

3-Yrs of Warm-Season Monthly Data on Nitrate, Phosphorus, E-Coli and Coliform at Sources and Mouths of the Kewaunee, Ahnapee, and E. Twin Rivers in Northeast Wisconsin

by

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Citizen volunteers for Kewaunee CARES and WAV

(Citizens Advocating Responsible Environmental Stewardship, and Water Action Volunteers)

For presentation at the 2016 WAV Symposium
in conjunction with the 38th annual Wisconsin Lakes Partnership Convention

April 1, 2016, Holiday Inn and Convention Center, Stevens Point, Wisconsin

The complete Power Point is publically available at kewauneecares.com

e-mail is kewauneecares4u@gmail.com

Information may also be obtained from the Kewaunee CARES Facebook Page

Outline of Presentation

Views of the watershed (see easel display; & Appendix for IDs of sites).

Early analysis of temporal nitrate trends for all three rivers.

Refined analyses based on 5-day prior rainfall:

Nitrate, Total Phosphorus, E. coli and Total Coliform.

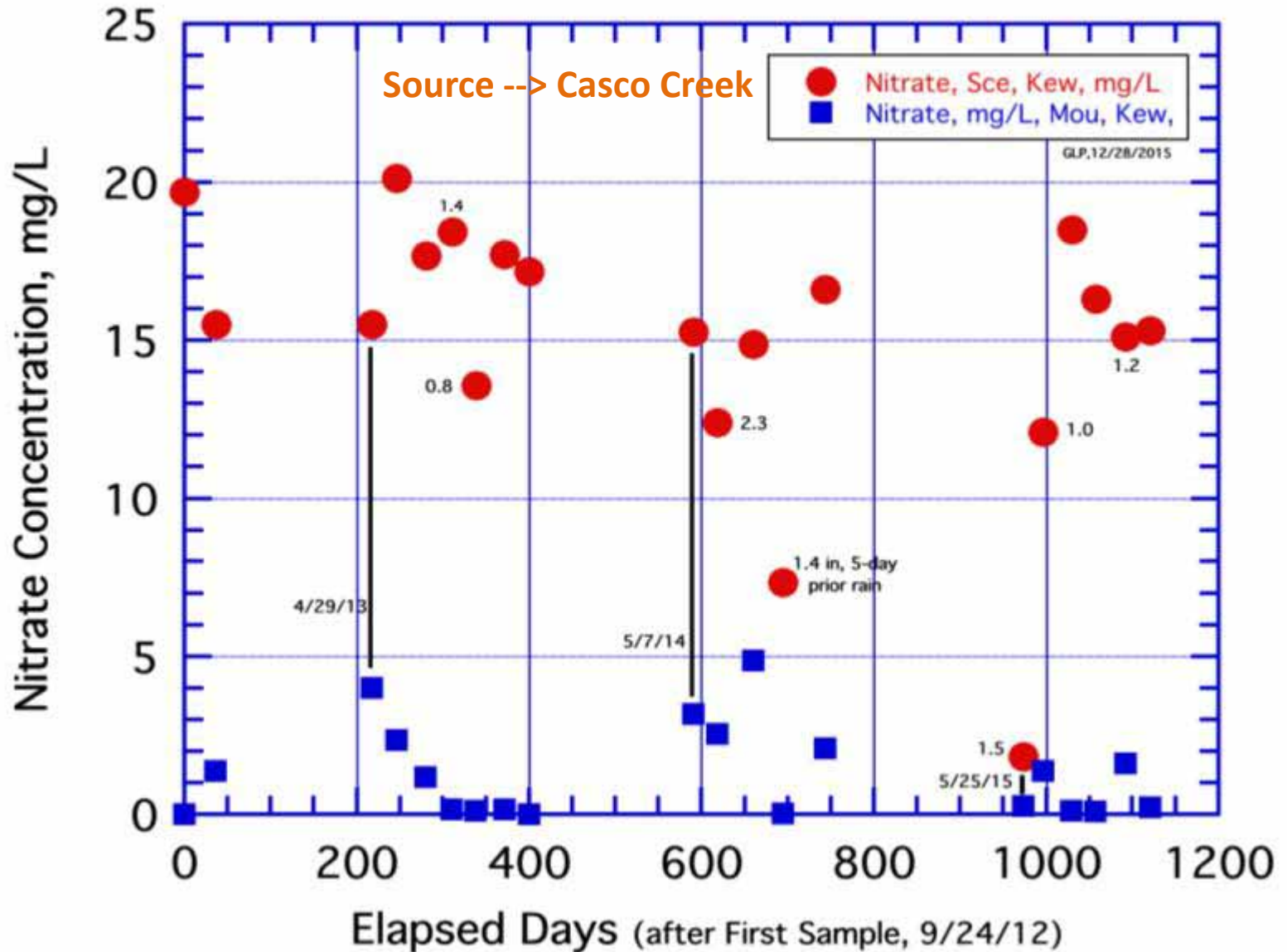
Past DNR & USGS Nitrate & Total-P data; cf. present Kewaunee R. data.

Recent UW Oshkosh and present Total P and E. coli data for Ahnapee R.

Bar graph summaries of mean concentrations and recommended limits.

Summary of major Results, and Conclusions

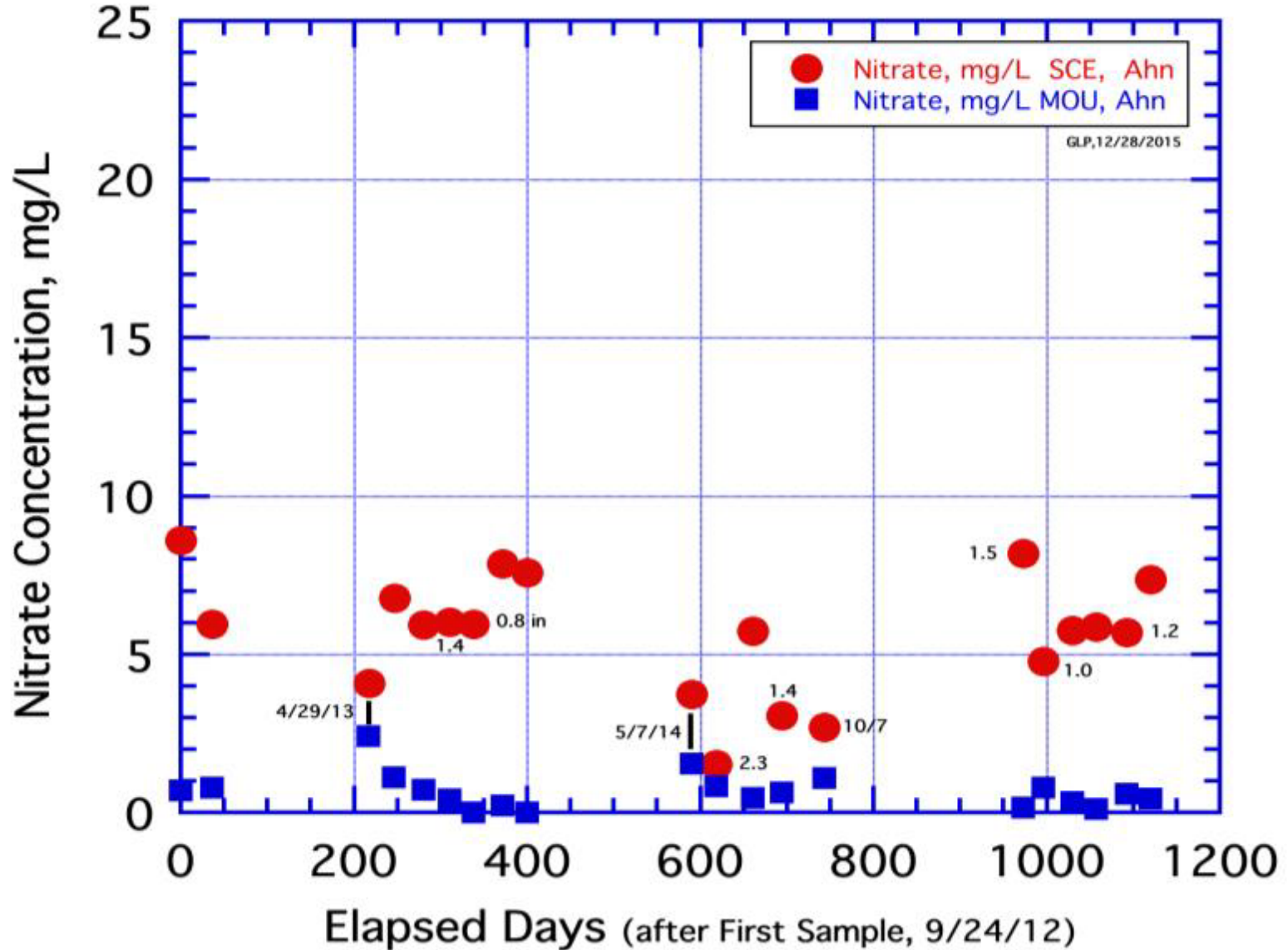
Nitrate vs Elapsed Time, Source & Mouth, Kewaunee River



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- 1) Source-Nitrate generally \gg than Mouth-NO₃ – but reduced by large 5-day prior rain.
- 2) Mouth-NO₃ decreases with spring warming, growth, activation of denitrifying bacteria.

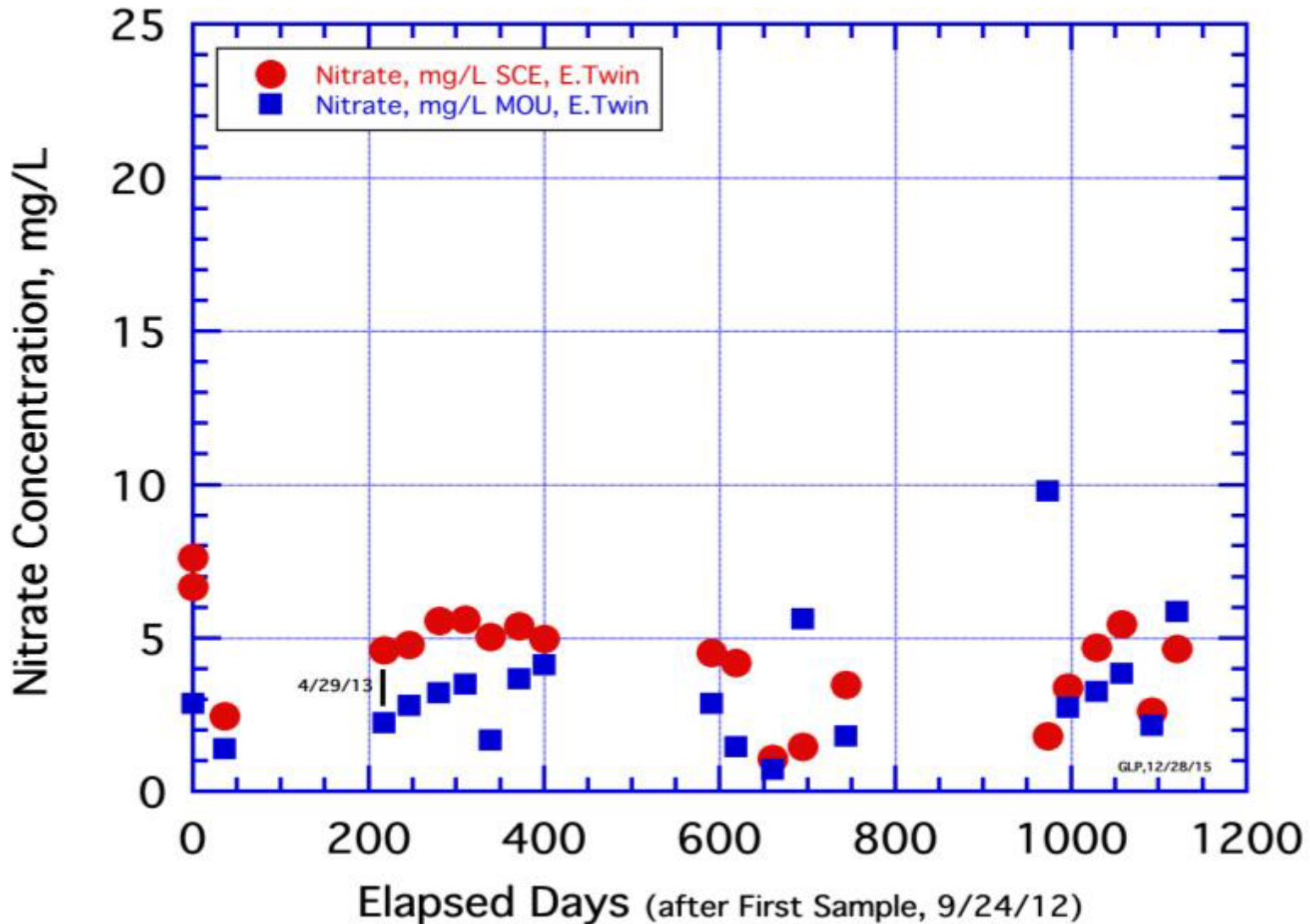
Nitrate vs. Elapsed Time, Source & Mouth, Ahnapee River



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- 1) Source-Nitrate for Ahnapee is about 1/2 that for Kewaunee River. Reasons unknown.
- 2) Seasonal decrease in Mouth-Nitrate to low values also occurs with spring warming.

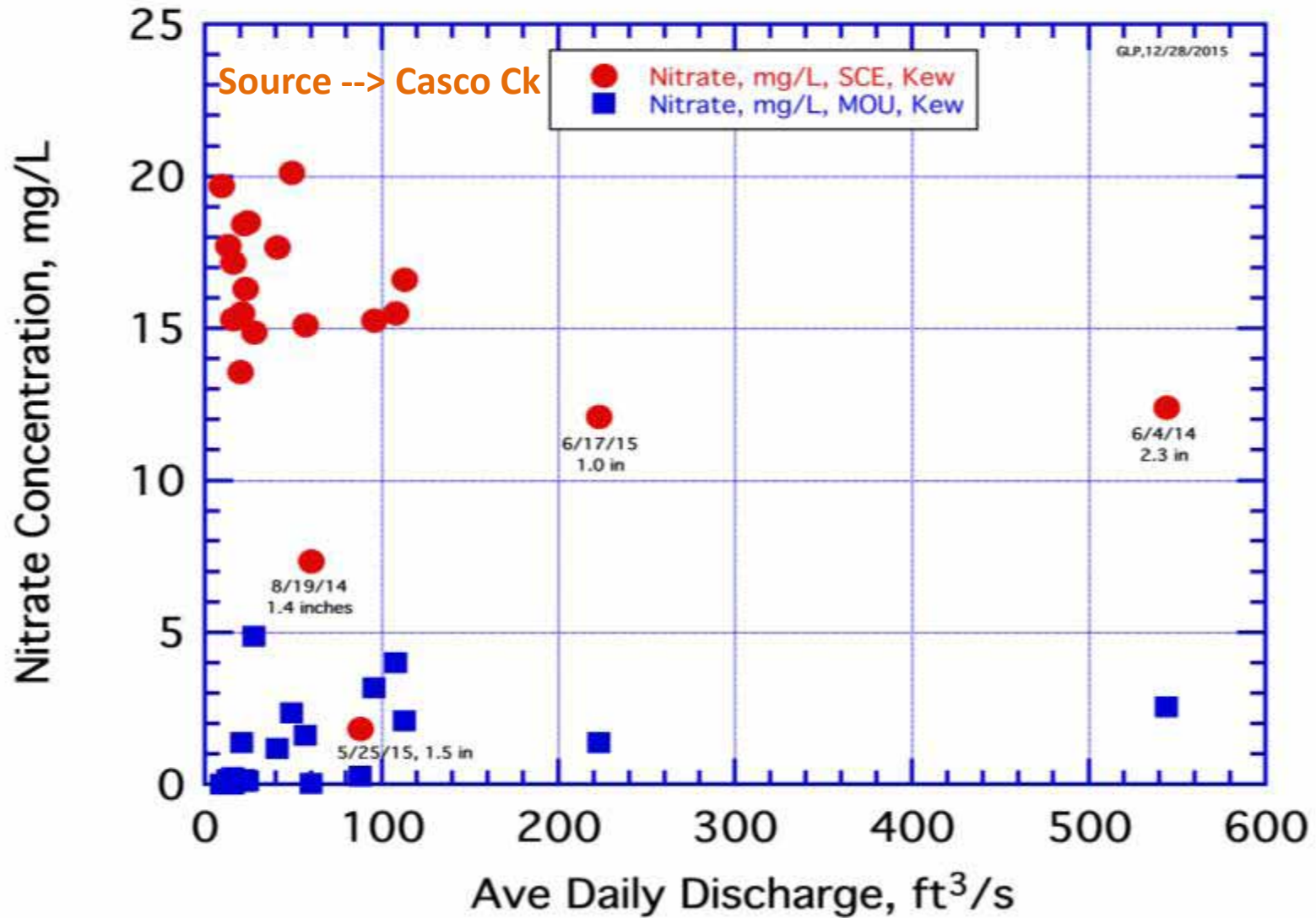
Nitrate vs. Elapsed Time, Source & Co. Exit (Tish Mills), E. Twin River



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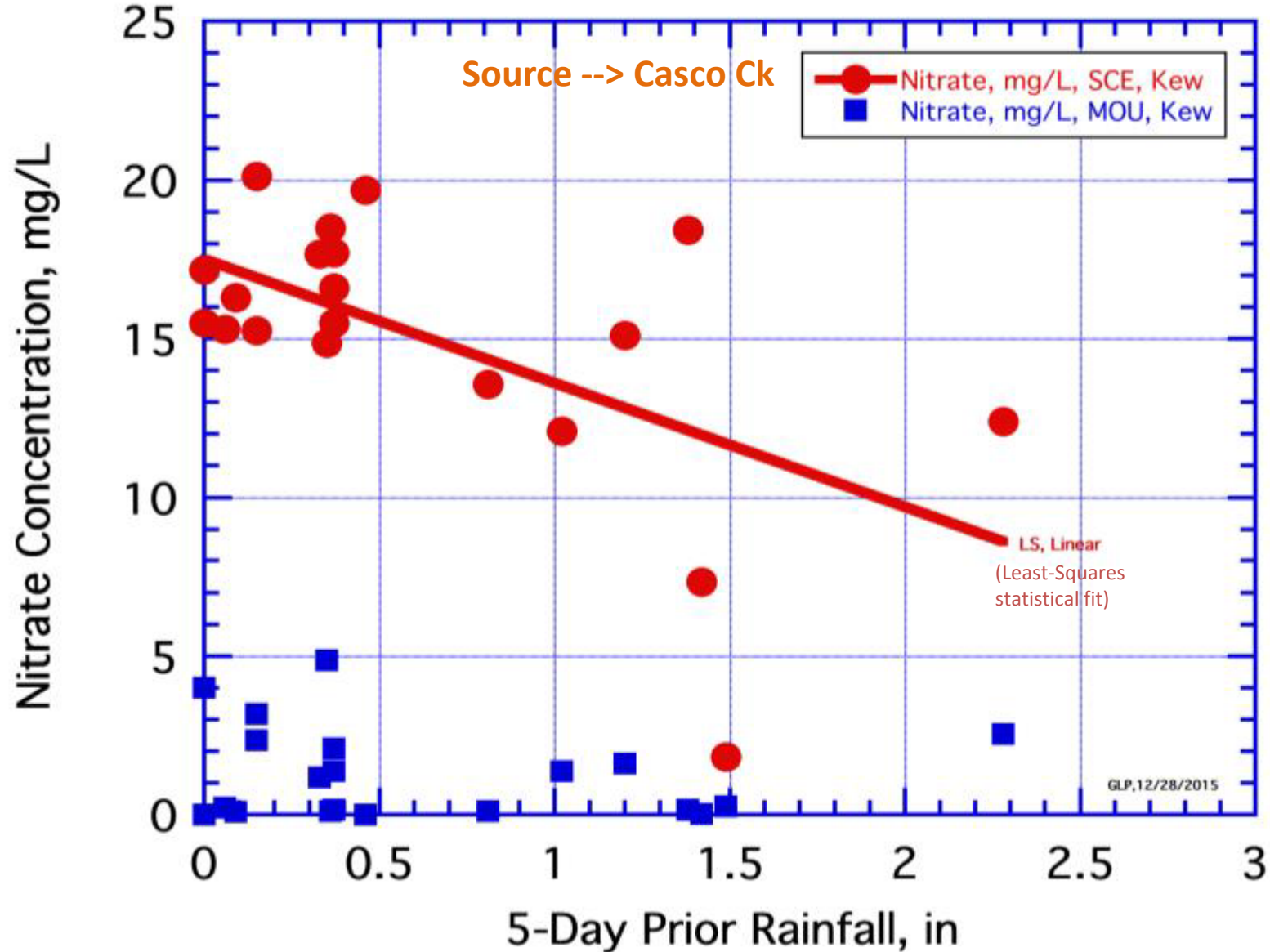
- 1) Source & County-Exit Nitrates are similar; Source-NO₃ is about 1/3 that for Kewaunee R.
- 2) Exit-Nitrates didn't decrease to low values (reduced upstream growth & de-nitrification?)

Kewaunee River Nitrate vs ave Daily Discharge (USGS) for Source and Mouth Locations



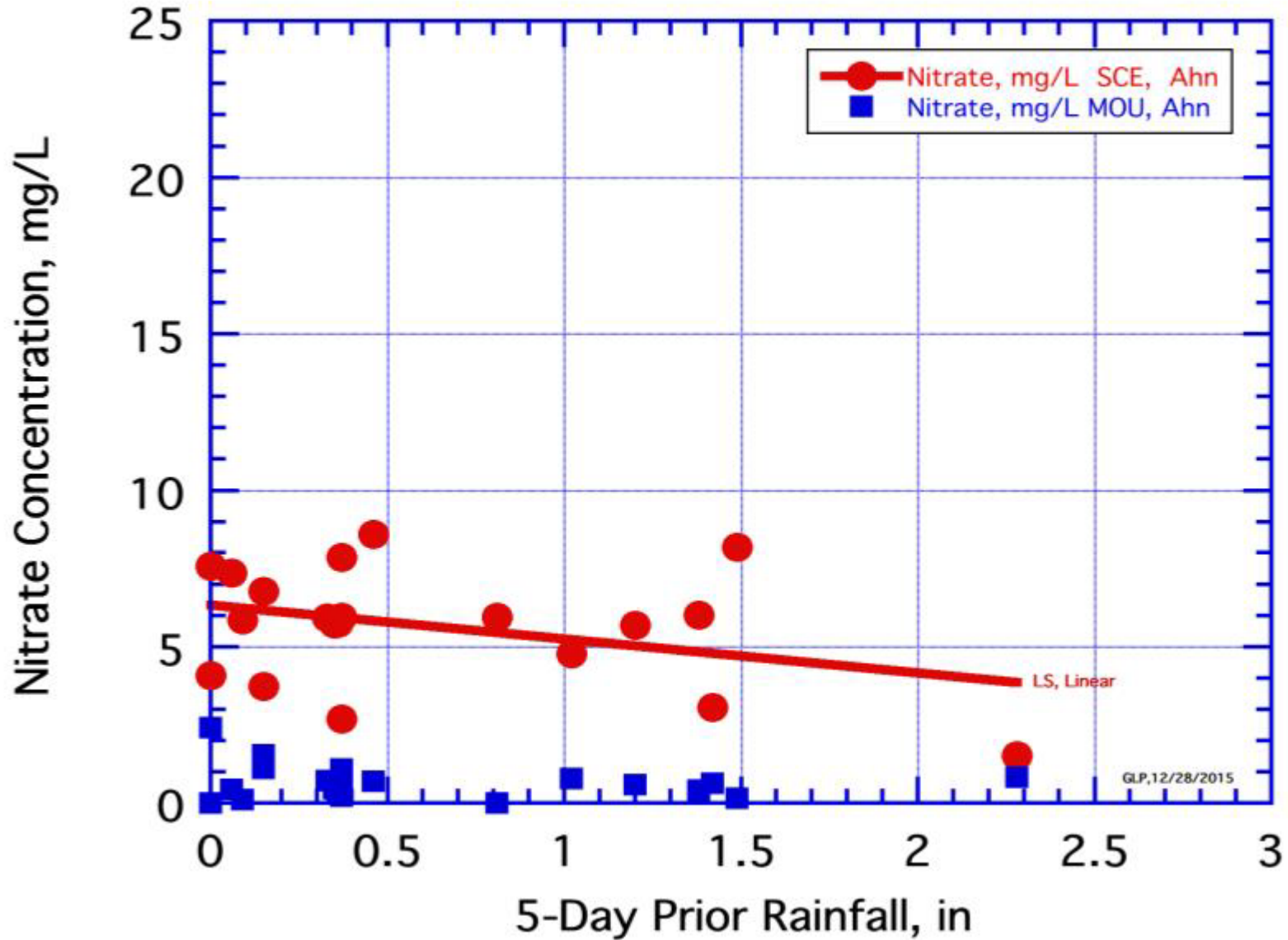
1) Correlation of Source-NO₃ with river Discharge rate isn't very good for high prior rainfall.

Nitrate vs. 5-Day Prior Rainfall, Source & Mouth, Kewaunee River



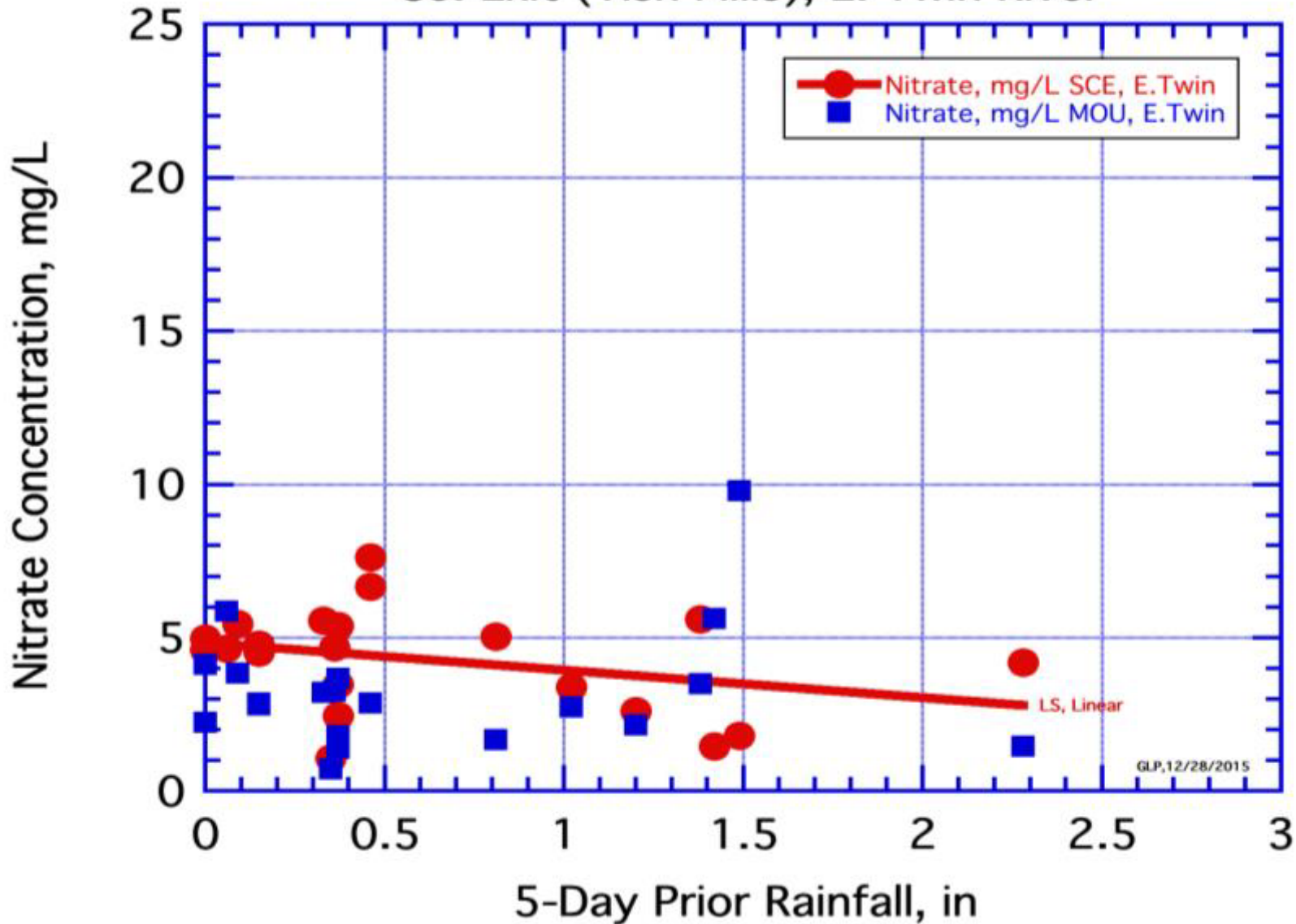
- 1) Correlation with 5-Day Prior Rainfall significantly better (than with river Discharge rate).
- 2) Source-NO₃ decreases with Prior Rainfall (due to prior removal by surface “washout”?)

Nitrate vs. 5-Day Prior Rainfall, Source & Mouth, Ahnapee River



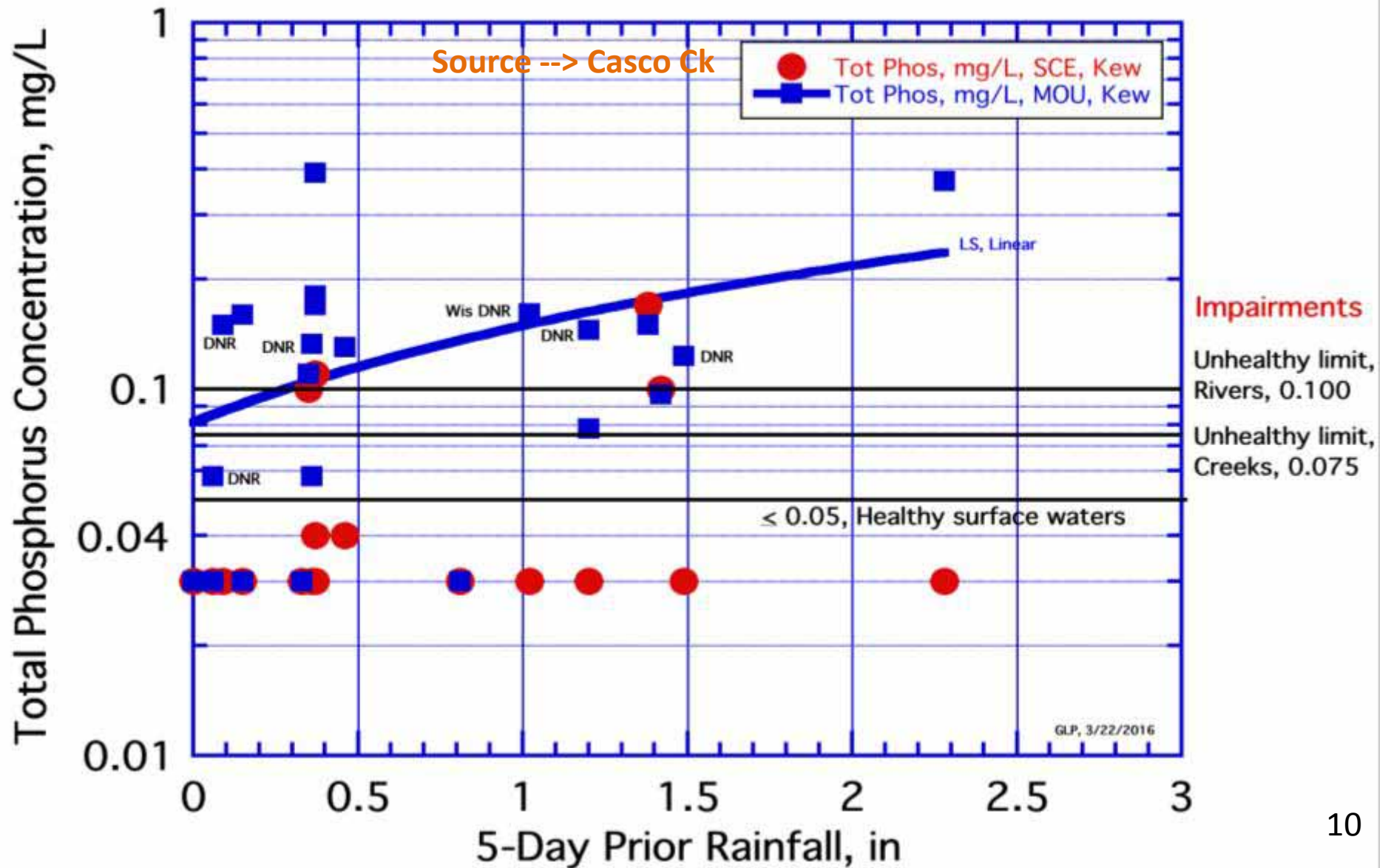
1) Source-NO₃ also decreases, but from a lower “zero-rain” base; processes likely similar.

Nitrate vs. 5-Day Prior Rainfall, Source & Co. Exit (Tish Mills), E. Twin River



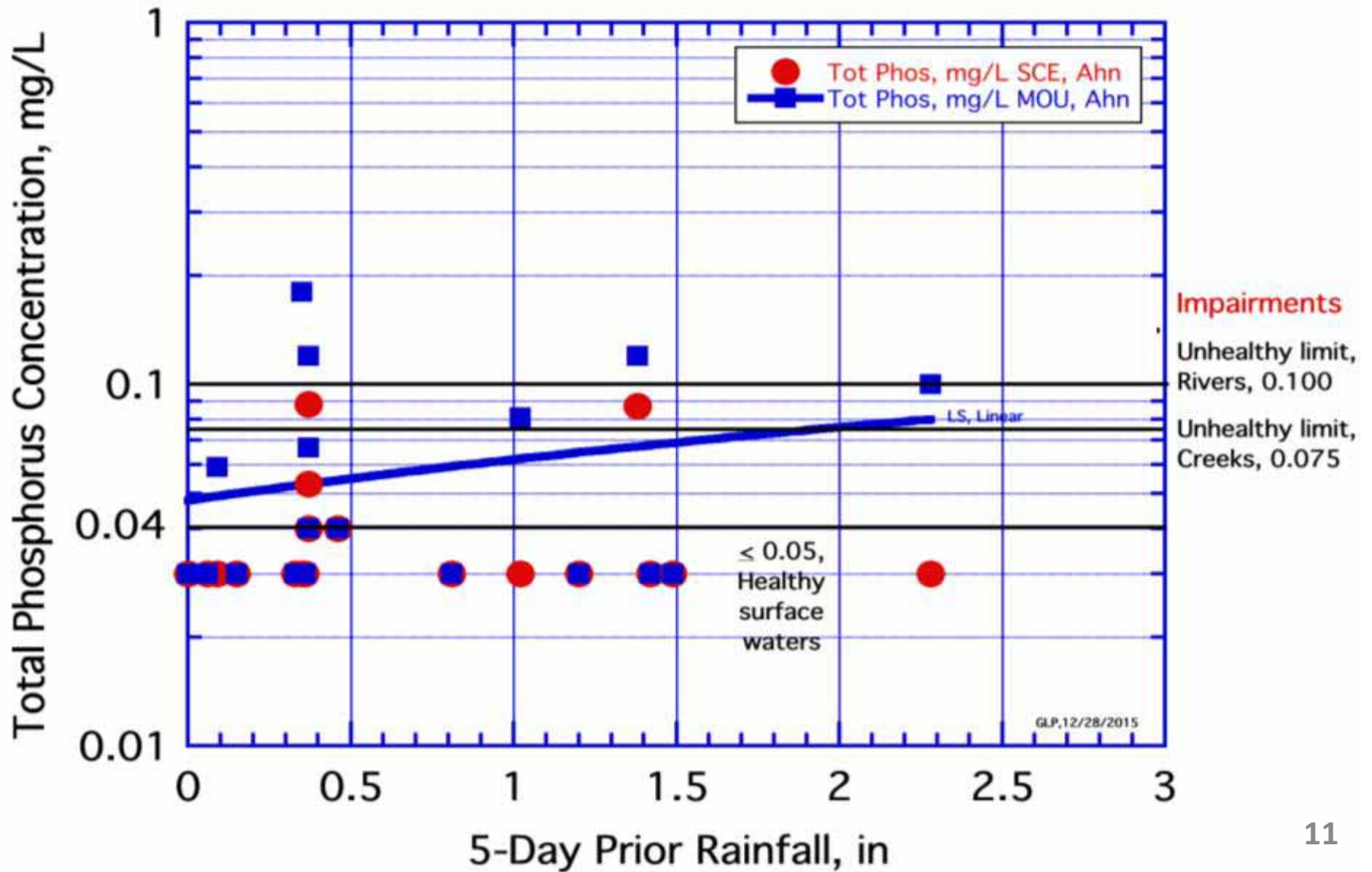
- 1) Similar decrease in Source-Nitrate with 5-day Prior Rainfall, but generally less evident.
- 2) County-Exit Nitrates also appear to decrease in E. Twin, but not very strongly.

Total P vs. 5-Day Prior Rainfall, Source & Mouth, Kewaunee River



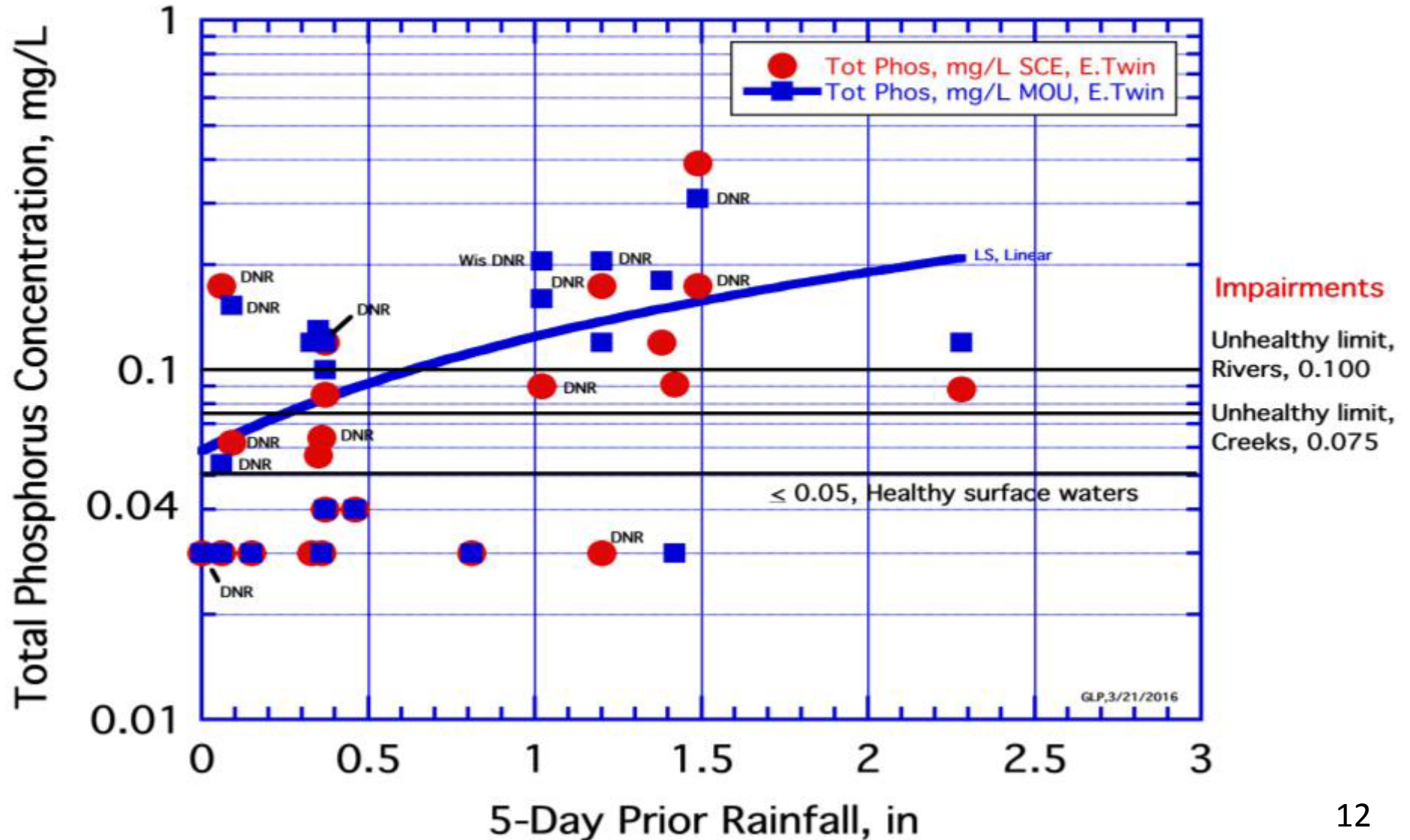
- 1) MOUTH Total P INCREASED with prior rainfall; likely due to runoff / erosion particulates.
- 2) Split-sample WDNR results are comparable to other data. **Impairment** is significant.

Total P vs. 5-Day Prior Rainfall, Source & Mouth, Ahnapee River



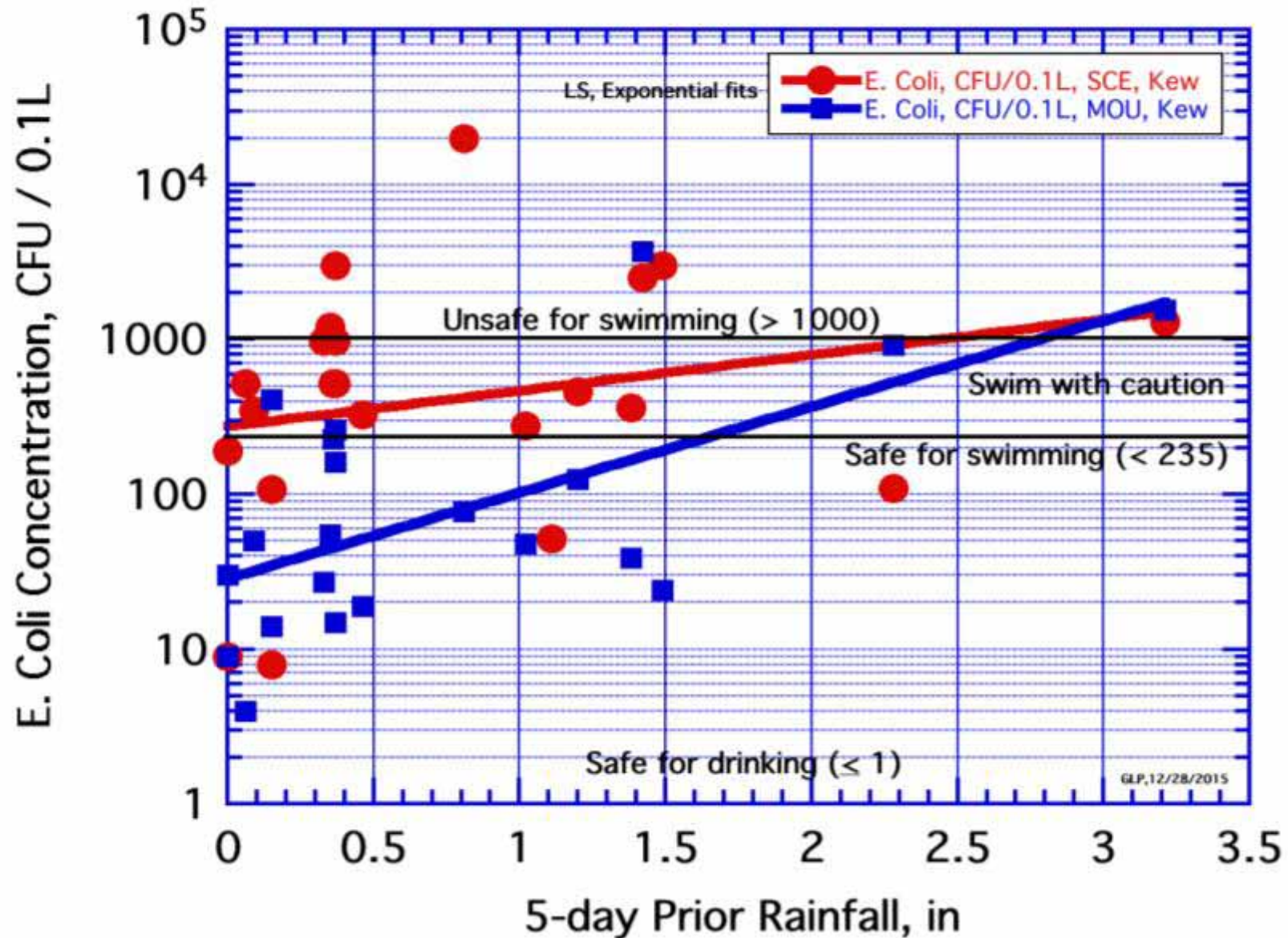
1) “Mouth” Total P of Ahnapee also increased with Prior Rain; river is **much less Impaired**.

Total P vs. 5-Day Prior Rainfall, Source & Co. Exit (Tish Mills), E Twin River



- 1) Large increase in Total P with Prior Rainfall; confirmation with several split samples.
- 2) From Source to County Exit at Tish Mills, the E. Twin river appears significantly **Impaired**.

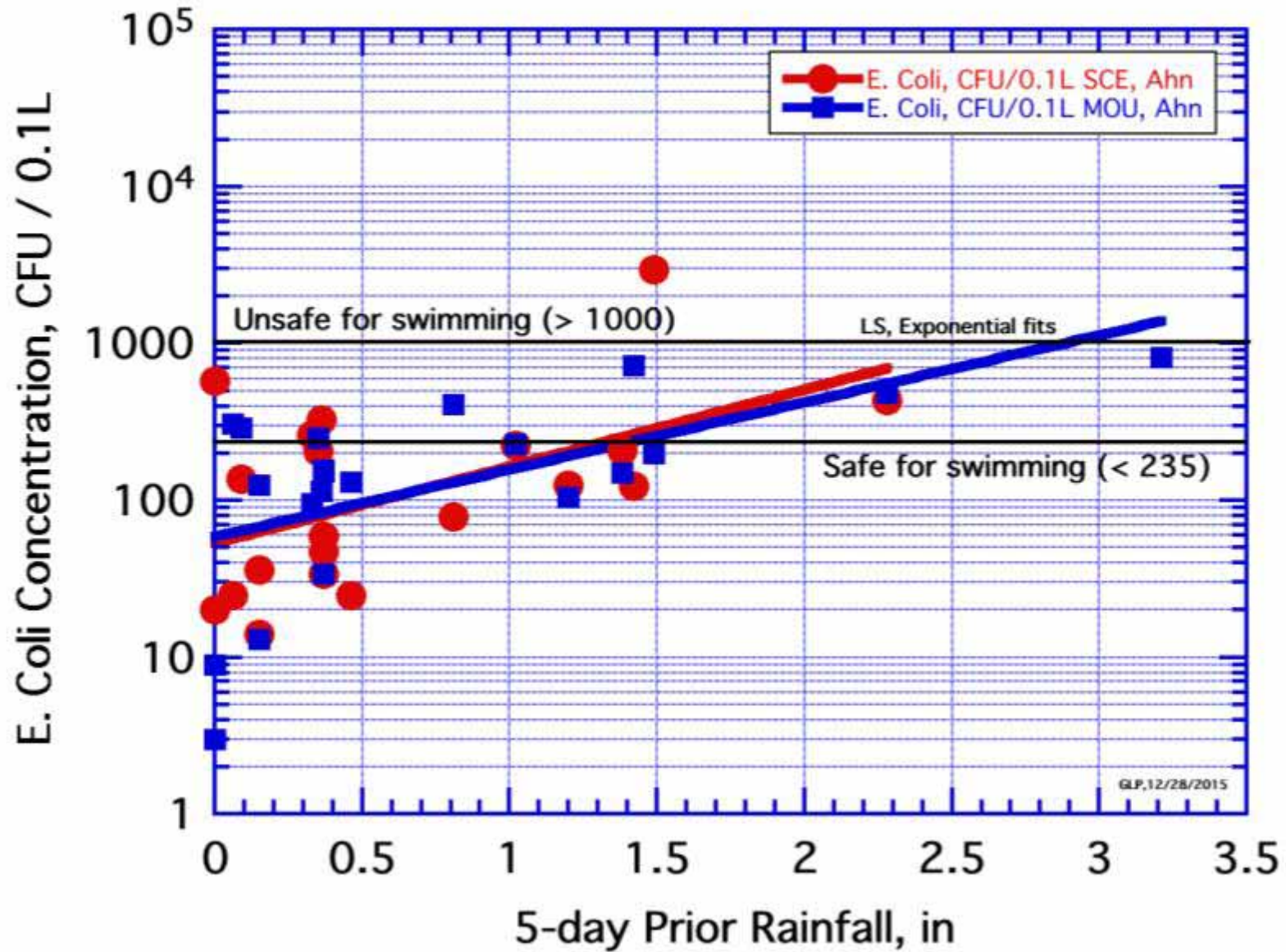
E. Coli vs 5-day Prior Rainfall, Source & Mouth of Kewaunee River



GLP,12/28/2015

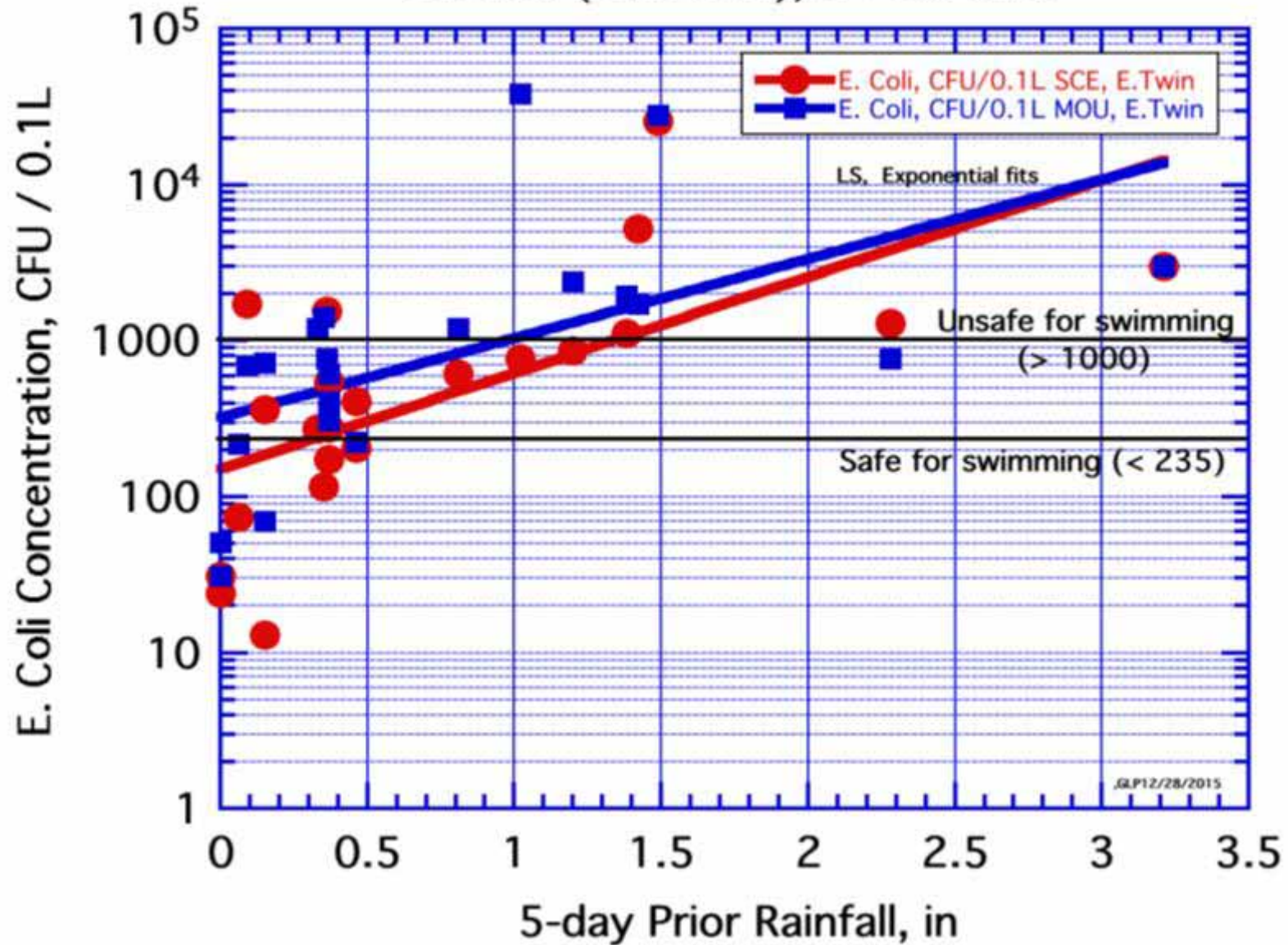
- 1) Kew. Source & Mouth E. coli INCREASE with prior rainfall; runoff and soil erosion effects.
- 2) Mouth E. coli affect Selner Beach safety, particularly when river outlet wraps-around pier.

E. Coli vs 5-day Prior Rainfall, Source & Mouth, Ahnapee River



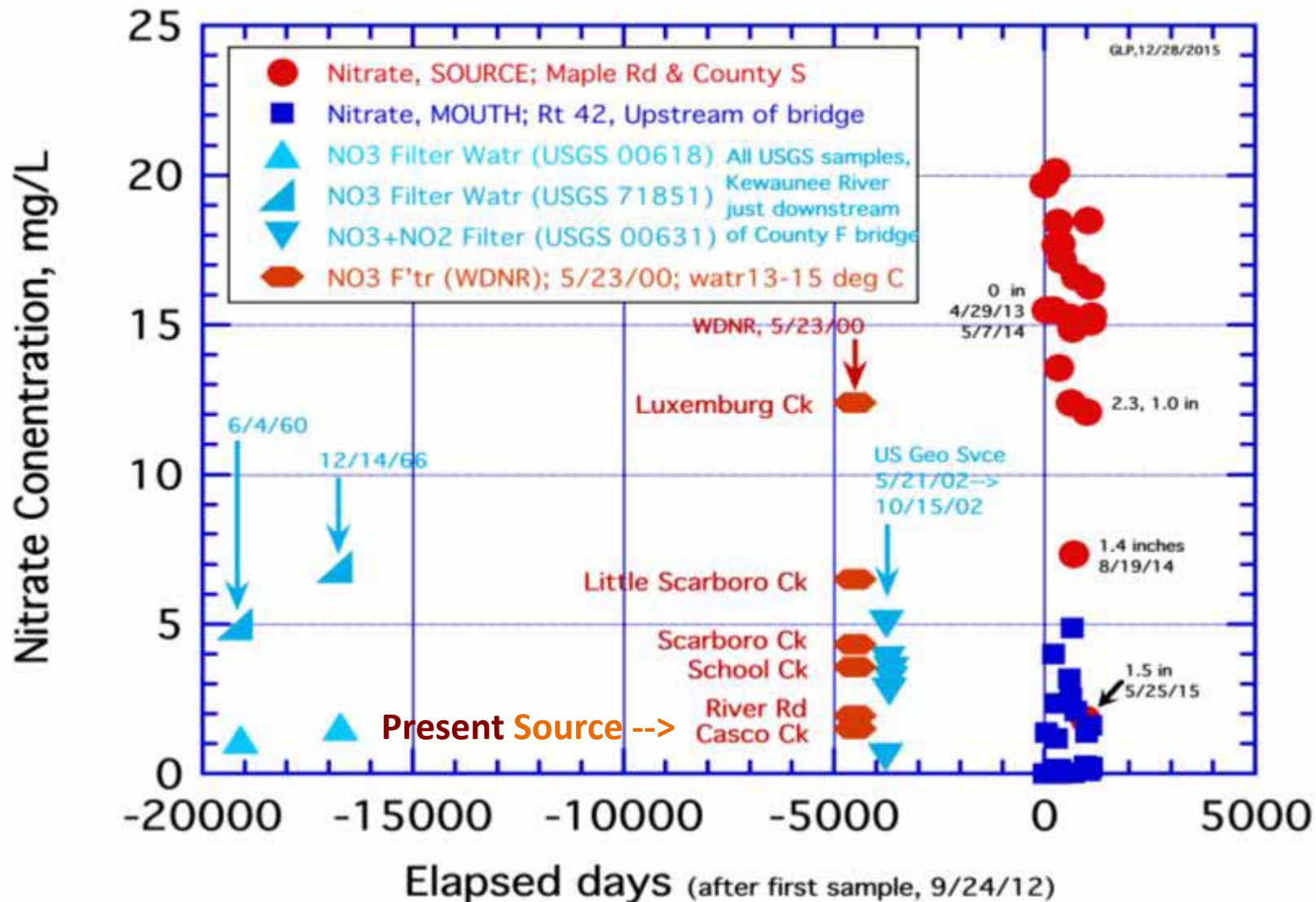
1) Similar increases in Ahnapee, but Source E. coli levels significantly lower than in Kew. R.

E Coli vs 5-day Prior Rainfall, Source & Co. exit (Tish Mills), E Twin River



1) Similar trends with E. Twin, but both E. coli became very high with increased Rainfall.

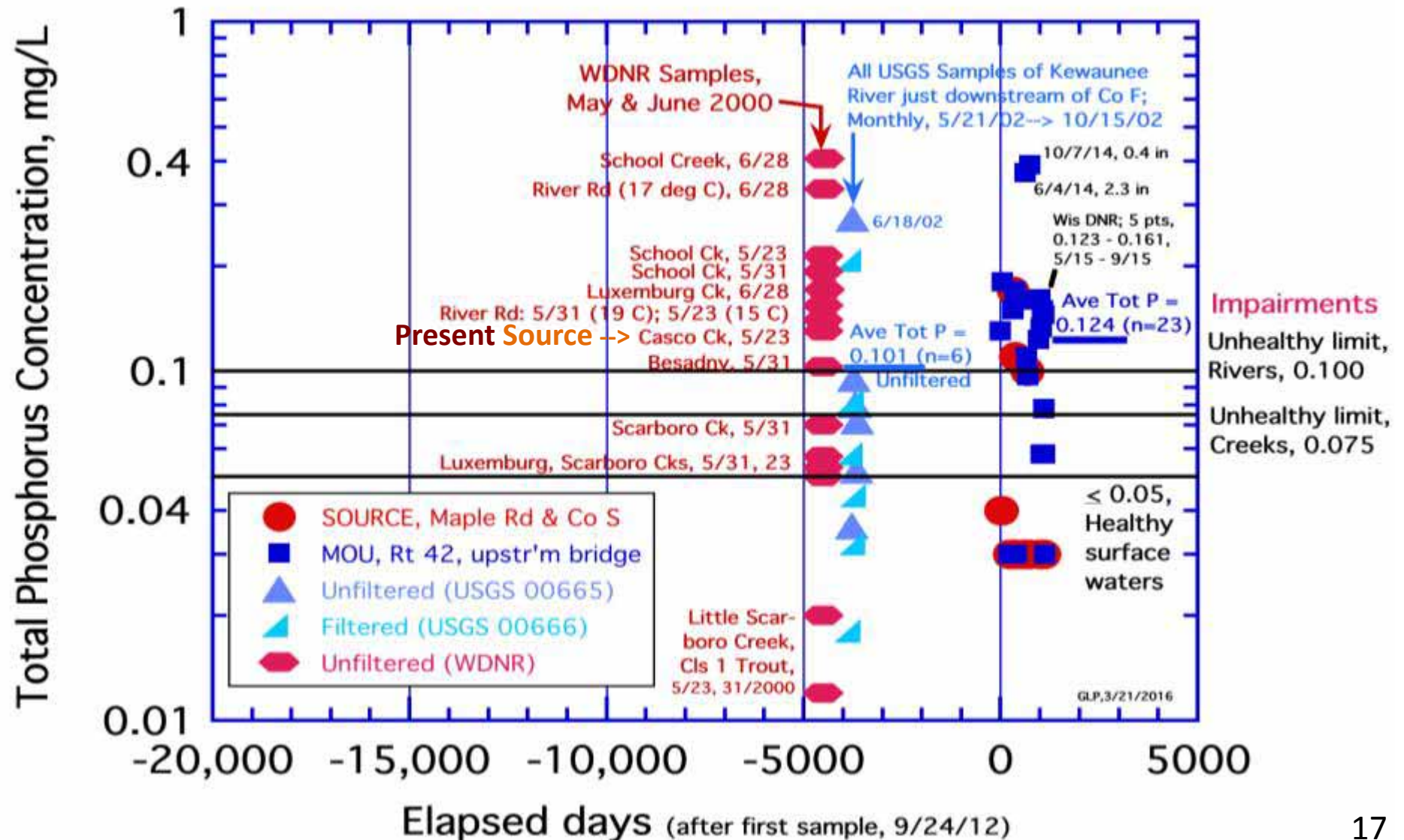
Past (USGS & DNR) and Present Nitrate vs Time, Kewaunee River



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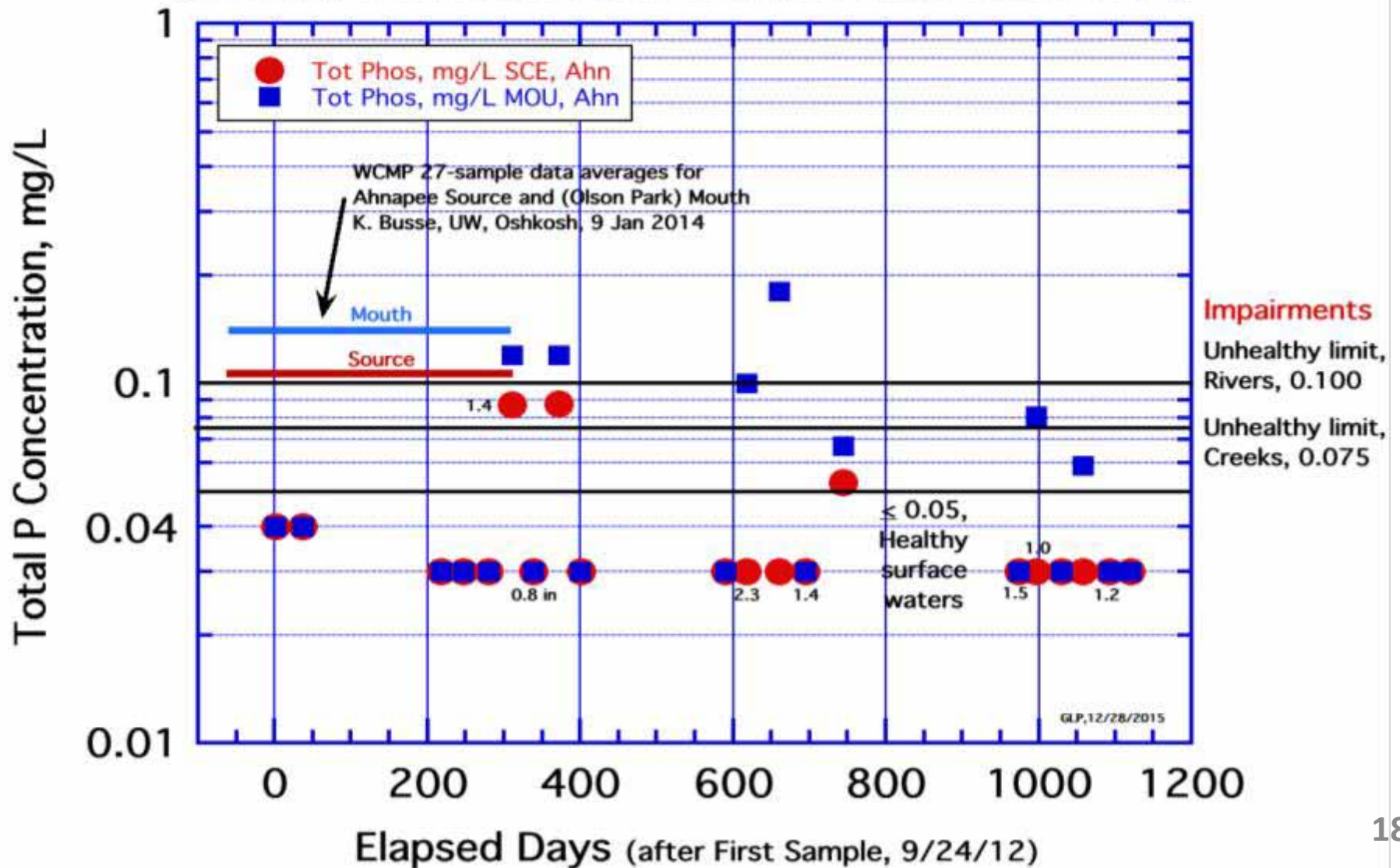
- 1) Based on *available* data, **Source-nitrate TRIPLLED over 15 – 50 yrs** in Kewaunee River.
- 2) **Mouth-nitrate has remained about the same**, based mainly on USGS data that are more extensive and applicable to Mouth-nitrate (downstream of Besadny) than WDNR data.

Past (USGS & DNR) and Present Total P vs Time, Kewaunee River



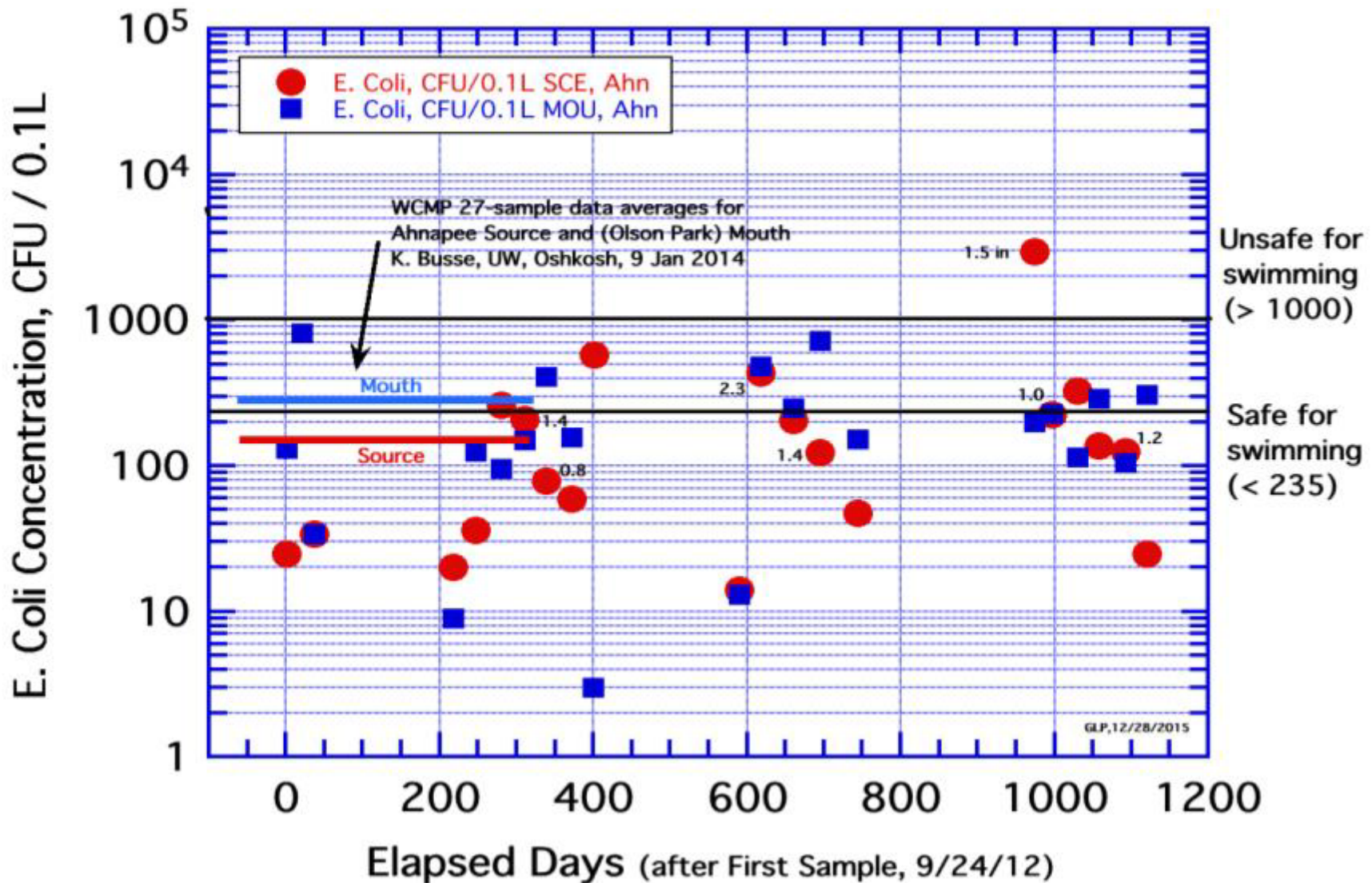
- 1) May & June 2000 WDNR data indicate **relatively high Source-Total P compared to now.**
- 2) Based on all 3 data sets, **Mouth-Total P increased about 20 % compared to 2000 - 2002.**

Total Phosphorus vs Elapsed Time, Source & Mouth, Ahnapee River (including comparisons with averaged UW, Oshkosh data)



- 1) Total P in Ahnapee at the (Olson Pk.) "Mouth" was consistently higher than at the Source.
- 2) Averaged UW Oshkosh data generally agree with present data (including Mouth > Source).

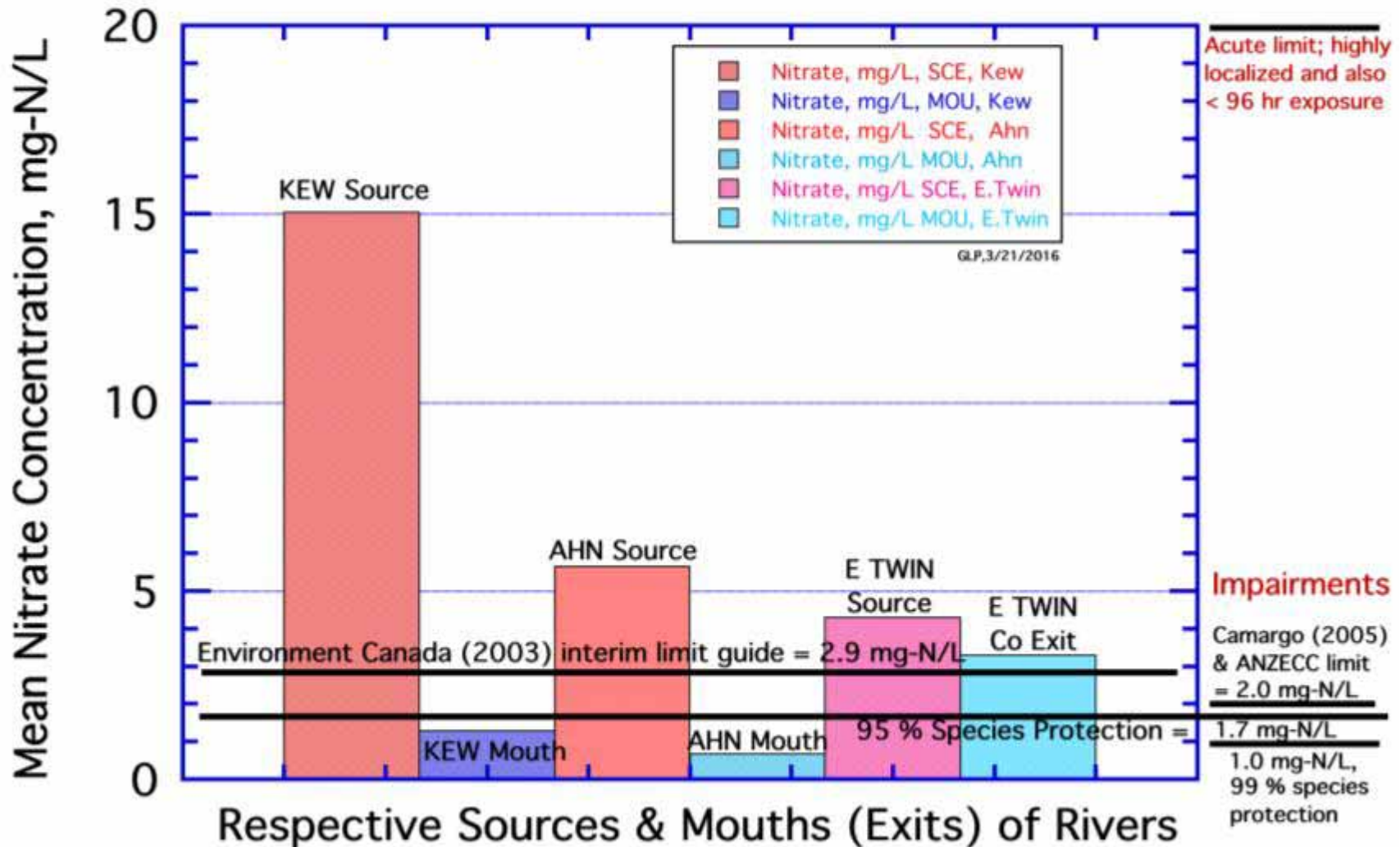
E Coli vs Elapsed Time, Source & Mouth, Ahnapee River (including comparisons with averaged UW, Oshkosh data)



- 1) Averaged Ahnapee E. coli data from UW Oshkosh agree very well with present data.
- 2) E. coli concentrations vary widely on a month to month (and also day to day) basis.

Mean Nitrate in Kewaunee, Ahnapee & E Twin Rivers

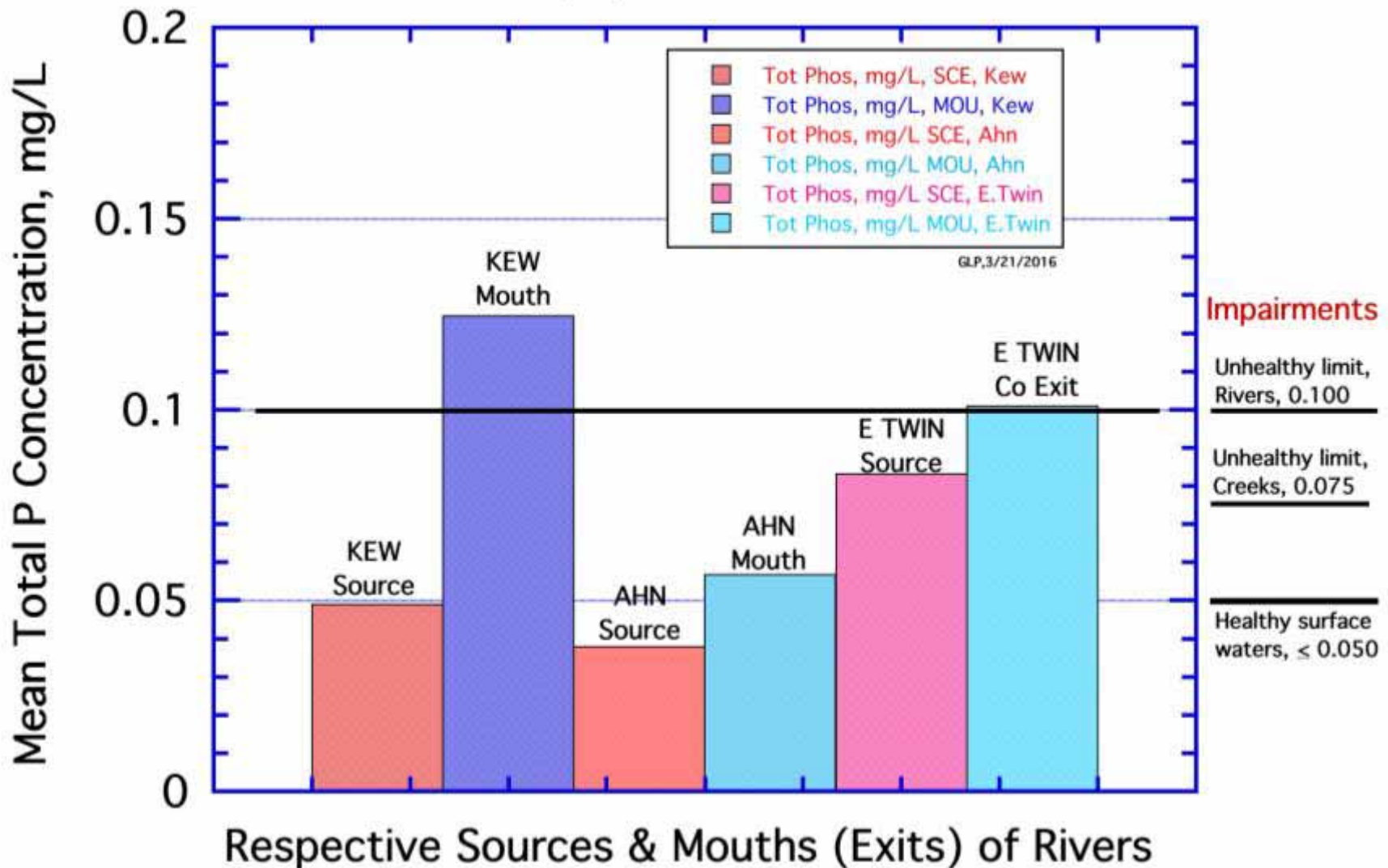
n ~ 20; Sept. '12 - Oct. '15. Nitrate limits from C.W. Hickey and M.L. Martin, NIWA Report No. R09/57 (2009); ISBN 978-1-86937-997-1



- 1) Nitrate in KEW Source >> impairment limits; detailed agricultural causes uncertain.
- 2) Mouth-Nitrates reflect consumption by in-water plant growth, and also consumption by denitrifying bacteria in river sediments under slow-flowing marsh-like conditions.

Mean Total Phosphorus in Kewaunee, Ahnapee & E Twin Rivers

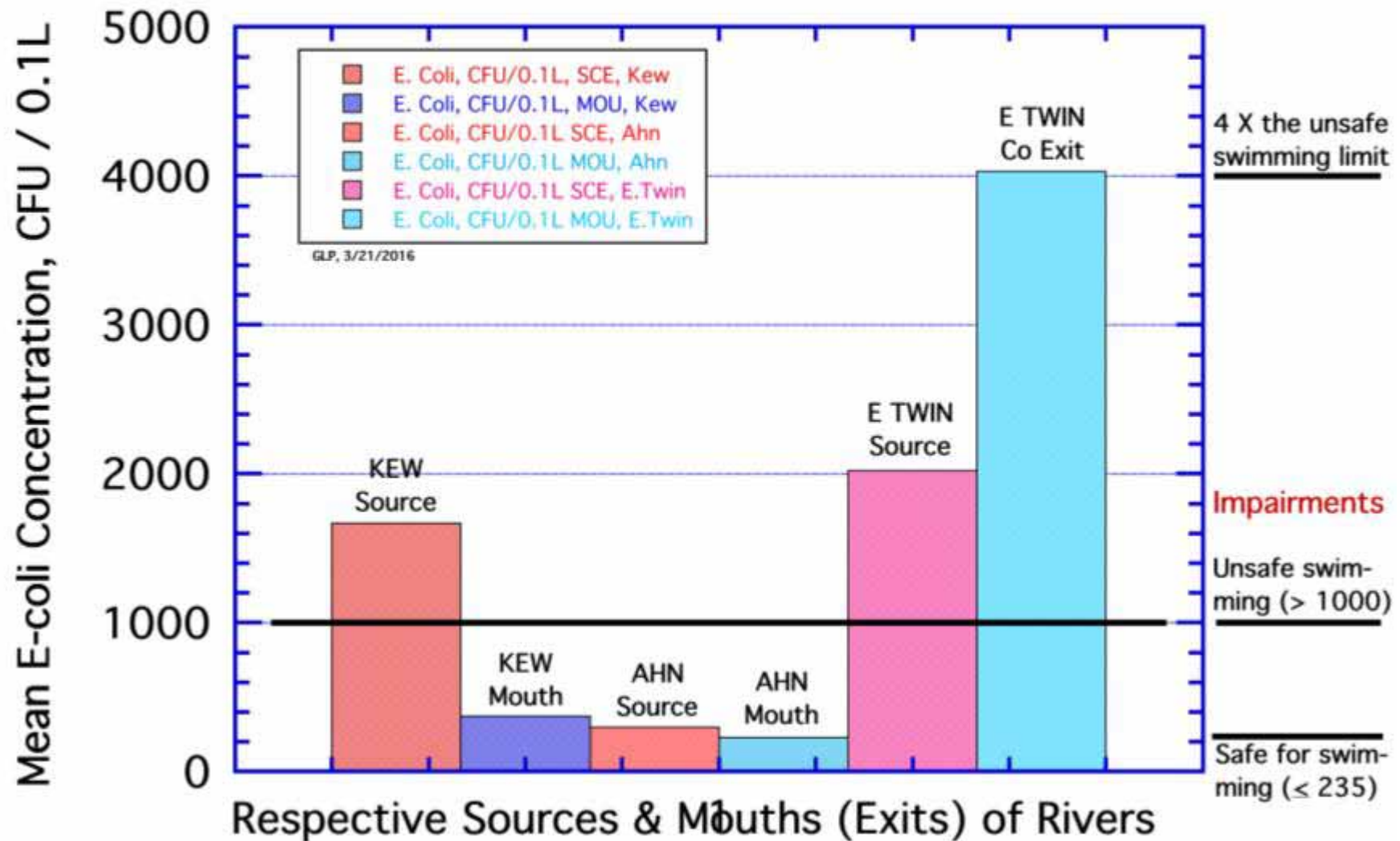
N ~ 20; Sept. '12 - Oct. '15



- 1) Total P in Kewaunee Mouth is “unhealthy” and is 2 X that near the Ahnapee Mouth.
- 2) Mean Total P concentrations in Mouth areas always exceeded con’s in Source areas.

Mean E-coli in Kewaunee, Ahnapee & E Twin Rivers

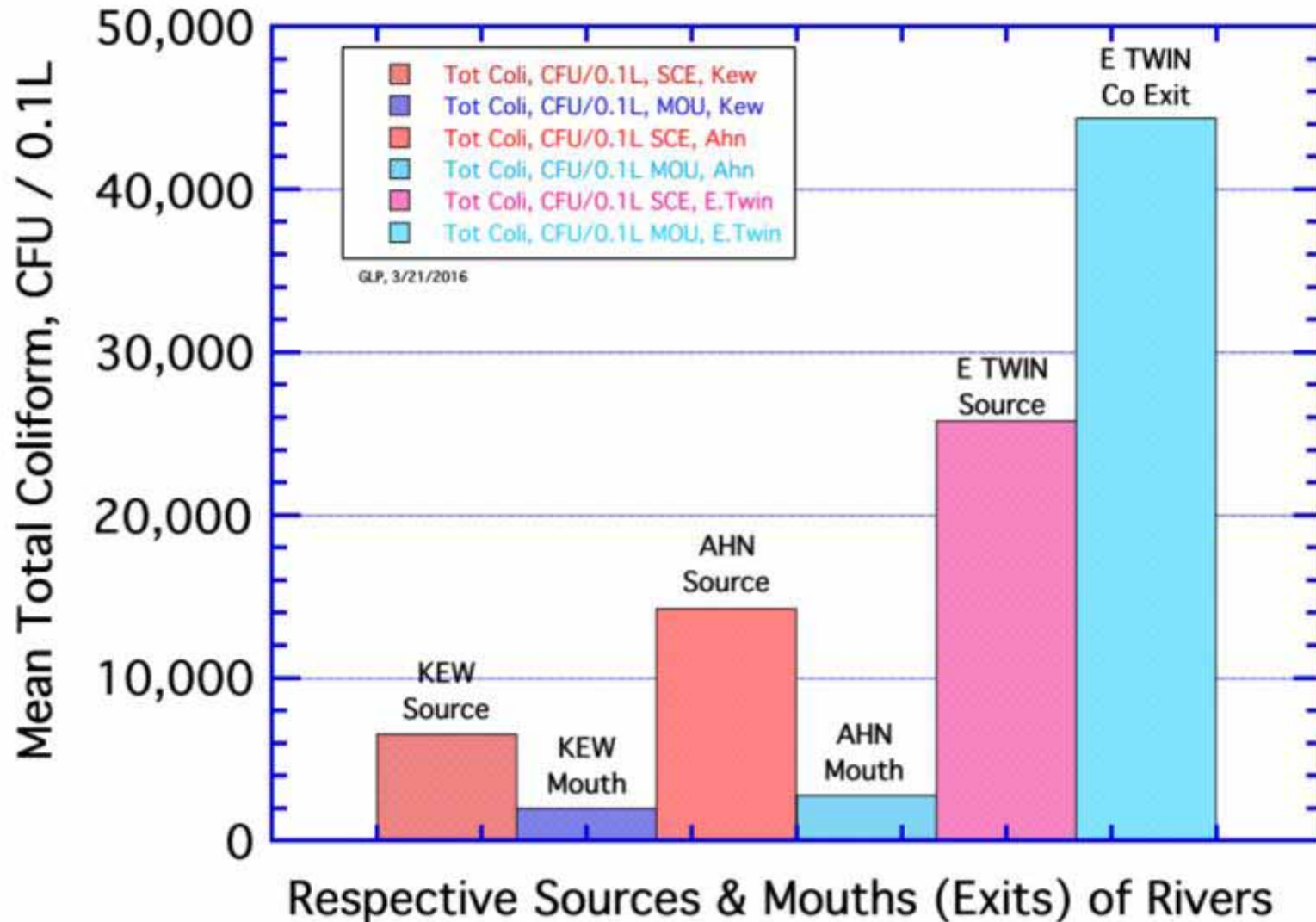
N ~ 20; Sept. '12 - Oct. '15



- 1) Mean E. coli from Kewaunee and Ahnapee Source areas become reduced downstream.
- 2) However, E. coli at the E Twin Co. exit was exceptionally high, for reasons unknown.

Mean Total Coliform in Kewaunee, Ahnapee & E Twin

N ~ 20; Sept. '12 - Oct. '15



- 1) Mean **Total coliform** concentrations are **much larger** than corresponding E. Coli values.
- 2) Reduction of Total coliform from Source to Mouth is strong for Kewaunee and Ahnapee.
- 3) **E Twin Source and Co. Exit show very high Total coliform** (more than 10 X mean E. coli).

Summary of Major Results, and Conclusions

Source-nitrates in Kewaunee R. **tripled** over last 15 - 50 years.

Total Phosphorus con's in Kew. R. mouth **increased about 20 %**.

Very high nitrates should be included in DNR/EPA impairment lists.

E. Coli, Source-nitrates, and Mouth-Total-P con's correlated strongly with "5-Day Prior Rainfall," which causes wash-down and soil erosion.

Projected Kew. Discharge of Total P, from 20 days, was **34,100 lb P/yr**. The projection depends strongly on large episodic River discharges, including heavy early-spring runoff (generally not sampled in Kew. R).

The projected P-discharge compares with 1984-WDNR ave = **42,000** for CYs 1969-1978 (annual ave's were **11,000 to 106,000**); and also with USGS unfiltered-P results (n=6 days) of **13,500 lb P/yr** for CY 2002.

Questions and Comments?

Written suggestions and comments are welcome.
Please see available handouts after session for further information.

**Copies of the Power Point presentation can be obtained from:
Kewaunee CARES website, kewauneecares.com
and e-mail is <kewauneecares4u@gmail.com>**

Information is also posted on Kewaunee CARES Facebook Page

Appendix A

Information Relevant to Kewaunee CARES / WAV Sampling Program

Quality Assurance Plan, Notes on Sampling, and Contacts

Sampling and Analysis of River Water in Kewaunee County, WI, from the Kewaunee, Ahnapee and East Twin Rivers was conducted from 24 Sept. 2012 thru 19 Oct. 2015 by Kewaunee CARES (Citizens Advocating Responsible Environmental Stewardship), allied with the Clean Water Action Council.

Trained water sampling personnel were always used (usually two assisted by two helpers) in the sampling, handling and labeling of at least three river water samples at each site (for Nitrate, Total Phosphorus, and E. Coli / Total Coliform). Photo and written documentation of water sampling processes, sampling time, location, air temperature, and sample bottles with definitive labels was employed throughout the study. Sample bottles were immediately placed in an ice chest prior to delivery for analysis. Also, duplicate water sample bottles (split samples) were sometimes sent to the Wisconsin DNR for Total Phosphorus analyses.

Analytichem LLC, registered in Wisconsin thru 12/31/2014 as WDATCP No. 115205-D3 (and also thru 2015) conducted the analyses and provided reports to the Kewaunee CARES organization. Methodology included: Nitrate reported as N (mg NO₃-N/L) using EPA Method 300; Total Phosphorus reported as P (mg P/L), analyzed by Pace Analytical; E. Coli, Standard Method 9223, MPN bacteria results in CFU / 0.1 L; Total Coliform, Standard Method 9223, MPN bacteria results in CFU / 0.1 L.

Data from Analytichem LLC data sheets were originally organized and analyzed through development of an inclusive Excel spreadsheet analysis. A 2-yr final draft dated 12/28/2014 was then made available to the public by Kewaunee CARES. Those Excel data were subsequently translated to respective DNR-provided Excel spreadsheet formats for uploads of sampling data and sampling-site location data to the WDNR for consideration in Wisconsin's 2016 impaired waters report to Congress and the EPA.

Whenever Nitrate, Total-Phosphorus, E. Coli and Total Coliform concentrations were reported as “smaller than” or “greater than” specific analytical limits because actual concentrations sometimes exceeded normal analytical ranges, a carefully checked and validated set of assumptions was used to plot the data – in order to provide representative and complete sets of data for the present respective plots. For results below the low detection limit, the following were applied: nitrate = 0.010 for < 0.014 mg NO₃-N/L; Tot-P = 0.03 for < 0.052 and Tot P = 0.040 for < 0.088 mg P/L. For results above the high detection limit: Total Coli = 3000 for > 2419.6; and Total Coli = 60,000 for > 48,392 CFU/0.1 L.

The 2-yr structured analyses (12/28/2014) and present data analyses being presented 4/1/2016 were generated by this writer, Gerald L. Pellett, a DRA at NASA Langley Research Center and warm-season resident in Kewaunee. The writer’s entire effort on this project has been as an unpaid volunteer for Kewaunee CARES, a non-profit organization allied as a working committee of the Clean Water Action Council. The organization’s website is kewauneecares.com and e-mail is <kewauneecares4u@gmail.com> ;information may also be obtained from the Kewaunee CARES Facebook Page. Further detailed information on the subject Kewaunee County river sampling program can be obtained from Kewaunee CARES leaders and participants in the sampling program, Mr. Lynn Utesch <lnutesch@yahoo.com> (920) 388-0868), and Dr. William Iwen <iwenwilliam22@gmail.com> (920) 487-7215.

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(757) 298-0029 (cell)
gleepellett@gmail.com

Some notes on Water Quality Limits (summary bar graphs show additional criteria)

The following Water Quality Limits are listed on the original Kewaunee CARES AnalytiChem certified water analysis data sheets (AnalyticChem Certification is noted in the QAP), and they apply to the present analyses.

Regarding E-Coli CFU/100 mL {Most Probable Number (MPN) of Colony Forming Units (CFU) per 100 milliliter river water}:

For E-Coli <1 CFU/100 mL, *water is safe for drinking*

For E-Coli 0 - 234, *No Public Beach advisory* (green sign, EPA / Great Lakes Research Initiative)

For E-Coli 235 - 999, *Public Beach advisory is issued* (yellow sign, EPA / GLRI)

For E-Coli >1000, *Public Beach is closed* (red sign, EPA / GLRI)

Regarding Phosphorus, mg P/Liter in river water:

For 0.01 - 0.05 mg P/L, Healthy, Good River Water Quality

For 0.05 - 0.10 mg P/L, Borderline Healthy

For > 0.10 mg P/L, Unhealthy

For Nitrates in drinking water, maximum allowed by the EPA is 10 mg NO₃-N/L

Sampling Locations

Kewaunee River Watershed, Kew-Srce1, Kewaunee River Source (Maple Rd & County S; **Casco Creek**), 90700

TK03, GPS coordinates: 44.61792, -87.60243

Kewaunee River Watershed, Kew-Mouth1, Kewaunee River Harbor Landing (next to Rt 42 bridge), 90700

TK03, GPS coordinates: 44.46366, -87.50408

Ahnapee River Watershed, Ahn-Srce1, Ahnapee River Source (Stevenson Pier Rd & County H), 94800

TK04, GPS coordinates: 44.74767, -87.53740

Ahnapee River Watershed, Ahn-Mouth1, Ahnapee River Mouth (Olson Park, Algoma), 94800

TK04, GPS coordinates: 44.61749, -87.44461

E Twin River Watershed, E.Twin-Srce1, East Twin River Source (County F & AB), 84000

TK02, GPS coordinates: 44.45698, -87.68444

East Twin River Watershed, E.Twin-Mid1, East Twin Midpoint (Towline Rd & Hwy 29), 84000

TK02, GPS coordinates:

East Twin River Watershed, E.Twin-Exit1, East Twin River Exit from County (County Rd BB & Mill Lane), 84000

TK02, GPS coordinates: 44.32953, -87.61972