

# Kansas Nutrient Reduction:

## Where We Came From, Where We Took It, Where We're Going

76<sup>th</sup> Annual KU Environmental Engineering Conference

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# Kansas Nutrient Reduction: Where we came from

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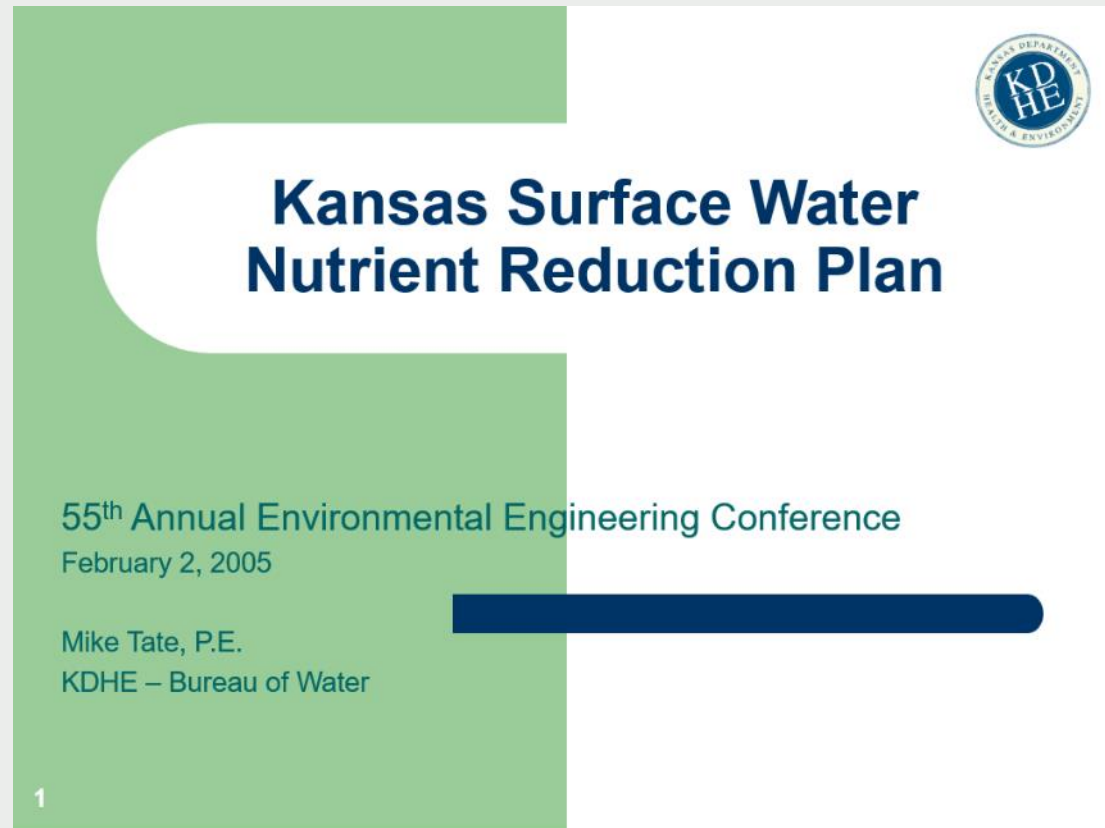
April 15, 2026



**T8 Environmental LLC**

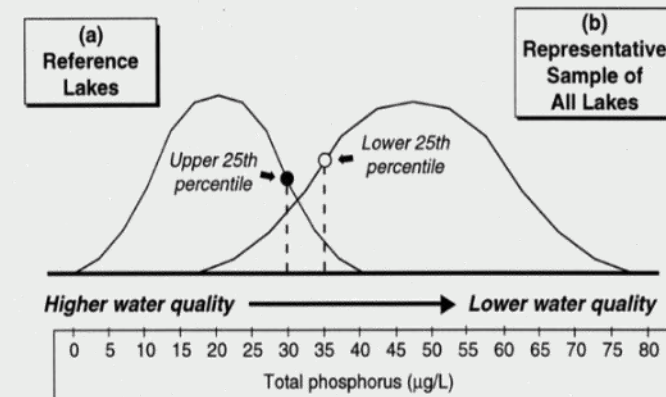
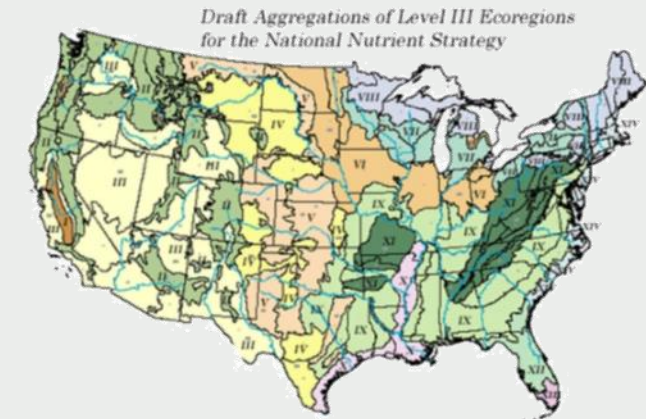
# Spoiler Alert

- 55<sup>th</sup> Annual KU Conference played a key role in KS nutrient reduction
  - Story to follow later



# What Spurred KS Nutrient Reduction Plan?

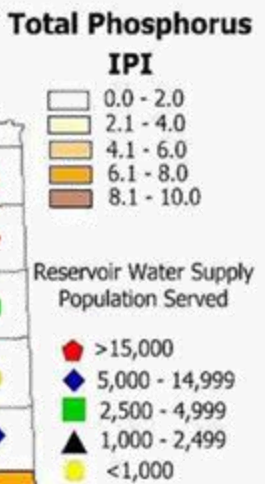
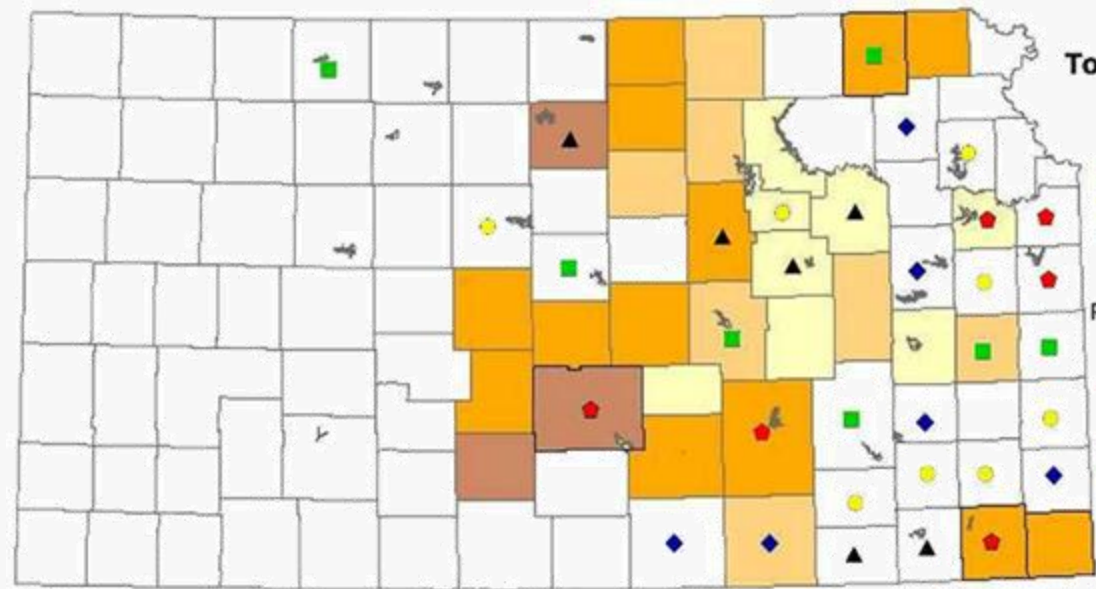
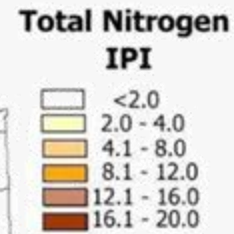
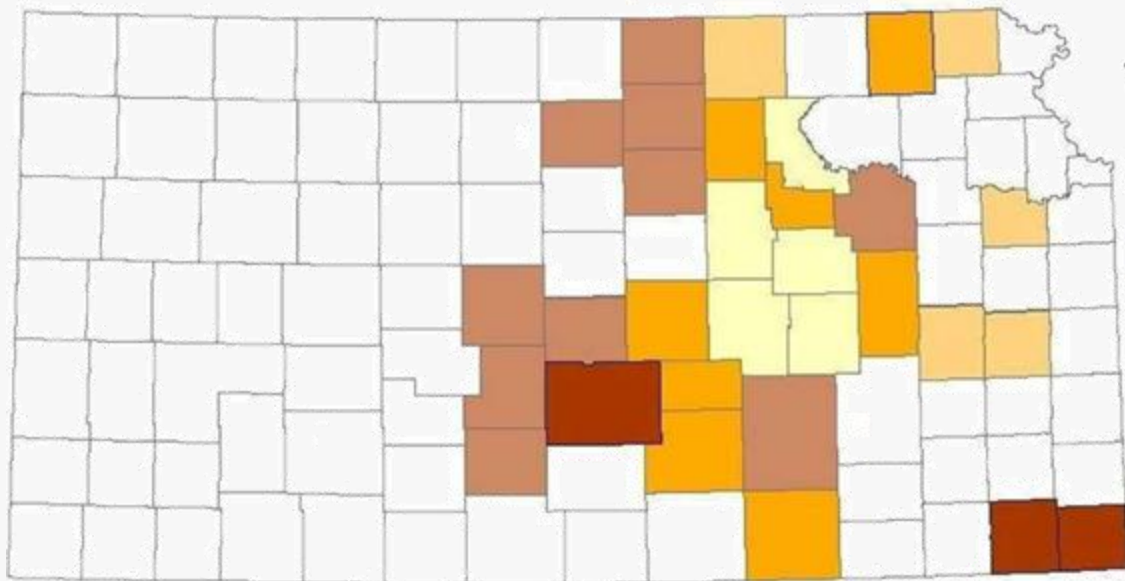
- 2001 EPA – states must develop a nutrient WQ criteria plan by 2004
  - Most did; most did not meet development targets
- EPA developed “ecoregional” criteria
  - Statistical exercise - Unlike other WQC
    - Numbers were generally very low
      - Much lower than POTWs could reasonably achieve
  - What does criteria mean for POTWs?
    - Compliance schedules that could not be met?
      - Possibly for decades?



# KS Surface Water Nutrient Reduction Plan

- In KS, we wrote a *"Surface Water Nutrient Reduction Plan"*
  - Technology-based permit limits for major POTWs
  - Industry-specific limits depending on waste stream
  - Focus money on key watersheds for nonpoint sources – ranked by:
    - Improvement Potential Index (IPI)
      - Presence/magnitude of reservoirs with public water supply intakes
      - Phosphorus fertilizer use
      - Excess on-farm manure phosphorus quantity
      - Nitrogen fertilizer use
      - Nitrogen fertilizer transport potential
      - Excess on-farm manure nitrogen quantity

# Improvement Potential Indices



# The Plan – A Few More Specifics

- POTWs  $\geq 1$  MGD – Utilize BNR
  - TN goal 8 mg/L and TP goal of 1.5 mg/L
  - 15-year phase in period, or when major upgrade occurs
- Industrial treaters with significant TN/TP discharge
  - Engineering studies costing out various reduction levels
- NPS
  - Utilize nutrient-based TMDLs
  - Protect drinking water reservoirs
  - Target activities based on county-established IPIs – TN/ TP

# Why Was KS So Contrarian?

- Most states viewed solely through a water quality standard lens
  - KS looked at through an implementation lens
    - The goal was to make WQ progress in a reasonable, cost-effective manner
  - KS understood nutrients were a vexing water quality problem
    - Wanted to make a serious effort to reduce – more than a paper exercise
    - At the same time understood in KS it was primarily a NPS issue, and
    - Understood water quality criteria would immediately impact PS
      - Without affordable technology, dischargers would be in infinite noncompliance
- The Plan tried to strike a reasonable PS/NPS balance
  - 20+ meetings with engineering, agriculture, and environmental groups
  - Some great input modified the draft plan
    - Still, disliked by many WQ advocates and many in the engineering and Ag communities
      - And some at KDHE

# The Kansas Plan and National Influence

- 2009 Nutrient Innovation Task Group (NITG) *Urgent Call to Action*
  - Key findings
    - “Current regulations disproportionately address certain sources in a watershed (e.g., municipal sewage treatment) at the exclusion of others…”
    - Add nitrogen and phosphorus to Secondary Treatment definition
    - Provide POTWs information on optimization
- 2011 – EPA memo - *Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions – “Stoner Memo”*
  - Nutrient Framework to give states “room to innovate”
  - One-size-fits all solution to N/P pollution is neither desirable nor necessary

# The Kansas Plan and National Influence

- 2016 – EPA memo – *Renewed Call to Action – “Beauvais Memo”*
  - EPA to work w/states to include TN & TP monitoring in NPDES major permits
  - EPA will survey POTWs across the country to assess:
    - How efficiently secondary treatment plants remove nutrients
    - How nutrient removal can be improved with enhancements to O&M
      - Share this information with states to assist with optimization
- 2022 –*Accelerating Nutrient Pollution Reductions in the Nation’s Waters – “Fox Memo”*
  - Support innovation/More focus on Ag (NPS)
  - Strongly encourage states to rely on numeric targets for WQ assessment
  - Prioritize strategies to support small, rural, and disadvantaged communities
    - Release a Lagoon Action Plan to help small, rural, & tribal communities

# The Rest Of The Story – Thank You KU!

- 55<sup>th</sup> EEC – February 5, 2005
  - Afternoon Wastewater Session focus on nutrients
    - James Barnard, PhD, PE – Black & Veatch
      - Approaches to Nutrient Reduction
    - Cliff Randall, PhD, Dist.M.ASCE – Professor Emeritus VA Tech
      - BNR and ENR Implementation in the Chesapeake Bay Watershed
    - Mike Tate, PE – KDHE
      - KS Nutrient Reduction Plan
  - One Conference Planner told me
    - *You are going to get schooled on nutrients!*

# The Rest Of The Story – Thank You KU!

## Cliff Randall, PhD

- 55<sup>th</sup> Annual KU EEC
  - BNR is doable
  - Technology is available today
  - Carrot and stick may be needed

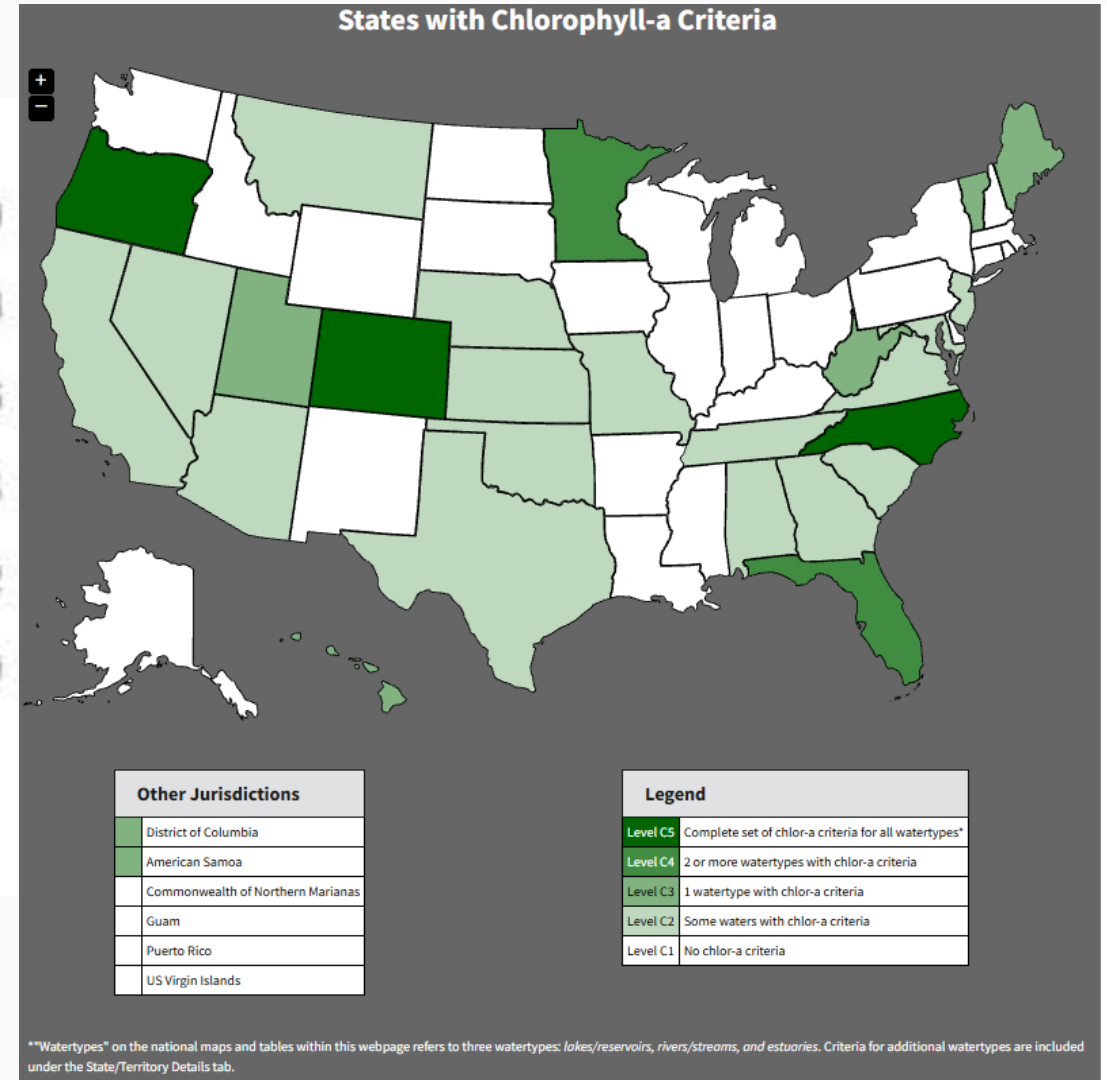
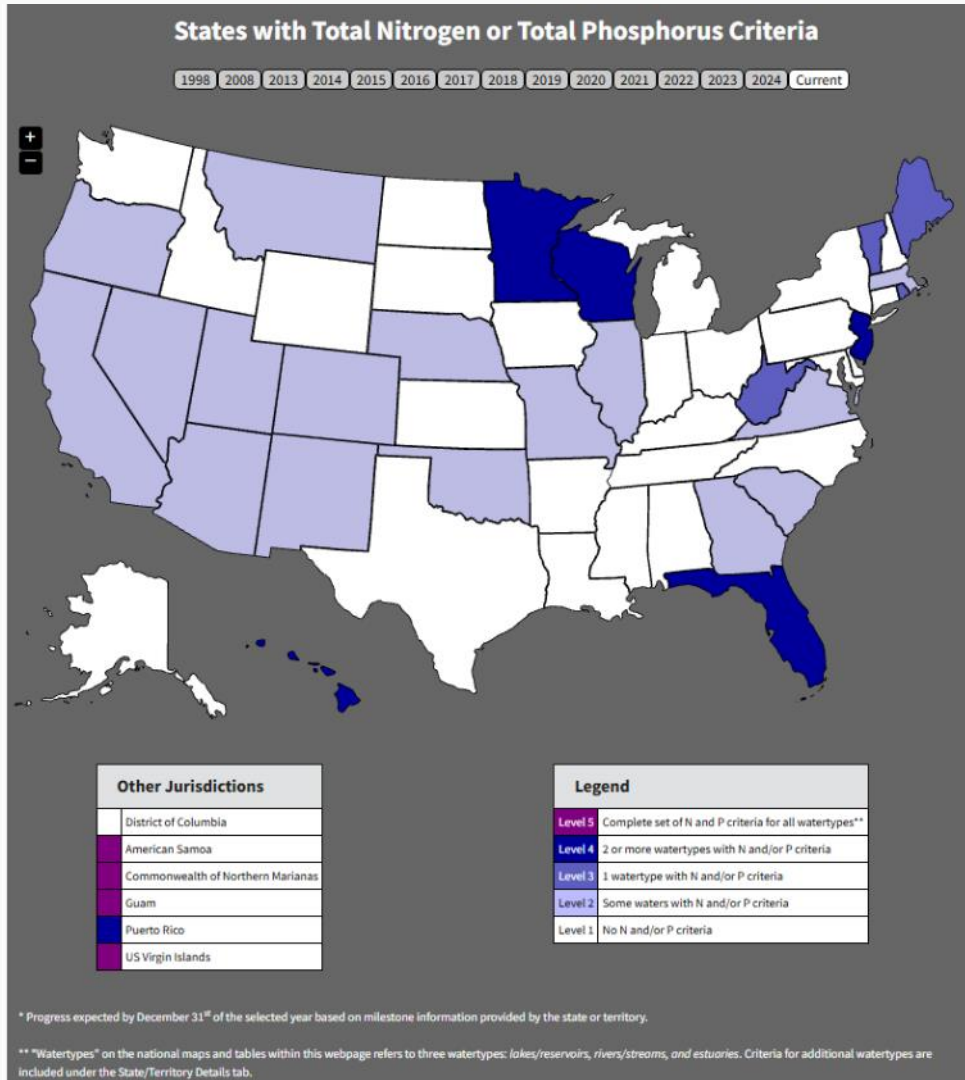
### HOW CAN THE RATE OF POINT SOURCE NUTRIENT REMOVAL IMPLEMENTATION BE ACCELERATED?

- Appropriate Technology is Available
  1. Biological Nutrient Removal
  2. Membrane Separation Wastewater Treatment
  3. Nutrient Recovery and Reuse
- Most Rapid Progress would be through Implementation of Known and Demonstrated Technologies
- Rapid Implementation Requires both a Carrot and a Stick
  - Financial Incentives plus Regulatory Requirements
- Also Need to Consider Innovative but Proven Technologies

# The Rest Of The Story – Thank You KU!

- James Barnard – *paraphrased*
  - The Kansas Plan looks reasonable
  - It provides time for wastewater treaters
  - It provides for BNR approaches to POTWs
    - The BNR values proposed for TN and TP are doable
- After the Conference – much less push back on the Plan!

# How Did Criteria Adoption Work For Others?



# How Did *The Plan* Work for Us?

- Gulf Hypoxia Loading Tool

- 2024 DMR Data
- POTW Majors

State	Average mg/L		Median mg/L	
	TN	TP	TN	TP
<b>KS</b>	11.0	1.8	7.5	1.6
<b>MO</b>	15.2	4.9	9.8	3.2
<b>NE</b>	24.6	7.1	17.7	5.1
<b>OK</b>	13.4	2.6	13.3	2.5
<b>CO</b>	13.7	2.1	13.9	2.4

# Kansas Nutrient Reduction: Where We Took It

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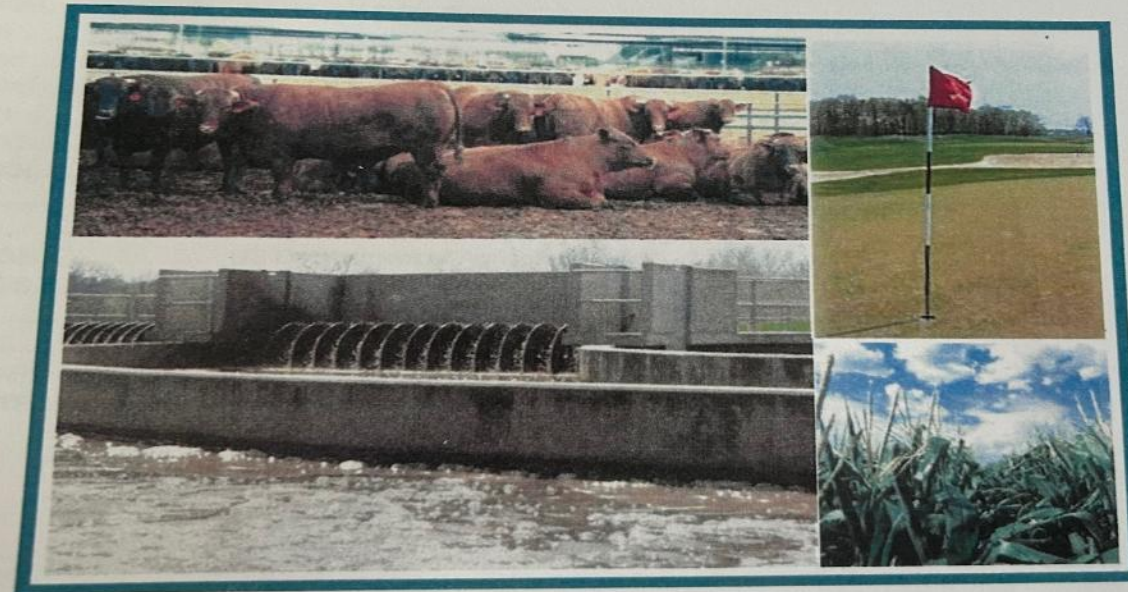
*Thomas C Stiles*



April 15, 2026

KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT  
BUREAU OF WATER

## SURFACE WATER NUTRIENT REDUCTION PLAN



DECEMBER 29, 2004

# In lieu of Water Quality Criteria, the Nutrient Reduction Plan Delegated Determining Appropriate Nutrient Levels to Other Planning Efforts

Kansas Water Plan: Emphasis of Nutrient Reduction as an Implementation Priority

Watershed Restoration and Protection Strategies (WRAPS): Primary Mechanism for Watershed Planning and Non-Point Source Reduction

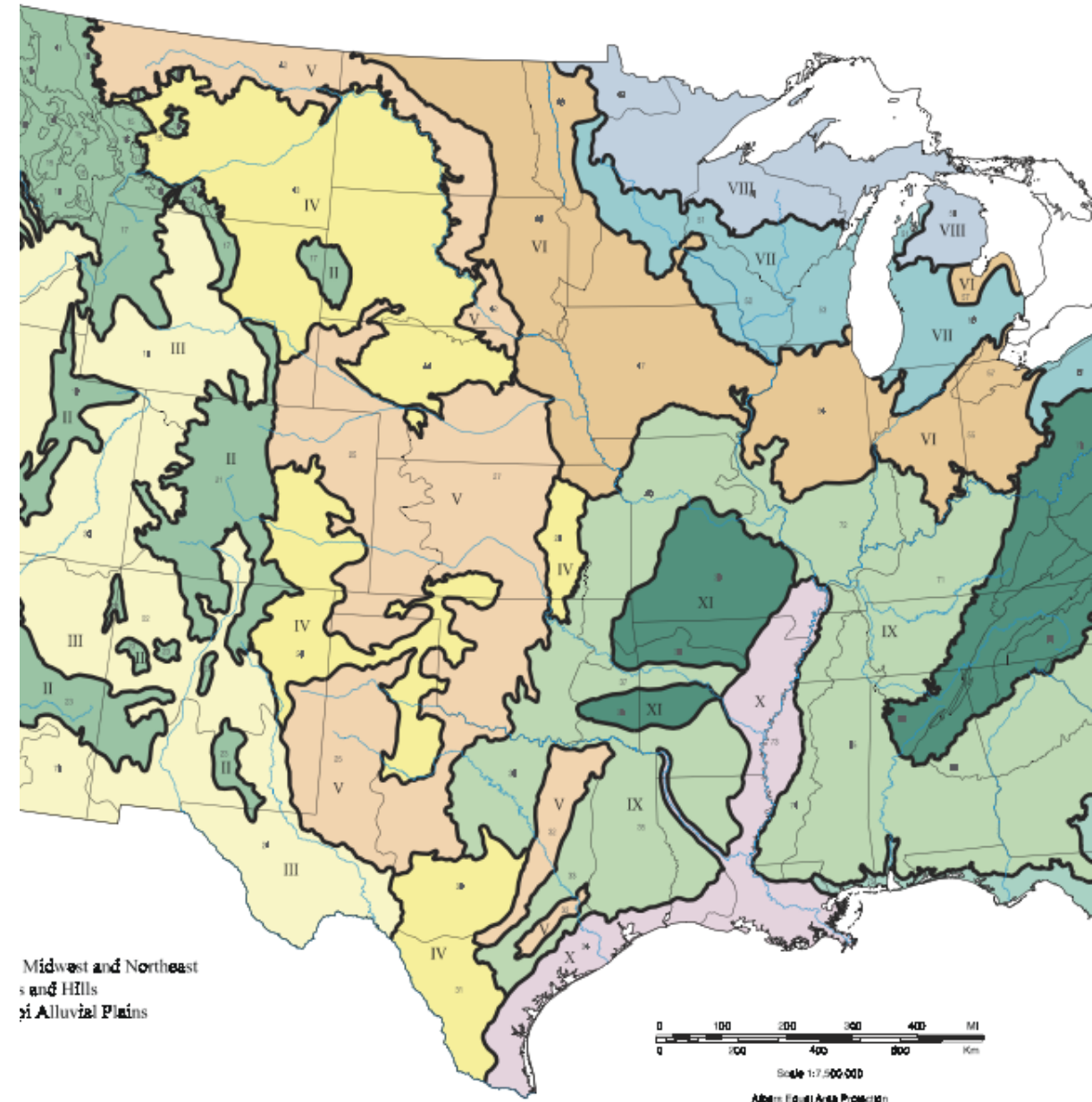
Total Maximum Daily Loads: Addressing Controls on Point and Non-Point Contributions to Excessive Nutrients

***“As the bases for criteria become more refined through the WRAPS and TMDL processes, they will be a future consideration, ...”***

# Identifying Nutrient Impaired Waters through 303d

- Reservoir Eutrophication is a Mainstay of the 303d List since 1996
- Early Stream Impairments Coded as Dissolved Oxygen, pH, & Biology
- Nutrient of Primary Concern: Phosphorus
- Methodology used the 2001 Ecoregion V Criteria Recommendation of 67 ug/l Covering 2/3 of Kansas
- Screening for 303d List:  $[TP]_m > 201 \text{ ug/l}$ 
  - 3 X 67 ug/l =
  - Worst of the Worst

## Draft Aggregations of Level III Ecoregions for the National Nutrient Strategy



# First TP TMDL Was Big Creek

- 2011 TMDL
- Median [TP]: 213 ug/l above Hays; 1230 ug/l below Hays
- WLA for Hays: 35.1 #/d [1.5 mg/l \* 2.8 MGD]
- Rolling 12-mos average
- Endpoints based on biological response
  - Macroinvertebrate Index < 4.5
  - Mayflies/Stoneflies/Caddisflies > 50%
  - Periphyton < 150 mg/m<sup>2</sup>
  - Chlorophyll a < 20 ppb
  - Achieved 3 Consecutive Years

## SMOKY HILL-SALINE BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Big Creek

Water Quality Impairment: Total Phosphorus

### 1. INTRODUCTION AND PROBLEM IDENTIFICATION

**Subbasin:** Big                      **Counties:** Russell, Ellis, Trego, Gove, and Sheridan

**HUC8:** 10260007  
**HUC10 (HUC12):** 01 (01, 02, 03, 04)  
02 (01, 02, 03, 04)  
03 (01, 02, 03, 04, 05)  
04 (01, 02, 03, 04, 05)

**Ecoregion:** Central Great Plains, Rolling Plains and Breaks (27b)

**Drainage Area:** 862 square miles

**Main Stem Water Quality Limited Segments (Appendix A):** Big Creek Segment 1 in Russell County; Segments 3 & 5 in Ellis County; Segment 7 in Trego & Gove Counties

<b>Main Segment</b>	<b>Tributaries</b>
Big Creek (1)	Walker Cr (2)
Big Creek (3)	North Fork Big Creek (4) Mud Cr (9)
Big Creek (5)	Chetolah Cr (8)
Big Creek (7)	Ogallah Cr (6)

**Designated Uses:** For Big Creek – all segments (1, 3, 5, & 7): Expected Aquatic Life Support, Food Procurement, Domestic Water Supply, Industrial, Irrigation and Livestock Watering and Ground Water Recharge. Primary Contact Recreation “C” on Segment 1; Primary Contact Recreation “B” on Segment 5; Secondary Contact Recreation “b” on Segments 3 and 7.

# 2024 Inventory of TMDLs

- Phosphorus – 31
  - Watersheds
- Ammonia & Nitrate – 7 / 8
  - Stream Segments Impacted by Point Sources
- Biology – 22
  - Stream Segments Impacted by Watersheds
- Eutrophication – 147
  - Reservoirs of all sizes
- At least 24 additional monitoring sites on streams cited as phosphorus impaired

## 2024 303(d) List of All Impaired/Potentially Impaired Waters

### Cimarron River Basin

#### 11040002

#### Upper Cimarron

Cat.	Stream/Lake	Impaired Use	Impairment	Station	Counties	Body Type	Priority
5	Cimarron Lake (Moss Lake Middle)	Aquatic Life	Eutrophication	LM060401	MT	Lake	2027
3	Cimarron Lake (Moss Lake Middle)	Water Supply	Fluoride	LM060401	MT	Lake	
5	Point of Rocks Lake (Moss Lake West)	Aquatic Life	Eutrophication	LM060501	MT	Lake	2027
5	Point of Rocks Lake (Moss Lake West)	Water Supply	Fluoride	LM060501	MT	Lake	2027
5	Point of Rocks Lake (Moss Lake West)	Water Supply	Sulfate	LM060501	MT	Lake	2027
3	Point of Rocks Lake (Moss Lake West)	Water Supply	Boron	LM060501	MT	Lake	
3	Point of Rocks Lake (Moss Lake West)	Aquatic Life	Dissolved Oxygen	LM060501	MT	Lake	

#### 11040006

#### Upper Cimarron-Liberal

Cat.	Stream/Lake	Impaired Use	Impairment	Station	Counties	Body Type	Priority
5	Cimarron River Near Forgan, Oklahoma	Aquatic Life	Selenium	SC222	ME, MT, SV, SW	Watershed	2027
4a	Cimarron River Near Forgan, Oklahoma	Water Supply	Chloride	SC222	ME, MT, SV, SW	Watershed	Low

# Implementation Dominated 2012 - 2025

- Investment in BNR
  - Originally 1.5 mg/l TP & 8 mg/l TN
  - Evolved to 1 mg/l TP & 10 mg/l TN
- Optimization of Treatment Train Process
  - Reduced Capital Outlay
- Stormwater – MS4
  - BMPs & Inverted Trading Opportunities
- Non-Point Source Reduction thru WRAPS
  - Soil Health & Input Management
- ENR for New and Expanding WWTP
  - 0.5 mg/l TP & 5 mg/l TN

## c. SPECIAL CONDITIONS - NUTRIENT REMOVAL

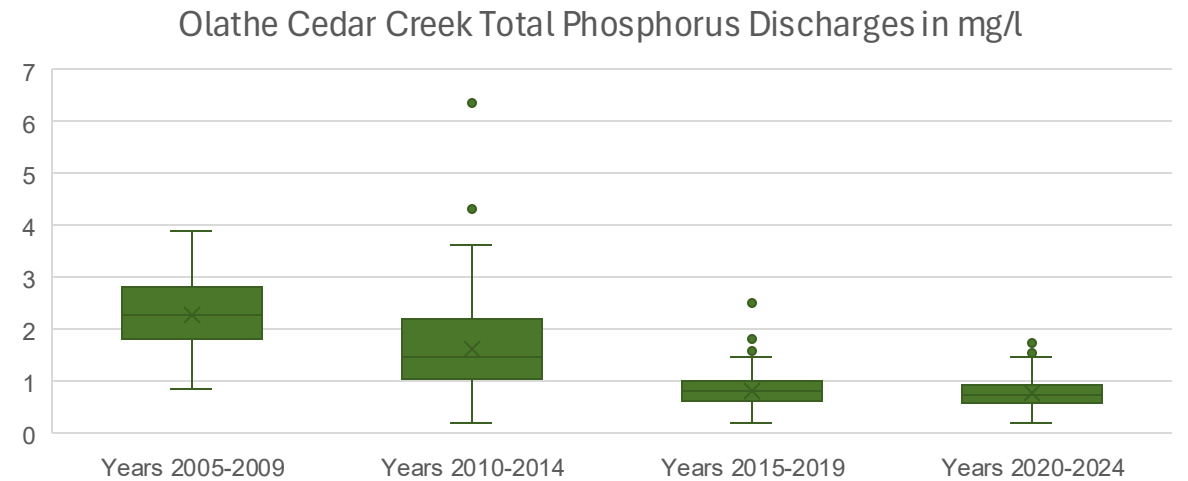
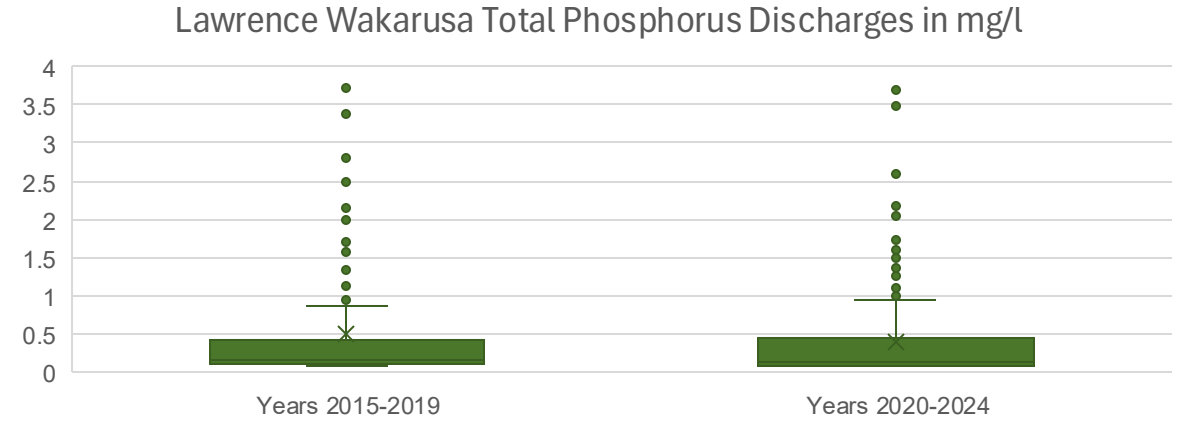
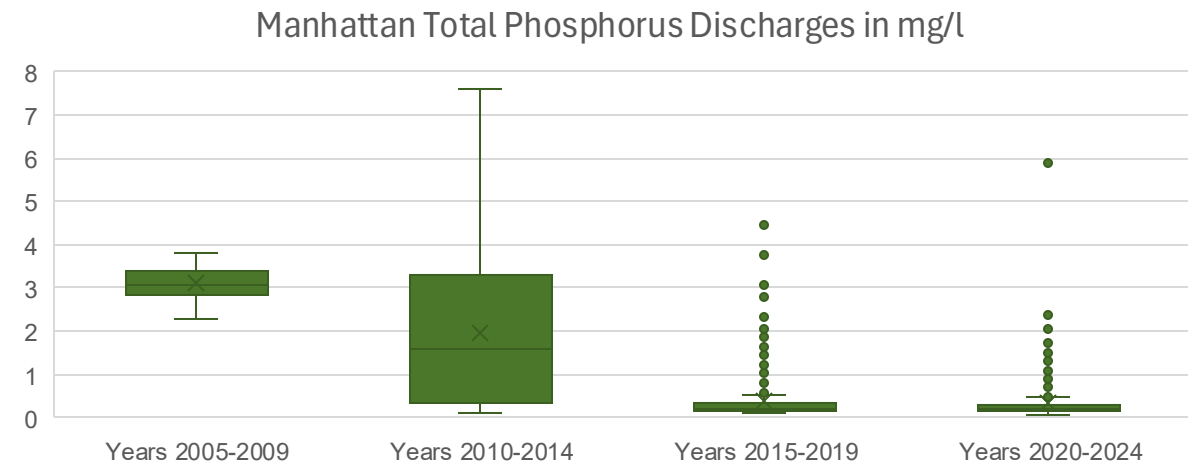
This wastewater treatment facility is designed for nutrient removal, and the permittee routinely operates the mechanical plant to maximize the level of nutrient removal. The goals for operations are to achieve the following effluent quality as annual average target effluent levels from the mechanical plant:

Total Nitrogen (as N)- mg/l	10.0 as an annual average goal
Total Phosphorus (as P)- mg/l	1.0 as an annual average goal
Total Phosphorus (as P)- lbs/day	20.9 as an annual average limit

These target goals are not to be considered as effluent limits for this permit. However, the Total Phosphorus mass loading is an enforceable permit limit. The Annual Average calculations are for a rolling 12-month time period calculated on a monthly basis. KDHE reserves the right to re-open this permit to impose limits for nutrients pursuant to Kansas law after such criteria or a TMDL limiting nutrients is adopted in the Kansas Surface Water Quality Standards.

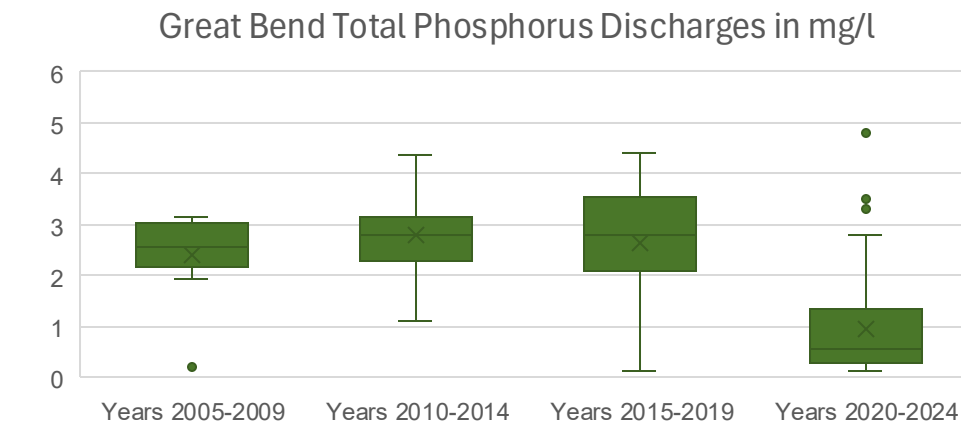
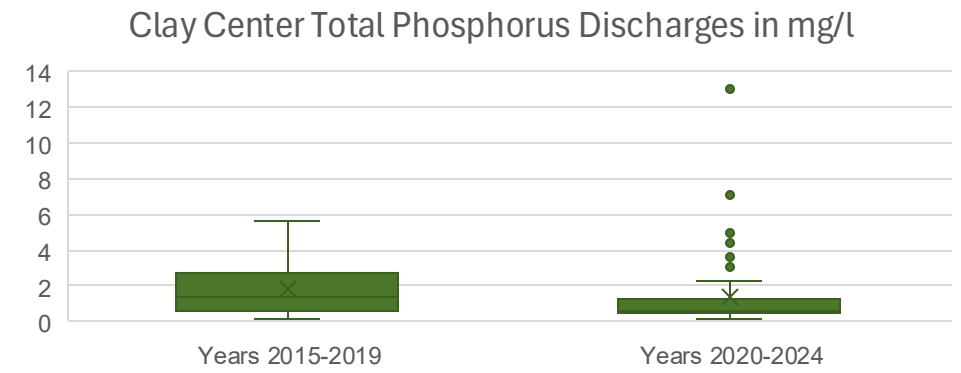
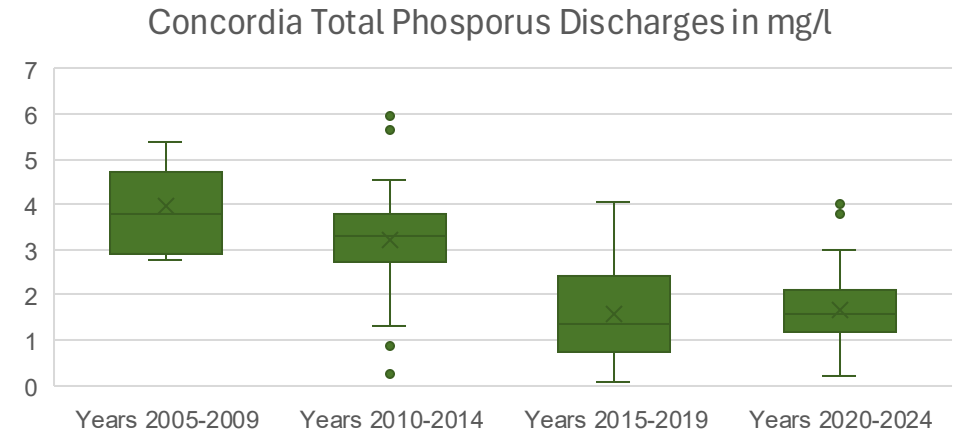
# Success Stories with BNR

- Manhattan
- Lawrence - Wakarusa
- Olathe – Cedar Creek
- Sub – 1 mg/l TP with operations
- Approaching ENR (0.5 mg/l TP)



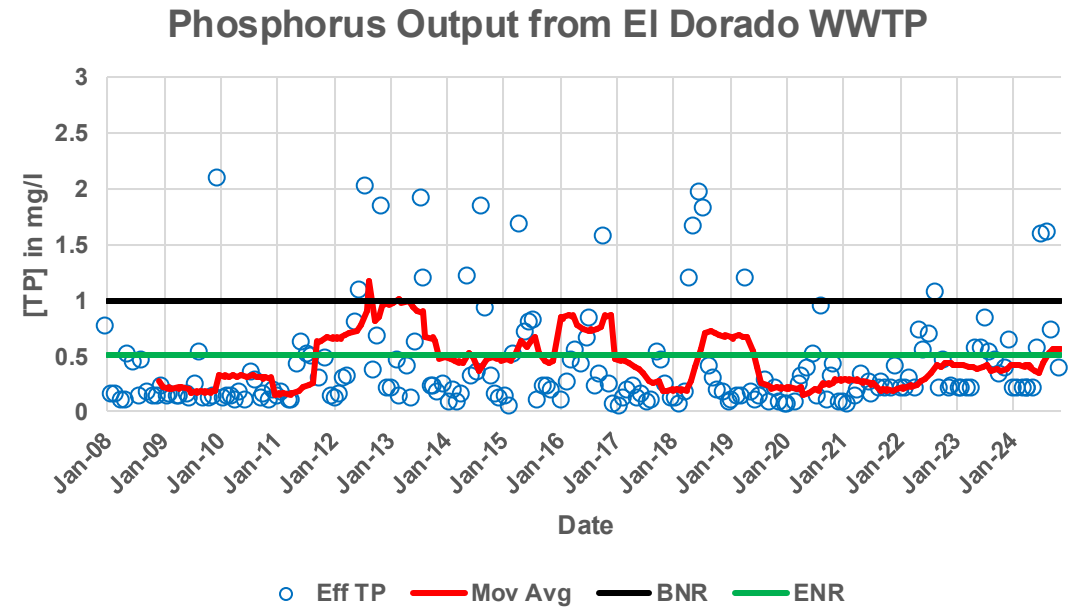
# Success Stories with Optimization

- Concordia
- Clay Center
- Great Bend
- Work by Jerry Grant and Grant Weaver and Nick Willis at Wichita State
- Dependent upon retaining wastewater plant operators



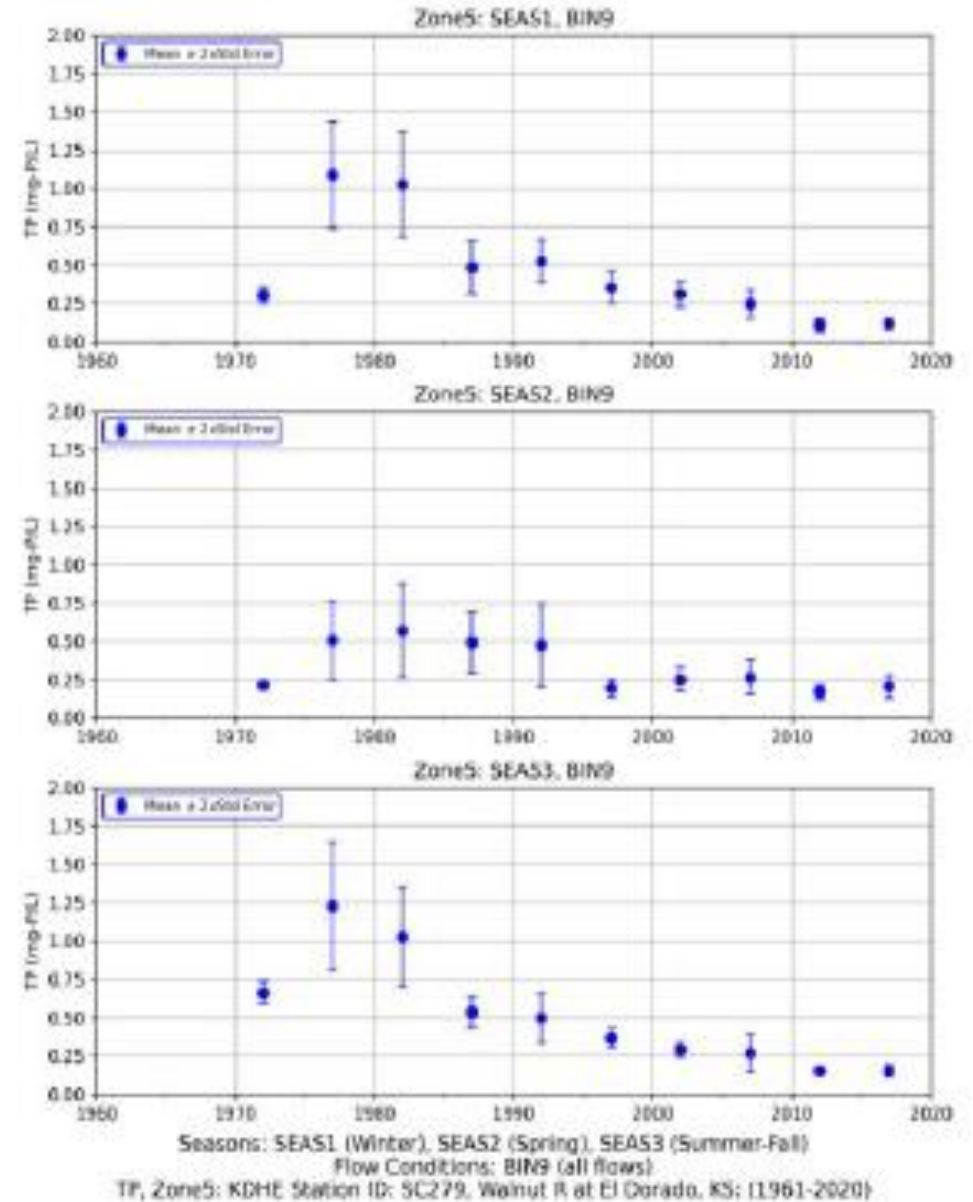
# Success Stories with Stormwater

- El Dorado Wastewater averages 0.45 mg/l, well below TMDL expectations
- TP Limit = WLA = 25.1#/d, discharges 7.3#/d
- City is also MS4 with TMDL requirements
- Most Kansas cities reside dominant rural watersheds
- Ag runoff (NPS) >> MS4 runoff (NPDES)
- Inverted Trading: City spends BMP money in watershed rather than in city
- City \$\$ matched with 319 and soil health \$\$ to pay for rural BMPs
- Any load reductions are credited to MS4



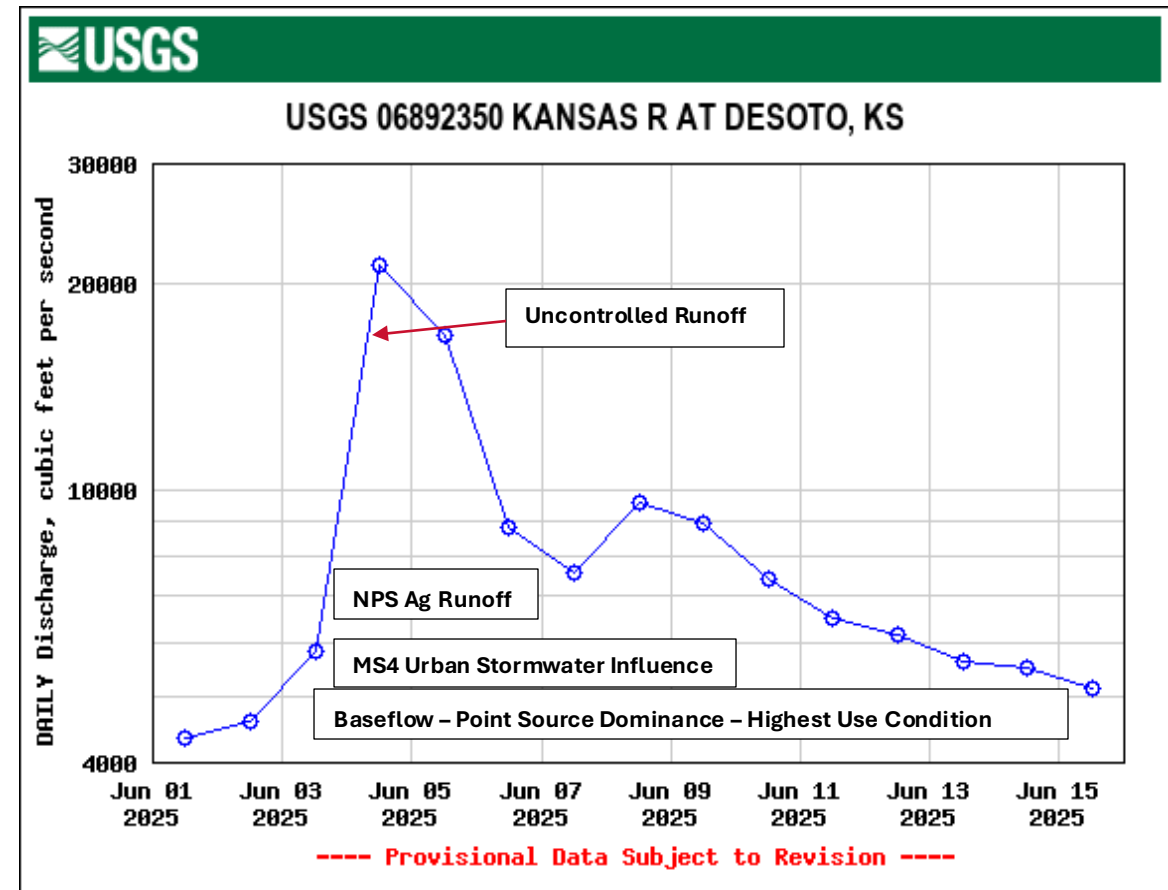
# Lessons Learned

- Lagoon WLA / Limits – Insignificant Contributors
- Industrial Permits – Game Changers
- Remediation Projects – Time Limited Dischargers
- New Facilities not Anticipated by TMDL
  - Data Centers
  - Panasonic and Satellite Industries
- Antidegradation – Push ENR on Facilities
- Success Seen at Baseflow, Falts with Runoff
- Biology Data Tell a Story, But Not Sure What



# Control and Success is a Function of Position on the Hydrograph

- At dry weather baseflows, WWTP exert a major influence on nutrient condition (but so do reservoir releases)
- As it starts raining, runoff from urban areas (impervious) contributes
- With more rain, the entire watershed, largely rural and unregulated dominates loading
- At some point, rainfall generates enough runoff that cannot be controlled by BMPs
- Rule of Thumb: 90+% of nutrient load enters reservoirs in less than 10% of the year.



# Handoff to Nutrient Reduction Strategy 2.0 – Next Gen Steps

- NPDES
  - Mech WWTP > 0.2 MGD; Lagoons > 0.5 MGD
  - Limit bioavailable nutrients (SRP, TIN)
  - TN & TP above reservoirs
  - Encourage reuse & inverted trading
  - Phase 2 TMDLs (ENR) after 2035
- WQS
  - NNC for “cleanest” reservoirs
- Biological Data – MMI linkage
- NPS – Soil Health & Nutrient Mgmt
- Interstate- Mo River, MO, OK

## Executive Summary

Nutrient pollution, or the excessive accumulation of nitrogen and phosphorus in water, is one of the most widespread, costly and challenging environmental problems of our nation. Nitrogen and phosphorus are nutrients that are natural parts of aquatic ecosystems. But when excessive amounts of nitrogen and phosphorus enter the aquatic environment — usually from a wide range of human activities — the water can become polluted. Nutrient pollution has negatively affected many streams, rivers, lakes, bays and coastal waters for the past several decades, resulting in serious environmental and human health issues and economic impacts.

This strategy outlines the nutrient issues facing Kansas, past and present efforts to reduce nutrient impacts and includes recommendations for increasing nutrient reduction efforts in the future through various mechanisms including:

- Support for nutrient reduction through treatment process optimization and biological nutrient reduction technology at municipal Publicly Owned Treatment Works (POTW)s.
- Continue to use narrative Water Quality Standards (WQS) for nutrients and, apart from one type of waterbody in Kansas, defer numeric nutrient development to the TMDL process of wasteload allocations.
- Evaluate the development of numeric nutrient criteria for lakes impounding water from watersheds dominated by grass and forest land cover with no point source influence.
- Aggressively explore using multi-metric indices to evaluate biological data for nutrient impacts on aquatic life use.
- Update eutrophication Total Maximum Daily Loads (TMDLs) written prior to 2015 and update Kansas' TMDL Vision 2.0 to reflect the direction of TMDL development between 2026 – 2035.
- Use ten-year average *chlorophyll a* levels in reservoirs to establish their trophic state and document their degree of eutrophic impairment and recovery.
- Rely on state NPS Management plan to implement on a wide scale, through all state partners, nutrient runoff from nonpoint sources and continue to implement watershed-based plans and nutrient reducing best management practice implementation in priority watersheds.

# Thank you!



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# Kansas Nutrient Reduction: Where We're Going

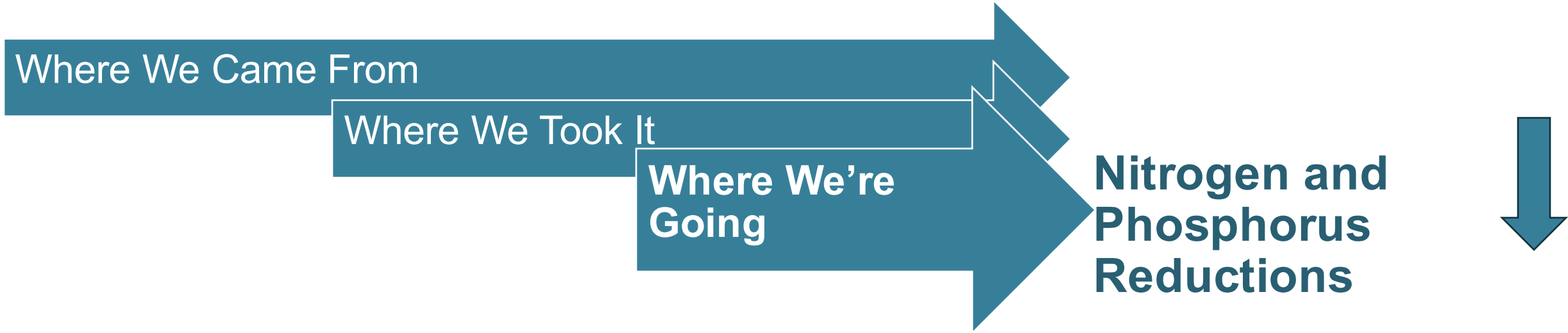
Ryan Eldredge, P.E.  
KDHE – Bureau of Water



76<sup>th</sup> Annual KU Environmental Engineering Conference

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# Nutrient Reduction Strategy



## Where We're Going

- Investment and Implementation
- Antidegradation to Drive Nutrient Reduction
- Permitting Techniques (Current and Future)
- Future TMDL Writing
- Future Technical Assistance
- Reuse Opportunities



- Investment and Implementation take time and \$\$\$
- Some of KS largest plants are just now implementing BNR upgrades
  - JCW Nelson Complex - \$610 Million
  - Wichita Lower Ark - \$357 Million
  - Other upgrades in the works
- Other facilities are working on optimization and/or smaller upgrades (Chem – P) in anticipation of upcoming permit limits



# Antidegradation Driving Nutrient Limits

- Antidegradation to Drive Nutrient Limits
- New or expanded mechanical plants will be expected to meet nutrient limits as required by TMDLs and/or the Kansas Antidegradation Policy
  - TP Reductions
  - TN Reductions addressed through ammonia limits and new Nitrate/Nitrite limits (10.0 mg/l)
- Facility expansion with existing TMDLs are usually bound by the existing WLA at the current Design Flow
  - 2X Flow =  $\frac{1}{2}$  Concentration

- Mostly all municipal mechanical plants include TN and TP monitoring with KDHE BNR Goals (10 mg/l TN and 1.0 mg/l TP)

The permittee shall continue to operate the treatment facility to maximize the level of nutrient removal to achieve the following goals as annual average target effluent levels from the mechanical plant:

Total Nitrogen (as N) - mg/l	≤ 10.0 as an annual average goal
Total Phosphorus (as P) - mg/l	≤ 1.0 as an annual average goal

These target goals are not to be considered as effluent limits for this permit. KDHE reserves the right to reopen this permit to impose limits for nutrients pursuant to Kansas law when such criteria are adopted in the Kansas surface Water quality Standards.

- TN and TP are tracked both as Monthly Average and Annual Average (Concentration and Load)

# Permitting Techniques

- Focus on mechanical WWTPs >0.20 MGD nutrient reduction.
- Work to convert <0.20 MGD mechanical WWTP to lagoon (NQ preferred).
- Evaluate phosphorus loading from municipal lagoons with design flows >0.50 MGD.
- Use of inverted water quality trading to link MS4 and WWTP performance to implement practices to abate nonpoint source nutrient loading in rural portions of shared watersheds.

# Permitting Techniques

	Current Permitting	Future Permitting Considerations
Total Phosphorus (TP)	<ul style="list-style-type: none"> <li>-Driven by TMDLs and Antidegradation</li> <li>-Annual Avg Load Limit</li> <li>-Concentration Goals</li> </ul>	<ul style="list-style-type: none"> <li>-Consider altering limits to Orthophosphate to target biologically available phosphorus</li> <li>-Concentration basis for facilities with large expansion potential</li> </ul>
Ammonia (NH <sub>3</sub> )	<ul style="list-style-type: none"> <li>-2013 Ammonia Criteria</li> <li>-Daily Max and Monthly Avg. Limits</li> </ul>	<ul style="list-style-type: none"> <li>-2013 Ammonia Criteria</li> <li>-Daily Max and Monthly Avg. Limits</li> <li>-Consider Total Inorganic Nitrogen (TIN) limits</li> </ul>
Nitrate/Nitrite (NO <sub>2</sub> +NO <sub>3</sub> )	<ul style="list-style-type: none"> <li>-Driven by TMDLs and Antidegradation</li> <li>-Annual Average Concentration Limit</li> </ul>	<ul style="list-style-type: none"> <li>-Driven by TMDLs and Antidegradation</li> <li>-Annual Average</li> <li>-Consider Total Inorganic Nitrogen (TIN) limits</li> </ul>
Total Nitrogen (TN)	<ul style="list-style-type: none"> <li>-Addressed by NH<sub>3</sub> and NO<sub>2</sub>+NO<sub>3</sub></li> <li>-Monthly and Annual Average Calculated</li> <li>-Concentration Goals</li> </ul>	<ul style="list-style-type: none"> <li>-Consider Total Inorganic Nitrogen (TIN) limits to target biologically available nitrogen</li> </ul>

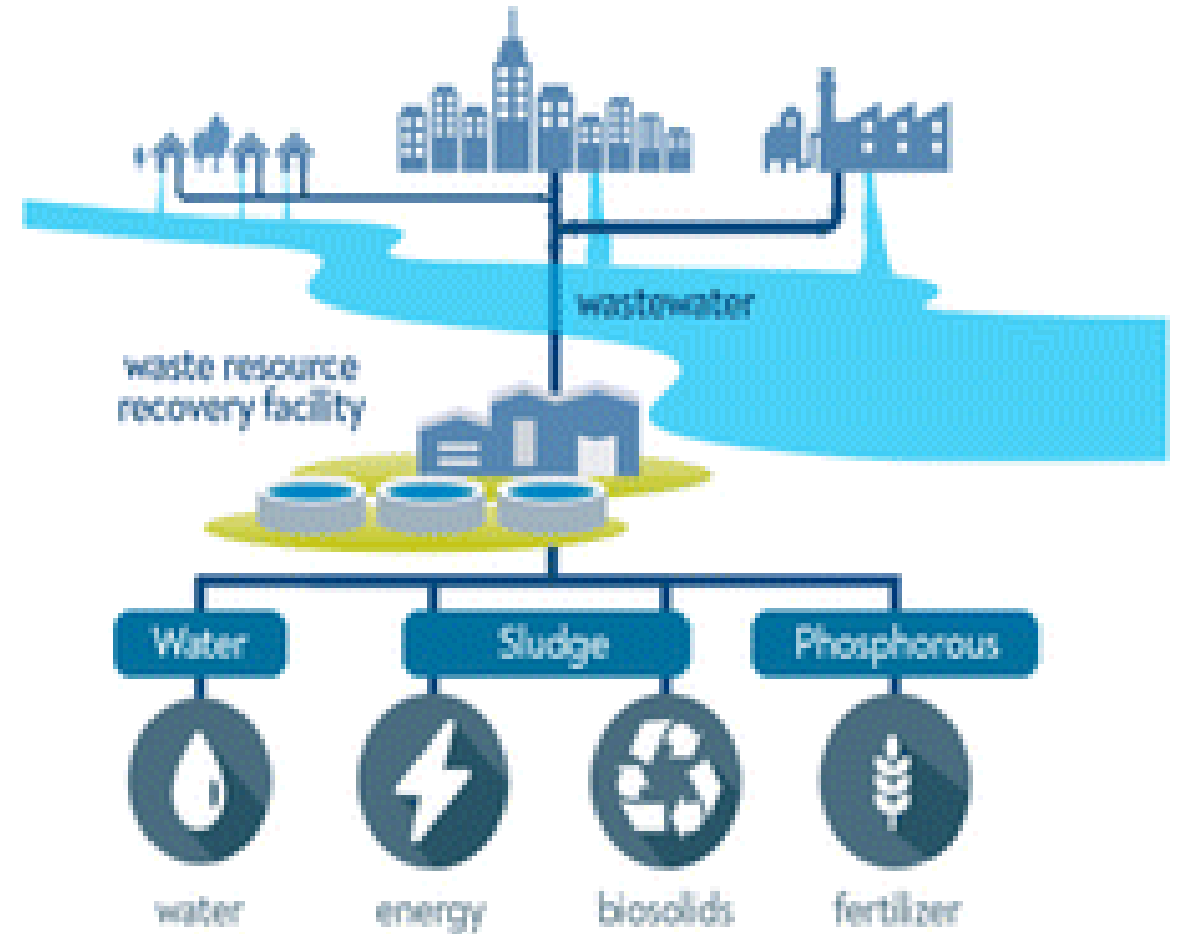
- Recent TMDL Changes
- Update Eutrophication TMDLs written prior to 2015
- Kansas' TMDL Vision 2.0 to reflect TMDL development 2026-2035.
- Future TMDLs – Drafting TMDLs to account for unforeseen future needs and consideration (Economic Growth)
- TMDL Phase 2 Limits – 2035 +

- Continued Technical Assistance support to ensure operator training on Nutrient Removal
- Invest in the people as well as the technology
- BNR facilities can reach lower ENR levels with quality operations



# Reuse Opportunities

- Water is a Resource!
- KDHE encourages facilities to explore reuse opportunities to help reduce nutrient load to streams
  - Agricultural
  - Recreational
  - Industrial
  - Potable



- KDHE working on finishing touches
- Next steps to Public Notice for public comment
- Hope to have finalized version issued in 2026.



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**KANSAS NUTRIENT  
REDUCTION STRATEGY 2.0  
2025-2035**

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Prepared by The Kansas Department of Health and Environment  
Bureau of Water

# Thank You!

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