MEMORANDUM

TO: Programs, Projects, and Operations Subcommittee

FROM: Ian Ghanavati, Water Resources Engineer

SUBJECT: Lower Platte River Corridor Alliance Joint Funding Agreement for the USGS Streamgage Trend Analysis

DATE: July 9, 2024

Real-time continuous water quality monitoring data has been collected by the USGS in cooperation with the Lower Platte River Corridor Alliance (LPRCA) in the lower Platte River since 2007. Data has been collected using streamgages on the Platte River at Louisville and Leshara, Elkhorn River at Waterloo, and Salt Creek near Ashland; the data collected has primarily included temperature, turbidity, dissolved oxygen, specific conductance, and nitrate/nitrite. Discharge data has also been collected.

The length of data collection (~17 years) by the USGS in partnership with the LPRCA offers an opportunity to complete statistical trend analysis on the continuous water quality data. The Papio NRD and other LPRCA partners have a long-term interest in the water quality of the Platte River and its tributaries and have water quality management plans in place for the area. The trend analysis may assist in these efforts by:

- Establishing a baseline trend and analysis method for future monitoring of the Platte River, which is anticipated to be impacted by rapid development in southern Sarpy County.
- Determining if long-term management changes are impacting the water quality of the Platte River, independent of year-to-year variation in precipitation/discharge.
- Determining if long-term temperature changes are occurring due to climatic effects.
- Better calculating real-time concentrations of related, but not directly measured, water quality constituents such as atrazine, *E. coli*, phosphorus, suspended sediment, and ammonia.

The proposed USGS Streamgage Trend Analysis has a total cost of $148,100 and will be completed over a period of 2 years. Of the total cost, USGS has agreed to contribute $53,260 and the LPRCA has agreed to contribute the remaining $94,840. Per the Joint Funding Agreement, the LPRCA contribution will be further divided into the following amounts:

1. $15,000 contributed by NDEE through a Section 319 Small Grants Project
2. $9,980 contributed by each of the following parties: UNL, NDNR, MUD, Lincoln Water, Nebraska Game and Parks, LPSNRD, LPNNRD, and the Papio NRD.

The project will be administered by LPSNRD on behalf of the LPRCA through the Joint Funding Agreement and a Section 319 Inter-governmental Agreement. The $9,980 cost share will be billed in two parts, $5,843 in FY25 and $4,137 in FY26.

Management recommends that the Subcommittee recommend to the Board that the General Manager be authorized to execute the attached Joint Funding Agreement for the USGS Streamgage Trend Analysis with the Partners defined in the Agreement for the total amount of $9,980, subject to such other terms and conditions as the General Manager deems necessary and District Legal Counsel approves as to form.

USGS Trend Analysis on Continuous Water Quality in the Lower Platte River

USGS Nebraska Water Science Center
Matt Moser, Brenda Densmore, and Dave Rus
2024-05-24

In partnership with members of the Lower Platte River Corridor Alliance

Introduction:
With continuous water quality data being collected in cooperation with the Lower Platte River Corridor Alliance (LPRCA) over the past 15 years, datasets are now sufficient to begin looking for potential water quality trends that are occurring in the lower Platte River. These data sets can be examined using modeling techniques to account for wet and dry years or missing data and detect water quality trends or facilitate comparisons between sites to better understand how the water quality in the Lower Platte River has changed over the monitoring. This short proposal describes the type of modeling that the USGS could complete in cooperation with the LPRCA to gain more information about the water quality of the Lower Platte River as represented by this monitoring data.

The Lower Platte River Corridor Alliance has cooperated with the USGS Nebraska Water Science Center since 2007 to collect continuous water quality data at four stream locations strategically placed in the lower Platte River basin to target specific watersheds. These include:

- Platte River at Louisville has had seasonal collection of water temperature, specific conductance, dissolved oxygen, and turbidity since the fall of 2007. Beginning in 2012, continuous nitrate data were also collected seasonally.
- Elkhorn River at Waterloo has had seasonal collection of water temperature, specific conductance, dissolved oxygen, and turbidity since the fall of 2007. Beginning in 2016, continuous nitrate data were also collected seasonally.
- Platte River at Leshara has had seasonal collection of water temperature, specific conductance, dissolved oxygen, turbidity, and nitrate since 2016.
- Salt Creek near Ashland has had seasonal collection of water temperature, specific conductance, dissolved oxygen, and turbidity since the fall of 2007.

The USGS has provided the Lower Platte River Corridor Alliance and the Natural Resources Districts (NRD with bi-yearly updates on the collected data with graphs, data summaries, and observations on how these continuous water quality variables were changing from year to year. These continuous data sets have also supported other water management operations and studies in these streams by documenting current water quality conditions.
The continuous water quality monitors can provide data for trend analysis over several years, river conditions, and multiple parameters. Continuous water quality monitors provide the ability to look at short term fluctuations in the river that traditional sampling can miss, as well as data that can be collected and analyzed over a variety of flow conditions. Continuous data such as this, provide the ability to look at a more complete picture of river conditions.
To date (2023), statistical analysis of the continuous water quality data being collected has not been completed to better understand how water temperature, specific conductance, dissolved

oxygen, turbidity, and nitrate are changed seasonally, during wet and dry years, and year to year over the period of data collection. Therefore, the full value of this continuous data record is not well understood.

Objectives:
The LPRCA and the USGS NEWSC are interested in completing statistical trend analysis on the continuous water quality data from the beginning of each record up to and including the 2023 monitoring season to better understand how these monitored parameters are changing over time. This project will also include an analysis of discharge trends during the same time period.

Conceptual approach:
The high-frequency data from continuous water quality monitoring provides many benefits but also provide challenges to the statistical analysis of trends because of the serial correlation (dependence upon previous data values) inherent in the measurements. Since many wide-spread, readily available continuous water quality data sets are just recently reaching length thresholds that make trend analysis practical (generally around 10 years), trend analysis using these types of data are an active research topic.

Using order statistics of daily values from continuous water quality data in Virginia streams, Porter and others (2020) were able to perform a trend analysis on high frequency data. The USGS Nebraska WSC would follow a similar method to analyze data and look for trends on data collected in Nebraska. Daily values would be utilized for data to run linear regressions on continuous water quality data in the lower Platte. This approach would look at overall trends occurring throughout the time frame and not analyze every single point.

The linear regressions would only focus on the extremes and averages observed within each selected time frame, and then compare those extremes and averages against similar time frames throughout the 15-year period where data have been collected. The USGS NEWSC would utilize previous R packages already established by the USGS and available in R to analyze the data.

Temporal changes in daily discharge statistics will be explored using methods available in the EGRET software (Hirsch and De Cicco, 2015). Daily discharge records can be used to perform Mann-Kendall trend tests, and the associated Thiel-Sen slope estimates, to create Quantile-Kendall plots (Hirsch, 2018) to evaluate discharge trends across the range of discharge values at each of the sites for a specified timeframe. These statistics will be explored as a possible method for trend analysis at the four sites in the lower Platte River. In addition to these trend analyses at each site, sites will be compared to better understand how the full system is changing over the years contributions to the system from the tributaries vs from the Central Platte.

The USGS also previously produced concentration predictions using surrogate relations in the Lower Platte River. These relations were published through a USGS Scientific Investigations Report (Schaepe et al, 2014) and were funded in part by a NET grant. These surrogate equations were developed using continuous water quality data collected from 2007 to 2011 and comparing those data to a USGS sample dataset. When these two data sets are combined, their relations were able to compute additional concentrations of analytes of concern that were

occurring in the stream throughout that period. The USGS is proposing to add in data collected from 2011 to 2023 to these equations to update the data to better reflect stream concentrations over the entire monitoring period. This will help represent the concentrations of additional constituents more accurately in the rivers. By updating these equations, better calculations would be made of real time concentrations of concern such as atrazine, *E.coli*, phosphorus, suspended sediment, and ammonia.

Potential outcome of the study:

The Lower Platte River Corridor Alliance and member NRDs have water quality management plans in place on the Platte River and its tributaries. Part of these water quality management plans are to look at impaired watersheds and water flowing into the river. The trend analysis being proposed can look at the collected continuous water quality data to help determine if long term management changes are impacting the water quality of the lower Platte River. The trends analysis will be able to account for wet vs dry years and see a clearer picture of how the water quality of the system is changing independent of discharge. Often during dry years, the amount of runoff into the channel is diminished which also decreases the quantity of contaminants and likewise during very wet years extremes in water quality are observed.

Long term changes can also possibly identify changes occurring in regard to climatic effects. The temperature in the lower Platte River can be analyzed throughout the previous 15+ years to see if any changes have occurred or are occurring.

The outcomes of this study will also provide a better understanding of how continuous water quality parameters in the Lower Platte River watersheds are changing over time since data collection started. The R scripts used to complete the data analysis will be created in a way that future years of collected data can be further analyzed through these same scripts. The statistical methods used will be described in a USGS scientific investigations report and the R script and resulting trends data will be published as a USGS data release in ScienceBase.

Study duration:

Data analysis will primarily occur during Federal Fiscal Year (FY) 2025, with report writing beginning at that same time. The final USGS Scientific Investigations Report and necessary data releases will be published in late FY 2026. The dates of the study will be from July 1, 2024, to October 31, 2026. An estimated timeline is as follows:

Activity	FY24	Federal Year 2025				Federal Year 2026			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Data gathering	X	X							
2. Statistical trend analysis		X	X	X	X	X			
3. Surrogate equation analysis and updates		X	X	X	X	X			
4. Report writing and production			X	X	X	X	X	X	X

Cost estimate:

The anticipated cost for the data analysis and report production are expected to be $148,100. This cost will be split between the USGS and Lower Platte Corridor Alliance members electing to participate in the trend analysis. Of the total cost, the USGS will be contributing $53,260 and the LPRCA members contributing $94,840. Below is an approximate funding breakdown of study.

Item	Section 319 *	Other LPRCA partners*	USGS**	Total
Personnel	**13,970**	**74,358**	**49,603**	**137,931**
Project Management	1,161	6,182	4,124	11,466
Data interpretation: Model Development	2,438	12,975	8,656	24,069
Data interpretation: Modeling	1,801	9,584	6,393	17,778
Report writing and preparation	5,142	27,370	18,258	50,771
Review Publication	3,428	18,247	12,172	33,848
Travel	**0**	**0**	**0**	**0**
Domestic Travel	0	0	0	0
Equipment	**0**	**0**	**0**	**0**
Weather Station	0	0	0	0
Supplies/Materials	**0**	**0**	**0**	**0**
Supplies/Mailing	0	0	0	0
Contractual	**0**	**0**	**0**	**0**
Outside Contracts	0	0	0	0
Other	**1,030**	**5,482**	**3,657**	**10,169**
Publication services USGS PSC	1,030	5,482	3,657	10,169
	0	0	0	0
Total	**$15,000**	**$79,840**	**$53,260**	**$148,100**

* Nonfederal Funds

** Federal funds not eligible for 319 match

Quality Assurance:

In order to ensure good quality data are collected and the data being analyzed are done so properly and meet the study objectives, the study will follow standards set by the USGS. These steps are done so that data that is collected and steps done during the analysis are documented and archived in a way that the general public could find any information on the products produced.

All data that will be analyzed in this study were collected by the USGS. In order to assure high quality continuous water data were collected, the USGS follows all protocols that are observed

in the USGS National Field Manual (USGS, 2018) and the USGS TM1D3 (Wagner and others, 2006). These documents are followed by all USGS offices to ensure consistent, high quality, reproducible data collection is collected across the United States. Equipment used in the collection of the data were frequently assessed to ensure high accuracy and precision of measurements was ongoing throughout the 17 years of data collection. Streams were assessed several times per year while data were collected in order to observe any horizontal or vertical mixing may have been occurring. This was done to ensure that the data being collected was representative of the stream and if any bias was present, it was documented.

Quality assurance done on the analysis will be done by following methods used by other trend analysis done across the USGS, as well as archiving these methods and analysis used to run the test on the data. Data analysis will be done in R utilizing WRTDS methods and standard regression equations. The steps that are done to analyze the data will be documented in the final report. All data code used to analyze the report will be saved and archived in USGS model archives wherever necessary.

References:

Helsel, D.R., Hirsch, R.M., Ryberg, K.R., Archfield, S.A., and Gilroy, E.J., 2020, Statistical methods in water resources: U.S. Geological Survey Techniques and Methods, book 4, chap. A3, 458 p., https://doi.org/10.3133/tm4a3. [Supersedes USGS Techniques of Water-Resources Investigations, book 4, chap. A3, version 1.1.]

Hirsch, R.M., and De Cicco, L.A., 2015, User guide to Exploration and Graphics for RivEr Trends (EGRET) and dataRetrieval: R packages for hydrologic data (version 2.0, February 2015): U.S. Geological Survey Techniques and Methods book 4, chap. A10, 93 p., https://dx.doi.org/10.3133/tm4A10.

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Kendall, M.G., 1975, Rank correlation methods (4th ed.): London, Charles Griffin.

Porter, A.J., Webber, J.S., Witt, J.W., and Jastram, J.D., 2020, Spatial and temporal patterns in streamflow, water chemistry, and aquatic macroinvertebrates of selected streams in Fairfax County, Virginia, 2007–18: U.S. Geological Survey Scientific Investigations Report 2020–5061, 106 p., https://doi.org/10.3133/sir20205061.

Schaepe, N.J., Soenksen, P.J., and Rus, D.L., 2014, Relations of water-quality constituent concentrations to surrogate measurements in the lower Platte River corridor, Nebraska, 2007 through 2011

Sen, P.K., 1968, Estimates of the regression coefficient based on Kendall's tau: Journal of the American Statistical Association, v. 63 p. 1379–1389

U.S. Geological Survey [USGS], 2018, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A10, accessed March 2023 at https://pubs.water.usgs.gov/twri9A.

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Yang, G., and Moyer, D.L., 2020, Estimation of nonlinear water-quality trends in high-frequency monitoring data: The Science of the Total Environment, v. 715, p. 136686, accessed February 2020 at https://doi.org/10.1016/ j.scitotenv.2020.136686.

For any additional questions or comments, please reach out to:

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JOINT FUNDING AGREEMENT

For

USGS STREAMGAGE TREND ANALYSIS

in the LOWER PLATTE RIVER

The "JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS" (hereinafter referred to as "the Agreement") to be executed by and among the Lower Platte South Natural Resources District, on behalf of the Lower Platte River Corridor Alliance and the following agencies (herein after referred to as "the Partners").

Lower Platte North Natural Resources District;

Papio-Missouri River Natural Resources District;

Nebraska Department of Natural Resources;

Nebraska Game and Parks Commission;

University of Nebraska Institute of Agriculture and Natural Resources;

Metropolitan Utility District; and

City of Lincoln - Water

The Partners agree as follows.

Scope of work

Real-time continuous water quality monitoring data has been collected by USGS personnel and equipment in cooperation with the Lower Platte River Corridor Alliance in the Platte River over the past 17 years. Monitoring devices include streamgages on the Platte River at Louisville, Elkhorn River at Waterloo, Platte River at Leshara, and Salt Creek near Ashland. Water quality data collected include temperature, turbidity, dissolved oxygen, specific conductance, nitrate/nitrite and others as available. Data has been displayed in real-time over the internet and collected generally March through October each year. Datasets are now sufficient to begin looking for potential water quality trends that are occurring. These data will be examined using modeling techniques to account for wet and dry years or missing data and detect water quality trends or facilitate comparisons between sites to better understand how the water quality in the Lower Platte River has changed over the monitoring period. The start time

for the trend analysis project is July 1, 2024, and is anticipated to be completed in two years.

Funding

The Lower Platte South Natural Resources District, on behalf of the Lower Platte River Corridor Alliance, will hold and disburse funds from all Partners as needed for this study. Each partner will provide $5,843 in December 2024 (FY25) and $4,137 in December 2025 (FY26) for a total of $9,980 for the three-year agreement. The total cost of the Trend Analysis Project is $148,100 with USGS contributing $53,260. The local match of $94,840 will be funded by a $15,000 Section 319 Small Grant through NDEE and the eight partners will fund the remaining balance of $79,840.

Effective date

The agreement shall become effective upon execution by all parties.

Duration of agreement

The agreement shall run through October 31, 2026, when all required funds have been received, data collection completed, and final report of the trend analysis is written.

This Agreement is hereby approved and executed by the following parties on the dates shown below.

IN WITNESS WHEREOF, this JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the Lower Platte South Natural Resources District on this ____ day of _____, 2024, pursuant to approved action by its Board of Directors.

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT

By:

_____

Mike Sousek, General Manager

This JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the Lower Platte North Natural Resources District on this ____ day of _____, 2024, pursuant to approved action by its Board of Directors.

LOWER PLATTE NORTH NATURAL RESOURCES DISTRICT

By:

_____

Eric Gottschalk, General Manager

This JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the Papio-Missouri River Natural Resources District on this ____ day of _____, 2024, pursuant to approved action by its Board of Directors.

PAPIO-MISSOURI RIVER NATURAL RESOURCES DISTRICT

By:

_____

John Winkler, General Manager

This JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the Nebraska Department of Natural Resources on this ____ day of _____, 2024,

NEBRASKA DEPARTMENT OF NATURAL RESOURCES

By:

_____

Thomas Riley, Director

This JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the Nebraska Game and Parks Commission on this ____ day of _____, 2024,

NEBRASKA GAME AND PARKS COMMISSION

By:

_____

Tim McCoy, Director

This JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the University of Nebraska Institute of Agriculture and Natural Resources on this ____ day of _____, 2024,

UNIVERSITY OF NEBRSAKA INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES

By:

_____

Michael Boehm, Vice Chancellor

This JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the Metropolitan Utilities District on this ____ day of _____, 2024,

METROPOLITAN UTILITIES DISTRICT

By:

_____

Kendall Minor, Sr. VP Chief Operations Officer

This JOINT FUNDING AGREEMENT for the USGS STREAMGAGE TREND ANALYSIS for the LOWER PLATTE RIVER CORRIDOR ALLIANCE is executed by the City of Lincoln on this ____ day of _____, 2024,

CITY OF LINCOLN

By:

_____

Leirion Gaylor Baird, Mayor