This report, the Kansas Integrated Water Quality Assessment (2010), was prepared by the Kansas Department of Health and Environment (KDHE) in response to water quality reporting requirements contained in sections 303(d), 305(b), and 314(a) of the federal Clean Water Act (CWA). Section 303(d) calls for the development of a list of waterbodies currently failing to meet established water quality standards, whereas sections 305(b) and 314(a) require information concerning the overall status of the state's surface waters and the programs responsible for water quality monitoring and pollution abatement.

The Kansas 2010 list of impaired waters (*i.e.,* 303(d) list) was included as an appendix to this report and posted, in its entirety, at http://www.kdheks.gov/tmdl/methodology.htm. This list was based primarily on data collected by the KDHE stream chemistry, stream biological, and lake and wetland monitoring programs and secondarily on information obtained from outside sources. Watersheds containing stream chemistry and/or stream biological monitoring stations represented the assessment units for flowing waters. Monitored lakes and wetlands represented the assessment units for standing waterbodies. In all, 537 water quality impairments were identified by KDHE and assigned a high priority for Total Maximum Daily Load (TMDL) development. The 303(d) list also identified waterbodies previously given a high priority but subsequently assigned to other prioritization categories.

Requirements related to section 305(b) were addressed, in large part, using data obtained through a stream monitoring program implemented in 2006. This program employed a probabilistic survey design to estimate the stream mileage failing to support the uses recognized in section 101(a) of the CWA (aquatic life support, food procurement, and recreation). The program's targeted sampling population included all classified streams that contained water during the summer low-flow periods of 2006–2008. Owing primarily to the occurrence of a severe drought that extended into 2006, only about 69% of the state's classified stream mileage was represented in the sampling population.

Monitoring data obtained during this reporting cycle indicated that 29% (19–39%) of the state's designated stream mileage fully supported all section 101(a) uses, whereas 71% (61–81%) was impaired for one or more uses (parenthetical values represent 95% confidence intervals). Aquatic life support, contact recreation, and food procurement uses were supported, respectively, in 40% (± 6%), 84% (± 5%), and 87% (± 9%) of the stream miles designated for these uses. Major causes of non-support for streams, in order of prevalence, were nutrient enrichment, sedimentation, weather-related impacts, and elevated levels of fecal bacteria. Sources primarily responsible for pollutant loadings and/or use impairments included agriculture (irrigated and non-irrigated crop production, livestock grazing and feeding operations, unrestricted cattle access), natural phenomena (weather-related impacts), and physical habitat degradation.

Additional section 305(b) and 314(a) reporting requirements were addressed using data from the department's lake and wetland monitoring program. This program surveyed 352 publicly owned and/or publicly accessible waterbodies (316 lakes and 36 wetlands) during the six-year reporting

period, 2004–2009. Physicochemical data obtained from the surveys were compared to established water quality standards to characterize the prevailing level of use support. Long-term trends in the trophic status of lakes and wetlands were analyzed using biological data collected from 1985 through 2009. These data were compared to an existing set of diagnostic thresholds used to interpret narrative water quality criteria for trophic state, nutrient enrichment, and water-column turbidity.

Approximately 9% of the assessed lake acreage fully supported all designated uses, whereas 91% was impaired for one or more designated uses. Sixteen percent of assessed wetland acreage either fully supported all uses or lacked sufficient data to evaluate conditions; the remaining 84% was impaired for one or more designated uses. Major causes of impairment in lakes and wetlands included nutrient enrichment, siltation, elevated turbidity levels, taste and odor problems, and zebra mussel (*Dreissena polymorpha*) infestations. Agriculture, municipal point sources, natural (*e.g.*, weather-related) phenomena, and non-native species introductions were the primary sources of these impairments. Approximately 69% of the assessed lake acreage exhibited no recent change in trophic condition, 25% experienced a measurable increase in trophic state, and 4% exhibited some improvement in trophic condition.

Sampling activities during 2006 coincided with one of the worst droughts on record for Kansas. From 2000 to 2006, annual average flows in many streams were lower than the flows reported during all previously recorded droughts. In 2007, major floods in southeastern Kansas scoured many rivers and creeks and produced sustained high stream flows for much of the summer. The combined effects of these dramatic weather-related events contributed to many of the water quality impairments documented during 2006 and 2007.

The renovation of many wastewater treatment facilities across the state has produced noticeable improvements in surface water quality. As point sources contributing to water quality impairments continue to decline, attention will shift increasingly to nonpoint sources. It is anticipated that watershed pollution control efforts, predicated largely on the development and implementation of TMDLs, will play an increasingly important role in the abatement of nonpoint source pollution in Kansas.

PART A: INTRODUCTION

Purpose

This document fulfills specific water quality reporting requirements placed on the State of Kansas by sections 303(d), 305(b), and 314(a) of the federal CWA. Sections 305(b) and 314(a) require a summary of the status of the state's surface waters, whereas section 303(d) calls for the development of a list of waterbodies currently failing to meet established water quality standards. Such waterbodies are regarded collectively as "impaired waters." Kansas is required under the CWA to take actions that improve the condition of impaired waters. These actions may include the development and implementation of TMDLs, water quality-based permit requirements, and/or nonpoint source (NPS) pollution control measures. This report presents an integrated response to the requirements of sections 303(d), 305(b), and 314(a). As such, it contains information relevant to upcoming water quality planning, monitoring, permitting, and pollution abatement initiatives in the state.

General Assessment Approach

KDHE administers several programs that collectively satisfy the environmental monitoring and reporting requirements of the CWA (KDHE, 2005b). These programs also provide the technical data needed to respond to existing and emerging water pollution problems. Departmental monitoring operations currently focus on the condition of the state's surface waters (rather than groundwater) and involve two different but complementary conceptual approaches. The first involves a targeted survey design that focuses on selected stream reaches, lakes, and wetlands. The second approach involves a probabilistic survey design that assesses randomly chosen stream reaches and extrapolates the monitoring results to the entire population of classified streams in the state. Targeted monitoring operations accommodate the development and refinement of the Kansas 303(d) list, whereas both targeted and probabilistic data are needed to meet section 305(b) and 314(a) reporting requirements.

Within KDHE, activities related to sections 305(b) and 314(a) of the CWA are performed by the Bureau of Environmental Field Services (BEFS), whereas work related to section 303(d) is performed by the Bureau of Water (BOW). Portions of this report addressing sections 305(b) and 314(a) characterize the overall condition of the state's streams, lakes, and wetlands and report on the prevalence of bioaccumulative contaminants in fish. They also describe the major monitoring networks and regulatory programs involved in the tracking, management, and abatement of surface water pollution. The 303(d) analysis differs from the 305(b) and 314(a) assessments in terms of statistical approach and monitoring period of interest. Moreover, under the provisions of the CWA, the appended 303(d) list has been subjected to public review/comment and now awaits the approval of the U.S. Environmental Protection Agency (EPA).

Organization of Report

The remainder of this report is divided into several major parts. Part B contains background information on surface water resources within the state, describes the governmental programs primarily responsible for improving water quality, considers the overall costs and benefits of

water pollution control, and summarizes several important water quality issues facing Kansas. Part C discusses the various water quality monitoring programs administered by KDHE, the diagnostic criteria and statistical methods employed in the 303(d) and 305(b) analyses, and the major findings stemming from these analyses. Part D summarizes the current status of groundwater quality monitoring efforts in Kansas. Finally, Part E describes the measures taken by KDHE to comply with the public participation provisions of the CWA, as related to the development of the 303(d) list. Technical appendices to this report provide additional information on KDHE's water quality monitoring programs and the results of the most recent 303(d), 305(b), and 314(a) assessments. Specifically, Appendix A identifies the individual water chemistry parameters considered in the 2010 305(b) assessment, Appendix B presents the most recently completed 303(d) list for Kansas, and Appendix C addresses the overall condition of the state's lakes and reservoirs, as required by section 314(a) of the CWA.

PART B: BACKGROUND

Total Waters

Table 1. Kansas atlas

Topic	Value
State population*	2,802,134
State surface area in square miles*	81,815
Number of major river basins	12
Total classified stream miles**	27,774
Number of classified lakes/reservoirs/ponds	316
Acres of classified lakes/reservoirs/ponds	191,103
Acres of classified freshwater wetlands	55,969

* Estimate for 2008, U.S. Census Bureau

** Based on Kansas surface water register, February 12, 2009 (derived from National Hydrography Dataset (NHD), 1:100,000 scale)

Water Pollution Control Program

Point Source Pollution Control

The Kansas point source program was initiated in 1907 (K.S.A. 65-161 *et seq*.) and continues to be modified and expanded in response to ongoing amendments to the CWA. The federal regulations implementing this law are found in Title 40 of the Code of Federal Regulations. Federal water pollution control programs are designed to protect the navigable waters of the United States, whereas the Kansas water pollution control program is designed to protect all surface water and groundwater resources in the state by controlling discharges from municipal, federal, commercial, and industrial wastewater treatment facilities (WWTFs) and large concentrated animal feeding operations (CAFOs).

In addition to regulating the wastewaters generated by these entities, the Kansas and federal programs have expanded recently into the area of stormwater pollution control. KDHE issues general permits for the control of stormwater runoff from construction and industrial sites, larger cities, and urbanized counties. Industrial facilities with individual permits are required to develop and implement stormwater pollution control plans as part of their individual permit requirements.

KDHE is authorized to administer federal and state laws governing the treatment, re-use, and discharge of wastewaters in Kansas. Specifically, the department is responsible for the development and periodic review of water pollution control permits, the approval of engineering plans and specifications for WWTFs and sewage collection systems, the development of stormwater best management practices or BMPs, the establishment of pretreatment requirements for facilities in non-pretreatment program cities, and the performance of treatment plant compliance reviews. The department also oversees the development and management of operator training and certification programs in Kansas. Non-overflowing WWTFs are regulated through the Kansas Water Pollution Control permitting system (K.S.A. 65-165). National Pollutant Discharge Elimination System (NPDES) permits are required for all discharging WWTFs and large CAFOs (Table 2). Wastewaters generated by these treatment facilities/operations are subject to technological effluent limitations, effluent guideline limits, and the Kansas surface water quality standards. Individual permits normally are issued for a period of five years, and all are reviewed by KDHE prior to re-issuance. The state's WWTF permit compliance record for the past two years is summarized in Table 3.

Table 2. Number of active KWPC and NPDES permits*

Number of Permitted Facilities					
Municipal and Commercial		**Industrial/Federal**		**Agricultural**	
Total Municipal and Commercial KWPC (non-overflowing)	412	Total Industrial/Federal KWPC (non-overflowing)	73	Agricultural NPDES	447
Discharging Lagoons	364	Total Industrial (discharging)	539	Agricultural State	1,337
Mechanical Treatment Facilities	138	Pretreatment	57	Agricultural Certification	1,616
Municipal Stormwater	58				
TOTAL	972		669		3,400

KWPC = Kansas Water Pollution Control
NPDES = National Pollutant Discharge Elimination System
* as of January 1, 2010

Table 3. Permit compliance record (absolute compliance* for discharging WWTFs)

Year	TYPE OF FACILITY	
	Municipal and Commercial	**Industrial and Federal**
2008	91%	97%
2009	91%	96%
Total Number	502	539

WWTF = wastewater treatment facility

*Absolute compliance means that a facility reported on all parameters specified in its NPDES permit and met all permit limits for the monitoring period (based on records submitted by facility).

Nonpoint Source Pollution Control

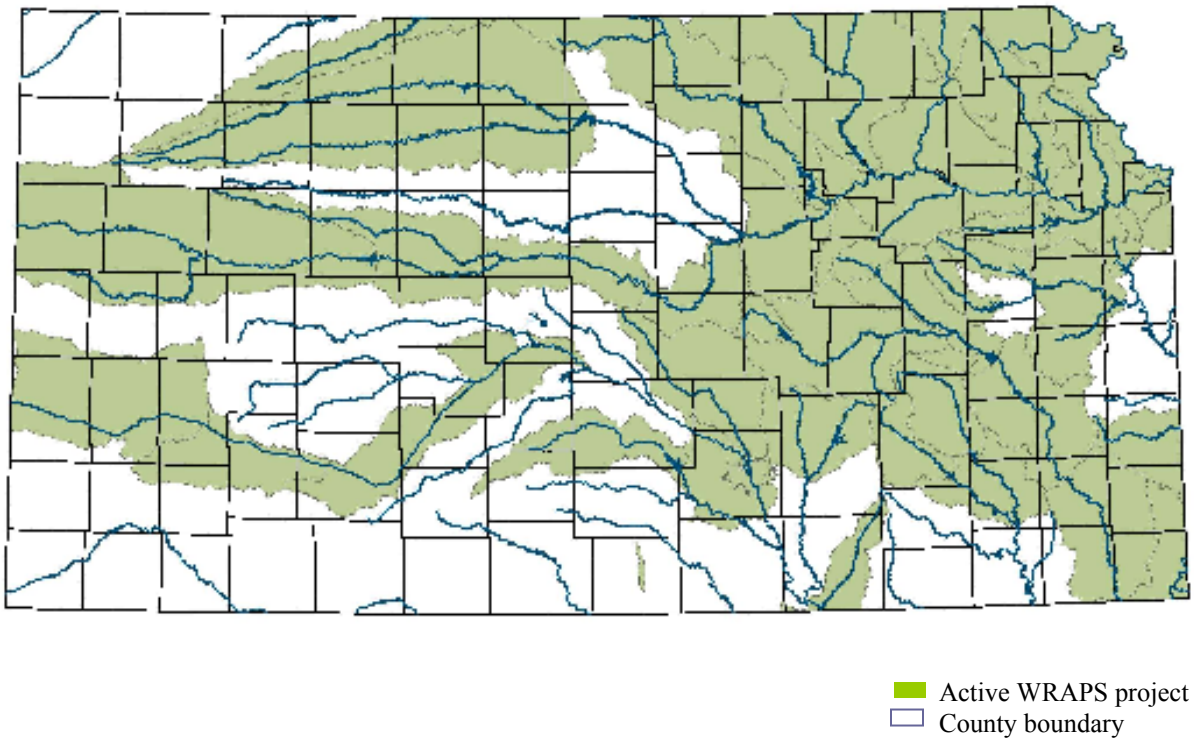
Watershed Restoration and Protection Strategy

Kansas has implemented a voluntary watershed-based program for controlling NPS pollution. Known as the Watershed Restoration and Protection Strategy (WRAPS), this program is unique because the natural resource agencies of Kansas, with support from EPA, aggressively seek citizen and stakeholder input and participation on watershed management and protection issues. This approach involves:

- Identifying watershed protection and restoration needs
- Establishing watershed protection and restoration goals
- Developing plans to achieve established goals
- Implementing fully developed plans

Watershed plans already implemented under WRAPS collectively serve and protect 55% of the state's total land surface. This includes most watersheds draining into large federal reservoirs (Figure 1). Annual investments in WRAPS total approximately $2.8 million (M). Of this amount, about $0.5 M is derived from State Water Plan funds, $1.2 M from CWA section 319 funds, and $1.1 M from local funding sources.

Figure 1. 2009 Kansas WRAPS Projects



Source Water Protection Program

Of the 1,045 public water supply systems in Kansas, 127 currently benefit from adopted wellhead protection plans or NPS watershed projects (Table 4). Source water protection plans have been completed and approved for 100 groundwater-based public water supply systems, and 73 of these plans have been formally adopted by the participating communities. Currently, 54 public water supply systems relying on surface water sources (streams and/or reservoirs) directly benefit from NPS watershed projects (Figure 2).

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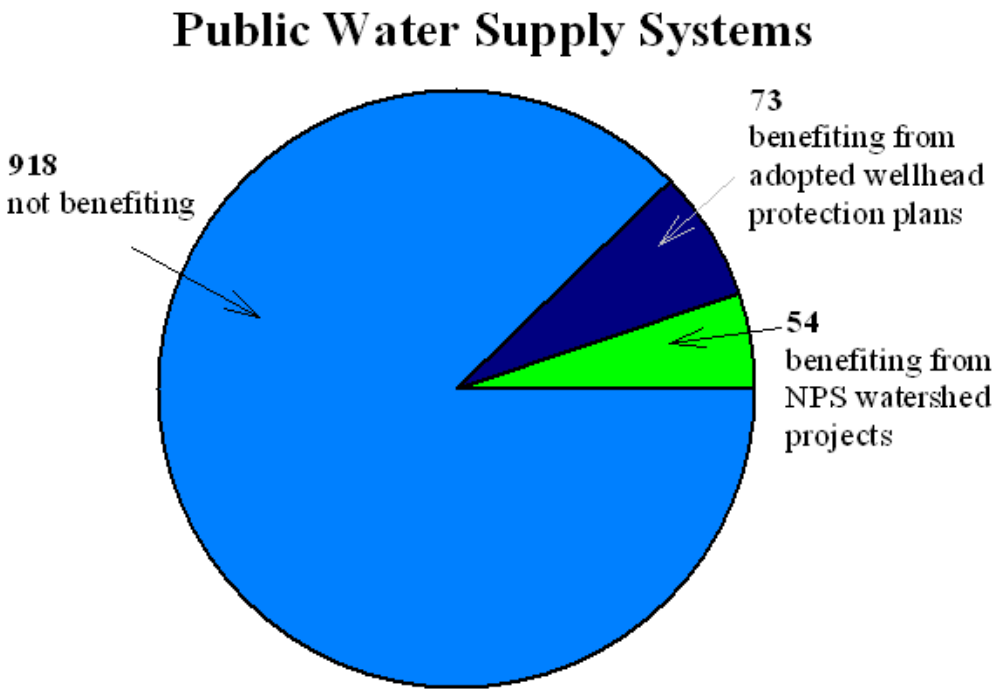
Table 4. Public water supply systems benefiting from wellhead protection plans and NPS watershed projects

Wellhead Protection Plans			Nonpoint Source Watershed Projects	
Number		Population Served	Number	Population Served
Registered	115	10,626	54	923,664
Approved	100	9,076		
Adopted	73	14,826		

Figure 2. Proportion/Number of Water Supply Systems Benefiting from NPS Watershed Projects and Wellhead Protection Plans



Local Environmental Protection Program

The Local Environmental Protection Program (LEPP) is administered by KDHE and funded by the Kansas Water Office (KWO) under the auspices of the State Water Plan. This program provides financial assistance to local governmental units developing and implementing environmental protection plans on behalf of their respective jurisdictions. All such plans include a sanitary code and address subdivision drinking water and wastewater treatment, solid and hazardous waste disposal, public water supply protection, and NPS pollution abatement. Currently, 103 of the 105 counties in Kansas participate in this program (Table 5).

Table 5. Summary of local environmental code actions through 2009

Status	Number
Adopted and Being Administered	103
Approved for Adoption	0
Under Development	1
No Action	1

Costs and Benefits of Water Pollution Control

The direct and indirect costs of water pollution control can be measured, or at least estimated, with some degree of confidence. In contrast, environmental benefits stemming from pollution control are less amenable to expression in monetary terms. Section 101(a) of the CWA establishes national water quality objectives and interim goals reflecting the belief that the costs of water pollution control are outweighed by the ecological and societal benefits of clean water. The following paragraph (and accompanying tables) address some of the major costs associated with water pollution control efforts in Kansas.

Pollution control expenditures in the state are associated predominantly with administrative expenses, capital investments, and operational costs for WWTFs. Although little information is available regarding the control costs borne by industrial and agricultural facilities, capital expenditures associated with the construction and upgrading of municipal WWTFs have been documented carefully by KDHE. For example, the department administers the Kansas Water Pollution Control Revolving Fund (KWPCRF), which provides low interest loans to municipalities for water pollution control projects. Available monies are maximized through the sale of "leveraged revenue bonds." During the past twenty years, these bonds have provided $891 M for facility improvements in Kansas. KDHE also coordinates the Community Development Block Grant (CDBG) program on behalf of the state. This program typically covers about 50% of the costs of a water pollution control project. During 2008 and 2009, KWPCRF, CDBG, and other state and federal programs provided about $132 M in financial aid to communities in Kansas (Table 6). NPS pollution abatement measures received much less funding (Table 7), relying instead on the predominantly voluntary measures discussed previously.

Table 6. KDHE cooperative funding for construction and expansion of municipal wastewater treatment facilities (monetary values in millions of dollars)

Funding Year (FY)	KWPCRF*		CDBG**		RD***	TOTAL
	Basic	Leveraged	Federal	Match	Federal	
2008	19.699	34.026	1.600	2.500	12.320	70.145
2009	28.945	19.163	3.295	3.653	7.284	62.340
TOTAL	48.644	53.189	4.895	6.153	19.604	132.485

* KWPCRF = Kansas Water Pollution Control Revolving Fund
** CDBG = Community Development Block Grants
*** RD = Rural Development Grants and Loans

Table 7. Nonpoint source pollution program awards (in dollars)

Award Category	2008	2009
Program Implementation	1,127,272	1,332,289
Abatement Projects	186,140	293,995
WRAPS Projects	2,255,088	1,942,216
Program Total	3,568,500	3,568,500

Major Environmental Concerns and Recommendations

Agricultural concerns. Agriculture exerts a profound influence on surface water quality conditions in Kansas. Erosion of cropland soils produces elevated concentrations of silt in many streams and lakes, often to the detriment of native aquatic and semiaquatic life. The presence of nitrogen- and phosphorus-containing fertilizers in field runoff promotes nuisance growths of algae and detracts from the recreational and drinking water supply uses of surface water. Stormwater runoff from feedlots, livestock wintering areas, and heavily grazed pastures introduces fecal pathogens and oxygen consuming organic wastes into nearby lakes and streams, sometimes compromising the sanitary condition of these waters. Pesticide residues in some drinking water supply lakes pose potential long-term risks to human health.

Efforts to alleviate the impacts of agriculture on the aquatic environment have focused primarily on the abatement of soil erosion and proper management of chemical fertilizers, biocides, and livestock wastes. Although the wider adoption of agricultural BMPs should lead to measurable reductions in stream contaminant levels, runoff water quality is not the only agricultural factor limiting the use attainment of surface waters. Throughout much of western Kansas, decades of irrigated crop production have exacted a heavy toll on stream life by lowering groundwater tables, reducing base stream flows, and transforming formerly perennial waterbodies into intermittent or ephemeral systems. In some areas of northeastern Kansas, stream channelization has radically simplified the original aquatic habitats and decimated a formerly diverse fish and shellfish fauna. Impoundments (large and small) throughout the state have encouraged the establishment of predominantly nonnative fish assemblages, fragmented the remaining stream habitats, and diminished the seasonal peak flows required by certain native fishes for spawning and egg development.

The complete restoration of these degraded aquatic ecosystems would require massive habitat rehabilitation efforts and fundamental changes in the laws, policies, and attitudes currently controlling the use and allocation of water in this region. Less effective (but more readily implemented) options for partially offsetting the historical effects of agriculture would include: the enhancement of minimum stream flows through the State-mediated purchase and retirement of senior water rights; the expansion of hatchery restocking programs for native fish and shellfish; the selective removal of lowhead dams and other barriers to fish migration; the installation of fish ladders and elevators on larger dams; and other related management initiatives – all in addition to concurrent improvements in agricultural practices. Most of these

concepts are not new. For example, the importance of maintaining migrational corridors for fish was emphasized repeatedly by Kansas officials during the late nineteenth century but never seriously considered in the course of water resource development (reviewed by Angelo *et al*., 2003).

Municipal and industrial concerns. Discharging WWTFs and other point sources also influence surface water quality throughout much of Kansas. Releases of inorganic nitrogen and phosphorus from some facilities promote blooms of filamentous or scum-forming algae in downstream waters and detract from their capacity to support primary and secondary contact recreation. Bypasses of raw or partially treated sewage occur each year owing to treatment plant malfunctions, operator error, and natural catastrophes. Such bypasses often result in fishkills and other serious water quality problems.

Stormwater runoff from lawns, golf courses, roadways, and parking lots often contains a complex mixture of chemical pollutants (*e.g*., biocides, fertilizers, oil, grease, antifreeze, deicing salts, solvents, detergents, asbestos). These substances can prevent the development and maintenance of representative aquatic communities in receiving surface waters. Similarly, concentrations of mercury, polychlorinated biphenyls (PCBs), and other bioaccumulative contaminants in fish taken from urban streams may pose unacceptable risks to human consumers. Many urban streams in the state also suffer from the illegal dumping of trash and other unwanted materials. The commonplace practice of discarding grass clippings and brush into streams (and the subsequent decay of these materials) reduces dissolved oxygen levels and jeopardizes populations of fish and other aquatic life. Discarded paint cans, pesticide containers, and batteries may leach appreciable quantities of toxic materials, thereby posing a serious threat to resident aquatic biota.

Urban sprawl negatively influences the physical habitats supporting aquatic life, in part because the attendant elimination of wetlands and riparian areas diminishes the capacity of urban watersheds to remove pollutants and mitigate the effects of flooding. Stormwater runoff from impervious surfaces such as paved areas and rooftops can lead to powerful flooding events, capable of scouring stream bottoms and eliminating the habitat required by some native aquatic species. The eventual channelization of most urban streams results in highly simplified aquatic habitats incapable of supporting the full range of fish and wildlife indigenous to this region. In many instances, the negative effects of urban development on streams, lakes, and wetlands could be reduced through careful planning and adherence to established BMPs and surface water quality standards. The retention of natural corridors or "greenways" along rivers and creeks, and strict adherence to the antidegradation provisions of the surface water quality standards (K.S.A. 28-16-28c(a)), would do much to preserve the natural physical and chemical attributes of the state's urban streams. Local, state, and federal authorities also could support litter cleanup initiatives more enthusiastically. Improvements in the visual and aesthetic character of urban waters would increase the perceived value of these resources and encourage their protection and sustainable use.

Nuisance aquatic species. A number of exotic plant and animal species have established populations within the state, and some may pose a serious risk to native aquatic life and the beneficial uses traditionally associated with surface waters. For example, Asian clams

(*Corbicula fluminea*) have established large populations in streams and lakes throughout the state, and the zebra mussel (*Dreissena polymorpha*) has gained a foothold in recent years in several major river basins. Both of these exotic bivalves can compete with or otherwise injure native shellfish species, and both can impair designated recreational and drinking water supply uses. At least four species of Asian carp have been reported from the state, and additional exotic fishes are expected to appear in Kansas in the near future. These animals can compete with native fish for food and shelter, and some dramatically reduce water clarity by disturbing bottom sediments during feeding.

A number of introduced plant species also have proven problematic. Thickets of salt cedar (*Tamarix* spp.) have become established along many streams in western and central Kansas, crowding out the native riparian vegetation and removing (via evapotranspiration) vast amounts of water from the adjoining streams and underlying alluvial aquifers. Purple loosestrife (*Lythrum salicaria*) has become the dominant herbaceous species in many wetlands, overwhelming many of the state's native plants and jeopardizing the animals depending on these plants for food and shelter. Eurasian watermilfoil (*Myriophyllum spicatum*), an exotic plant sold in the aquarium trade, has been discovered in several streams in western Kansas and in a few lakes in eastern Kansas. This plant propagates via seeds and vegetative fragments and can spread rapidly between waterbodies by attaching to boat propellers, boat trailers, and fishing gear. Once introduced into a lake or stream, it tends to form dense mats of vegetation that can interfere with recreational activities, crowd out native aquatic vegetation, disrupt the feeding behavior of native fish, and choke water intakes used for municipal water supply, power generation, and irrigation.

PART C: SURFACE WATER MONITORING AND ASSESSMENT

Monitoring Programs

Targeted Monitoring Operations

Stream chemistry monitoring program. The stream chemistry monitoring program is the largest and longest running environmental monitoring operation administered by the BEFS Technical Services Section. Water samples are obtained routinely from streams throughout Kansas and analyzed for a suite of physical, organic, inorganic, radionuclide, and bacteriological parameters (Appendix A). The program database currently comprises over two million records representing nearly 400 active and inactive monitoring locations and approximately 100 different analytical parameters. Some records in the database date to the late 1960s, and several monitoring sites have a continuous period of record extending from that time to the present (KDHE, 2007a).

Currently, the stream chemistry sampling network comprises 320 monitoring sites spanning all the major river basins and physiographic regions of Kansas. Monitoring personnel visit about 165 core sites on a bimonthly basis every year, whereas the remaining 155 sites are monitored using a four-year rotational approach; *i.e.*, samples are collected bimonthly from approximately 25 percent of these sites each year. Sampling sites have been chosen to represent water quality conditions in specifically targeted watersheds or stream reaches. For example, some sites reflect water quality conditions in streams as they enter or exit Kansas, others represent conditions above or below major WWTFs, urban areas, or reservoirs, and still others reflect water quality conditions in predominantly rural watersheds. A few "minimally altered" and several "least impacted" reference streams have been included in the network to gain a better understanding of baseline water quality conditions in the various ecoregions of Kansas (Chapman *et al.,* 2001). Stream reaches hosting monitoring sites range in size from first to eighth order on the Strahler (1957) scale (based on the NHD 1:100,000 stream coverage). As currently configured, the network provides water quality information useful in the characterization of pollutant loadings from more than 97 percent of the state's contributing drainage area. Many monitoring sites are located near the lower terminus of eight-digit hydrological unit code (HUC) watersheds and play an important role in the development and refinement of TMDLs for 303(d)-listed streams.

Stream biological monitoring program. This program examines the structural attributes of aquatic macroinvertebrate assemblages and utilizes this information to provide a more refined picture of the ecological status of streams in Kansas. Unlike water chemistry measurements alone, which reflect conditions occurring at the moment of sample collection, biological monitoring provides an integrated measure of environmental condition over time frames ranging from weeks to years, depending on the biological assemblage of interest. The KDHE aquatic macroinvertebrate database currently contains some 65,000 high resolution (predominantly genus/species level) records, and a separate freshwater mussel database contains approximately 14,000 high resolution records.

The macroinvertebrate sampling network includes nearly 200 monitoring sites distributed throughout the state. Samples normally are obtained from 60–65 sites each year, including 45 core stations and 15–20 rotational stations sampled three consecutive years per rotation. The

remaining sites in the sampling network represent short-term monitoring stations that are visited by staff on a sporadic basis as dictated by TMDL development needs or other regulatory considerations. As weather conditions allow, monitoring activities at all sites adhere to a seasonal rotation to reduce statistical bias and provide a more comprehensive picture of the resident macroinvertebrate communities; *i.e.*, samples are collected during the spring of one year, the summer of the next, and the fall of the next, a cycle that is repeated every three years (core sites) or every rotational sequence. Streams hosting core or rotational monitoring sites range in size from second to eighth order on the Strahler scale. Approximately 50 percent of the sites are located on fifth or sixth order streams and 80 percent are located on fourth to seventh order streams. The sampling network incorporates a targeted monitoring strategy comparable to that employed in the stream chemistry monitoring program. However, a greater proportion of core sites in the biological monitoring program are located on minimally impacted or least impacted reference streams (KDHE, 2010d).

Lake and wetland monitoring program. This program surveys water quality conditions in publicly owned and/or publicly accessible lakes and wetlands throughout Kansas. Program personnel visit individual waterbodies on a three- to five-year rotational schedule, and field measurements and subsequent laboratory analyses provide data on a large suite of physical, organic, inorganic, and biological (phytoplankton and macrophyte) parameters (Appendix A). The program's primary database now contains more than 250,000 analytical records representing more than 300 waterbodies. Watersheds associated with many of these monitored lakes and wetlands are surveyed periodically with respect to prevailing land use/land cover and the location and size of any discrete pollutant sources (WWTFs, CAFOs, etc.). Macrophyte community composition and aerial macrophyte coverage also are evaluated in selected waterbodies smaller than 300 acres (KDHE, 2010c).

Water quality information currently is obtained from 121 lakes and wetlands distributed throughout the state. These include all 24 federal reservoirs, most state-administered fishing lakes (those retaining open water in most years), various other state, county, or locally owned lakes, several privately owned but publicly accessible lakes, and seven state or federally owned marshes. Because only a few of these waterbodies are naturally occurring, an effort has been made to identify artificial lakes in minimally disturbed or least disturbed watersheds to serve the function of reference systems. This program routinely shares a large amount of data and expertise with other agencies and organizations involved in lake and wetland management, environmental restoration, water quality monitoring, and environmental education. Additional collaborative efforts have addressed the abatement of toxic algal blooms and taste/odor problems in public drinking water supply reservoirs.

Fish tissue contaminant monitoring program. This program obtains information on chemical contaminant levels in fish collected from streams and lakes in Kansas (KDHE, 2010a). Staff of the Kansas Department of Wildlife and Parks (KDWP) and EPA perform or assist with sampling activities in some waterbodies. Whole-fish samples (composite samples of three to six individuals) are obtained from selected monitoring sites, transferred to the EPA laboratory in Kansas City, and analyzed for organochlorine pesticides, PCBs, toxic metals, and other bioaccumulative contaminants. Resulting data are used to track the occurrence of these contaminants within the ecological food web and to ascertain temporal and spatial trends in

environmental condition. Composite fillet samples also are obtained from both targeted and probabilistic monitoring sites and analyzed by the EPA laboratory for contaminants of potential human health concern. In consultation with KDWP, KDHE evaluates the contaminant data to determine the need for issuing, rescinding, or modifying local fish consumption advisories. The fish tissue database currently comprises approximately 18,000 records, representing 217 sites and more than 200 (79 detected) contaminant parameters (Appendix A).

Fish tissue samples normally are obtained each year from 30–40 waterbodies across the state. Targeted sampling efforts focus primarily on streams and lakes with known water quality problems and existing fish consumption advisories. Although chlordane traditionally has been viewed as the contaminant of greatest concern (Arruda *et al.* 1987a-b; KDHE 1988a-b), chlordane concentrations in fish have declined dramatically in recent years, and attention has shifted gradually to mercury, PCBs, and a few other persistent contaminants. The agency recently has devoted a greater proportion of its monitoring resources and laboratory sample allocation to the collection and analysis of predatory fish from recreational reservoirs. This new initiative acknowledges national trends in mercury levels in freshwater fish and the potential for mercury-related health problems, especially in more vulnerable segments of the human population (*e.g.*, children and women of child bearing age) (EPA 2000a-b; http://epa.gov/waterscience/ fish/advice/factsheet.html). On January 4, 2010, revised advisories were issued for nine waterbodies in eastern and central Kansas owing to elevated levels of mercury, PCBs, and/or other contaminants in fish and shellfish (KDHE, 2010b).

Probabilistic Monitoring Operations

Stream probabilistic monitoring program. Probabilistic sampling is a method of environmental monitoring that yields statistically representative information on the physical, chemical, and/or biological condition of natural resources. It differs from conventional sampling in that probabilistic monitoring stations are a randomly selected subset of the resource as a whole. In Kansas, stream chemistry and stream biological monitoring programs traditionally have employed a targeted monitoring design that positions stations in a deliberate and strategic manner (*e.g.*, near the terminus of a specific watershed or above and below a discrete pollution source). Although these programs are of critical importance in determining site- and watershed-specific water quality conditions, funding and logistical constraints limit the number of targeted sites that can be sampled on an ongoing basis. In contrast, probabilistic monitoring focuses on the total resource rather than the individual monitoring locations. Results generated from this approach can be extrapolated with known confidence to the state's entire population of streams, including hundreds of smaller waterbodies (*e.g.*, headwater streams) largely outside the historical and current purview of the targeted monitoring programs.

In 2004, KDHE participated in EPA's National Wadeable Streams Assessment and gained a familiarity with the application of probabilistic sampling designs and associated field methods (EPA, 2004; http://www.epa.gov/owow/streamsurvey/WSA_Assessment_Dec 2006.pdf). In 2005, availability of supplemental monitoring funds under section 106(b) of the CWA provided an opportunity for BEFS to: (1) develop a quality assurance management plan and accompanying set of standard operating procedures for a similar statewide probabilistic program;

(2) hire and train two environmental scientists to assist with the implementation of field and taxonomic duties; (3) develop a list of randomly selected (candidate) stream reaches; (4) obtain landowner permission to perform evaluations on these stream reaches; (5) initiate probabilistic monitoring operations; and (6) develop a methodology for applying probabilistic data to 305(b) water quality assessments. Probabilistic monitoring was formally implemented in June 2006 under the auspices of the newly created Kansas stream probabilistic monitoring program or SPMP.

From its inception, the SPMP was designed to complement, rather than supplant, the department's traditional monitoring programs. Targeted monitoring continues to serve as the primary basis for 303(d) list development, TMDL formulation, and NPDES permit review and certification. Although site selection procedures for the probabilistic and targeted monitoring programs differ substantially, field methodologies developed for the targeted programs have been integrated with little alteration into the probabilistic program. This decision has maintained methodological continuity across programs and facilitated inter-program data comparisons. Staff of the targeted monitoring programs have contributed to the development of the SPMP and continue to play an important role in the implementation of this program, primarily by providing training and participating in field and laboratory operations and quality control functions.

The SPMP sampling network is predicated on a random, but spatially balanced, site selection process (see Kaufmann *et al.*, 1991; Messer *et al.*, 1991; Larsen *et al.*, 1994; Urquhart *et al.,* 1998; Herlihy *et al.*, 1998, 2000). Site coordinates are based on the random selection of points from the universe of classified stream segments identified in the most recently approved version of the Kansas surface water register (KSWR) (KDHE, 2009). This register represents all potential sampling locations or "the sampling frame." It is subject to incremental change over time owing to the deletion or addition of classified stream segments (KAR, 2004; KDHE, 2005a). In effect, an infinite number of potential sampling sites can be selected from the KSWR, allowing a manageable subset of about 30–50 newly selected sites to be sampled each year. Additional details are given in the SPMP quality assurance management plan (KDHE, 2007b).

SPMP personnel and other participating BEFS employees endeavor to evaluate surface water chemistry, macroinvertebrate community composition, and phytoplankton community composition at each of the scheduled sampling locations. Physical habitat data also are collected to help discriminate between chemistry- and habitat-mediated constrains on the biotic community. As mentioned previously, SPMP personnel employ field protocols developed originally for the BEFS targeted stream monitoring programs. These established protocols are robust, and their utility has been demonstrated over the course of several decades. Moreover, data comparability and consistency among monitoring programs may prove important to future statewide water quality assessments.

Assessment Methodology

305(b) Assessment Methodology

Two statewide monitoring programs, the SPMP and the lake and wetland monitoring program, produced information amenable to inclusion in this 305(b) assessment. The statistical methods and assumptions employed in the assessment are presented separately for these two programs in the following paragraphs.

Stream Probabilistic Monitoring Program

The target population for the 2010 probabilistic stream assessment comprised that portion of the KSWR stream extent that contained water during the summer low-flow periods of 2006–2008. The sampling frame used to represent the target population was the December 2005 version of the KSWR. Reporting was based on the segment geometries and uses published in the February 12, 2009 version of the KSWR. The sampling frame for reporting represented approximately 27,774 stream miles.

Site selection was performed by the EPA design team in Corvallis, Oregon (Olsen, 2006) using the methods and assumptions of Stevens and Olsen (2004). All desk and field reconnaissances were performed by KDHE personnel. The target population was determined to comprise 19,298 stream miles or about 69% of the sampling frame (a difference attributable largely to severe drought conditions and an accompanying loss of stream mileage during 2006). Data collected during 2006–2008 were used to assess the prevailing level of support for CWA section 101(a) uses (Table 8).

Table 8. Types of data used in assessing designated use support (2006–2008)

Designated Use	Macroinvertebrate Community Structure	Water Chemistry	*E. coli* Concentrations	Fish Tissue Chemistry
Aquatic Life	X	X		
Contact Recreation			X	
Food Procurement				X

The capacity of a given stream reach to provide for recreation, food procurement, and aquatic life support was determined by considering the local water chemistry, fish tissue chemistry, suspended bacterial concentrations, and condition of the benthic macroinvertebrate community. Monitoring sites meeting the applicable water quality criteria or diagnostic thresholds for a given use were deemed “fully supportive” of that use. Any site failing to meet these criteria or thresholds was deemed “non-supportive” of the use. Assigned causes and sources of non-support were based on several considerations, including the prevalence and proximity of upstream point sources and nonpoint sources, point source performance during the reporting period, dominant land uses within the watershed (and near the sampling location), and any instream manifestations reflecting degraded water quality (silt blanketing of sediments, large growths of filamentous or mat forming algae, effluent odors, etc.).

Aquatic Life Use. Stream macroinvertebrate data from 138 randomly chosen sites were considered during the assessment of the aquatic life use (Figure 3). Use support was determined using the site scores for four biological metrics: macroinvertebrate biotic index (MBI), nutrient-oriented Kansas biotic index (KBI-NO), Ephemeroptera-Plecoptera-Trichoptera index (EPT), and percent EPT with respect to total macroinvertebrate abundance (%EPTCNT). Support thresholds for these metrics were derived from an analysis of 26 reference streams, all sampled during the 2006–2008 assessment period (Figure 3).

Reference and probabilistic sites were partitioned into three stream flow categories (<10 cfs; 10 to 99 cfs; ≥100 cfs) using 10-year median discharge estimates for the bracketing stream reaches (Perry *et al.,* 2004). Within each flow category, support thresholds for the biological metrics were set at the 75th percentile (MBI and KBI-NO) or 25th percentile (EPT and %EPTCNT) reference site score (www.epa.gov/bioindicators/html/biological_endpoints.html). This procedure effectively adjusted the expected performance of each monitored stream reach on the basis of stream size (*e.g.*, a second order stream would not be expected to support the same number of EPT taxa as a sixth order stream, but it would be expected to perform as well as a similarly sized stream in the absence of environmental stressors). Support thresholds derived from this process are presented in Table 9.

Table 9. Aquatic life use non-support thresholds for biological metrics across three stream flow groups

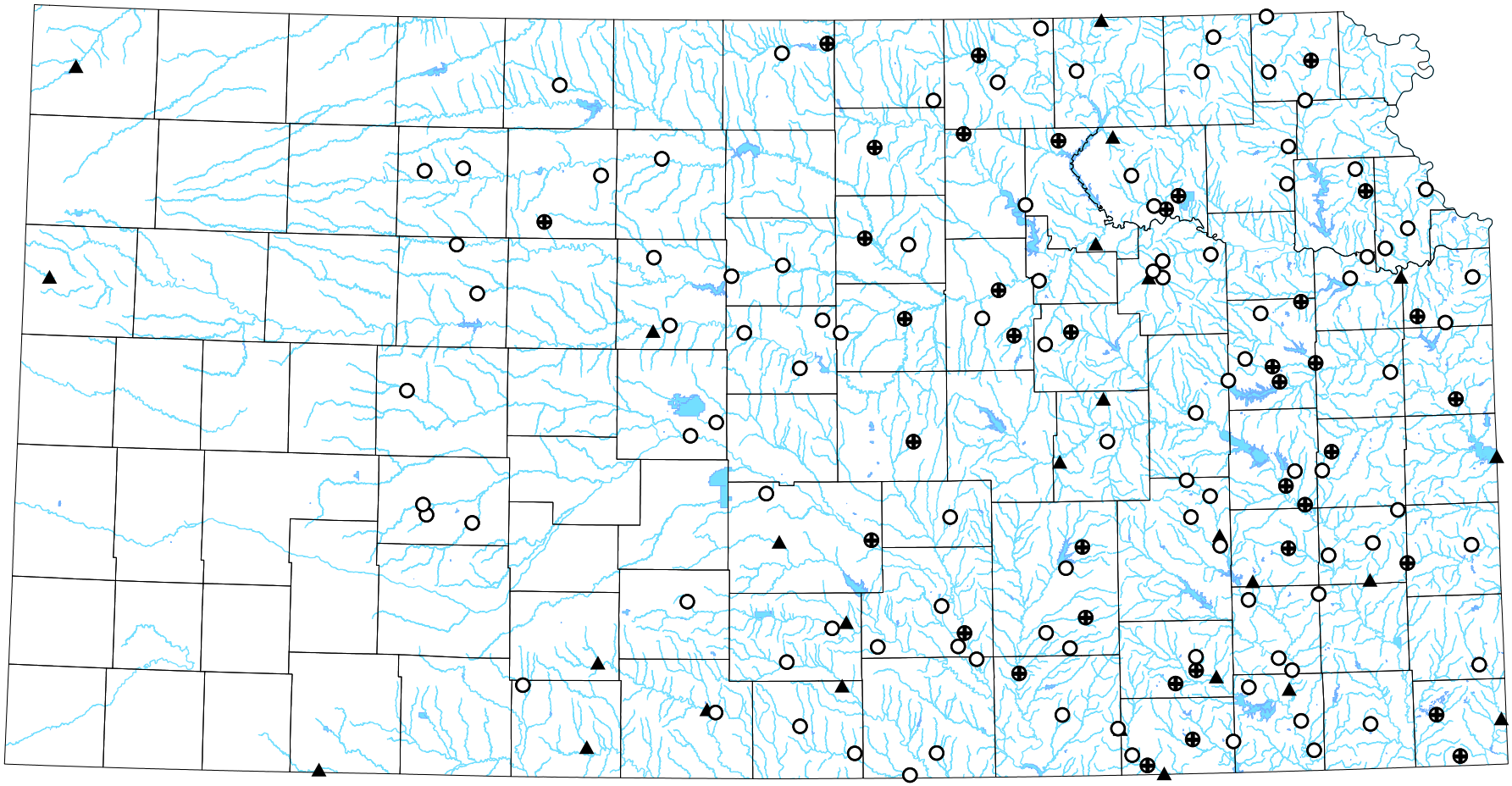
Flow Group	MBI	KBI-NO	EPT	%EPTCNT
<10 cfs	>5.40	>3.02	<6	<23
10 –99cfs	>4.82	>2.82	<7	<31
≥100 cfs	>4.27	>2.52	<15	<41

Scores for probabilistic sites were compared to the flow-adjusted thresholds and assigned a value of 1 (non-support) or 2 (full support). These values were averaged across the four metrics to obtain a final average value for each site. If an average support value exceeded 1.5, the site in question was deemed fully supportive of the aquatic life use. If an average value was less than 1.5, the site was considered non-supportive of the aquatic life use.

In some instances, the average support values equaled or closely approached the full support/non-support threshold (*i.e.*, 1.5). Chemistry data were used in these instances to assign sites to the most appropriate use attainment category. If pollutant concentrations were found to exceed a given acute or chronic aquatic life criterion in at least 25% of samples, the site in question was deemed non-supportive of the aquatic life use. However, chronic (48- to 96-hour) criteria were not applied to transient stream runoff events, and the dissolved oxygen criterion was not applied to instances of drought-induced pooling.

Figure 3. Kansas Stream Probabilistic Monitoring Network

2006−2008



KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

2010 Integrated Report

Probabilistic site

Fish tissue collected at site

Reference site

County boundary

Kansas Surface Water Register, 2009

major streams

major lakes and wetland complexes

Contact Recreational Use. All probabilistic sites were assessed for recreational use support based on measured suspended concentrations of *Escherichia coli*. This bacterium is part of the normal intestinal fauna of humans and many other warm blooded animals. It is utilized in many water quality studies as a general indicator of fecal contamination. For formal (*e.g.*, 303(d)) regulatory purposes, bacteriological criteria generally are applied as geometric mean concentrations, calculated using data from at least five different samples collected in separate 24-hour periods during a 30-day assessment window (K.A.R. 28-16-28d-e). The frequency and timing of the SPMP sample collections did not meet these rigid requirements. Therefore, the results reported below for the state as a whole (*i.e.*, pursuant to section 305(b) of the CWA) were based on seasonal samples collected from each probabilistic site over the course of a single year.

Based on studies undertaken previously by the former BEFS Use Assessment Section, each stream segment listed in the KSWR was assigned to one of four recreational use categories (two primary and two secondary) depending on stream size, extent of public access, and other use attainability considerations (KDHE, 2005a). *Escherichia coli* data from each probabilistic site were compared to the applicable criterion concentration. Many of these sites were designated for secondary contact recreation only, in which case all available data were combined and the geometric mean was compared directly to the appropriate criterion concentration. Sites designated for primary contact recreation were evaluated with respect to recreational season (primary contact, April 1 – October 31; secondary contact, November 1 – March 31), and the geometric mean for each season was compared to the appropriate criterion concentration (Table 10). If the geometric mean exceeded the applicable criterion concentration during any season, the monitoring site in question was deemed non-supportive of the recreational use.

Table 10. *Escherichia coli* criteria used in recreational use assessments

Use	**Colony Forming Units (CFUs)/100mL**	
Primary Contact Recreation	**Geometric Mean April 1 – Oct. 31**	**Geometric Mean Nov. 1 – March 31**
Class B	262	2,358
Class C	427	3,843
Secondary Contact Recreation	**Geometric Mean Jan. 1 – Dec. 31**	
Class a	2,358	
Class b	3,843	

*Food Procurement Use***.** Fish contaminant data were obtained from 38 probabilistic stream sites during 2006–2008 (Figure 3). All of the corresponding stream segments had an estimated median discharge of 3.0 cfs or more (Perry *et al.*, 2004) and were regarded as viable candidates for fish tissue sampling. At each site, SPMP personnel endeavored to collect one composite (three- to five-fish) sample of a representative bottom-feeding fish species (*e.g.*, channel catfish, common carp) and another composite sample of an open-water predatory species (*e.g.*, largemouth bass). Food procurement use support was assessed on the basis of measured contaminant concentrations and contaminant-specific hazard threshold values for a consumption

rate of greater than two meals per month (EPA, 2000a-b). For contaminants with both carcinogenic and non-carcinogenic endpoints, the more conservative of the two endpoints was applied in the 305(b) assessment (EPA, 2000a-b). Fish contaminants rated as carcinogens were assessed on the basis of EPA cancer potency factors and an allowable population cancer risk of 1:100,000. Non-carcinogens were evaluated using EPA health endpoints for chronic systemic effects. Further assumptions included consumption of fish tissue over the duration of an average human lifetime, average adult body weight, and eight-ounce meal portions. If the level of a contaminant was found to surpass the applicable threshold concentration, the site in question was deemed non-supportive of the food procurement use.

*Population Extent Estimation***.** Data from the 138 sites assessed for aquatic life and contact recreation and from the 38 sites assessed for food procurement were used to derive estimates for the target population as a whole. If a site failed to support any single designated use, it was considered non-supportive overall. The design team at the EPA Western Ecology Division provided the population extent and variance estimates given in this report (personal communication, Tony Olsen). Calculations were performed using the "R" programming environment (www.r-project.org), the most current "sp" and "spsurvey" custom software modules (www.epa.gov/nheerl./arm/analysis pages/software.htm), and the methods and assumptions of Diaz-Ramos *et al*. (1996) and Stevens and Olsen (2003).

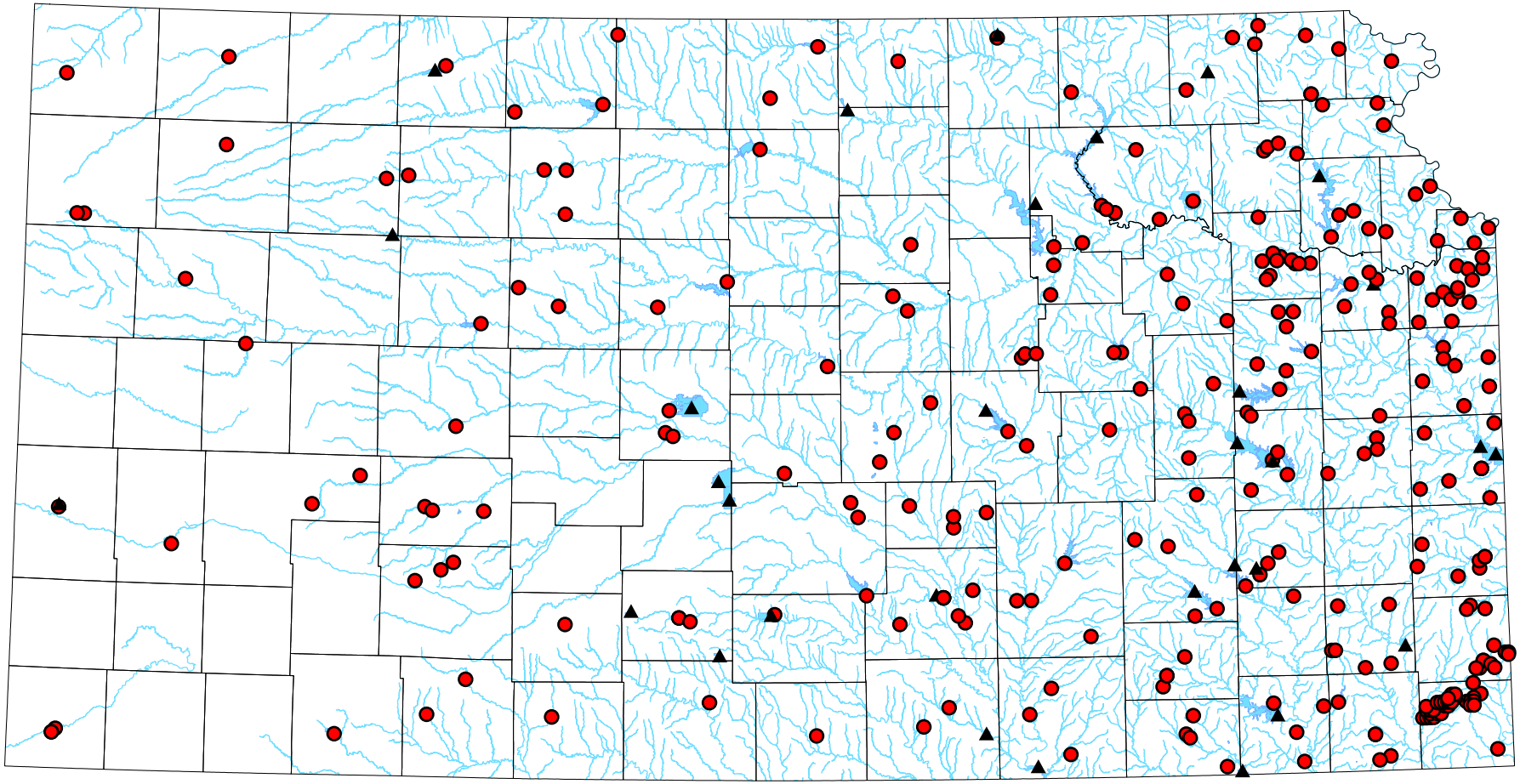
Lake and Wetland Monitoring Program

This targeted monitoring program assessed 316 publicly owned and/or publicly accessible lakes and wetlands during the six-year reporting period, 2004–2009 (Figure 4). Physicochemical data were obtained from each waterbody and compared to established water quality standards to characterize the prevailing level of use support. A lake or wetland was deemed non-supportive of a designated use if more than 25% of the samples exceeded a given criterion associated with that use, partially supportive if more than 10% (but fewer than 25%) of the samples exceeded the criterion, and fully supportive if a smaller percentage of samples exceeded the criterion. This assessment focused primarily on epiliminetic water quality conditions, but temperature data were evaluated to a maximum depth of 3.0 m irrespective of the thermal stratification status of the monitored waterbodies.

The 305(b) assessment also considered long-term trends in the trophic condition of monitored lakes and wetlands. Mean concentrations of chlorophyll-a were computed for each waterbody based on the entire period of record for that waterbody. These concentrations were compared to an existing set of thresholds used to interpret narrative standards for lake trophic state, nutrient enrichment, and turbidity (KAR, 2004; Appendix C). Mean chlorophyll-a thresholds for the contact recreational and domestic water supply uses were: <10 ug/L (fully supportive); 10–12 µg/L (fully supportive but threatened); 12–20 ug/L (partially supportive); and >20 ug/L (non-supportive). Mean chlorophyll-a thresholds for irrigation, livestock watering, secondary contact recreation, and aquatic life support uses were: <18 ug/L (fully supportive); 18–20 ug/L (fully supportive but threatened); 20–30 ug/L (partially supportive); and >30 ug/L, with blue-green algal dominance, or >56 ug/L, regardless of algal composition (non-supportive).

Figure 4. Kansas Lake and Wetland Monitoring Network

2004 – 2009



County boundary

Lake site

Wetland site

Kansas Surface Water Register, 2009

major streams

major lakes and wetland complexes

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT

2010 Integrated Report

303(d) Assessment Methodology

The 2010 list of impaired (Category 5) waters builds upon listings developed in 2008. A complete description of the procedures and assumptions applied during the preparation of this list is provided in the report, *Methodology for the Evaluation and Development of the 2010 Section 303(d) List of Impaired Water Bodies for Kansas* (http://www.kdheks.gov/tmdl/methodology. htm).

Development of the 2010 list relied primarily on data from targeted water quality monitoring programs administered by BEFS and described elsewhere in this report. The statewide water quality assessment prepared by BEFS pursuant to section 305(b) of the CWA also provided initial candidate waters for listing. BOW performed more extensive follow-up analyses, and these provided the final basis for identifying and listing impaired waters in Kansas.

Stream chemistry data were obtained from the statewide network of permanent monitoring stations (assessment period, 2000–2009) and rotational stations (assessment period, 1990–2009) and analyzed using binomial techniques with adjustments to combat Type II error. Streams impaired by excessive concentrations of total suspended solids and total phosphorus were identified using screening values developed by BOW. Formal numeric criteria for these two pollutants likely will be promulgated by KDHE in the near future as part of the triennial water quality standards review process.

Watersheds monitored by the individual stream chemistry stations comprised stream assessment units for the 303(d) list. Waters flowing directly into some large reservoirs were not surveyed as part of the stream chemistry monitoring network, in which case the contributing watersheds were assessed using data obtained from the reservoirs.

The public notice for the draft 2010 303(d) list provided a mechanism for soliciting all readily available water quality data from other agencies, organizations, and individuals (see Part E, this report). However, no additional information was submitted to KDHE by outside parties. The final 303(d) list identified 537 Category 5 water quality impairments (http://www.kdheks.gov/tmdl/download/2010_303_d_List_of_All_Impaired_Waters.pdf).

Priorities and Schedules

Since 1999, TMDL development efforts in each of the state's twelve major river basins have adhered to a five-year rotational schedule. The 2010 303(d) list identifies all waterbodies in Kansas scheduled for TMDL development through the end of 2012 (Appendix B). During the next reporting cycle (2010–2012), TMDL development and revision efforts will focus primarily on the Kansas/Lower Republican, Missouri, Marais des Cygnes, Cimarron, Lower Arkansas, and Upper Arkansas basins. These high priority efforts will address water quality impairments related to low levels of dissolved oxygen and elevated levels of ammonia, phosphorus, selenium, radionuclides, and fecal bacteria. Nutrient enrichment (eutrophication) and biological impairment concerns also will be addressed in the upcoming TMDLs.

In addition to the planned TMDL development activities, further study will be conducted to clarify the importance of various sources of phosphorus entering the Kansas and Arkansas rivers. Other medium priority concerns may be addressed during 2010–2012 depending on the availability of staff and resources.

Tracking Previously Listed Waters

The 2010 303(d) list also identifies waters from previous lists that were once impaired by a pollutant (Category 5) but that are now placed in other listing categories established by EPA. TMDLs have been established for most of the Category 5 waters identified on the 1998, 2002, and 2004 lists. Waters with approved TMDLs are placed in Category 4a (http://www.kdheks.gov/ tmdl/).

A number of waterbodies in Kansas have been placed in Category 4b, meaning their particular impairments have been addressed by some means other than the development of a TMDL. For most of these waters, the indicated impairments have been addressed through the NPDES permitting process (that is, through effluent limits and schedules of compliance leading to WWTF upgrades). Discharge monitoring records indicate that most of these WWTFs now comply with their NPDES permits and that the streams receiving treated effluent should now comply with applicable surface water quality criteria. Several stream segments were transferred from Category 5 to Category 2 in 2008, meaning that their water quality problems were resolved. Several other segments have been proposed for transfer to Category 2 in 2010. Should WWTFs discharging into the de-listed segments continue to have compliance issues, the affected stream reaches will revert back to Category 5.

Atrazine impairments in a limited number of waterbodies in the Little Arkansas River watershed have been addressed through a Category 4b watershed plan. No further Category 4b watershed plans are under development at this time. Active WRAPS groups may choose to address atrazine issues prior to the development of a TMDL, but impaired waters will remain in Category 5 pending TMDL finalization or the resolution of the impairments.

Currently, only one waterbody in Kansas is assigned to Category 4c, meaning its documented water quality impairment is not caused by a pollutant. In this case, biological impairment (defined by macroinvertebrate monitoring) appears to be linked to deficient hydrology brought about by drought and diversions. This impairment can be managed best through water allocation management and water rights administration. The affected stream reach will be reevaluated in 2012.

Several waterbodies in Kansas have been assigned to Category 3, which means their water quality may be impaired but a definitive determination is not possible owing to insufficient supporting data. In some such cases, high bacterial levels appear to be impacting the designated recreational use, but more intensive sampling is needed to appropriately assess compliance with the applicable standards. All waters placed in Category 3 are scheduled for additional monitoring and evaluation.

As mentioned previously, some waters in the state have been assigned to Category 2, meaning they were once listed as impaired but now seemingly comply with applicable water quality criteria. This outcome usually reflects the availability of more recent monitoring data, or the occurrence of WWTF upgrades, changes in water quality criteria, or the removal of designated uses through the use attainability analysis (UAA) process. In addition, all chlordane-related fish consumption advisories have been withdrawn in the state, reflecting the suspension of this pesticide's registration in 1988 and subsequent declines in chlordane levels in fish.

Finally, those surface waters in Kansas lacking any known historical or contemporary water quality impairments have been assigned to Category 1. All categorical assignments (Categories 1–5) are recorded by KDHE in an electronic database. The most recent revision to this extensive database has been submitted to EPA as part of the 2010 integrated report.

Assessment Results

305(b) Assessment Results

Probabilistic Stream Assessment

The KSWR identifies all currently classified stream segments in Kansas. Collectively, these represent about 27,774 stream miles and include both perennial and intermittent waters. During prolonged droughts, some of this mileage is expected to be nonviable for sampling purposes. Thus, the target sampling population is restricted to those classified stream segments containing substantive aquatic habitats during the assessment period of interest. These habitats may include isolated pools, continuously wetted (but non-flowing) reaches, or continuously flowing reaches.

Based on a combined desk and field reconnaissance, the target sampling population during the summers of 2006–2008 was estimated at 19,298 stream miles or approximately 69% of the total classified stream mileage. This extent was assessed for recreational and aquatic life support uses using chemical and biological data from 138 monitoring sites. As discussed previously, the food procurement use was assessed using fish tissue contaminant data from only 38 sites. Table 11 summarizes the overall use support findings for streams in Kansas. Table 12 highlights some of the major features of the probabilistic sampling effort.

Table 11. Overall use support for streams (in miles)

Waterbody Type	Extent Supporting All Designated (§101(a)) Uses	Extent Failing to Support One or More Designated (§101(a)) Uses	Total Targeted Extent	Total Assessed Extent
Streams (target population only)	5,594 ± 1,889*	13,704 ± 1,889*	19,298	19,298

*95% confidence intervals derived using local variance estimator (Stevens and Olsen, 2003)

Table 12. Probabilistic stream assessment fact sheet

EPA Project ID	KSR-06950
Project Name	Kansas stream probabilistic monitoring program
Type of Waterbody	Stream or river
Units of Measurement	Miles
Size of Target Population	19,298 miles
Designated Uses	Aquatic life, contact recreation, and food procurement*
Percent attaining	29% (19–39%)
Percent not attaining	71% (61–81%)
Percent nonresponse	0%
Indicators	Macroinvertebrate community assessments, water chemistry analyses, fish tissue contaminant analyses, *E. coli* measurements
Assessment Date	20100329
Precision	95%

*Food procurement was designated for only 69% of the target population, so the assessment mileage for this use was 13,244 miles

Stream Use Support in Relation to Individual Designated Uses

Those uses of surface water recognized in section 101(a) of the CWA correspond to the following three uses in Kansas: aquatic life support, contact recreation, and (human) food procurement (K.A.R. 28-16-28b *et seq.*). The first two uses apply in some form to virtually all streams listed in the KSWR. Contrastingly, the food procurement use is assigned only to a portion (63%) of the state's classified stream mileage. The Kansas surface water quality standards recognize additional uses of surface water, but these are not considered in this probabilistic assessment (Table 13).

Table 13. Allocation of designated uses among classified streams

Designated Use	Proportion of Total Stream Mileage Designated for Specified Use*
Aquatic life support (any category)	100%
Contact recreation (any category)	99%
Food procurement	63%
Groundwater recharge	67%
Drinking water	58%
Livestock watering	70%
Industrial water supply	58%
Irrigation	67%

* relative to the entire KSWR extent of 27,774 miles

Table 14 presents use support findings for individual section 101(a) uses (aquatic life support, contact recreation, and food procurement). The indicated 95% confidence intervals were derived using a local variance estimator approach (Stevens and Olsen, 2003). The relatively large confidence intervals associated with the food procurement use reflect the smaller number of probabilistic sites with reported data for fish tissue chemistry.

Table 14. Support of individual designated uses in streams (in miles)

Designated §101(a) Use	Total Targeted Extent	Total Assessed Extent	Extent Supporting Indicated Use*	Extent Failing to Support Indicated Use*	Extent with Insufficient Data
Aquatic Life	19,298	19,298	7,691 ± 1,212	11,607 ± 1,212	0
Contact Recreation	19,298	19,298	16,222 ± 1,035	3,077 ± 1,035	0
Food Procurement	13,244	13,244	11, 501 ± 1,255	1,743 ± 1,255	0

* 95% confidence intervals derived using local variance estimator approach (Stevens and Olsen, 2003)

Causes and Sources of Stream Impairment

Likely causes and sources of non-support were determined for each probabilistic monitoring site exhibiting water quality impairments. Published and unpublished water quality studies, and geographical coverages identifying point and nonpoint sources of pollution, were considered during this phase of the probabilistic assessment. Findings were extrapolated to the overall population of streams targeted during the 2006–2008 assessment period. Because multiple causes and sources of impairment were associated with some individual monitoring sites, the stream mileage affected by all causes and sources was not amenable to meaningful summation (Tables 15 and 16).

Table 15. Major causes of water quality impairments in streams

Cause Category	Impaired Mileage
Toxic contaminant in water	1,479
Toxic contaminant in fish tissue	1,674
Nutrient enrichment	10,278
Sedimentation/siltation	4,832
Escherichia coli contamination	2,959
Hydrological modification	810
Drought condition	4,747

Major causes of non-support for streams, in order of prevalence, were nutrient enrichment, sedimentation, natural climatic conditions, and elevated *E. coli* concentrations. Sources primarily responsible for pollutant loadings and/or use impairments included agriculture (irrigated and nonirrigated crop production, livestock grazing and feeding operations, unrestricted cattle access), natural phenomena (*e.g.*, weather-related impacts), and physical habitat degradation.

Sampling activities during 2006 coincided with one of the worst droughts on record for Kansas. From 2000 to 2006, annual average flows in the Republican River, Smoky Hill River, Solomon River, upper Kansas River, and upper Arkansas River, as well as in many tributaries, were lower than the flows reported during all previously recorded droughts (*e.g.*, 1929–1941; 1952–1957) (http://ks.water.usgs.gov/Kansas/waterwatch/drought/drought-comparison.rev.htm). The drought ended in southeastern Kansas during the summer of 2007, when counties in that portion of the state received nearly 20 inches of rain between June 26 and June 30. These rainfall events resulted in major floods that scoured many larger waterbodies. They also resulted in sustained high stream flows for much of the summer. The combined effects of these dramatic weather-related events clearly contributed to many of the stream impairments documented during 2006 and 2007.

Targeted Lake Assessment

Causes and Sources of Lake Impairment

About 93% of the reported lake acres were monitored for the entire suite of physical, chemical, and biological parameters common to KDHE lake surveys (Appendix A). Also, during the past five years, all lakes listed in the KSWR were subjected to formal UAAs. Some of the smaller lakes were not represented in the routine monitoring network, and in such cases UAA data were used to evaluate compliance with water quality criteria and use support thresholds. Table 17 summarizes use support ratings for lakes monitored or evaluated during this 305(b) reporting cycle. Table 18 partitions this information by beneficial use category.

Table 16. Major sources of water quality impairments in streams

Source Category	Impaired Mileage
Agriculture	
General agriculture	5,807
Crop production	1,733
Unrestricted cattle access	894
Livestock grazing or feeding	3,238
Weather related natural phenomena	
Drought-related impacts	4,747
Major flooding	140
Urbanization	
High density urban area	475
Municipal point source	475
Rural residential area	335
Urban runoff/storm sewer	140
Hydrological modification	
Flow regulation	1,284
Major dam	140
Channelization	1,369
Low water crossing	335
Atmospheric deposition (toxins)	1,674
Active mines or quarries	140
Highway or road runoff	475
Natural source	140

Table 17. Summary of fully supporting, threatened, and impaired lakes (in acres)

DEGREE OF USE SUPPORT	ASSESSMENT CATEGORY		TOTAL ASSESSED ACRES
	EVALUATED	MONITORED	
Insufficient Data	530	0	530
Fully Supporting of All Uses	2,488	14,490	16,978
Threatened for One or More Uses (But Not Impaired for Any Uses)	243	2,005	2,248
Impaired for One or More Uses	11,105	160,242	171,347
Total Size Assessed	14,366	176,737	191,103

Table 18. Individual use summary for lakes (in acres)

Goals	Use	Size Assessed	Fully Supporting	Full Support But Threatened	Partially Supporting	Non Supporting	Insufficient Data
Protect and Enhance Ecosystems	Aquatic Life (acute criteria)	191,103	114,605	11,106	61,002	4,288	102
Protect and Enhance Public Health	Fish Consumption+	191,103	190,071	0	369	641	22
	Shellfishing	*	*	*	*	*	*
	Primary Contact	190,976	32,663	8,574	145,691	3,968	80
	Secondary Contact	191,103	119,017	11,110	57,066	3,808	102
	Domestic Water Supply	189,323	22,173	4,998	112,172	49,450	530
Social and Economic Enhancement	Irrigation	190,468	145,190	20,507	20,852	3,389	530
	Livestock Water Supply	190,483	149,583	20,510	15,732	4,128	530
	Cultural	*	*	*	*	*	*

* = Category not applicable.

+ = Based on food procurement criteria for water as well as fish tissue analysis. During the 2004–2009 time period, 50 lakes, comprising 133,048 acres, were assessed for heavy metals, PCBs, and pesticides in fish tissue.

Major causes of non-support for lakes, in order of prevalence, were zebra mussel infestations, siltation, nutrient enrichment, and taste and odor problems stemming primarily from nutrient enrichment and excessive algal growth (Table 19). Sources primarily responsible for pollutant loadings and/or use impairments included non-native species introductions, general agriculture, and discharges from municipal WTTFs (Table 20).

Of the 176,737 monitored lake acres, 14,624 acres (8.3%) exhibited some level of impairment from heavy metals and/or pesticides (*i.e.*, toxic parameters). Of the 14,366 evaluated lake acres, 6,528 acres (45.4%) exhibited some level of impairment due to the same parameters.

The zebra mussel continued to expand its distribution in Kansas during this 305(b) assessment period. Populations of this invasive bivalve were documented in eight lakes, totaling 62,806 acres (33% of reported lake acreage). This is approximately twice the acreage reported in the 2008 305(b) report. As mentioned previously, zebra mussels can compete with (or otherwise injure) native shellfish populations, and they can also dramatically reduce the fitness of surface water for recreational and water supply uses.

Table 19. Lake acres impaired by various cause categories

CAUSE CATEGORY	CONTRIBUTION TO IMPAIRMENT	
	MAJOR	MODERATE/MINOR
Cause Unknown	0	0
Pesticides (atrazine)	112	5,284
Heavy Metals (arsenic)	0	9,232
Heavy Metals (copper)	0	282
Heavy Metals (lead)	0	1,029
Heavy Metals (selenium)	0	8,572
Heavy Metals (mercury)	0	232
Fluoride	11	5,325
Boron	0	0
Nutrients and Eutrophication	32,837	136,725
pH (high)	233	820
pH (low)	0	13
Siltation and Turbidity	43,027	16,803
Low Dissolved Oxygen	0	13,479
Chloride	0	15,990
Sulfate	638	40,644
Flow Alterations	633	3,588
Pathogen Indicators	0	0
Taste and Odor	29,244	0*
Aquatic Plants	146	253
Zebra Mussels	62,806	0
Perchlorate	128	0

* = Taste and odor incidents that might be characterized as "moderate/minor" often are not brought to the attention of KDHE. Therefore, all documented acreage for this cause category is reported as "major." Moderate/minor incidents are believed to be numerous, based on the large number of algal blooms observed in Kansas lakes during the summer months.

Table 20. Lake acres impaired by various source categories

SOURCE CATEGORY	CONTRIBUTION TO IMPAIRMENT	
	MAJOR	MODERATE/MINOR
Municipal Point Sources	25,600	122,141
Agriculture	34,391	122,092
Urban	964	12,487
Resource Extraction	0	1,037
Hydromodification	3,533	7,213
Atmospheric Deposition	0	232
Natural Sources	554	41,232
In-Lake Management	104	153
Resuspension	9,705	269
Introduction of Non-Native Organisms	62,806	0
Unknown	0	0

Acid Effects on Lakes

Approximately 190,038 acres of lakes in Kansas were monitored or evaluated for pH. This accounted for 99.4% of the lake acreage considered in this integrated report. Recorded water quality impacts were related almost entirely to high pH values, occurring when lakes were over-enriched with nutrients and suffered from accelerated eutrophication rates and advanced trophic conditions.

During this reporting cycle, only two lakes exhibited an epilimnetic pH below 6.5 units. These lakes were located in the Mined Land Lakes Recreational Area of southeastern Kansas, in basins created by former strip mines. Many decades have passed since this area was actively mined for coal. Some lakes in the region have been treated sporadically with lime to prevent low pH problems. Anecdotal accounts suggest that a few privately owned strip pit lakes continue to exhibit low pH.

In Kansas, the lack of widespread acidification problems is attributable largely to the region's modest level of industrialization, relatively good air quality, and prevailing limestone geology. With respect to the latter factor, much of this region is underlain with calcareous bedrock and contains soils derived from the weathering of this bedrock. Therefore, the state has some natural defense against the atmospheric deposition of acids and acid precursors.

Trends in Lake Water Quality

Trends in water quality are difficult to determine for individual lakes in Kansas, owing primarily to a traditional emphasis on the performance of statewide assessments rather than intensive, site-specific studies. Lake trophic status appears to provide the best long-term indicator of water quality and has been used by KDHE for 305(b) assessment purposes for many years. For the

purposes of this report, trend analyses for individual lakes were performed only if the water-bodies had undergone three or more trophic state assessments since the inception of the lake and wetland monitoring program. These analyses involved the following considerations:

(1) If there was an evident decrease in trophic state over time, the lake was assigned to the "improving" category.

(2) If there was an evident increase in trophic state over time, the lake was assigned to the "degrading" category.

(3) Lakes were assigned to the "stable" category if assessments changed very little over time, or if they fluctuated widely, preventing the detection or confirmation of any trend.

(4) Lakes were assigned to the "unknown" category if they had little or no historical data or if fewer than three trophic state assessments had been performed during the monitoring period of record.

Table 21 summarizes the trophic condition of lakes assessed during the most recent 305(b) reporting cycle. Table 22 summarizes the results of the trend analyses performed for lakes with sufficient monitoring data.

Table 21. Trophic status of lakes during this reporting cycle

TROPHIC STATUS	NUMBER OF LAKES (number and percent total)		ACREAGE OF LAKES (acres and percent total)	
Argillotrophic	12	3.80	42,098	22.03
Oligomesotrophic	14	4.43	452	0.24
Mesotrophic	36	11.39	12,183	6.38
Slightly Eutrophic	49	15.51	28,165	14.74
Eutrophic	66	20.89	89,620	46.90
Very Eutrophic	44	13.92	13,974	7.31
Hypereutrophic	87	27.53	3,546	1.86
Dystrophic	0	0	0	0
Unknown	8	2.53	1,065	0.56
Totals	316	100.0	191,103	100.0

Table 22. Trophic state trends in lakes

CATEGORY	NUMBER OF LAKES		ACREAGE OF LAKES	
	COUNT	% TOTAL	ACRES	% TOTAL
Assessed for Trends	316	100.0	191,103	100.0
Improving	16	5.06	7,514	3.93
Stable	150	47.47	131,165	68.64
Degrading	43	13.61	47,087	24.64
Trend Unknown	107	33.86	5,337	2.79

Targeted Wetlands Assessment

Extent of Wetland Resources

Dahl (1990) estimated that Kansas historically contained 841,000 acres of wetlands but had lost about half this acreage by 1980. Similarly, a study conducted by the U.S. Fish and Wildlife Service concluded that Kansas retained only 435,400 acres of wetlands as of 1980 (WRAP, 1992). The state's remaining wetlands generally fall into one of the following descriptive categories: palustrine freshwater marshes, palustrine saltwater marshes, riparian wetlands, playas, or wet meadows.

Approximately 56,000 acres of wetlands were assessed by KDHE during the most recent 305(b) reporting cycle. This total included all state and federally administered public wetland areas, plus several wetlands owned or managed at the local level. It did not include any privately owned waterbodies, which account for a large share of the state's remaining wetland resources.

Integrity of Wetland Resources

Of the 55,969 acres (36 wetlands) assessed during the most recent reporting cycle, 45,066 acres (81%; 8 wetlands) were monitored by KDHE and the condition of an additional 10,903 acres (19%; 28 wetlands) was evaluated by the department using available information. Aquatic life support and secondary contact recreation traditionally have comprised the major designated uses of wetlands in Kansas. These uses were applicable to all wetlands monitored or evaluated by KDHE during the 2004–2009 reporting period.

Only about 103 acres of wetlands were deemed fully supportive of the aquatic life support use. In contrast, 6,035 acres were judged partially supportive and 40,749 acres were judged non-supportive of this use. The condition of additional 9,082 acres was considered "unknown" owing to insufficient data. In most cases, this categorical assignment was associated with a lack of standing water when the field surveys were conducted by KDHE.

Water quality conditions were deemed fully supportive of secondary contact recreation in 104 wetland acres, partially supportive in 6,034 acres, and non-supportive in 40,749 acres.

Conditions were fully supportive of food procurement in 43,592 acres and partially supportive in 3,295 acres. No assessed acreage was considered non-supportive of the food procurement use.

The primary causes of wetland impairment were nutrient enrichment and extreme trophic state, high turbidity levels, high pH levels, hydrological modifications, drought, and elevated selenium levels. The major sources of these impairments were agricultural runoff, hydrologic modifications, and natural processes related to drought.

Approximately 74.8% of the assessed wetland acreage was categorized as hypereutrophic, 0.8% as slightly-to-very eutrophic, 0.1% as mesotrophic, and 8.2% as argillotrophic. The remaining acreage (16.2%) was not assigned to a trophic category owing to insufficient data. With respect to trends in trophic condition, approximately 52% of the assessed acreage was characterized as stable over time, 27% as degrading over time, and 4% as improving over time. Trends for the remaining acreage (17%) could not be determined owing to insufficient data.

Development of Wetland Water Quality Standards

Wetlands are classified as "waters of the state" in the Kansas surface water quality standards. UAAs have been completed for all classified (publicly owned and/or publicly accessible) wetlands, and the results have been incorporated into the KSWR. Classified wetlands and classified lakes receive identical protection under the standards' narrative and numeric water quality criteria, antidegradation provisions, and related implementation procedures. Although EPA has promoted wetland-specific biocriteria, the development of definitive biocriteria is not feasible at this time.

Additional Lake/Wetland Protection and Assessment Activities

Wetland protection responsibilities are distributed among several agencies in Kansas. KDHE, KDWP, the Kansas Department of Agriculture, and the U.S. Army Corps of Engineers (ACOE) all participate in wetland protection and regulation activities. Kansas statutes direct KDHE and seven other state agencies to review proposed wetland development projects for possible environmental effects (K.S.A. 82a-325 *et seq.*).

In general, any agency, company, or person planning to physically alter a regulatory wetland must first file a CWA section 404 (dredge and fill) permit application with ACOE. These applications are routed to KDHE for CWA section 401 (water quality certification) purposes. The department determines the likely impact of the proposed action on water quality, then approves the action, approves it with modifications, or denies the action based on the projected impacts.

Another recent and noteworthy activity in Kansas has been the description of reference conditions for lakes and wetlands. Data from "minimally impacted" or "least impacted" waters have been used to define conditions that likely would occur in similar waterbodies in the absence of significant human perturbations. Reference determinations provide a valuable tool for establishing water quality restoration goals.

Using water quality data collected since the 1970s, the following general conclusions have been reached with respect to reference conditions in Kansas. Lakes with minimal pollutant loads can be expected to exhibit mesotrophic to slightly eutrophic conditions, low total nutrient concentrations, and high water clarity (Dodds *et al*., 2006). Wetlands can be expected to exhibit a trophic state in the low-to-mid eutrophic range, with low-to-moderate nutrient concentrations (KDHE, 2002).

303(d) Assessment Results

The Kansas 2010 303(d) list identifies 537 water quality impairments requiring the development of TMDLs. The complete list is included in the printed version of the integrated report submitted to EPA (Appendix B). This list also can be accessed by the public via the web at http://www.kdheks.gov/tmdl/methodology.htm.

PART D. GROUNDWATER

Kansas no longer maintains a statewide groundwater quality monitoring program, and funding for the renewal of such an enterprise appears unlikely in the near future. However, an earlier monitoring program (suspended in 2002 owing to budgetary constraints) routinely evaluated groundwater quality at more than 200 sites in Kansas. Individual wells in the monitoring network were sampled on a two-year rotational basis, with approximately half the wells being sampled in any given year. All wells in the network adhered to specific siting, depth, and construction criteria, and the network as a whole was deemed representative of the state's major aquifer systems. The program's surviving electronic database contains roughly 150,000 records spanning 120 different physical, chemical, and radiological parameters and 327 groundwater quality monitoring locations. Additional background information is presented in the program's QAPP and accompanying set of SOPs, last revised in December 2000 (KDHE, 2000; http://www.kdheks.gov/environment/qmp_2000/download/2007/GQMP_QAMP.pdf).

Some groundwater quality information continues to be gathered by KDHE through the efforts of its major regulatory bureaus. For example, the Bureau of Environmental Remediation routinely samples groundwater from the vicinity of nearly 200 abandoned landfills and groundwater remedial sites, 1,500 storage tank cleanup sites, and a few active surface mining operations. The Bureau of Waste Management obtains groundwater quality information from a few dozen active landfills and hazardous waste sites across the state. BOW requires a number of major NPDES permit holders to periodically submit data on groundwater quality. Examples include large CAFOs, meat processing facilities, electrical power plants, injection wells, and a few municipal WWTFs. Monitoring activities generally focus on surficial groundwater and/or a very limited set of analytical parameters. Although public drinking water supplies are monitored for a wide range of parameters pursuant to the federal Safe Drinking Water Act, samples are collected after treatment and do not reliably reflect the condition of the raw water source. These assorted monitoring operations are not intended to provide representative information on the state's major aquifer systems or to serve as a coordinated and comprehensive ambient groundwater quality monitoring program.

Summary tables pertaining to groundwater have been provided as follows:

Table 23. Summary of state groundwater protection programs

Programs or Activities	Check (X)	Implementation Status	Responsible State Agency
Active SARA Title III program	X	fully established	KDHE*
Ambient groundwater monitoring		(suspended)	(KDHE)
Aquifer vulnerability assessment	X	on going	KDHE*
Aquifer mapping	X	fully established	KGS
Aquifer characterization	X	on going	KGS
Comprehensive data management	X	on going	KDHE
EPA-endorsed Core Comprehensive State Groundwater Protection Program	X	under review	KDHE
Groundwater discharge permits	X	fully established	KDHE
Groundwater Best Management Practices	X	fully established	KDHE
Interagency coordination for groundwater protection initiatives	X	on going	KWO
NPS controls	X	fully established	KDHE*
Pesticide State Management Plan	X	EPA approved plan implementation proceeding	KDA
Pollution Prevention Program	X	fully established	KDHE
RCRA Primacy	X	fully established	KDHE
Source Water Assessment Program (SWAP)	X	fully established	KDHE
State Water Plan Orphan Sites	X	fully established	KDHE
State RCRA with more stringent requirements than RCRA Primacy	X	fully established	KDHE
State septic system regulations	X	fully established	KDHE
Underground Storage Tank (UST) installation requirements	X	fully established	KDHE
UST Remediation Fund	X	fully established	KDHE
UST Permit Program	X	fully established	KDHE
Underground Hydrocarbon Storage Well Program	X	fully established	KDHE
Underground Injection Control Program	X	fully established	KCC & KDHE
Vulnerability assessment for drinking water/wellhead protection	X	EPA approved plan implementation proceeding	KDHE
Well abandonment regulations	X	fully established	KDHE
Wellhead Protection Program	X	approved plan implementation proceeding	KDHE
Well installation regulations	X	fully established	KDHE

*principal administrative agency
KCC = Kansas Corporation Commission
KDA – Kansas Department of Agriculture
KGS – Kansas Geological Survey
KWO – Kansas Water Office

Table 24. Major sources of groundwater contamination

Ten Highest Priority Contaminant Sources	Factors Considered in Selecting a Contaminant Source	Types of Contaminants
Agricultural Activities: Chemical and grain facilities/applications	A,C,D	B,C,D,E
Animal feedlots	A,C,D,E	E,J
Storage and Treatment: Storage tanks (AST/LUST)	A,B,C,D	D
Surface impoundments	A,E	E,H
Disposal Activities: Landfills/illegal dumping	A,C,E	C,D,G,H
Other: Active/abandoned industrial facilities	A,B,C	B,C,D,E,G,H,I,M
Oil and gas activities	A,B,C,D	D,G,I
Pipelines and sewer lines	A,E	C,D,E
Salt water intrusion	B,C,E	G
Spills, trucking, rail	A,D	B,C,D,E,G,H

Factors Considered in Selecting a Contaminant Source:
(A) Human health and/or environmental risk (toxicity)
(B) Size of population at risk
(C) Location of sources relative to drinking water sources
(D) Number and/or size of contaminant sources
(E) Hydrogeologic sensitivity

Types of Contaminants:

(A) Inorganic pesticides	(F) Fluoride	(K) Protozoa
(B) Organic pesticides	(G) Salinity/brine	(L) Viruses
(C) Halogenated solvents	(H) Metals	(M) PCBs
(D) Petroleum compounds	(I) Radionuclides	
(E) Nitrate	(J) Bacteria	

Table 25 Groundwater contamination: statewide cumulative summary through 2009

Source Type	# of Kansas Sites	# of Sites with Confirmed Releases	# with Confirmed Groundwater Contamination	Primary Contaminants	# of Site Assess-ments	# of Sites with Source Removed	# of Sites with CAPs	# of Sites with Active Remediation	# of Sites with Cleanup Resolved
NPL	13	13	13	VOCs, metals	13	unavailable	0	8	4
CERCLIS (non-NPL)	86	86	11	VOCs, metals & PCBs	86	unavailable	1	66	55
DOD/FUDS	375	375	108	VOCs, metals, refined petroleum	375	unavailable	0	78	63
LUST	10,282	4,930	4,190	gasoline and diesel fuels	10,282	unavailable	not applicable	346	8,743
RCRA Corrective Action	34	34	34	VOCs, metals & semi-volatiles					
Solid Waste Landfills	167	26	26	VOCs	165	not applicable	5	5	0
Underground Injection *	32	0	0	-	0	0	0	0	0
Underground Hydrocarbon Storage Wells	10	0	0	-	0	0	0	0	465
State Sites **	1,699	1,697	909	VOCs, metals, refined petroleum	1,699	unavailable	36	515	565
NPS	unknown								

CAPs - Corrective Action Plans
CERCLIS - Comprehensive Environmental Response, Compensation, and Liability Information System (Includes non-NPL Management Assistance (CERCLA Lead and Supefund sites)
DOD/FUDS - Department of Defense/Formerly Used Defense Sites
LUST - Leaking Underground Storage Tanks
NPL - National Priority List NPS - Nonpoint Source RCRA - Resource Conservation and Recovery Act*
* Represents Class I and III injection wells and hydrocarbon storage sites, but does not include Class II brine injection wells.
** Numbers do not include sites under KCC jurisdiction or LUST sites.

PART E. PUBLIC PARTICIPATION

As required by federal regulation and the Kansas Continuing Planning Process, the 2010 303(d) list and associated methodology were subjected to public review through a variety of venues. Formal public notice of the list was made via the Kansas Register on January 21, 2010. This notice included a link to the KDHE TMDL website, from which interested parties were able to review or download the entire 303(d) list and a detailed description of the developmental methodology. During February and March, 2010, KDHE convened four public hearings to solicit comments on the proposed list. These hearings were held in Mound City, Bern, Hutchinson, and Great Bend in conjunction with Basin Advisory Committee (BAC) meetings.

The public comment period for the proposed list was held open until March 19, 2010. KDHE received only two formal letters of comment. The first, from Friends of the Kaw, expressed a concern about elevated levels of fecal bacteria in the lower Kansas River and recommended that more aggressive enforcement actions be taken to address this issue. The second letter, from EPA Region VII, commented on the use of screening values for assessing/listing impairments related to total phosphorus and total suspended solids. It warned that screening values should not be construed as applicable or appropriate water quality criteria. The letter also outlined the elements comprising a complete 303(d) submittal package. These elements included data, documentation, methodologies, priorities, and schedules. KDHE concurred with the stipulated elements and confirmed that the screening values for total phosphorus and total suspended solids were developed solely for 303(d) listing purposes.

KDHE also met with members of the Marais des Cygnes, Missouri, Lower Arkansas, and Upper Arkansas BACs. Members of the Cimarron BAC were briefed via written memorandum. These various advisory committees consisted of individuals having an interest in water resource issues and representing various uses of water (public water supply, irrigation, recreation, etc.). BACs represent the primary local forums for water planning and policy development under the Kansas Continuing Planning Process. Their members work closely with KDHE to establish priorities in relation to the 303(d) listing process and the implementation of TMDLs.

KDHE also briefed several WRAPS groups representing the river basins coming into rotation during 2010–2012. As discussed previously, these groups work closely with the State to plan and implement water quality management/improvement projects at the watershed level.

Based on the proposed 2010 303(d) list, it is projected that as many as 30 TMDLs will be developed during the upcoming assessment cycle (2010–2012). Work will focus on water quality impairments in the Kansas/Lower Republican, Missouri, Marais des Cygnes, Lower Arkansas, Upper Arkansas, and Cimarron river basins. The next (2012) 303(d) review will evaluate the TMDLs developed and implemented from 1999 through 2003 and the possible need for additional de-listings. This review likely will result in other updated listings for waterbodies located in southeastern and northwestern Kansas.

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Appendix A.

List of Parameters

Stream Chemistry Monitoring Program

Core Composite and Inorganic Parameters

Alkalinity, total (as $CaCO_3$)
Aluminum, total recoverable
Ammonia, total (as N)
Antimony, total recoverable
Arsenic, total recoverable
Barium, total recoverable
Beryllium, total recoverable
Boron, total recoverable
Bromide
Cadmium, total recoverable
Calcium, total recoverable
Carbon, total organic
Chloride
Chromium, total recoverable
Cobalt, total recoverable
Copper, total recoverable
Dissolved oxygen
Fluoride
Hardness, total (as $CaCO_3$)
Iron, total recoverable
Kjeldahl nitrogen
Lead, total recoverable
Magnesium, total recoverable
Manganese, total recoverable
Mercury, total
Molybdenum, total recoverable
Nickel, total recoverable
Nitrate (as N)
Nitrite (as N)
pH (field)
Phosphate, ortho- (as P)
Phosphorus, total (as P)
Potassium, total recoverable
Selenium, total recoverable
Silica, total recoverable
Silver, total recoverable
Sodium, total recoverable
Specific conductance
Strontium, total recoverable
Sulfate
Thallium, total recoverable
Total dissolved solids (calculated)
Total suspended solids
Turbidity
Vanadium, total recoverable
Zinc, total recoverable
Temperature (field)
Uranium, total recoverable

Stream Chemistry Monitoring Program - continued

Core Organic Parameters

Acetochlor	p,p'-DDD	Metribuzin (Sencor)
Alachlor	p,p'-DDE	PCB-1016
Aldrin	p,p'-DDT	PCB-1221
Atrazine (Aatrex)	Dieldrin	PCB-1232
alpha-BCH	Endosulfan I	PCB-1242
beta-BCH	Endosulfan II	PCB-1248
delta-BCH	Endosulfan sulfate	PCB-1254
gamma-BCH (Lindane)	Endrin	Picloram (Tordon)
Butachlor	Heptachlor	Propachlor (Ramrod)
Carbofuran (Furadan)	Heptachlor epoxide	Propazine (Milogard)
Chlordane	Hexachlorobenze	Simazine
Cyanazine (Bladex)	Hexachlorocyclopentadiene	2,4,5-T as acid
2-4-D as acid	Methoxychlor	2,4,5-TP as acid (Silvex)
DCPA (Dacthal)	Metolachlor (Dual)	Toxaphene

Supplemental Organic Parameters

Bromacil
Chlorophyll-a
Chlorpyrifos (Dursban)
Deethylatrazine
Deisoproplyatrazine
Diazinon
Pentachlorophenol
Pheophytin-a
Prometon (Pramitol)

Core Microbiological Parameters

Escherichia coli (*E. coli*)

Stream Chemistry Monitoring Program - continued

Supplemental Radiological Parameters

Actinium-228
Americum -241
Antimony-125
Barium-140
Beryllium-7
Cerium-141
Cerium-144
Cesium-134
Cesium-136
Cesium-137
Chromium-51
Cobalt-57
Cobalt-58
Cobalt 60
Gallium 67
Gross alpha
Gross beta
Indium-111
Iodine-123
Iodine-131
Iodine-132
Iodine-133
Iron-59
Lanthanum-140
Manganese-54
Molybdenum-99
Neodymium-147
Neptunium 239
Niobium 95
Potassium 40
Radium-226
Ruthenium-103
Ruthenium-106
Technetium-99m
Thorium-228
Tritium
Ytterbium-169
Zinc-65
Zirconium-95

Field Measurements

pH
Specific conductance
Temperature

Lake Monitoring Program

Core Composite and Inorganic Parameters

Alkalinity, total
Aluminum
Ammonia
Antimony
Arsenic
Barium
Beryllium
Boron
Bromide
Cadmium
Calcium
Chloride
Chromium
Cobalt
Copper
Fluoride
Hardness, total
Iron
Kjeldahl nitrogen
Lead
Magnesium
Manganese
Mercury
Molybdenum
Nickel
Nitrate
Nitrite
Ortho-phosphate
pH
Phosphorus, total
Potassium
Selenium
Silica
Silver
Sodium
Specific conductance
Strontium
Sulfate
Thallium
Total dissolved solids
Total organic carbon
Total suspended solids
Turbidity
Vanadium
Zinc

Core Organic Parameters

2,4-D
2,4,5-T
Acetochlor
Alachlor
Aldrin
Atrazine
Butachlor
Carbofuran (Furadan)
Chlordane
Cyanazine (Bladex)
DCPA (Dacthal)
p,p'-DDD
p,p'-DDE
p,p'-DDT
Deethylatrazine (breakdown product)
Deisopropylatrazine (breakdown product)
Dieldrin
Endosulfan I & II
Endosulfan sulfate
Endrin
Alpha BHC
Beta BHC
Gamma BHC (Lindane)
Delta BHC
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorocyclopentadiene
Methoxychlor
Metolachlor (Dual)
Metribuzin (Sencor)
PCB-1016
PCB-1221
PCB-1232
PCB-1242
PCB-1248
PCB-1254
PCB-1260
Picloram (Tordon)
Propachlor (Ramrod)
Propazine (Milogard)
Silvex (2,4,5-TP)
Simazine
Toxaphene

Core Microbiological Parameters
Escherichia coli (*E. coli*)

Lake Monitoring Program – continued

Miscellaneous Core Parameters

Algal taxonomy*
Chlorophyll-a
Dissolved oxygen
Macrophyte abundance*
Phaeophytin-a
Photosynthetically active radiation (PAR)*
Secchi depth*
Temperature
Total inorganic carbon (by calculation)

* not a chemical analysis

Fish Tissue Monitoring Program

Fillet Analysis

Core Inorganic Parameters

Cadmium
Lead
Mercury
Selenium

Core Organic Parameters

p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
gamma-Hexachlorocyclohexane (BHC)
PCB-1248
PCB-1254
PCB-1260
Pentachloroanisole
Technical Chlordane
    Oxychlordane
    cis-Chlordanet
    trans-chlordane
    cis-Nonachlor
    trans-Nonachlor
Trifluralin (Treflan)

Fish Tissue Monitoring Program – continued

Whole-fish Analysis

Core Inorganic Parameters

Cadmium
Lead
Mercury
Selenium

Core Organic Parameters

1,2,4,5 -Tetrachlorobenzene
p,p'-DDD
p,p'-DDE
p,p'-DDT
Dieldrin
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
gamma-Hexachlorocyclohexane (BHC)
Mirex
PCB-1248
PCB-1254
PCB-1260
Pentachloroanisole
Pentachlorobenzene
Technical Chlordane
Trifluralin (Treflan)

APPENDIX B.

2010 303(d) List of Impaired Waters

The list can be accessed by the public via the web at

http://www.kdheks.gov/tmdl/methodology.htm.

APPENDIX C.

Kansas 2010 CWA Section 314(a) Report

Summary

This document satisfies various water quality reporting requirements placed on the State of Kansas by section 314(a) of the federal Clean Water Act (CWA). Specifically, it addresses the contemporary status of publicly owned and/or publicly accessible lakes within the state, evaluates historical trends in water quality, and identifies water pollution control measures and lake restoration programs currently being implemented in Kansas. Section 314(a) also requires the development of a list of lakes known to suffer from water quality impairments. This list is provided in the preceding Appendix B.

Table C.1 summarizes the results of aquatic life use support (ALUS) assessments performed on lakes by the Kansas Department of Health and Environment (KDHE). Contemporary water quality conditions were assessed using water chemistry and biological data obtained during the summers of 2004–2009. Historical trends in water quality were assessed using biological data extending further back in time, in many instances to the mid 1980s.

Table C.1. ALUS assessment results for lakes in Kansas

Degree of Support	Acres Assessed Using Biological Habitat Data Only	Acres Assessed Using Physico-Chemical Data Only	Acres Assessed Using Biological and Physico-Chemical Data	Total Acres Assessed for ALUS
Insufficient Data	0	0	0	102
Fully Supported	0	0	114,605	114,605
Fully Supported But Threatened	0	0	11,106	11,106
Partially Supported	0	0	61,002	61,002
Not Supported	0	0	4,288	4,288

Table C.2 presents information on the total number and acreage of lakes impacted by identifiable sources of pollution, and on the total number and acreage of lakes lacking identified use impairments. Most of the state's smaller lakes exhibit impairments related to nonpoint sources, whereas many larger lakes are impacted by a combination of point and nonpoint sources. The values given in Table C.2 represent any level of point source-related impairment and any magnitude and combination of nonpoint source-related impairment. Some lakes have both source types within their watersheds, preventing meaningful summation of the two numerical columns in the table.

Table C.2. Lake impairments related to point sources and/or nonpoint sources

Pollution Source	Lake Number	Lake acreage
Point Sources	25	147,741
Nonpoint Sources	248	171,347
No Identifiable Pollution Sources	68	19,756

Background

A total of 316 publicly owned and/or publicly accessible lakes were assessed by KDHE during the most recent 314(a) reporting cycle. This represented all such lakes known to KDHE through previous monitoring activities or through the publications of other natural resource agencies, most notably the Kansas Department of Wildlife and Parks (KDWP) and the U.S. Army Corps of Engineers (ACOE). The assessed lakes comprised a total surface area of 191,103 acres at normal conservation pool levels. In Kansas, lakes with shorelines under common private ownership generally are considered private waterbodies. Pursuant to the Kansas surface water quality standards, however, some may be listed as classified waterbodies if they represent public drinking water supplies or are open to the general public for recreational use (KAR, 2004).

In this report, all classified lakes, reservoirs, and ponds are regarded as significant public waterbodies. This acknowledges that any standing (or "lentic") waterbody that is owned by, or accessible to, the general public will provide benefits to the general population (*e.g.*, recreational and water supply benefits). These waterbodies also provide habitat for indigenous aquatic and semi-aquatic organisms, such as fish and migratory waterfowl. Except for wetlands, this report labels all lentic waterbodies as "lakes" to avoid the semantics involved in distinguishing among naturally occurring lakes and artificially constructed reservoirs and ponds.

Trophic Status

Trophic state classifications for lakes in Kansas are based primarily on planktonic chlorophyll-a concentrations, corrected for phaeophytin-a and averaged over the entire monitoring period of record. This approach acknowledges that planktonic algal biomass forms the base of the typical lacustrine food web. Aquatic macrophytes and epiphytic algae also contribute to biological production but rarely comprise a large portion of the lacustrine food web base. Therefore, lake trophic state assignments in Kansas seldom require adjustment for macrophytic production and/or epiphytic algal production.

Mean chlorophyll-a concentration provides an excellent indicator of lake primary productivity and production. In addition, high algal biomass often can diminish a lake's aesthetic appeal, reduce its recreational value, increase the costs of producing potable water, and interfere with other water supply uses (*e.g.*, irrigation and livestock watering). Accordingly, trophic state provides a useful indicator for assessing a lake's use support status.

In many Midwestern lakes, accelerating rates of sedimentation often accompany the eutrophication process. Available monitoring data allow for only a rough assessment of sedimentation impacts in Kansas. In most instances, water quality impacts related to sedimentation are inferred from shoreline weathering, influent stream observations, watershed land use configuration, and the general turbidity of the lake in question. If high turbidity seems to pose a chronic problem, trophic state may be assigned on the basis of nutrient concentrations and turbidity levels rather than chlorophyll-a concentrations.

For the purposes of this 314(a) assessment, mean chlorophyll-a values for a given lake have been converted to a corresponding trophic state class using the approach of Carlson (1977). This approach employs the following scale, where TSI refers to trophic state index (as determined by mean chlorophyll-a concentration):

Oligomesotrophic	TSI < 40
Mesotrophic	TSI 40 to 49.99
Eutrophic	TSI 50 to 63.99
Slightly Eutrophic	TSI 50 to 54.99
Fully Eutrophic (Eutrophic)	TSI 55 to 59.99
Very Eutrophic	TSI 60 to 63.99
Hypereutrophic	TSI >63.99
Lower Hypereutrophic	TSI 63.99 to 69.99
Upper Hypereutrophic	TSI >69.99

In addition, KDHE has applied two additional trophic state classes in this 314(a) assessment:

Argillotrophic Waterbody is chronically light-limited and nutrient rich, resulting in artificially low algal biomass and chlorophyll-a concentrations.

Dystrophic Waterbody is highly colored by humic/organic dissolved matter, potentially resulting in lower than expected chlorophyll-a concentrations. Dystrophic lakes are rare in Kansas.

The eutrophic class is divided into three sub-classes to better describe the expected levels of use impairment. The hypereutrophic class is divided into two sub-classes for the same reason. In distinguishing among the hypereutrophic sub-classes, blue-green algal (cyanophycean) dominance is considered by KDHE and ultimately factored into the use support assessments. Table C.3 summarizes the lake trophic state assignments made during this 314(a) reporting cycle.

Table C.3. Trophic status summary for lakes in Kansas

Trophic Status	Lake Number and Percentage		Lake Acreage and Percentage	
Argillotrophic	12	3.80	42,098	22.03
Oligomesotrophic	14	4.43	452	0.24
Mesotrophic	36	11.39	12,183	6.38
Slightly Eutrophic	49	15.51	28,165	14.74
Eutrophic	66	20.89	89,620	46.90
Very Eutrophic	44	13.92	13,974	7.31
Hypereutrophic	87	27.53	3,546	1.86
Dystrophic	0	0	0	0
Unknown	8	2.53	1,065	0.56
Totals	316	100.0	191,103	100.0

A majority of the assessed lakes fell into the slightly-to-fully eutrophic and upper hypereutrophic classes, whereas most lake acreage was assigned to the slightly-to-fully eutrophic and argillotrophic classes. These findings reflect the fact that most lakes in Kansas are relatively small and shallow and are impacted rather strongly by pollution sources (on a watershed acreage-to-lake acreage basis). Also, several large lakes in the state are located on rivers that import a great deal of eroded sediment. These lakes are chronically turbid and generally assigned to the argillotrophic class.

Owing to insufficient data, nearly 3% of the lakes assessed during this reporting cycle could not be assigned confidently to a particular trophic state class. These lakes comprised less than 1% of the assessed lake acreage.

Pollution Control Methods

To prevent or reverse water pollution problems in lakes throughout Kansas, KDHE offers technical advice and limited technical support. The department also provides limited financial support in the form of CWA section 319 grants. Most grants are awarded to promote public awareness and to implement watershed best management practices (BMPs).

The KDHE Bureau of Environmental Field Services (BEFS) has operated a technical assistance program for water supply lakes since 1989. To date, about 160 investigations have been undertaken by the bureau. Most have dealt with drinking water supply taste and odor problems, algal blooms, fish kills, or related public health concerns. BEFS's role in many of these investigations has focused on the provision of taxonomic (algal identification) assistance to drinking water purveyors and lake managers.

BEFS also maintains a lake and wetland water quality monitoring program to help the State of Kansas meet various environmental surveillance and reporting requirements set forth in the

CWA (*e.g.*, sections 303(d), 305(b), 314(a)). This program has been in place since 1975 and provides a near-census of the state's classified lake acreage. Water quality data obtained through this program have supported the development of numerous water quality models of interest to lake managers. Moreover, these data have facilitated the tracking of long-term trends in water quality on a statewide basis.

Past lake restoration projects in Kansas depended primarily on Clean Lakes Program (CLP) awards from the U.S. Environmental Protection Agency (EPA). Responsibilities related to funding have been transferred effectively to the KDHE Bureau of Water (BOW), which maintains a nonpoint source pollution control program supported largely by CWA section 319 grants. However, even with the availability of section 319 pass-through monies, lake restoration projects in the state have been reduced markedly in overall scope. In the past, cost-match requirements were imposed on communities, and this often reduced the level of interest in CLP projects. This problem is perhaps even more pronounced under the current, section 319-based funding approach.

BOW also provides guidelines for the construction of new water supply lakes in Kansas. Recommendations include: the use of fences to keep cattle at least 15 feet from the high water mark; a prohibition on the direct discharge of treated or untreated wastewater to any water supply lake; a prohibition on the placement of wastewater facilities, septic tanks, or sanitary sewers within 200 feet of the high water mark; and the assessment of the pollution potential of any watershed draining into a planned water supply lake. When reviewing Natural Pollutant Discharge Elimination System (NPDES) discharge permits and setting effluent limits, a discharging facility's proximity to a water supply lake is considered carefully by BOW.

The Kansas Department of Wildlife and Parks (KDWP) also provides lake technical assistance to resource managers and interested citizens. Most of this agency's efforts are geared toward fisheries management rather than improvements in surface water quality. Some common fisheries practices (*e.g.*, use of grass carp, *Ctenopharyngodon idella*, for plant control; use of mechanical devices to aerate or destratify lakes) can exacerbate existing water quality problems.

Lake Restoration and Rehabilitation Efforts

Several lake restoration techniques have been applied in Kansas, but the efficacy of most has not been documented carefully in the peer-reviewed scientific literature. Two common practices involve the use of copper sulfate for algal control and grass carp for macrophyte control. KDHE has tended to discourage both practices. Applied copper often accumulates in the bottom sediments posing long-term water quality concerns. The feeding action of grass carp can both reduce water clarity (through direct agitation of bottom sediments and exposure of shallow sediments to wind and wave action) and increase algal abundance (through remineralization of the nutrients contained in macrophytes).

Established macrophyte beds are important for maintaining the health of lakes in Kansas. Fortunately, at least two aquatic herbicides registered for use in Kansas have selective control capabilities for the nuisance exotic plant, Eurasian watermilfoil (*Myriophyllum spicatum*). As Eurasian watermilfoil continues to expand into lakes throughout Kansas, the use of these new

herbicides (fluridone and triclopyr) may supplant grass carp as the preferred control technique. Currently, 15–20% of the lakes monitored by KDHE are infested with Eurasian watermilfoil.

KDWP also engages in lake restoration and rehabilitation, primarily for fisheries management purposes. For example, discarded Christmas trees are used to augment fish shelter in many lakes throughout the state, and water levels are manipulated to maximize fish spawning habitat and encourage waterfowl production. KDWP annually submits water level adjustment plans for the state's larger federal lakes to the Kansas Water Office. These plans are subject to public review and ultimately must be reviewed and approved by the ACOE.

Mechanical aeration is another widely applied lake restoration technique. Unfortunately, this technique usually is implemented without adequate study to determine whether water column aeration/mixing will positively impact water quality. KDHE strongly discourages the use of aerators unless (1) a properly conducted study has concluded that the action will improve water quality and (2) the condition being addressed cannot be resolved using other, less damaging restoration techniques.

Adherence to BMPs constitutes the most effective and efficient means of protecting and restoring lake water quality in Kansas. BMPs address a wide range of human activities, and many BMPs are applicable to both agricultural and urban settings. Some of the more important structural practices relate to the installation and maintenance of: vegetated buffer strips along streams and shorelines; stormwater runoff diversion/holding structures in some urban and concentrated livestock settings; sediment retention ponds above larger lakes; and treatment wetlands below urban areas and some agricultural operations. Most structural BMPs are installed under the auspices of the Natural Resource Conservation Service (NRCS) and local conservation districts, often in cooperation with KDHE and/or KDWP. Non-structural BMPs generally relate to grazing, cropping, and fertilizer and biocide application practices.

NPDES permits for wastewater treatment facilities and confined animal feeding operations sometimes are modified by KDHE to protect and restore lake water quality. The existing and potential impact of these facilities/operations on downstream waters is considered during permit review and the accompanying public participation process.

Dredging is another option for restoring smaller lakes. Owing to funding constraints, however, comparatively few dredging projects have been attempted in the state. Such projects have become even less common since the mid 1990s, when Congress ceased funding the CLP. KDHE is aware of only two recent dredging projects in Kansas, one in Plainville Lake (Rooks County) and the other in Mission Lake (Brown County).

From approximately 1980–1997, when CLP (Phase 1) funds were available for lake diagnostic studies and restoration projects, watershed restoration measures were implemented at the following Kansas lakes (total surface area = 1,367 acres):

Ford County Lake (Ford County)
Sabetha City Lake (Nemaha County)
Lake Afton (Sedgwick County)

Olathe Lake (Johnson County)
Chanute Santa Fe Lake (Neosho County)
Nemaha County State Fishing Lake (Nemaha County)
Herington Reservoir (Dickinson County)
Rimrock Lake (Riley County)
Mary's Lake (Douglas County)

Only Lone Star Lake (Douglas County) and Ford County Lake were eventually dredged under the auspices of Phase 2 of the CLP. These two lakes comprised 243 surface acres.

As mentioned previously, the BOW nonpoint source program provides pass-through funds to communities and other entities pursuant to section 319 of the CWA. Under this program, lake restoration initiatives in the state have focused primarily on watershed improvements (*e.g.,* BMP implementation) rather than on dredging and other in-lake treatments.

Impaired and Threatened Lakes

Table C.4 summarizes the overall use support ratings for lakes assessed during this 314(a) reporting cycle. Table C.5 partitions these ratings by individual designated uses. About 93% of the reported lake acres were monitored for the entire suite of physical, chemical, and biological parameters common to KDHE lake surveys. Also, during the past five years, all lakes listed in the Kansas surface water register were subjected to formal UAAs. Some of the smaller lakes were not represented in the routine monitoring network, and in such cases the UAA data were used to evaluate compliance with water quality criteria and use support thresholds.

Table C.4. Summary of use support ratings for lakes in Kansas

Degree of Use Support	Assessment Category		Total Assessed Acreage
	Evaluated	Monitored	
Insufficient Data	530	0	530
Fully Supporting of All Uses	2,488	14,490	16,978
Threatened for One or More Uses (But Not Impaired for Any Uses)	243	2,005	2,248
Impaired for One or More Uses	11,105	160,242	171,347
Total Size Assessed	14,366	176,737	191,103

Table C.5. Support summary for individual uses in Kansas lakes (in acres**)**

Goals	Use	Size Assessed	Fully Supporting	Full Support but Threatened	Partially Supporting	Non Supporting	Insufficient Data
Protect and Enhance Ecosystems	Aquatic Life (acute criteria)	191,103	114,605	11,106	61,002	4,288	102
Protect and Enhance Public Health	Fish Consumption+	191,103	190,071	0	369	641	22
	Shellfishing	*	*	*	*	*	*
	Primary Contact	190,976	32,663	8,574	145,691	3,968	80
	Secondary Contact	191,103	119,017	11,110	57,066	3,808	102
	Domestic Water Supply	189,323	22,173	4,998	112,172	49,450	530
Social and Economic Enhancement	Irrigation	190,468	145,190	20,507	20,852	3,389	530
	Livestock Water Supply	190,483	149,583	20,510	15,732	4,128	530
	Cultural	*	*	*	*	*	*

* = Category not applicable.

+ = Based on food procurement criteria for water as well as fish tissue analysis. During the 2004–2009 time period, 50 lakes, comprising 133,048 acres, were also assessed for fish tissue burdens of heavy metals, PCBs, and pesticides.

Table C.6 summarizes the major and minor causes of water quality impairment documented during this reporting cycle. Table C.7 presents the corresponding information for sources of impairment. Major causes of non-support for lakes, in order of prevalence, were zebra mussel infestations, siltation, nutrient enrichment, and taste and odor problems stemming primarily from nutrient enrichment and excessive algal growth. Sources primarily responsible for pollutant loadings and/or use impairments included non-native species introductions, general agriculture, and discharges from municipal wastewater treatment facilities.

Of the 176,737 monitored lake acres, 14,624 acres (8.3%) exhibited some level of impairment from heavy metals and/or pesticides (*i.e.*, toxic parameters). Of the 14,366 evaluated lake acres, 6,528 acres (45.4%) exhibited some level of impairment due to the samee parameters. These findings were similar to the results presented in previous 314(a) reports.

During this reporting cycle, the zebra mussel (*Dreissena polymorpha)* continued to expand its distribution in Kansas. As of December 2009, populations of this invasive bivalve had been documented in eight lakes, totaling 62,806 acres (33% of reported lake acreage). This is approximately twice the acreage indicated in the 2008 314(a) report. Zebra mussels have the capacity to injure native fish and shellfish populations and to reduce the fitness of surface waters for recreational and drinking water supply uses (KDWP, 2005)

Table C.6 Lake acreage impacted by various cause categories

Cause Category	Impaired Lake Acreage	
	Major Impairment	Minor Impairment
Cause Unknown	0	0
Pesticides (atrazine)	112	5,284
Heavy Metals (arsenic)	0	9,232
Heavy Metals (copper)	0	282
Heavy Metals (lead)	0	1,029
Heavy Metals (selenium)	0	8,572
Heavy Metals (mercury)	0	232
Fluoride	11	5,325
Boron	0	0
Nutrients and Eutrophication	32,837	136,725
pH (high)	233	820
pH (low)	0	13
Siltation and Turbidity	43,027	16,803
Low Dissolved Oxygen	0	13,479
Chloride	0	15,990
Sulphate	638	40,644
Flow Alterations	633	3,588
Pathogen Indicators	0	0
Taste and Odor	29,244	0*
Aquatic Plants	146	253
Zebra Mussels	62,806	0
Perchlorate	128	0

* = Taste and odor incidents that might be characterized as "moderate/minor" often are not brought to the attention of KDHE. Therefore, all documented acreage for this cause category is reported as "major." Moderate/minor incidents are believed to be numerous, based on the number of algal blooms observed in Kansas lakes during the summer months.

Table C.7. Lake acreage impacted by various source categories

Source Category	Impaired Lake Acreage	
	Major Impairment	Minor Impairment
Municipal Point Sources	25,600	122,141
Agriculture	34,391	122,092
Urban	964	12,487
Resource Extraction	0	1,037
Hydromodification	3,533	7,213
Atmospheric Deposition	0	232
Natural Sources	554	41,232
In-Lake Management (grass carp only)	104	153
Resuspension	9,705	269
Introductions of Non-Native Organisms	62,806	0
Unknown	0	0

Acid Effects on Lakes

Approximately 190,038 acres of lakes in Kansas were monitored or evaluated for pH. This accounted for 99.4% of the lake acreage considered in this 314(a) report. Nearly all water quality impacts related to high pH occurred when lakes were over-enriched with nutrients and suffered from accelerated eutrophication rates and advanced trophic conditions.

Only two lakes exhibited an epilimnetic pH below 6.5 units. These lakes were located in the Mined Land Lakes Recreational Area of southeastern Kansas, in basins created by former strip mines. Many decades have passed since this area was actively mined for coal. Some lakes in the region have been treated sporadically with lime to prevent low pH problems. Anecdotal accounts suggest that a few privately owned strip pit lakes continue to exhibit low pH.

In Kansas, the lack of widespread acidification problems is attributable largely to the region's modest level of industrialization, relatively good air quality, and prevailing limestone geology. With respect to the latter factor, much of this region is underlain with calcareous bedrock and contains soils derived from the weathering of this bedrock. Therefore, the state has some natural defense against the atmospheric deposition of acids and acid precursors.

Trends in Water Quality

Trends in water quality are difficult to determine for individual lakes in Kansas, owing primarily to a traditional emphasis on the performance of regional or statewide assessments rather than intensive, site-specific studies. However, lake trophic status appears to provide the best long-term indicator of water quality and has been used by KDHE for 314(a) assessment purposes for

many years. In this report, trend analyses for individual lakes have been performed only if the waterbodies have undergone three or more trophic state assessments since the inception of lake monitoring activities. These analyses have involved the following considerations:

(1) If there was an evident decrease in trophic state over time, the lake was assigned to the "improving" category.

(2) If there was an evident increase in trophic state over time, the lake was assigned to the "degrading" category.

(3) Lakes were assigned to the "stable" category if assessments changed very little over time, or if they fluctuated widely, preventing the detection or confirmation of any trend.

(4) Lakes were assigned to the "unknown" category if they had little or no historical data or if fewer than three trophic state assessments had been performed during the monitoring period of record.

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Table C.8 summarizes the results of the trend analyses performed for lakes with sufficient monitoring data.

Table C.8. Trends in the trophic status of lakes in Kansas

Category	Lake Number and Percentage		Lake Acreage and Percentage	
Assessed for Trends	316	100.0	191,103	100.0
Improving	16	5.06	7,514	3.93
Stable	150	47.47	131,165	68.64
Degrading	43	13.61	47,087	24.64
Trend Unknown	107	33.86	5,337	2.79

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