Alternatives to 7Q10 for Nutrient Permitting

New Hampshire Water Quality Standards Advisory Committee,

October 11, 2018

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NH Dept. of Environmental Services

Outline

I. Legislation to change RSA in 2017
II. Existing Permitting Process
III. NH Nutrient Criteria
IV. Ambient TP Targets for Permitting
    I. Regional TP concentration
    II. Neighbor thresholds
V. Looking at the ambient TP data in New Hampshire
    I. As a function of flow
    II. As a function of watershed position
    III. As a function of existing assessments
VI. Existing Limits and Loads
VII. Flow Duration Statistic Relationships (7Q10 vs August Median)
VIII. Projected Possible Limits and Loads based on August Median flow

Legislation to change RSA in 2017

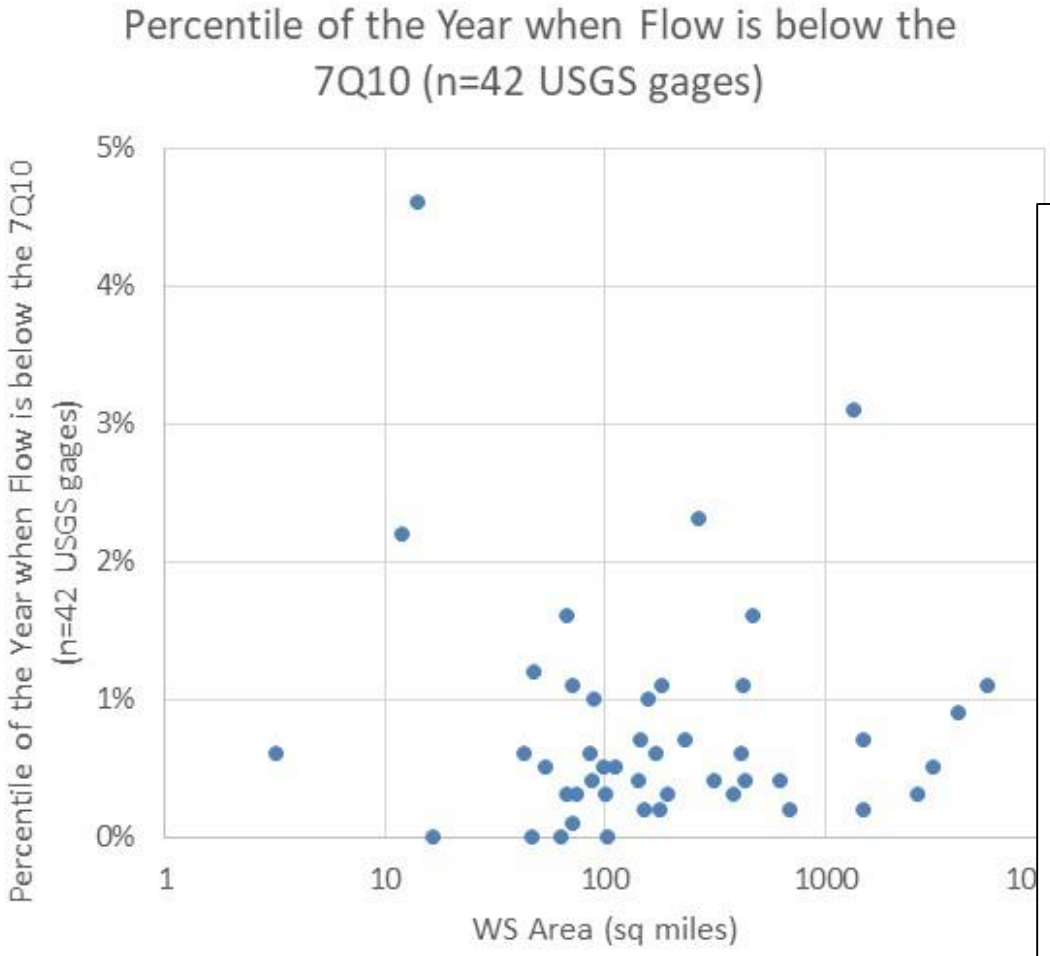
RSA 485-A:8 II.

ADDED

"The commissioner shall not calculate nutrient discharge limits for aquatic life and human health criteria based on 7Q10 flow or such other flow criteria more restrictive than 7Q10."

- Rochester and the Great Bay Coalition believe using 7Q10 for setting nutrient permit limits is too conservative
  - Based on what some other states use, and because effects of nutrients on water quality (i.e., higher plant growth, low DO, etc.) can take longer to manifest than the 1 week averaging period associated with the 7Q10 flow.

(April 12, 2018 – NHDES)



Recap of Some Differences between Toxic and Nutrient Effects

Toxics	Nutrients
• Many are not normally detectable in natural waters	• Present in natural waters
• Short-term (1 hr - 4 day) action	• Longer-term manifestation
• Direct effects on survival, growth, and reproduction	• Effects are indirect and some are aesthetic/subjective
• Threshold effects	• Gradational effects
• Numeric targets based on dose-response studies	• Numeric targets can be highly generalized

(Jan 11, 2018 – Clifton Bell)

Permit Methodology for TP Until Legislation Change

Reasonable Potential and Permit Limits
Based on targets of --

- 7Q10 Flow
- 100 ug/L TP ambient target concentration

REASONABLE POTENTIAL

- water quality based permitting regulations (40 CFR § 122.44(d))
  - discharges must be evaluated to determine the "reasonable potential" to cause, or contribute to an excursion of a numeric or narrative water quality criteria.
  - "reasonable potential" take into account existing controls on point and non-point sources of pollution.
  - Where there is "reasonable potential", a water quality based limit must be developed.

(Jan. 11, 2018 – EPA R1)

REASONABLE POTENTIAL (CONTINUED)

- A water body does not need to be on the 303(d) list of impaired waters for a facility to receive a water quality based effluent limitation.
- The NPDES permitting program and implementing regulations are preventative programs so that impairments will not occur.

(Jan. 11, 2018 – EPA R1)

REASONABLE POTENTIAL CALCULATION

- RP calculations based upon a mass balance equations where: $Q_uC_u + Q_dC_d = Q_rC_r$
- Calculations for reasonable potential use the following information
  - Design flow of the POTW
  - Maximum (if less than 10 samples) or 95th percentile (for 10 samples or more) TP concentration in the effluent
  - Upstream 7Q10 flow
  - Median upstream TP concentration
  - Since TP limits are seasonal (April 1 – October 31) TP data from this timeframe are used
- If the resultant downstream concentration exceeds 0.09 mg/l then reasonable potential exists and a water quality based effluent limitation is established.

(Jan. 11, 2018 – EPA R1)

Permit limits are not equal to nutrient criteria.

Existing TP Limits in EPA NPDES Permits

- EPA Methodology to Calculate Reasonable Potential and Permit Limits Based on Simple Mass-Balance Eqn. (unless a TMDL).
- Existing Background set at median of available data.

- Facilities with existing TP permit limits cannot have less stringent limits due to federal “anti-backsliding” regulations.
- NPDES is a preventative program; limits must comply with WQStds.

NH Nutrient Criteria

Env-Wq 1703.14 Nutrients.

(a) Class A waters shall contain no phosphorus or nitrogen unless naturally occurring.

(b) Class B waters shall contain no phosphorus or nitrogen in such concentrations that would impair any existing or designated uses, unless naturally occurring.

(c) Existing discharges containing phosphorus or nitrogen, or both, which encourage cultural eutrophication shall be treated to remove the nutrient(s) to ensure attainment and maintenance of water quality standards.

Env-Wq 1703.19 Biological and Aquatic Community Integrity.

(a) All surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.

(b) Differences from naturally-occurring conditions shall be limited to non-detrimental differences in community structure and function.

East Br. Saco River, (NHRIV600020301-03)
Summer Median TP = 6 ug/L (n=8)

06-EBS, June 21,2017

Hodgson Brook, (NHRIV600031001-04)
Summer Median TP = 43 ug/L (n=25)

00K-HOB, August 2, 2018

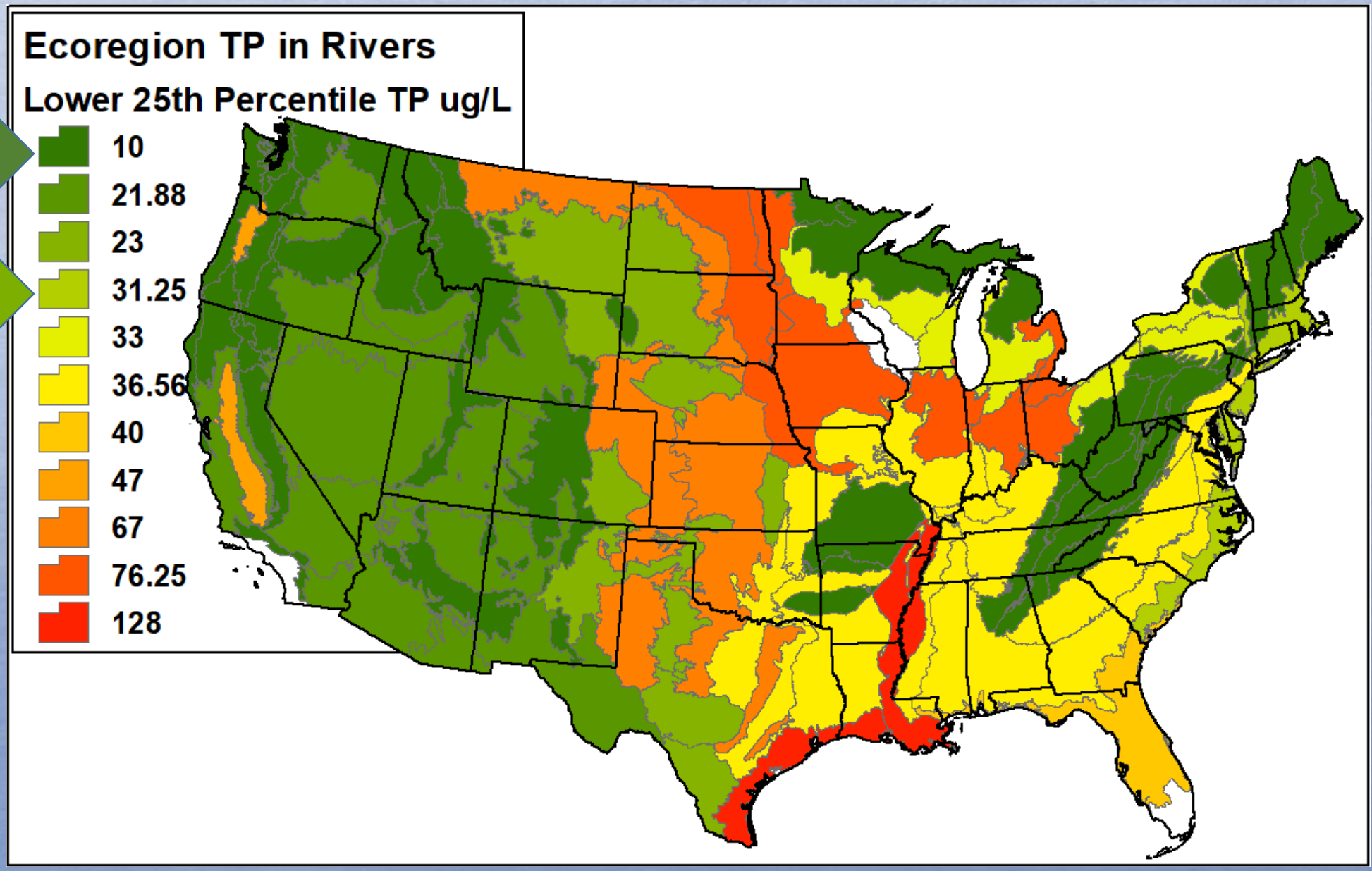
Ambient TP Targets for Permitting

I. Regional TP concentration
II. Neighbor thresholds

Regional TP concentrations

17-LMP, Lamprey R

EPA Ecoregional values



Various USEPA-Approved TMDLs Use Summer Median Flows

Malibu Creek, CA

TP target: 0.100 mg/L

Mora River, NM

TP target: 0.020 – 0.030 mg/L

Jackson River, VA

•TP target: 0.060 mg/L

Florida uses *annual* geometric mean targets (less seasonality)

2. The nutrient thresholds set forth in the table below are achieved.

Nutrient Watershed Region	Total Phosphorus Nutrient Threshold[1]	Total Nitrogen Nutrient Threshold[1]
Panhandle West	0.06 mg/L	0.67 mg/L
Panhandle East	0.18 mg/L	1.03 mg/L
North Central	0.30 mg/L	1.87 mg/L
Peninsular	0.12 mg/L	1.54 mg/L
West Central	0.49 mg/L	1.65 mg/L
South Florida	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.

[1]These values are annual geometric mean concentrations not to be exceeded more than once in any three calendar year period.

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Some USEPA-Approved TMDLs Use "Typical" or "Representative" Summer

Black River, VT

- TP target based on observed 1999 loadings
- (equated to 0.26 mg/L TP)

Lower Boise River (ID)

Modeled 2012 growing season

TP target: 0.070 mg/L

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Example: Boulder Creek, CO

- 30Q5
- Effects-based modeling approach (WE&RF demonstration)
- Endpoints: Periphyton, DO, & pH criteria
- TP target: 0.100 – 0.170 mg/L

Example: Minnesota Eutrophication Standards

- TP criteria expressed as long-term (multi-year averages)
  - River criteria of 0.050 – 0.150 mg/L depending on region
- TMDLs use time or flow-weighted growing season average flows (Jun-Sep)
  - Depends on whether lake or river criteria control
- Guidance for permitting cites use of 80% exceedance flow for impaired rivers

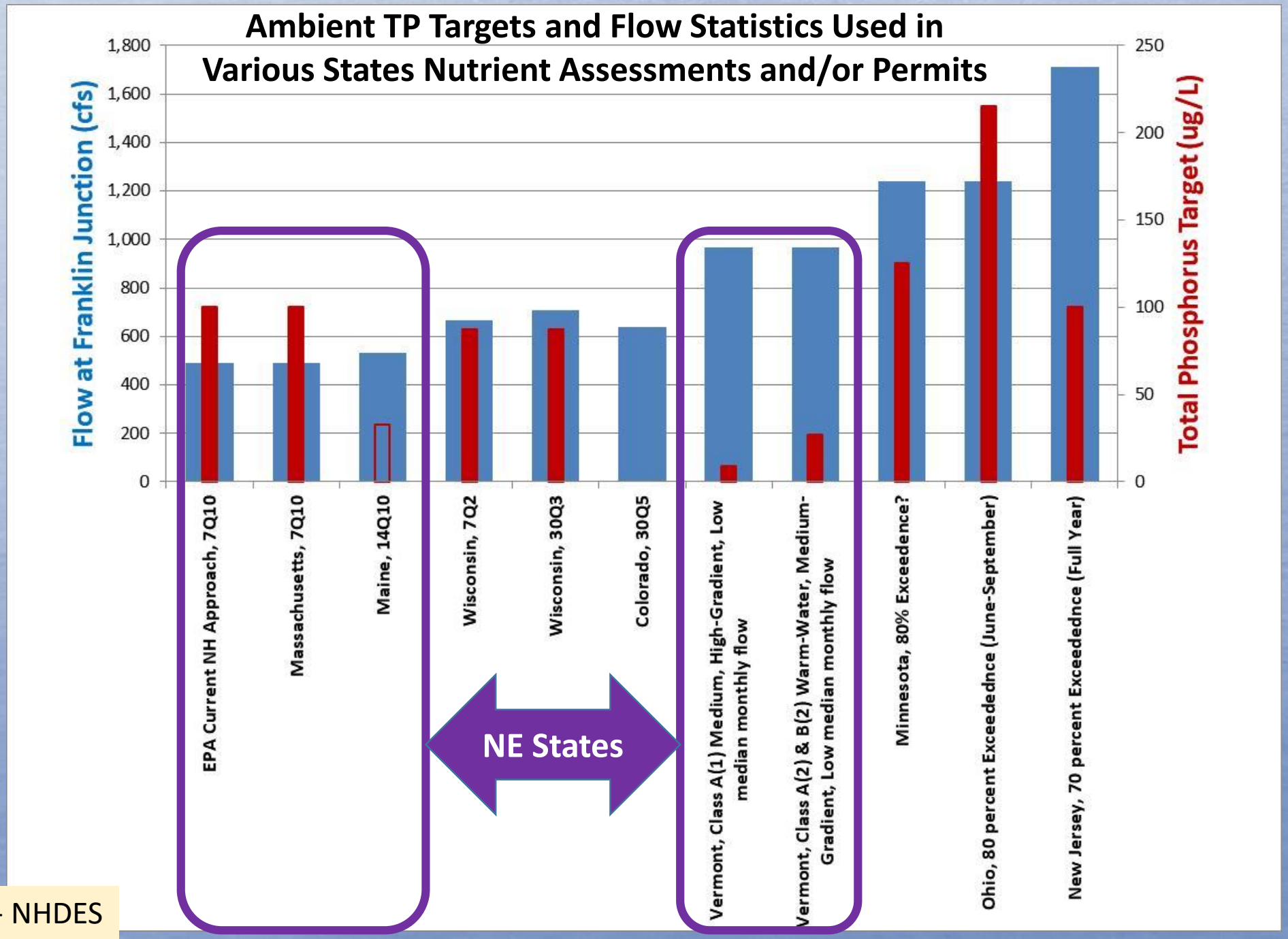
Example: Wisconsin Phosphorus Water Quality Standards and Guidance

- P criteria developed as median growing season (May-Sep) targets:
  - 0.100 mg/L for rivers
  - 0.075 mg/L for streams
- Guidance for permitting/RPA for rivers cites use of 30Q3 or 7Q2 (mismatch with standards?)

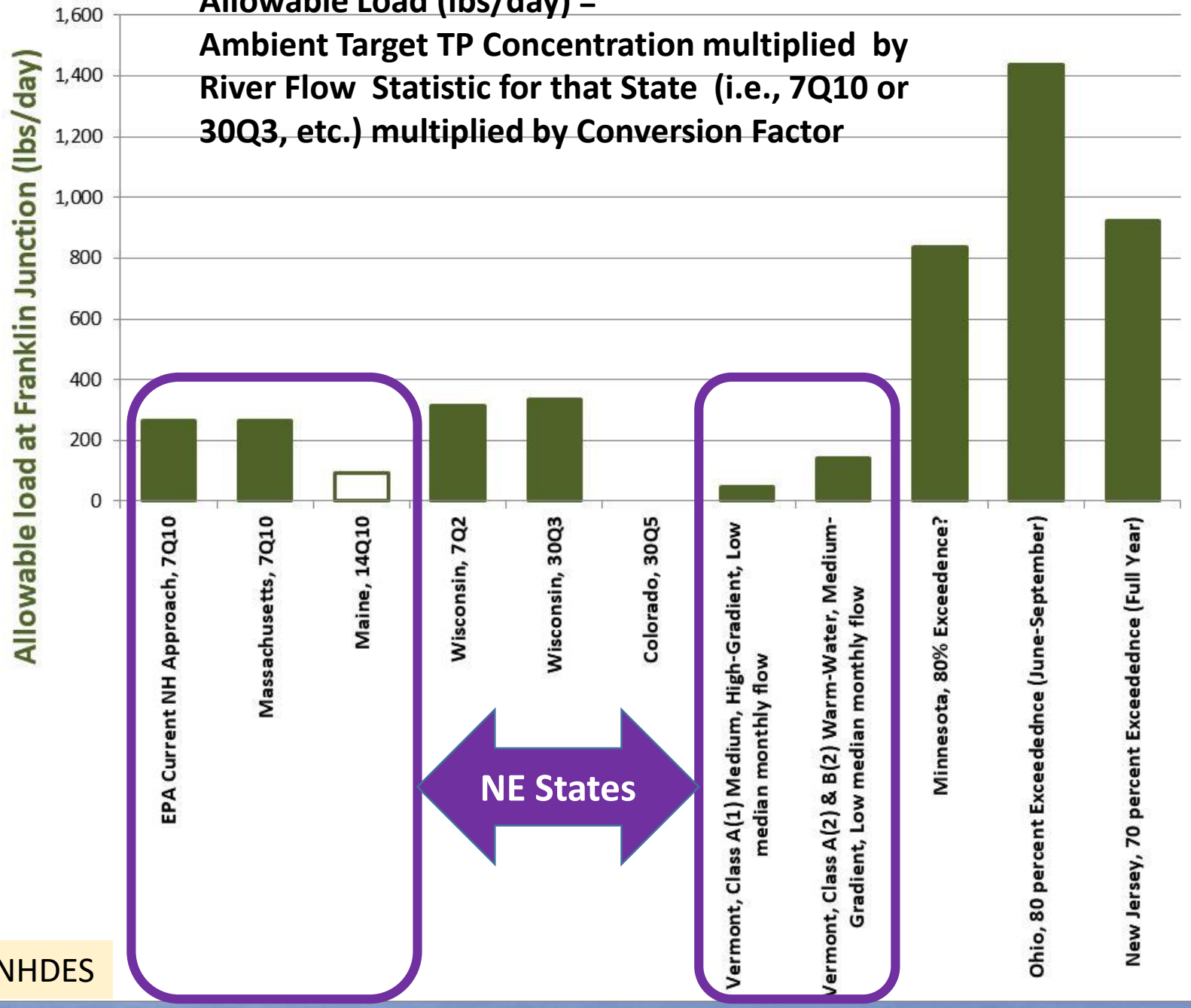
Other examples

- *New Jersey Technical Manual for Phosphorus Evaluations* (August 2008)
  - Low-flow frequency which is exceeded 70% of the time
  - TP target: 0.100 mg/L
- *Nutrient Criteria for Vermont's Inland Lakes and Wadeable Streams (2016)*
  - Lowest median monthly flow that occurs during the summer growing season
  - P target: 0.010 mg/L in mountain streams (>2,500' elev.)
- *Draft Technical Support Document for Nutrient Water Quality Standards for Ohio Rivers and Streams*
  - 80% exceedance flow
  - TP target: 0.130 – 0.300 mg/L

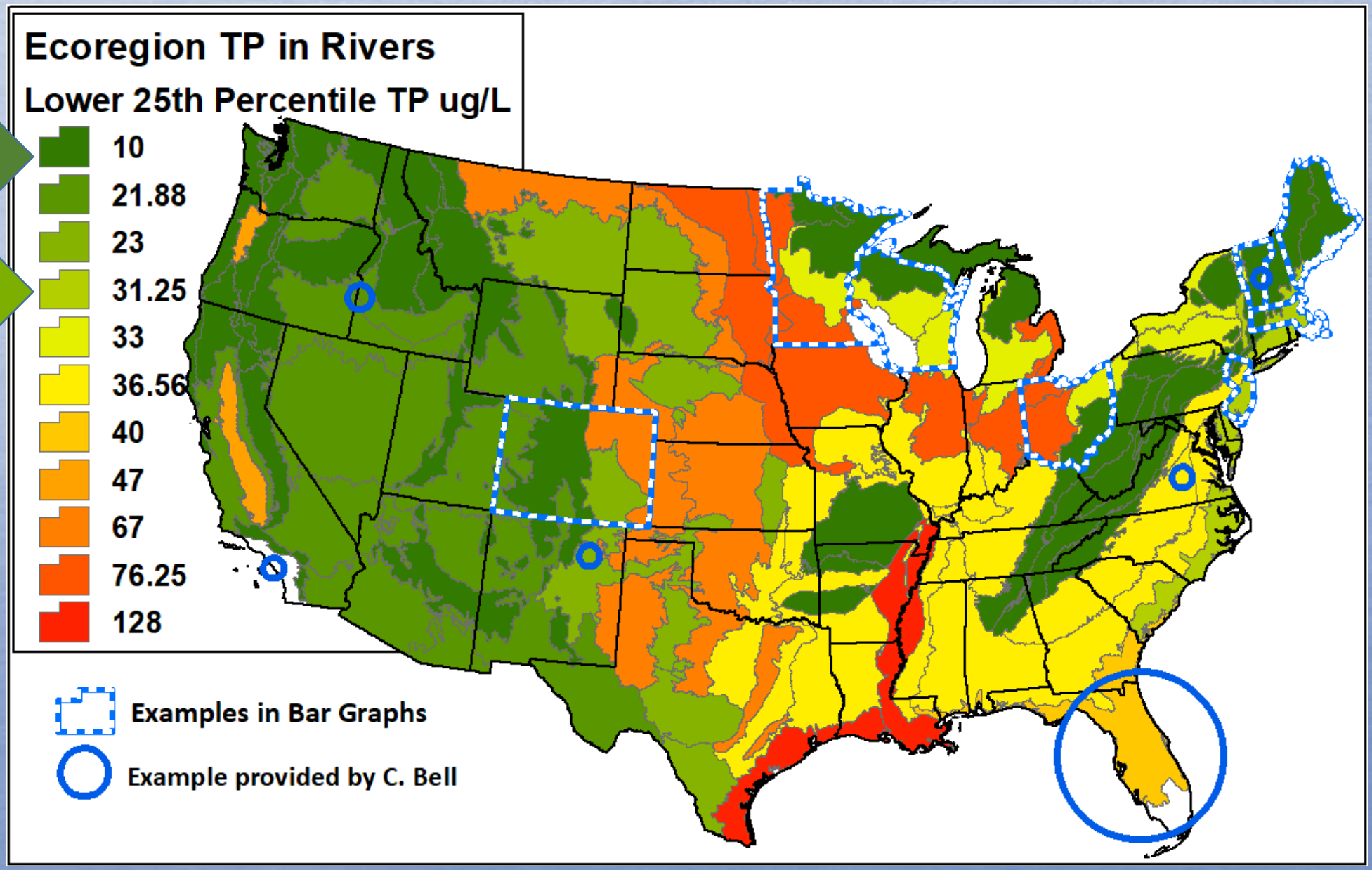
Ambient TP Targets and Flow Statistics Used in Various States Nutrient Assessments and/or Permits



Allowable Load (lbs/day) =
Ambient Target TP Concentration multiplied by River Flow Statistic for that State (i.e., 7Q10 or 30Q3, etc.) multiplied by Conversion Factor



EPA Ecoregional values



Ambient TP Thresholds/Criteria of Neighboring States

Vermont (Criteria)

- 98% of Vermont Rivers Covered
- Summer low median monthly flow (generally August) used as index flow
- Target TP based on Endpoints;
  - Macroinvertebrate Biological Condition
- TP = 9-27 ug/L at Summer Low Median Monthly Flow (generally August)

	Class A(1)			Class B(1)			Classes A(2) and B(2)		
Stream Type[2]	Small, High-Gradient	Medium, High-Gradient	Warm-Water, Medium Gradient	Small, High-Gradient	Medium, High-Gradient	Warm-Water, Medium Gradient	Small, High-Gradient	Medium, High-Gradient	Warm-Water, Medium Gradien
Nutrient Concentrations									
Total Phosphorus (µg/L)[3]	10	9	18	10	9	21	12	15	27

Vermont Water Quality Standards Environmental Protection Rule Chapter 29A (Effective January 15, 2017)

Maine (Thresholds)

- Target TP based on Endpoints by Class;
  - Class AA & A = 18 ug/L
    - Algae metrics on tolerant/intolerant species
    - Macroinvertebrate Trophic Condition
    - Reference stream TP 90th percentile
    - TP 75th-90th percentile for all AA & A waters with no impairments
  - Class B = 30 ug/L
    - Macroinvertebrate conditional probability of attainment
    - TP and Minimum DO
    - 75th percentile for sites attaining macroinvertebrate thresholds
    - TP 75th-90th percentile for all B waters with no impairments
  - Class C = 33 ug/L
    - Percent algae cover
    - 75th percentile for sites attaining macroinvertebrate thresholds
    - TP – Chlorophyll-a relationship
- TP = 30 ug/L at 14Q10 (>7Q10 but < August Median)

Looking at ambient New Hampshire TP data:

i. Grab Samples –vs– waterbody medians at “low” flows
ii. As a function of flow in a waterbody
iii. As a function of watershed position
iv. As a function of existing assessments

05-NWL, Newell Br

Looking at ambient NH TP data grab samples –vs– waterbody medians at “low” flows

- Pair every AUID with a representative USGS flow gage to get a surrogate flow.
- Pair every river and impoundment TP sample (n = 49,471) with the daily flow data from the representative USGS flow gage.
- Do math.

Contoocook R, 2005

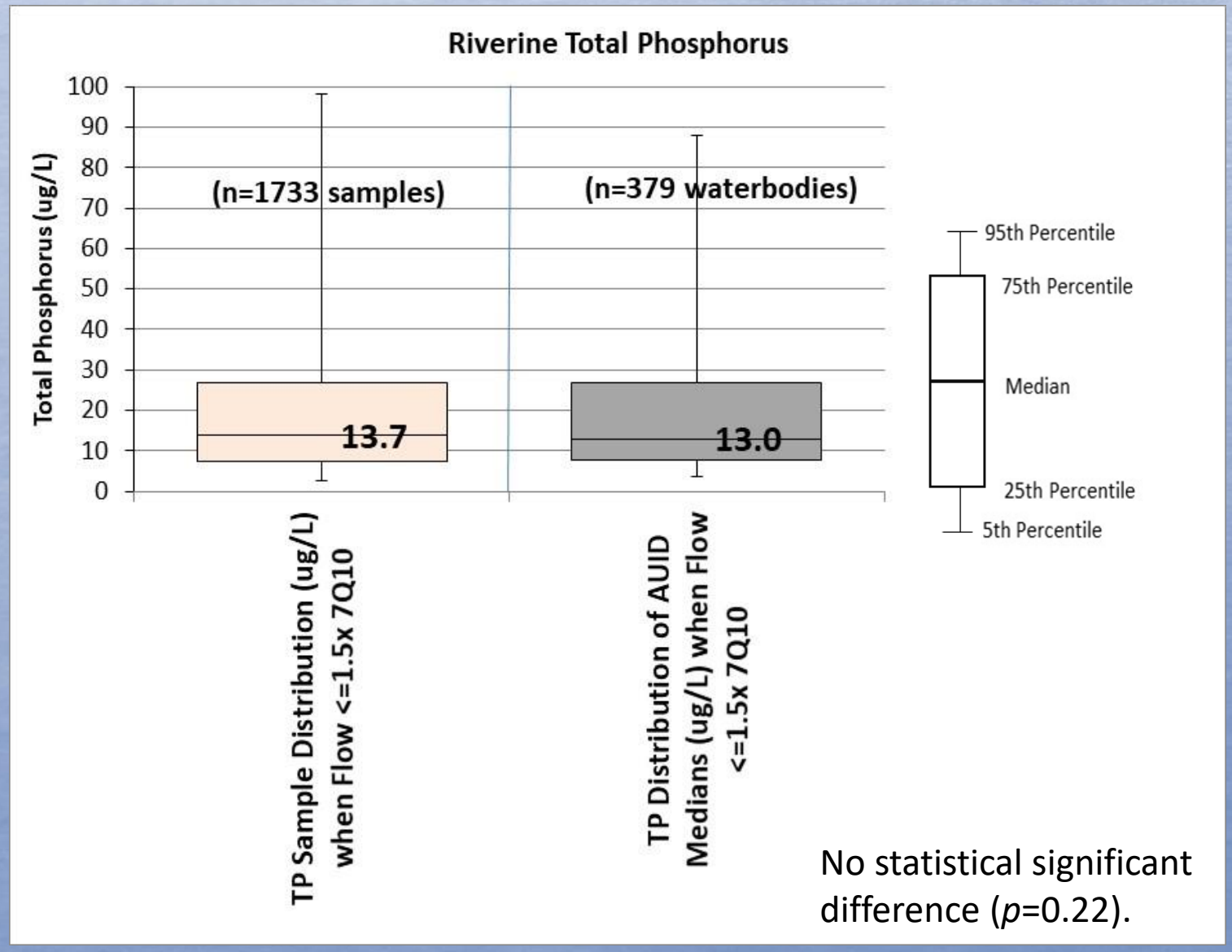
How do statistics from grab samples and AUID medians compare?

I. At Low flow (<1.5x 7Q10)?

II. At a common summer low flow (+/- 25% of August Median)?

05-SEB, Sebbins Br

How do statistics from grab samples and AUID medians compare?
→Near 7Q10 in Rivers



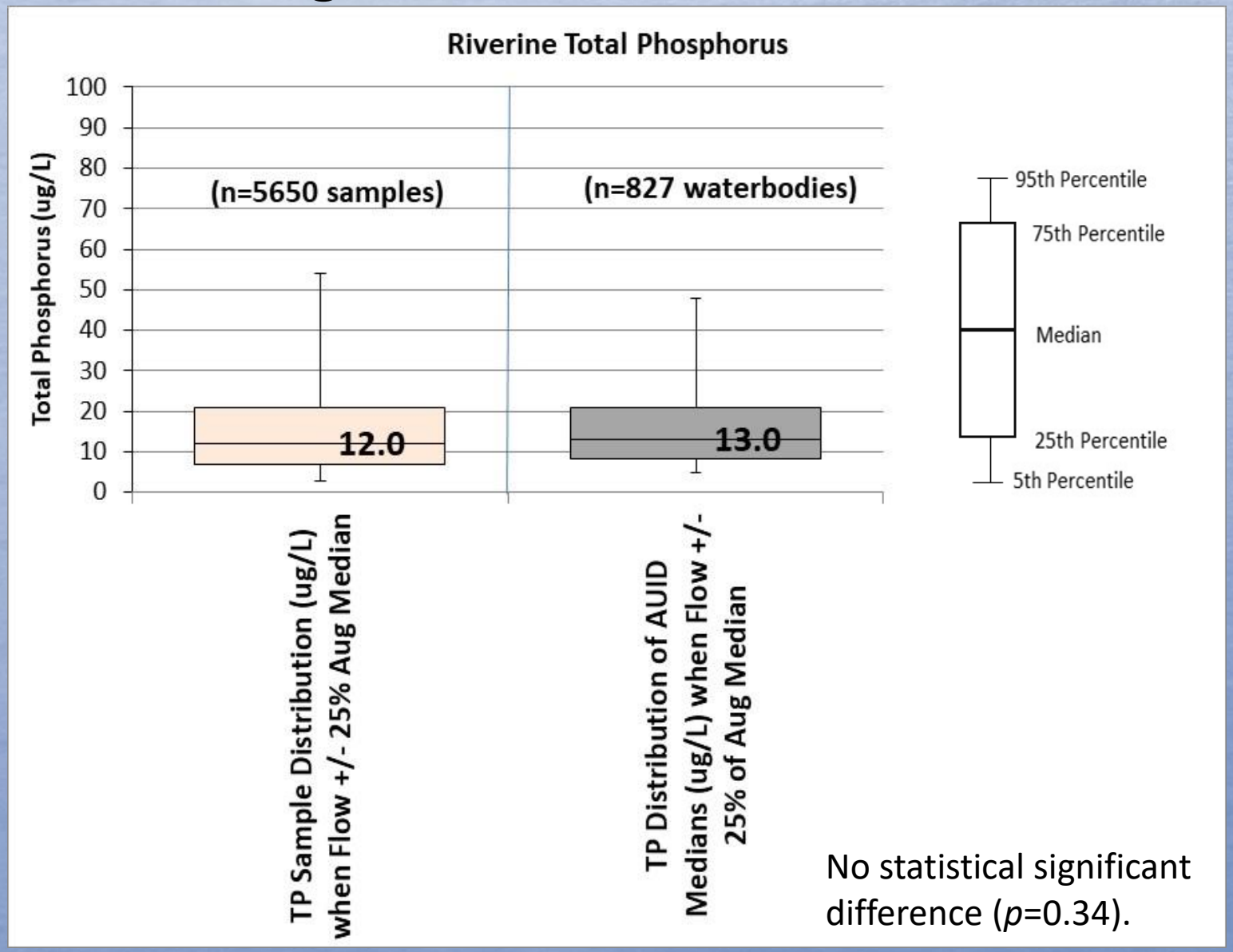
No statistical significant difference (p=0.22).

- Very well.
- Generally quite low.

01M-PGS, Paugus Br

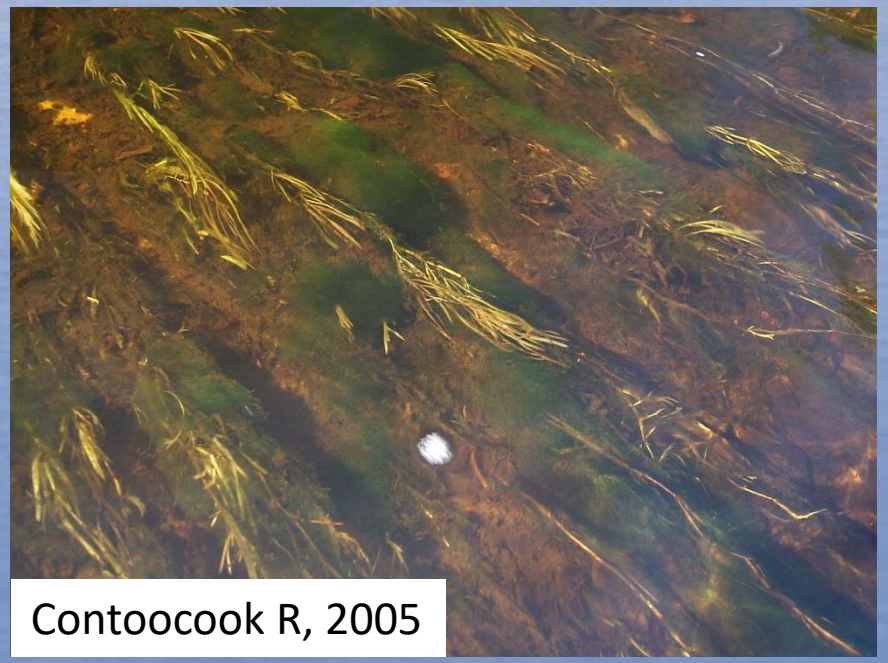
How do statistics from grab samples and AUID medians compare?

→Near August Median in Rivers



No statistical significant difference (p=0.34).

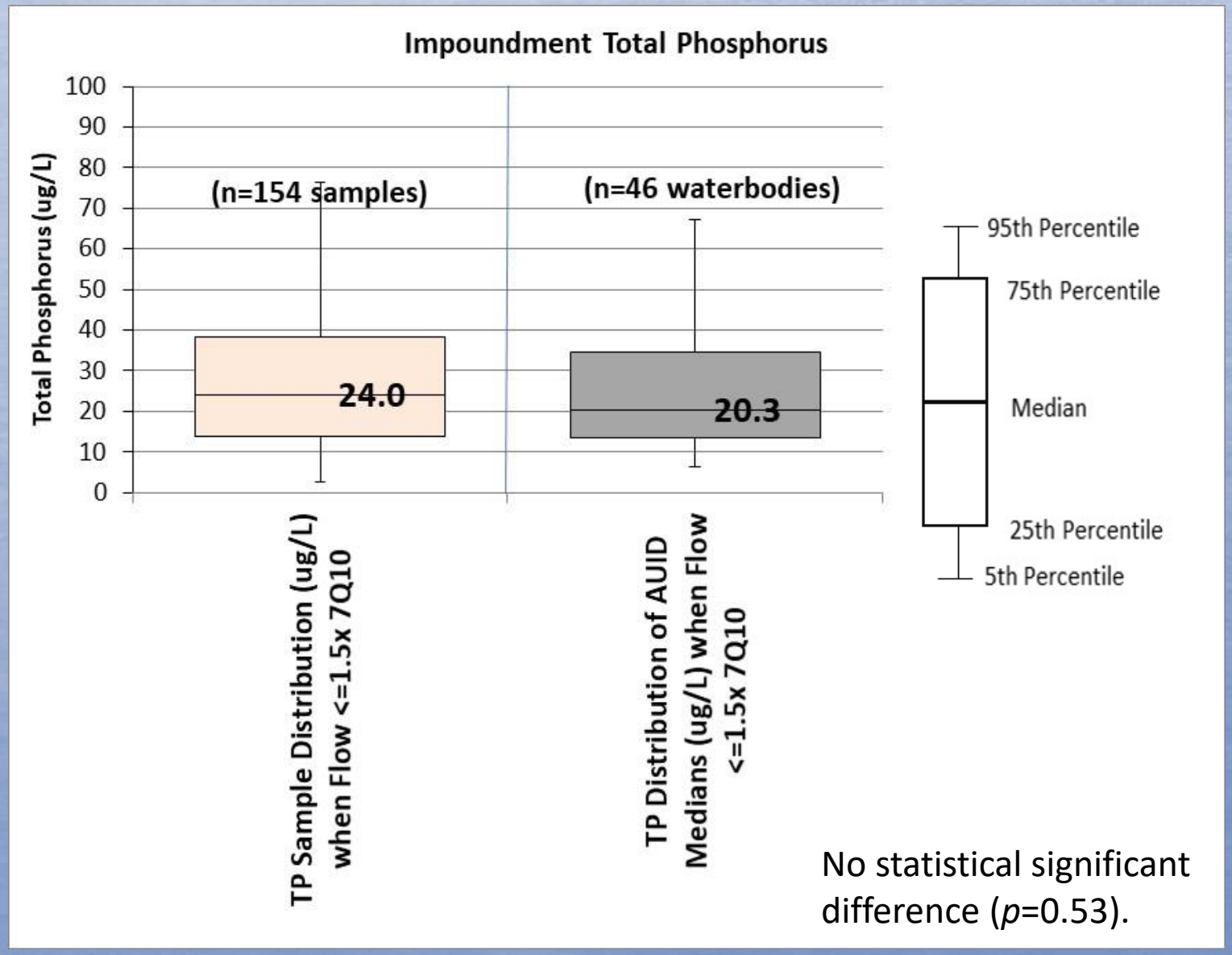
- Very well.
- Generally quite low.
- Looks like 7Q10



Contoocook R, 2005

How do statistics from grab samples and AUID medians compare?

→Near 7Q10 in Impoundments

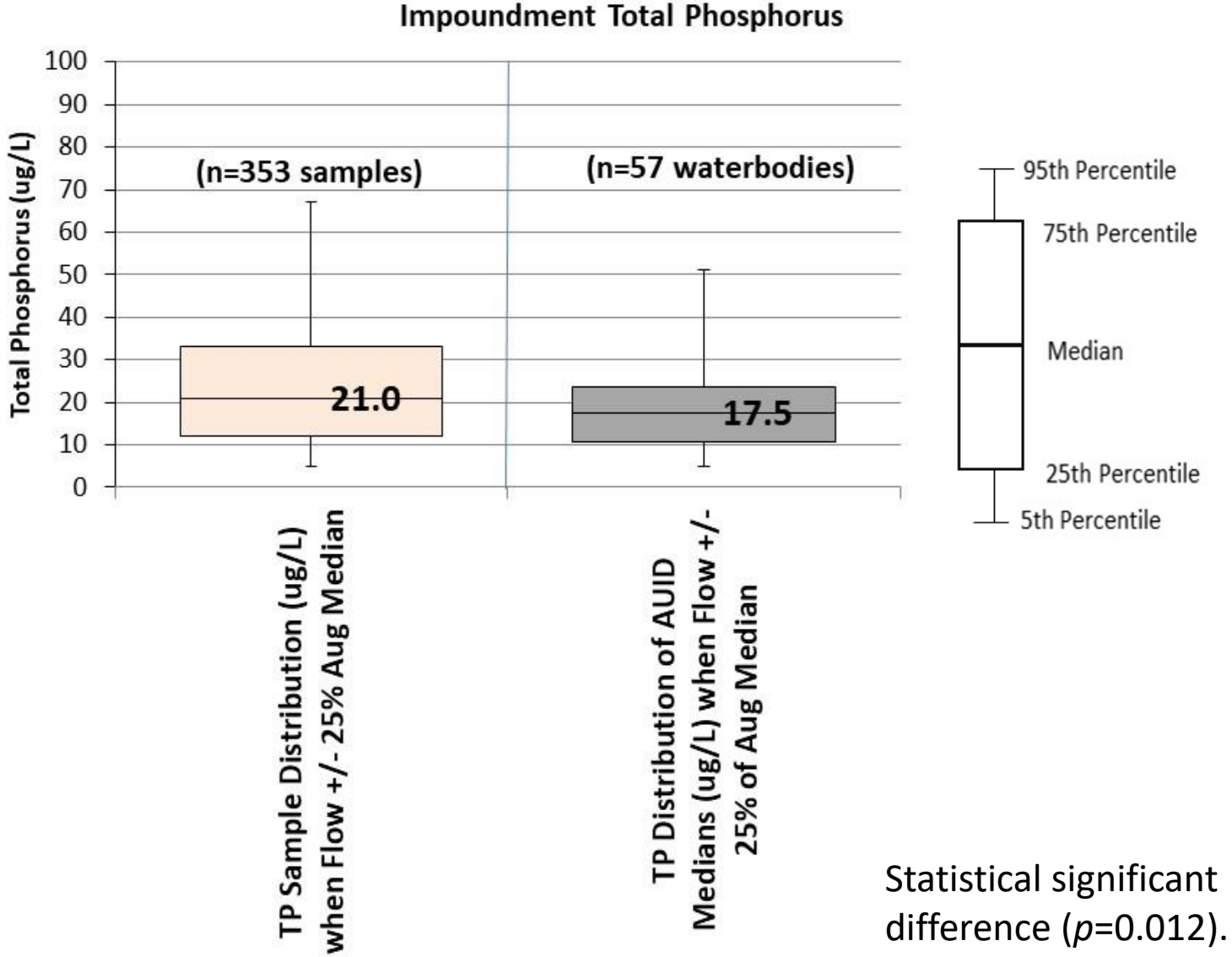


No statistical significant difference (p=0.53).

- Harder to say due to lower samples count
- Quite well.
- Generally low.

01-BWB, Bowman Br

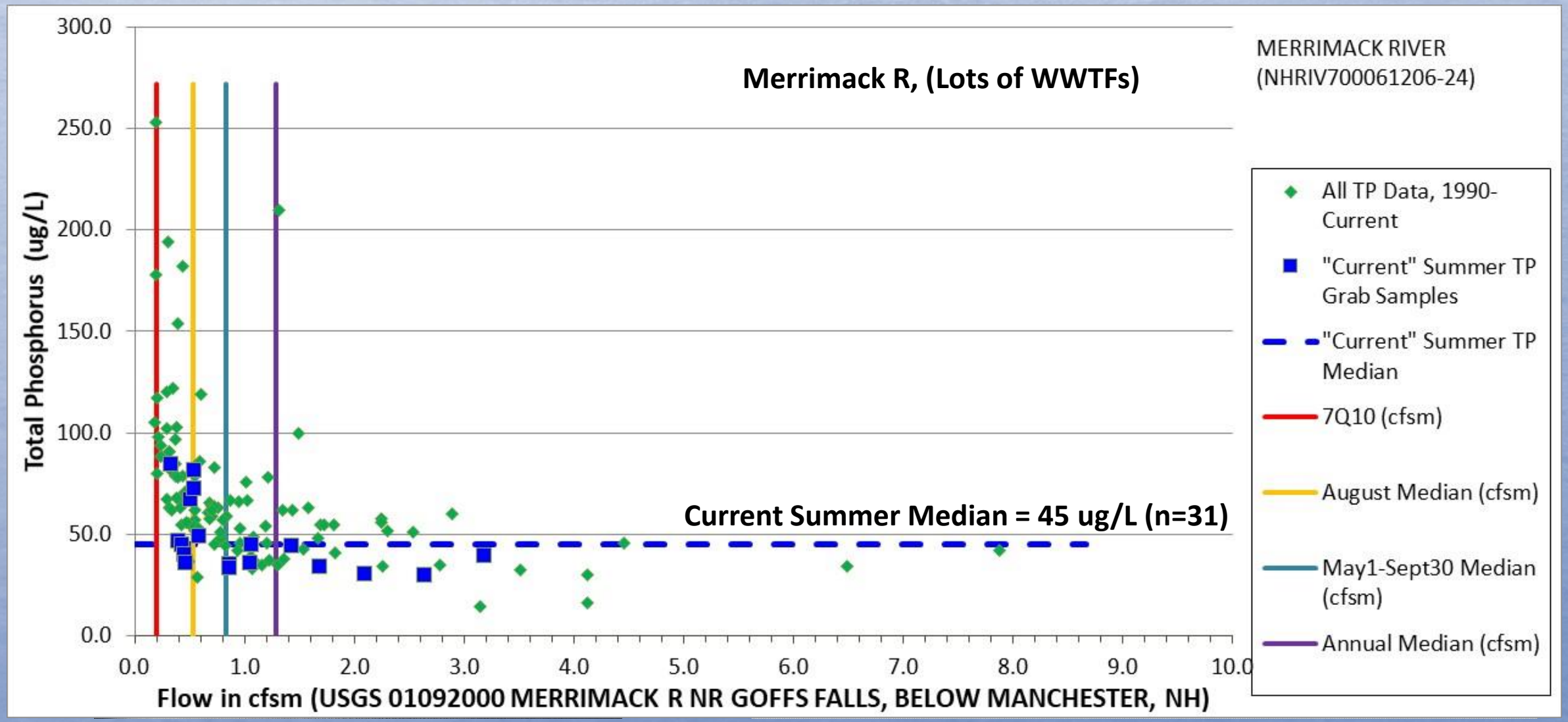
How do statistics from grab samples and AUID medians compare?
→Near August Median in Impoundments



Statistical significant difference (p=0.012).

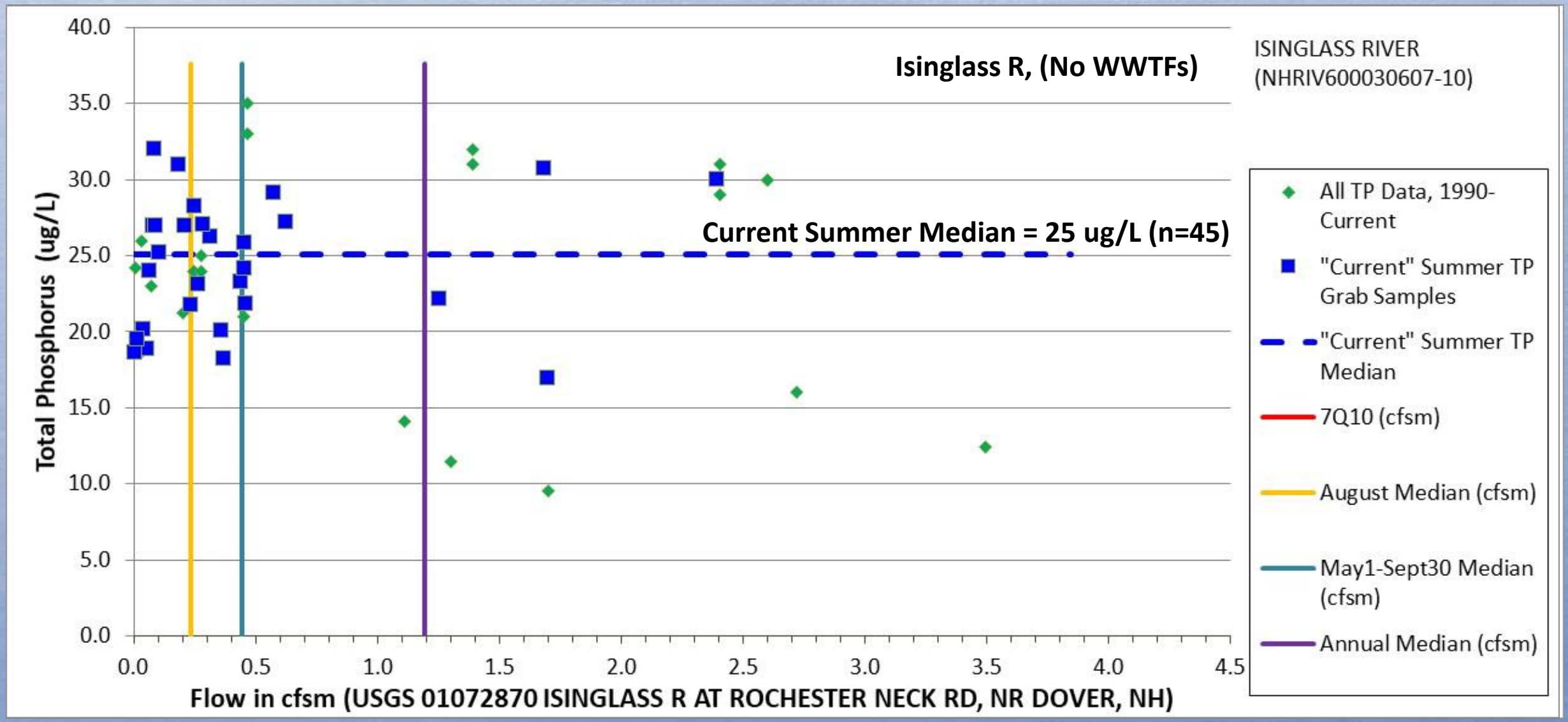
- Some bias toward samples in those waters with higher TP.
- Generally quite low.
- Looks like 7Q10.

Does TP increase as flow decreases?



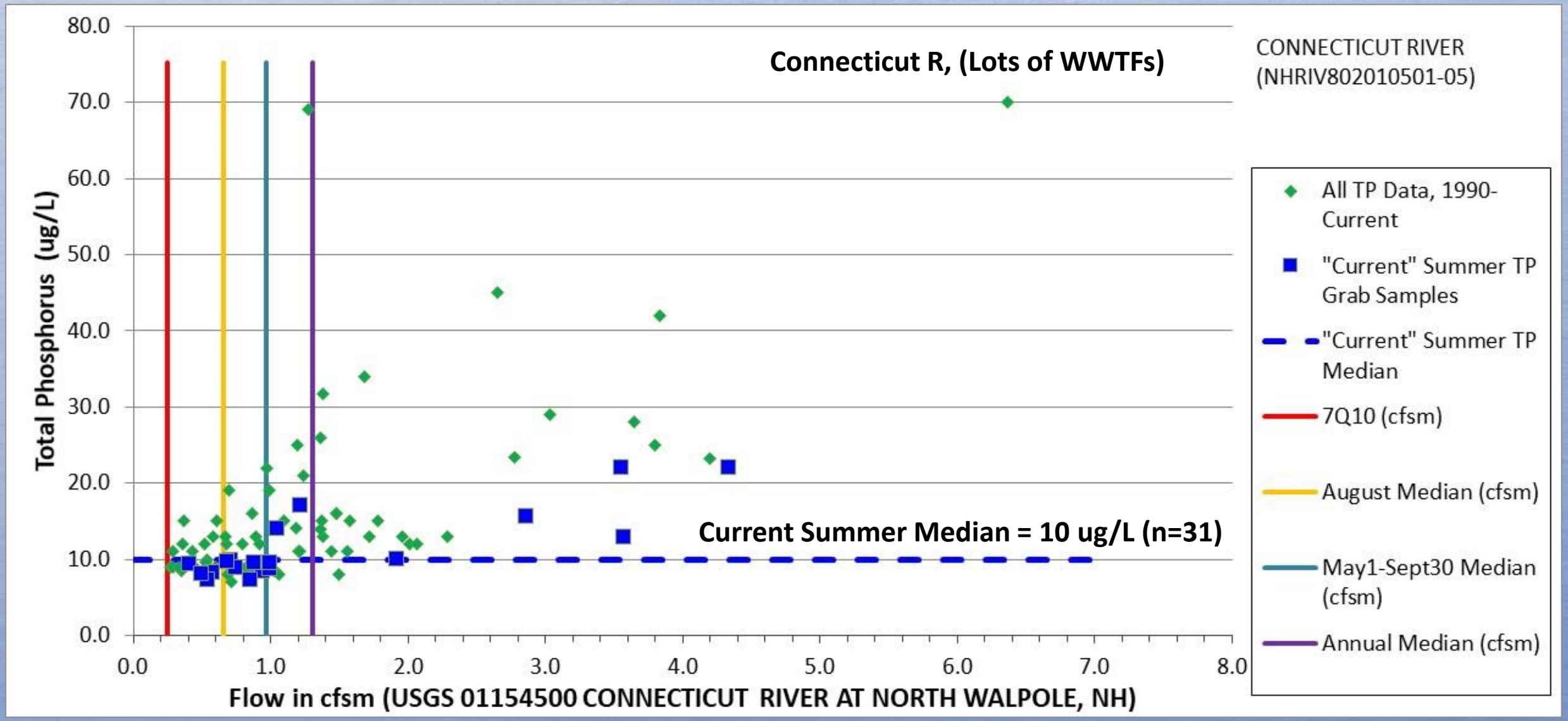
Perhaps.

Does TP increase as flow decreases?



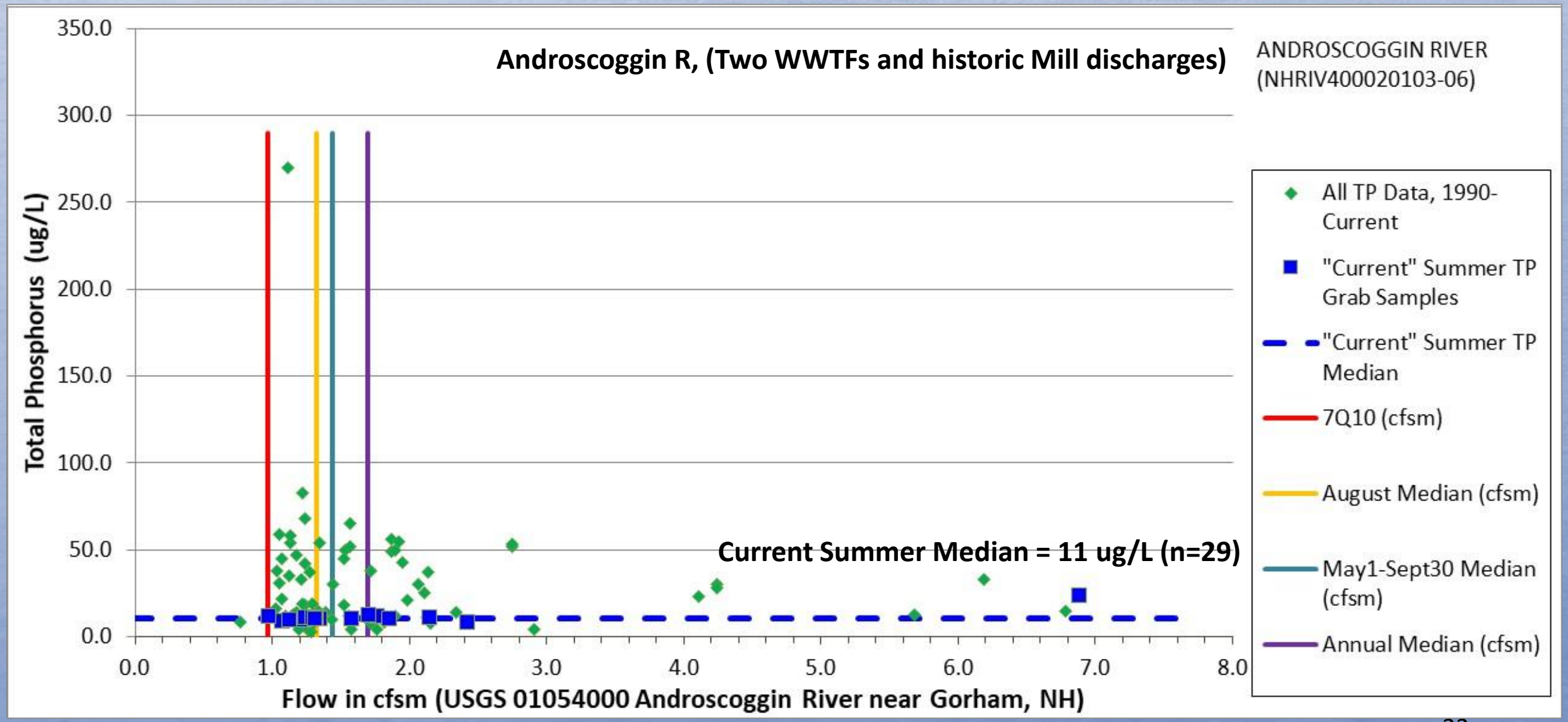
Looking at many sites, generally no.

Does TP increase as flow decreases?



Not in the Connecticut River.

Does TP increase as flow decreases?



Generally no, unless there is a large WW input.

Does TP increase as flow decreases?

- Generally no unless there are WWTFs.
- Can we identify how WWTFs typically change ambient TP?

01-CBB, Colby Br, Litchfield

Looking at ambient TP as a function of watershed position

- Waterbodies receiving waste water effluent to surface waters

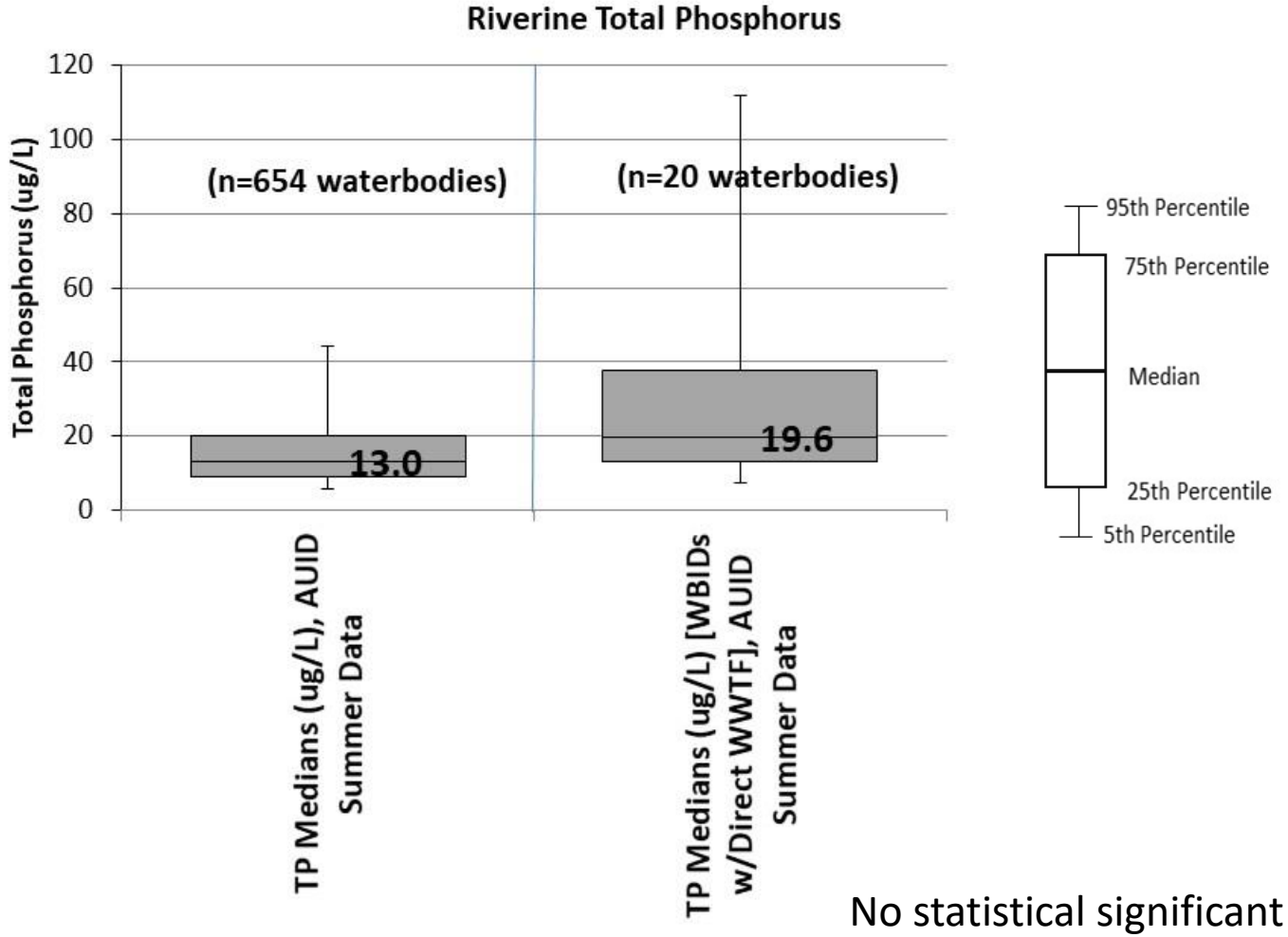
How different are summer waterbody medians between AUIDs with and without direct WWTF discharges?

- From current summer median calculations (5yr summer medians).

03-SKB, Sucker Br

How do statistics from AUIDs with direct WW discharges compare to AUIDs without direct WWTF discharges?

→In Rivers



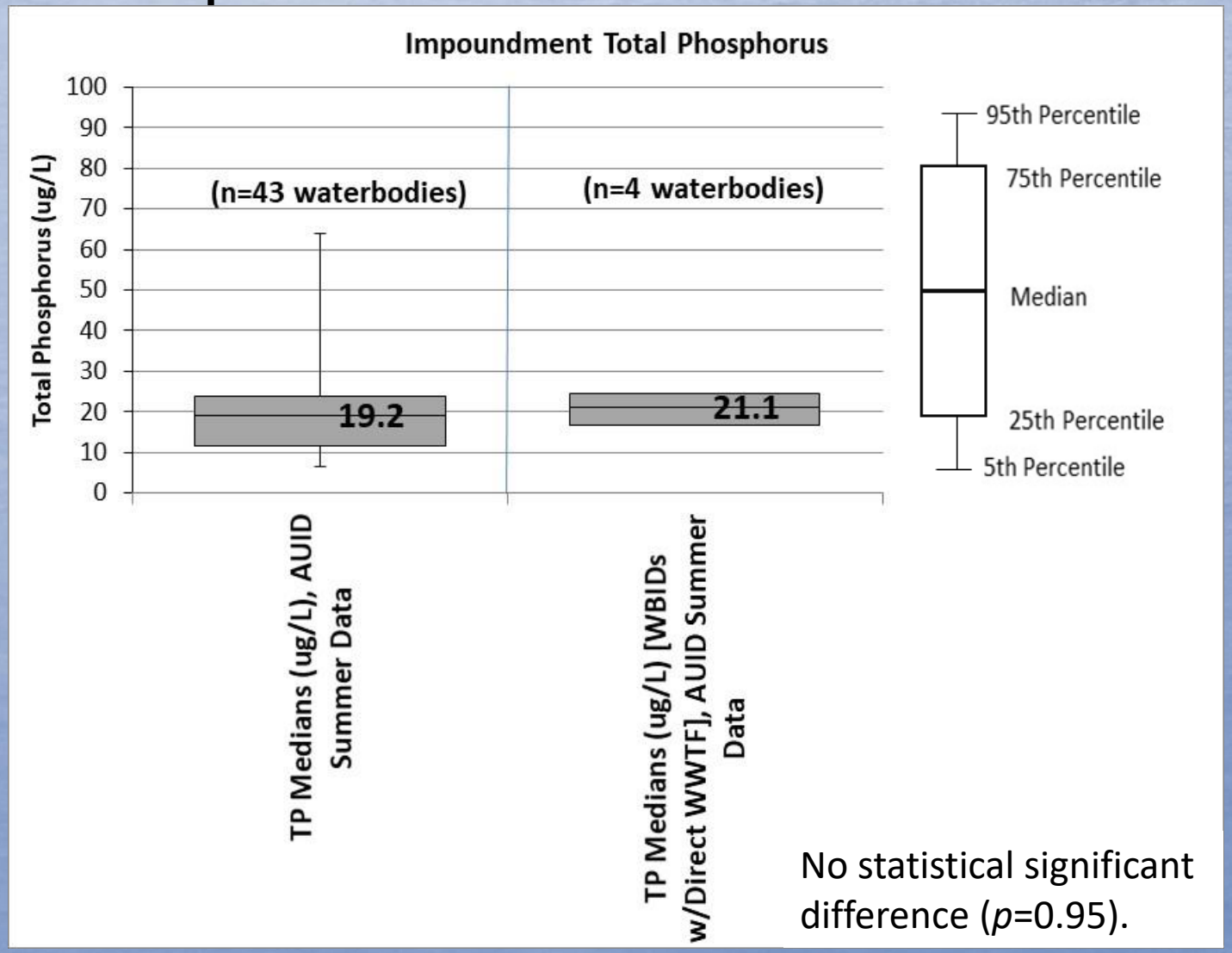
No statistical significant difference (p=0.65).

- Elevated in those with direct WW inputs.
- Generally quite low.

11-SMS, Simms Stream

How do statistics from AUIDs with direct WW discharges compare to AUIDs without direct WWTF discharges?

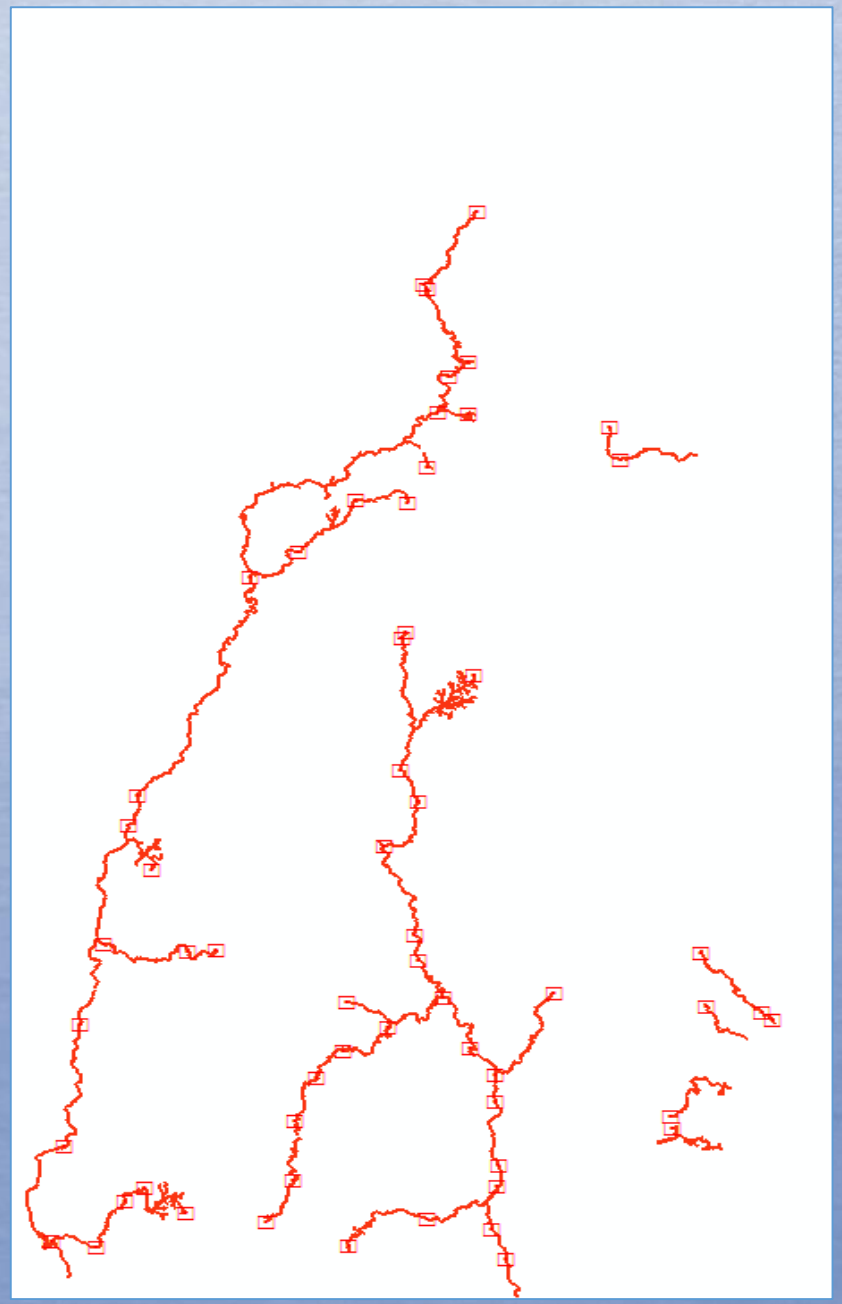
→In Impoundments

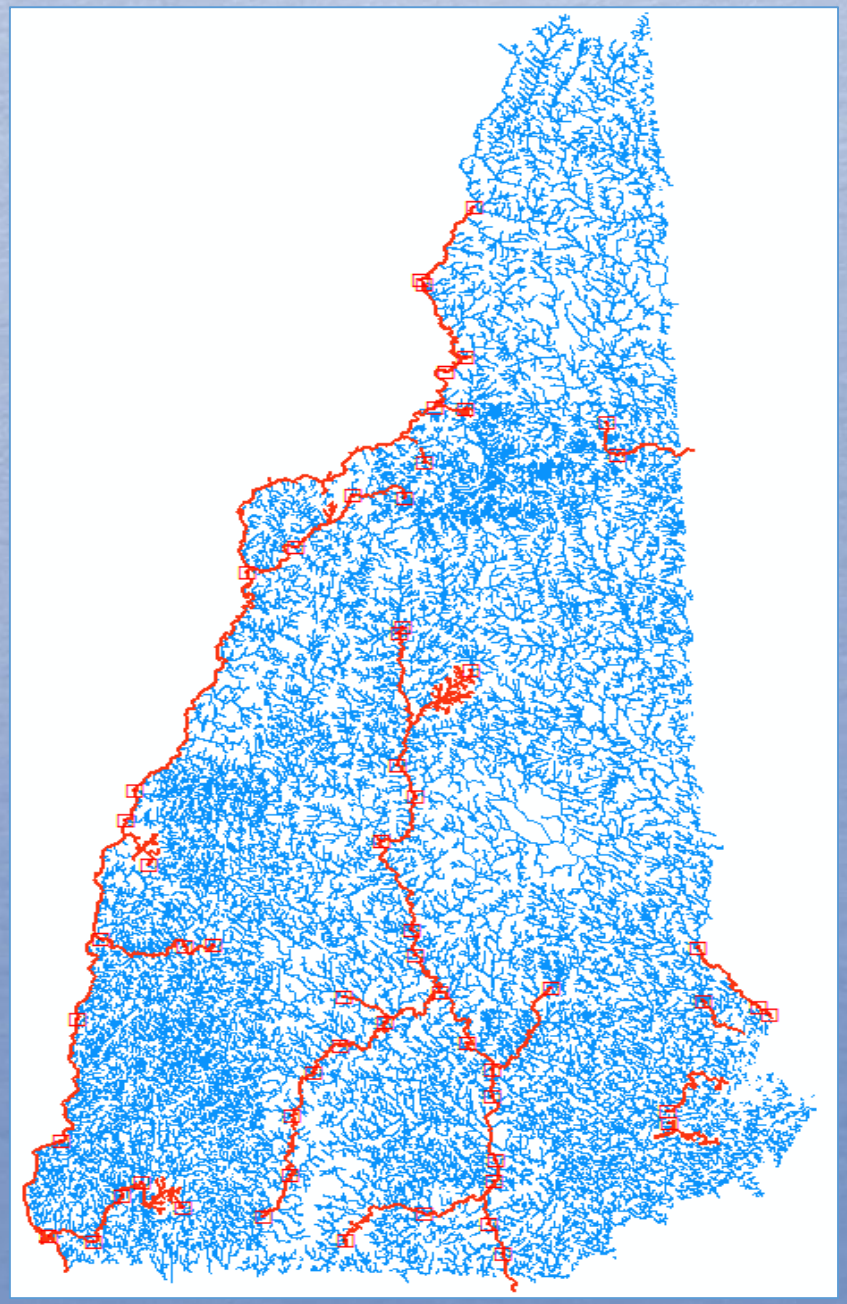


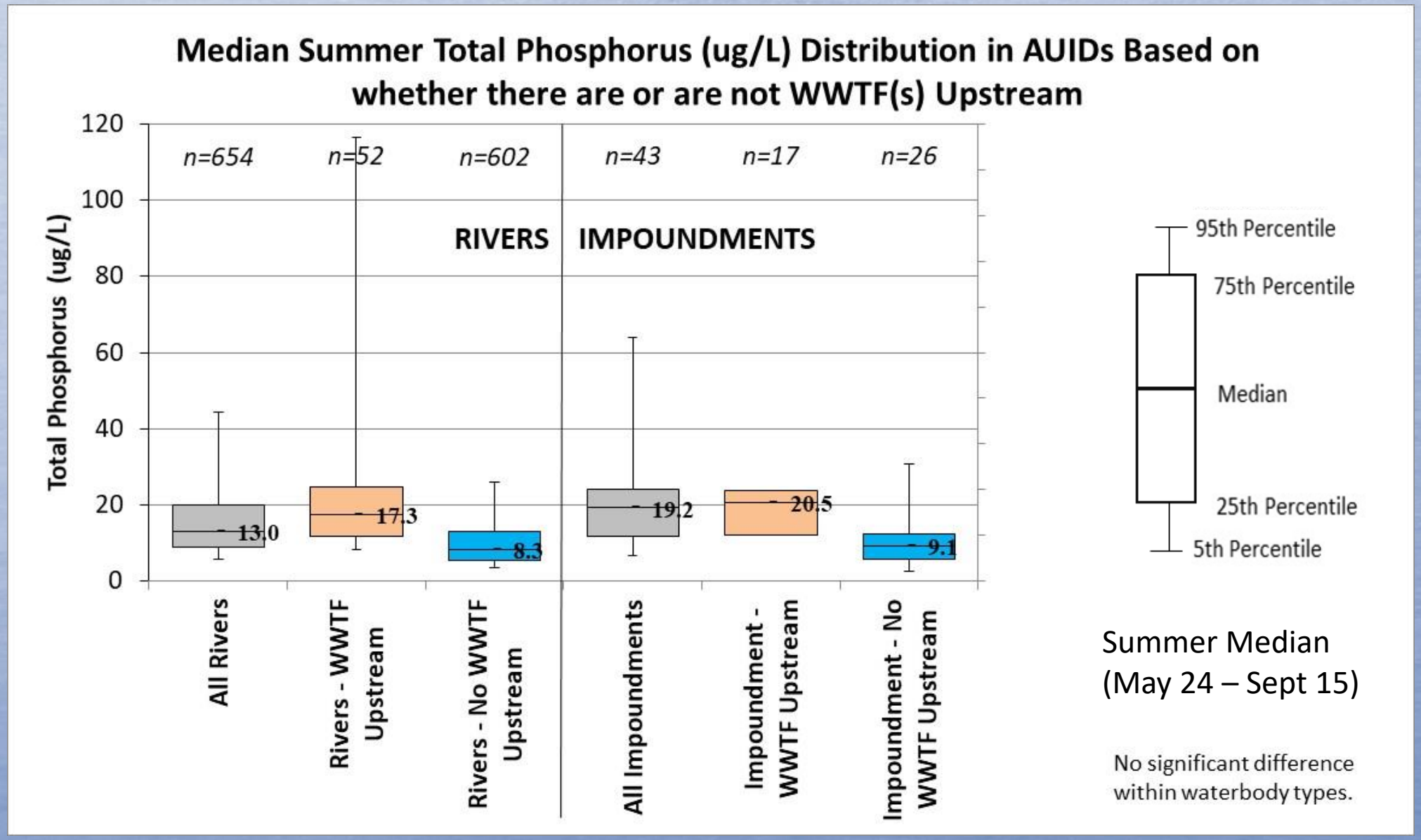
No statistical significant difference (p=0.95).

- Only an n=4 for those with direct WW inputs.
- Generally quite low.

Waterbodies receiving NPDES WWTF effluent (red) and everyone else (blue)



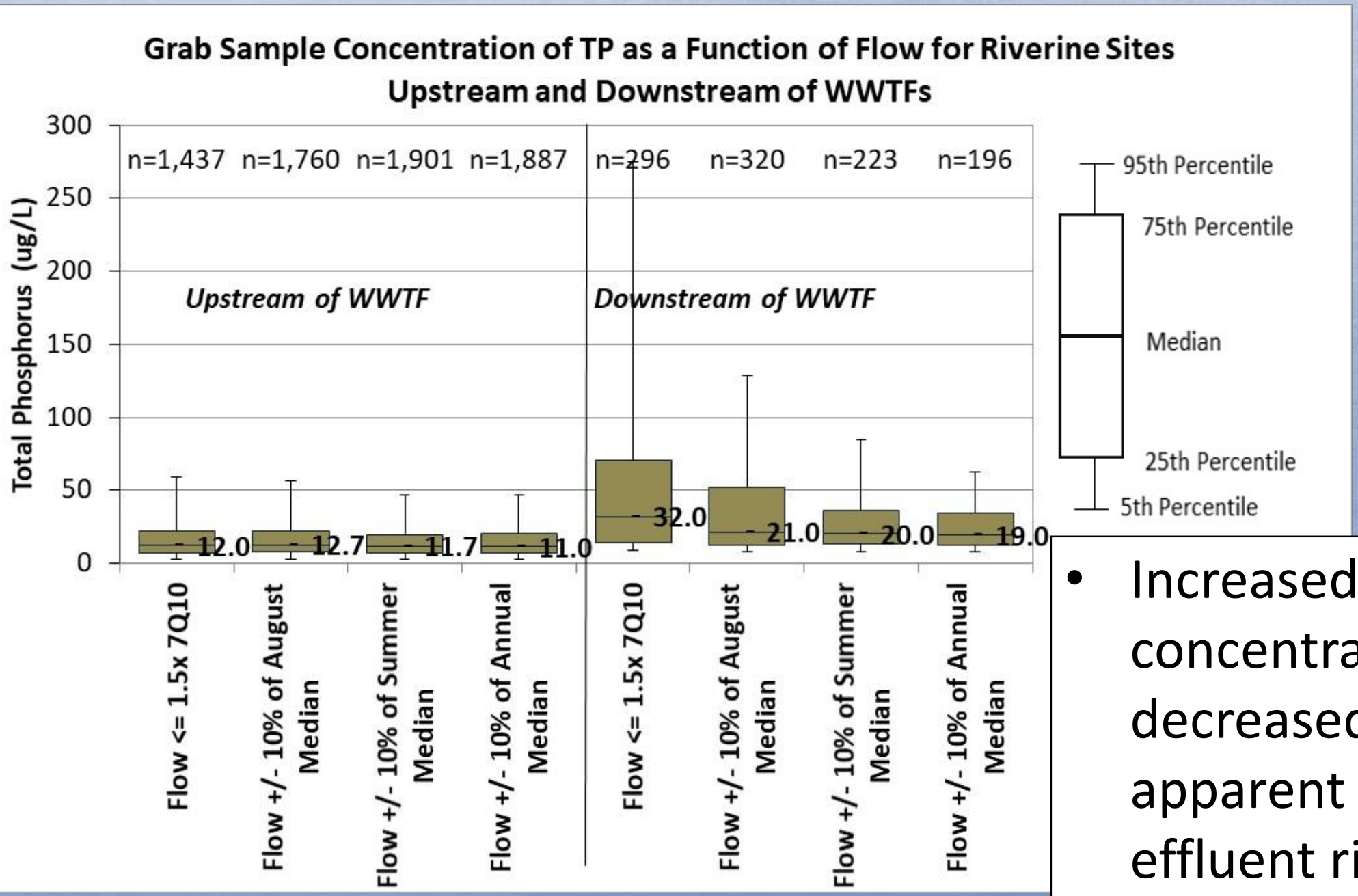




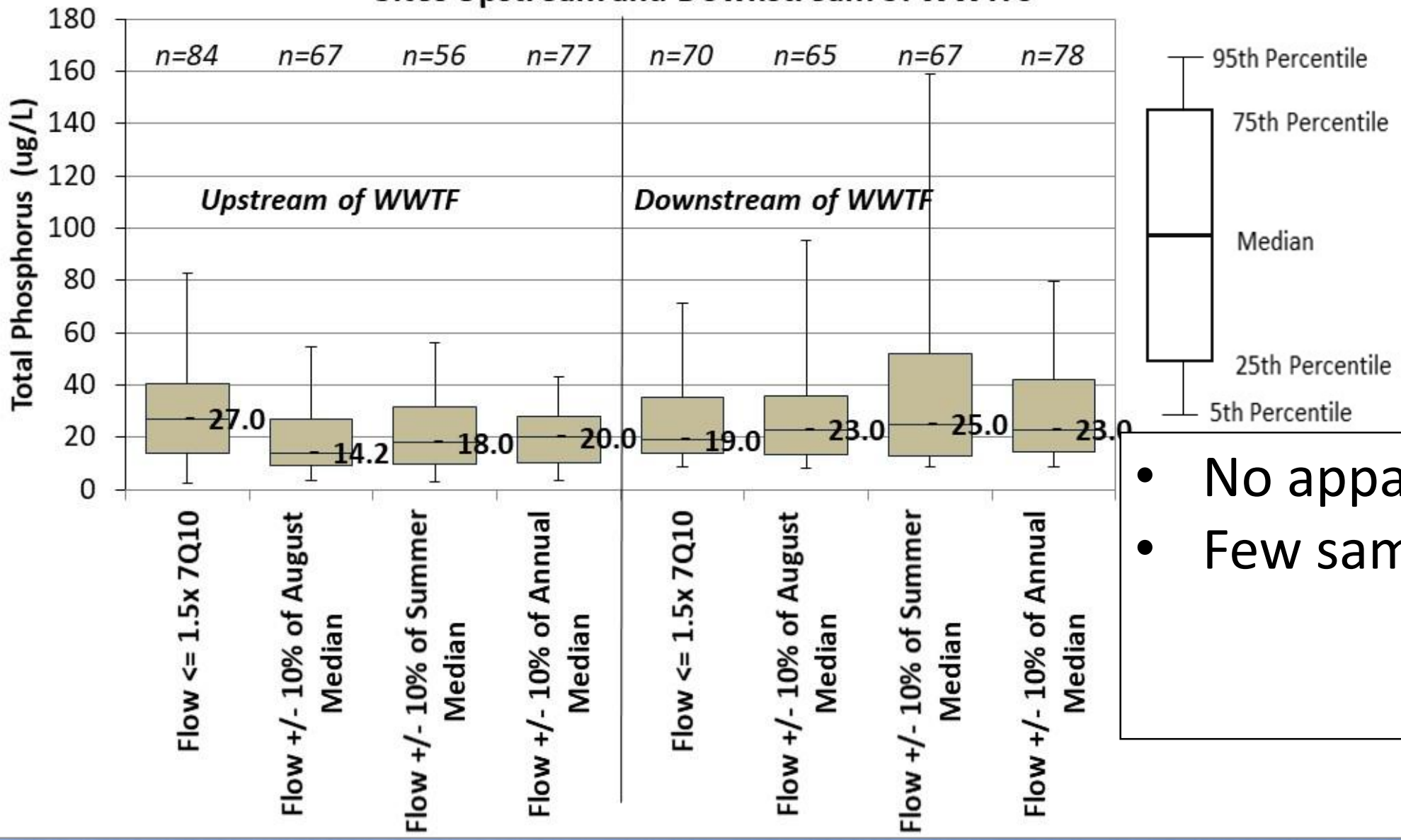
WWTF effluent apparent in ambient data.
Concentrations generally very low.

What do TP concentrations look like over a range of flows for rivers and impoundments with and without wastewater effluent?

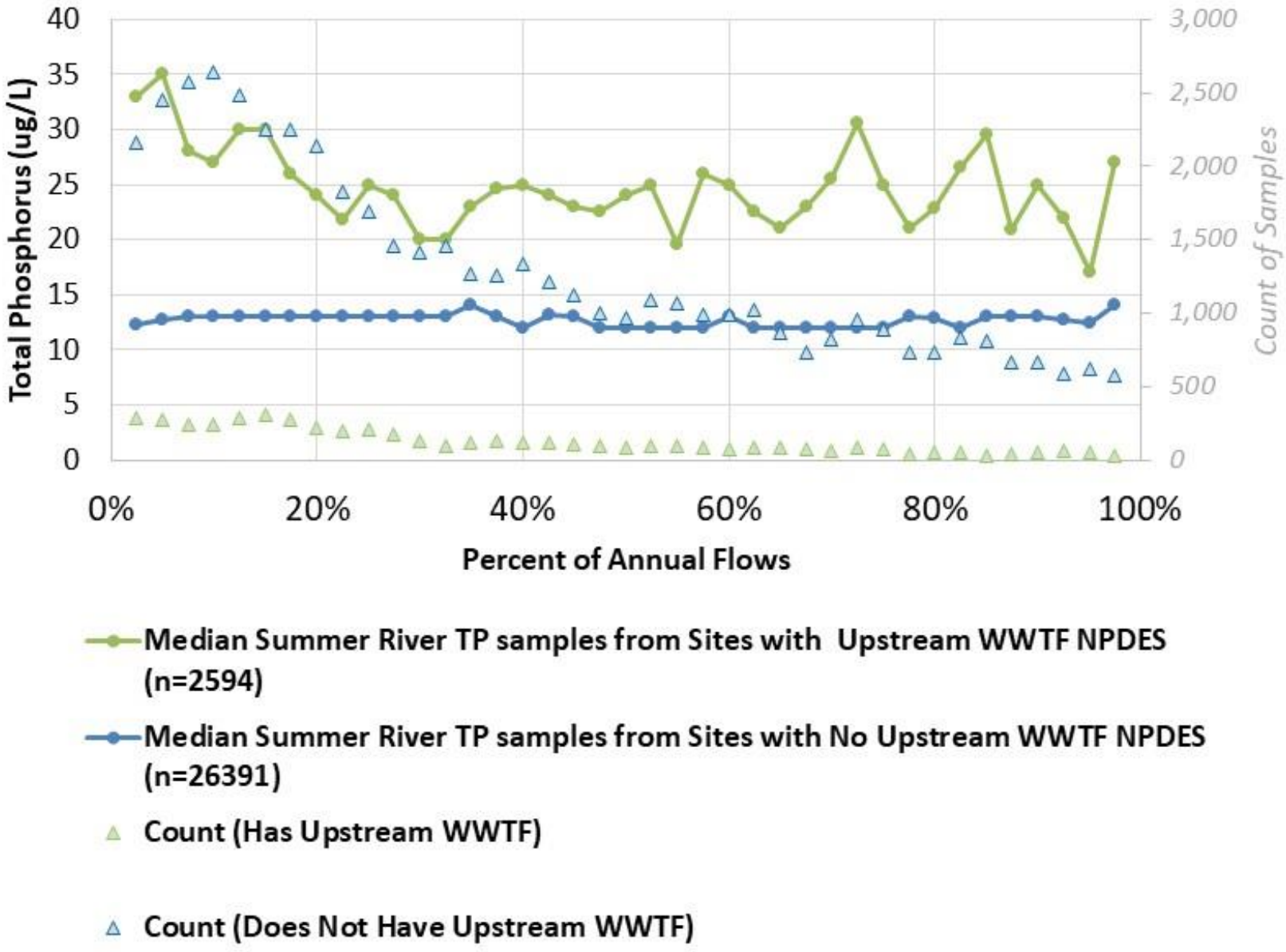
03-OSS, Ossipee R



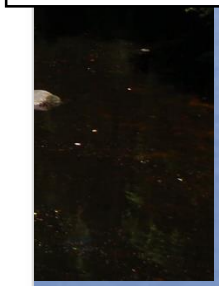
- Increased concentration as flow decreased only apparent in WWTF effluent rivers.



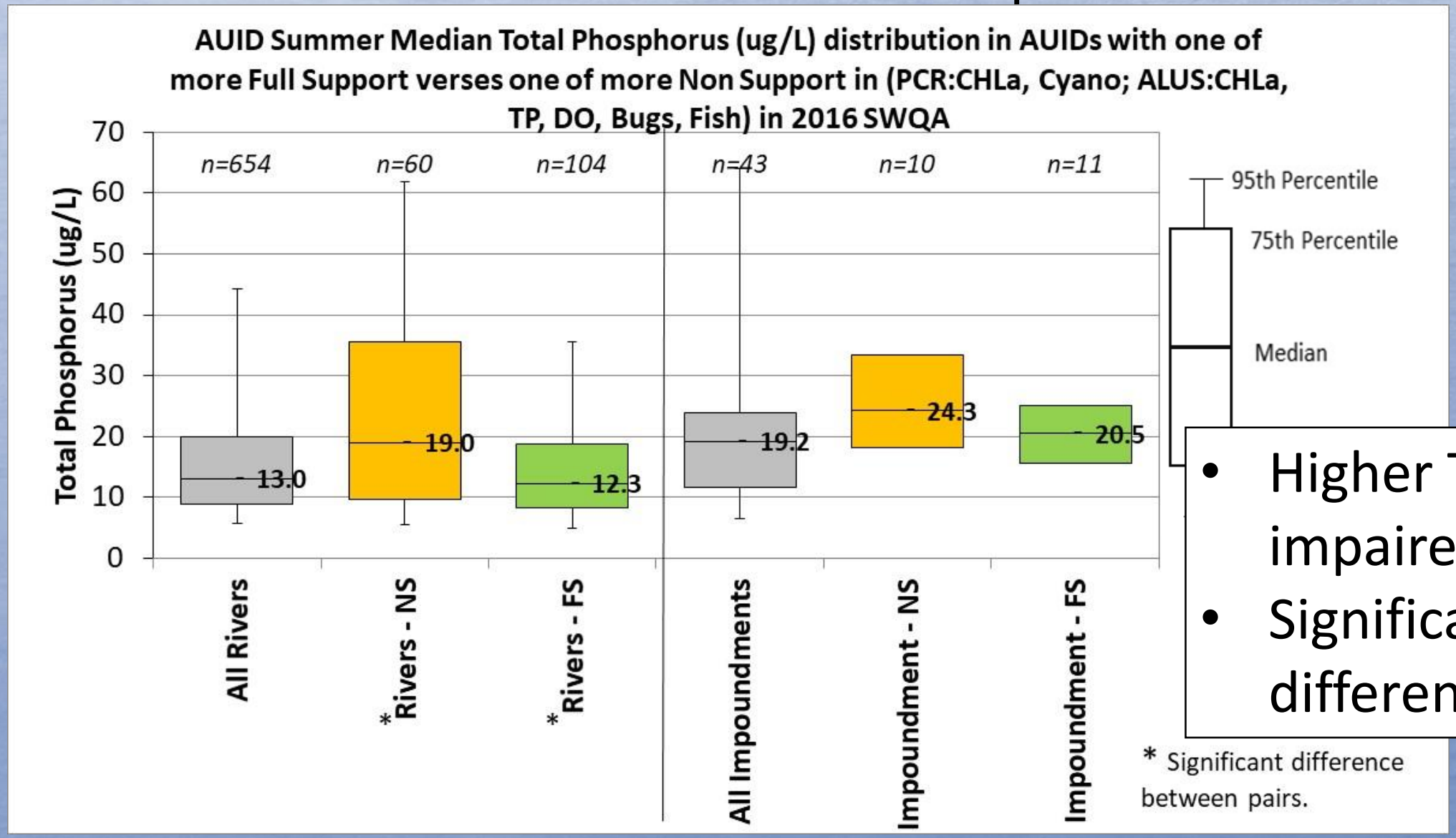
- No apparent trends.
- Few samples.



- Rivers without WWTF effluent are adapted to consistent TP over the full range of flows.



Looking at ambient TP as a function of existing assessments – Rivers and Impoundments

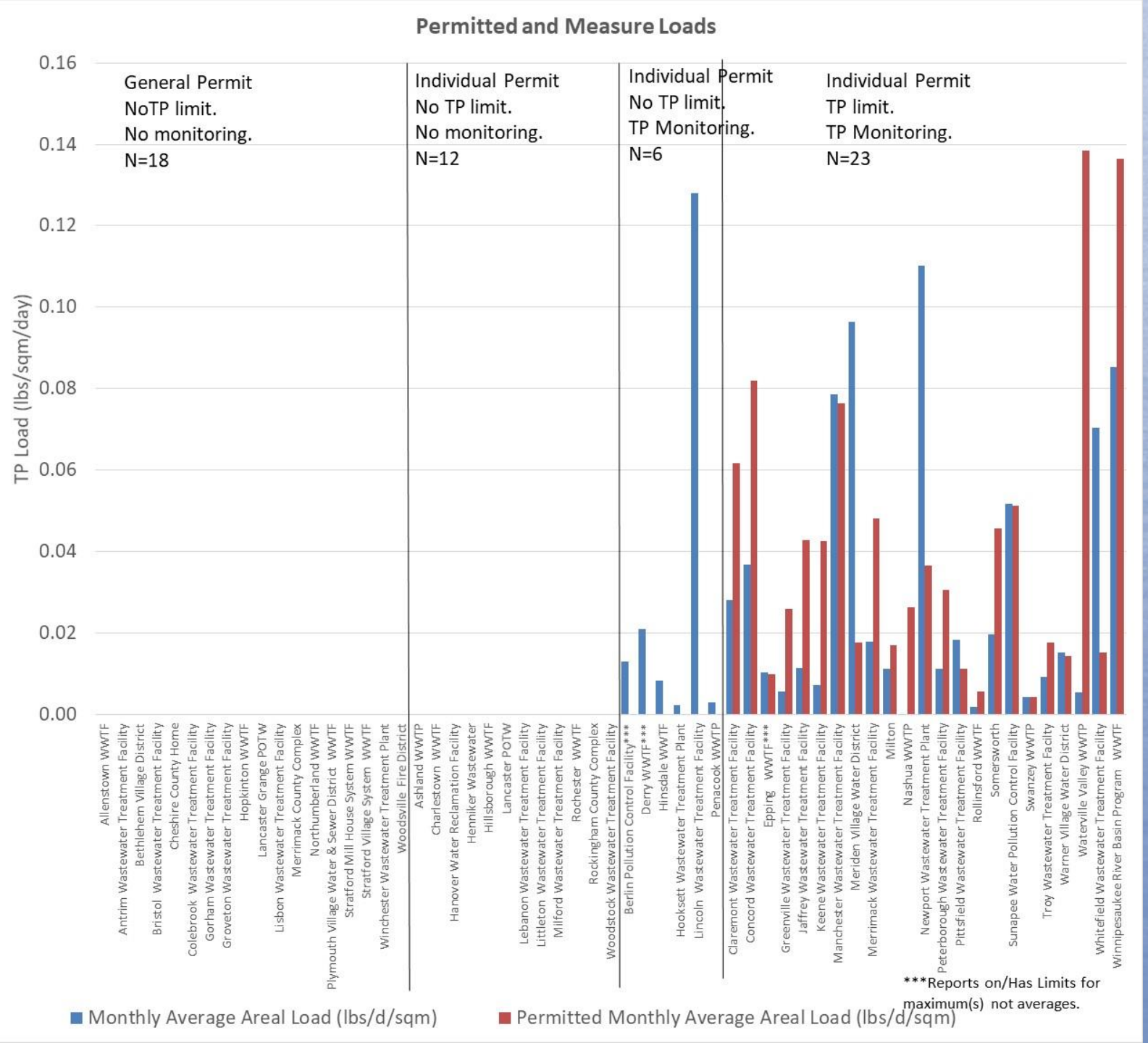


- Higher TP in impaired waters.
- Significant difference in rivers.

Comparison of Permitted to Current TP Loads

- Permitted Flow
- Permitted TP
- 4 year average DMR Flow and TP
- Receiving waterbody's watershed area

03-SSR, S. Br. Sugar R

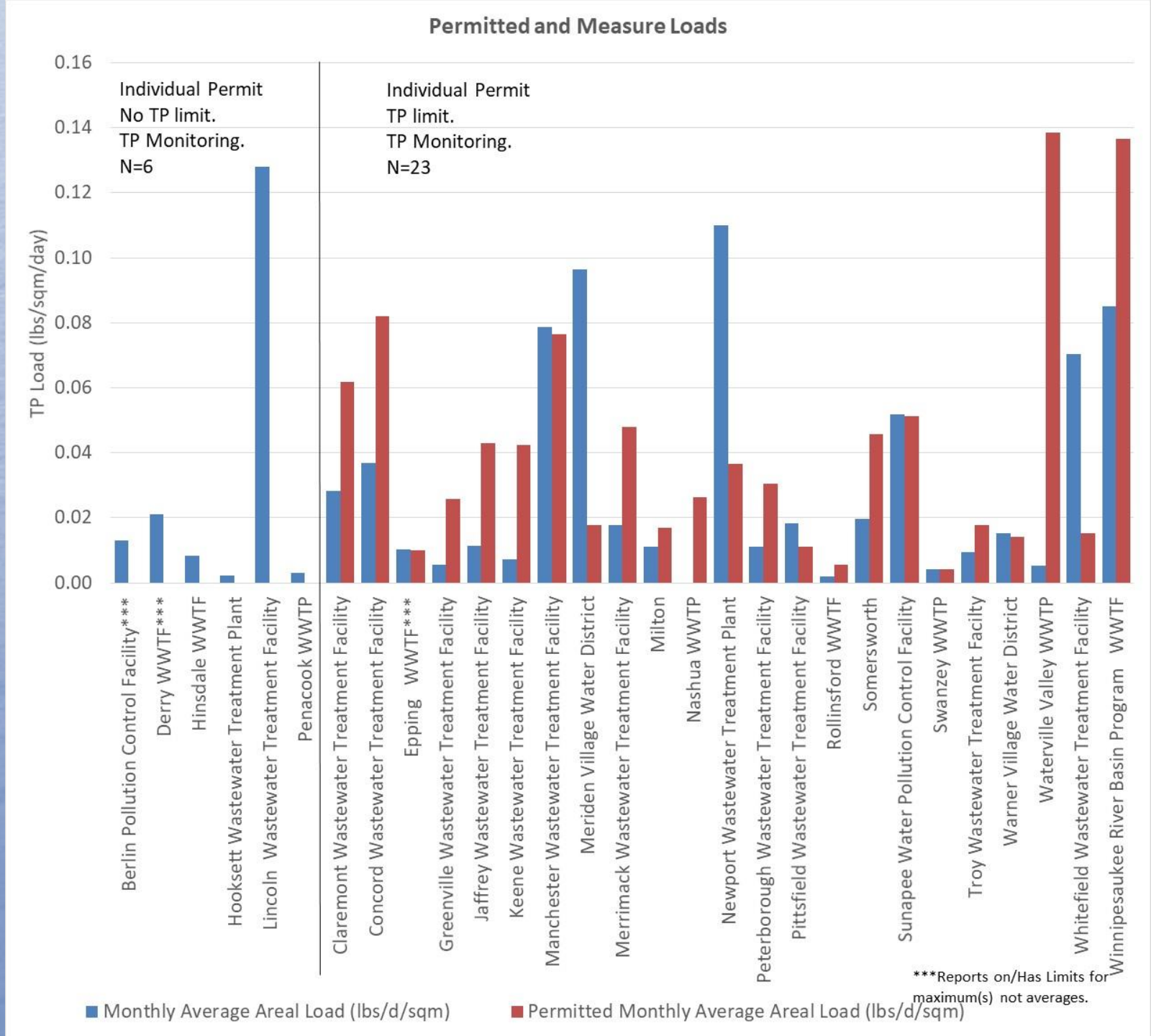


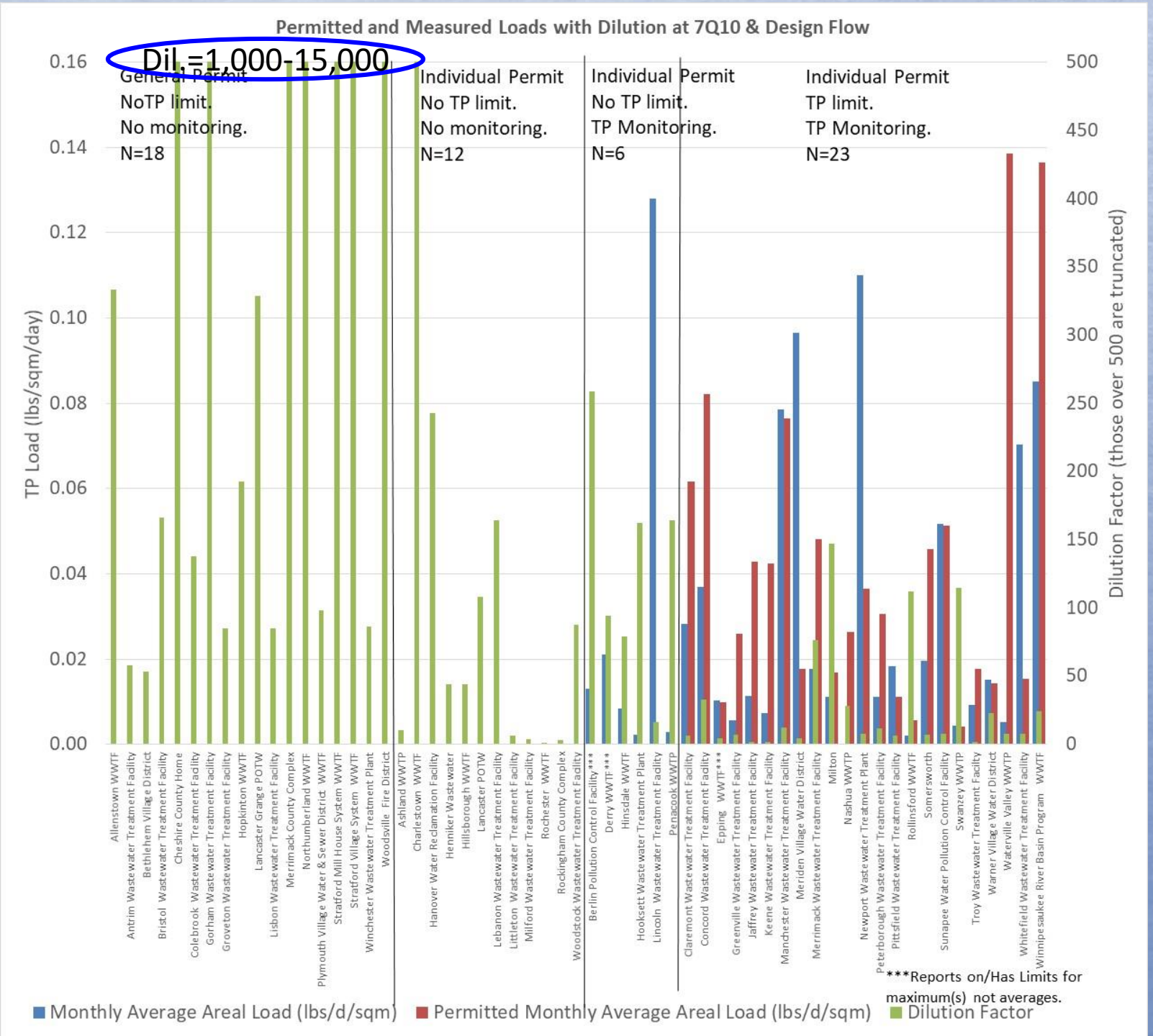
- RED - Permitted Load
- BLUE - Current Load based on 4 year average DMR flow and TP

- 59 Facilities
- 23 (39% have TP limits)

- RED - Permitted Load
- BLUE - Current Load based on 4 year average DMR flow and TP

- Most facilities meeting their limits.

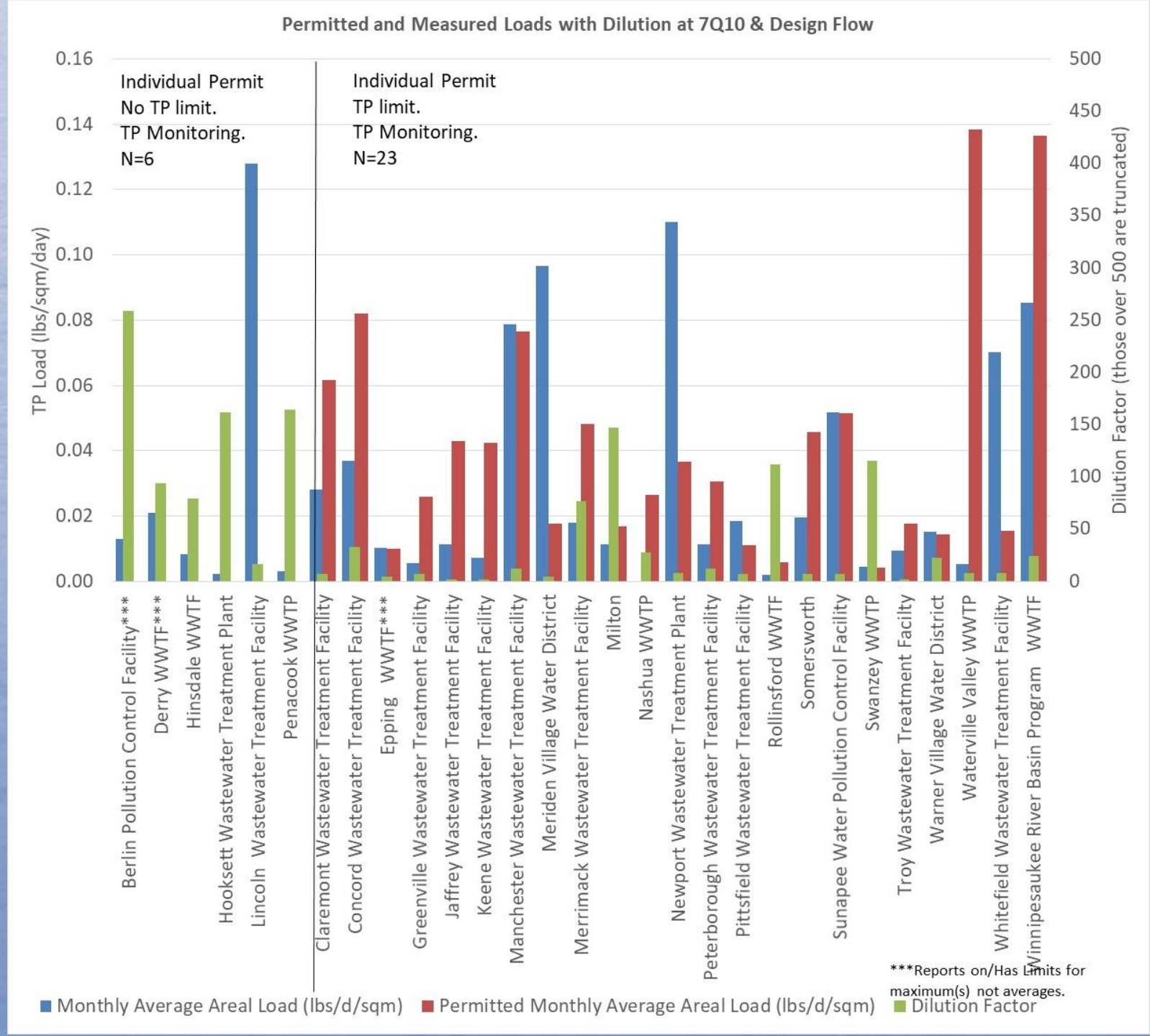




- GREEN – Dilution factor
- RED - Permitted Load
- BLUE - Current Load based on 4 year average DMR flow and TP
- 59 Facilities
- 23 (39% have TP limits)
- Most facilities without limits have very high dilution.

- GREEN – Dilution factor
- RED - Permitted Load
- BLUE - Current Load based on 4 year average DMR flow and TP

- Facilities with high dilution have limits when there are other facilities in the watershed.



Potential effects of Using Flows Other than 7Q10 for Permitting

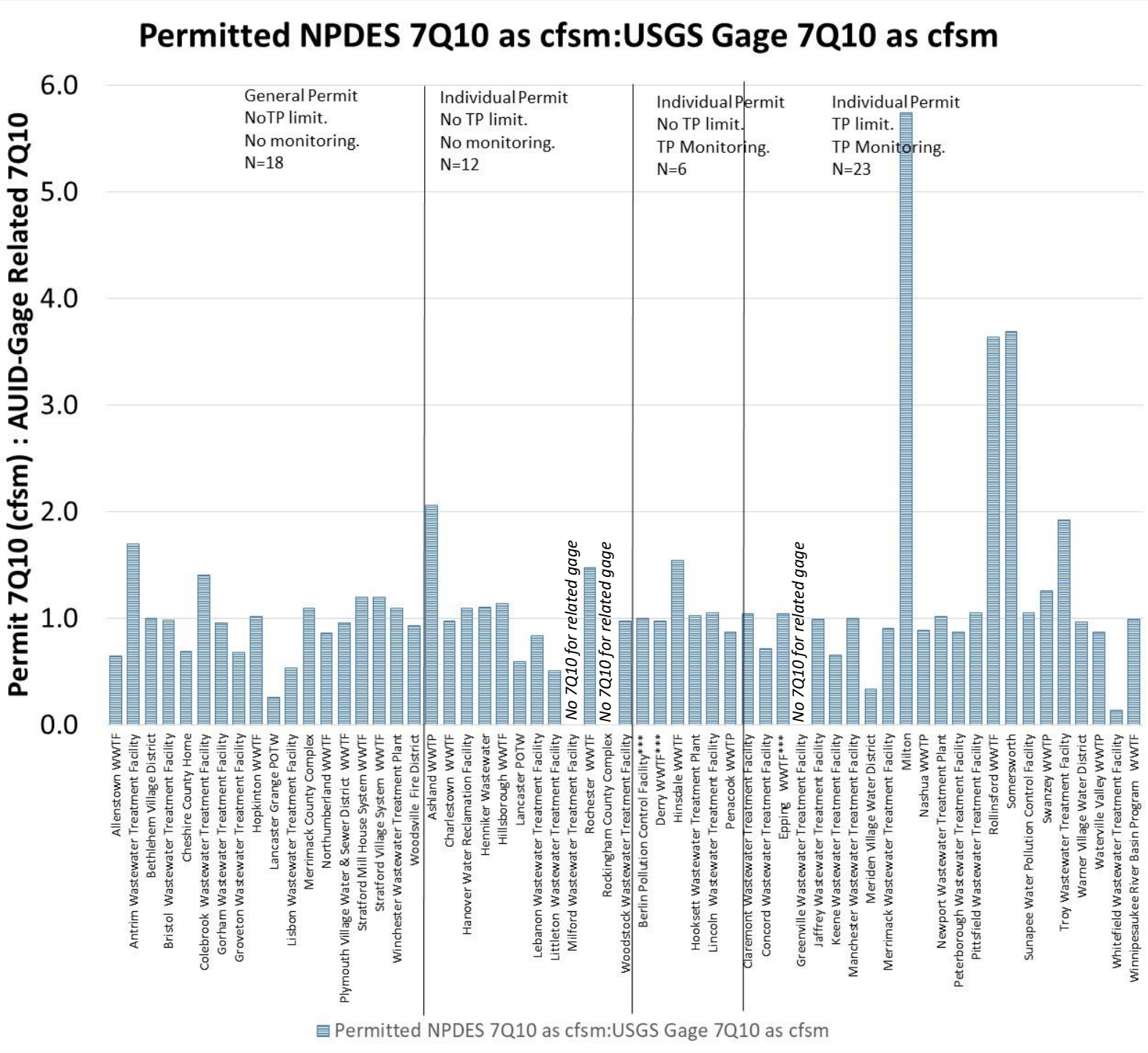
I. Comparing flow statistic methodologies.
II. What if we use the background concentration used in actual permits for facilities with TP limits.
III. Predict loadings at different flow targets and backgrounds.
IV. With permitted loading, what might we expect at August median Flow?

01A-SGR, Sugar R

Potential effects of Using Flows Other than 7Q10 for Permitting

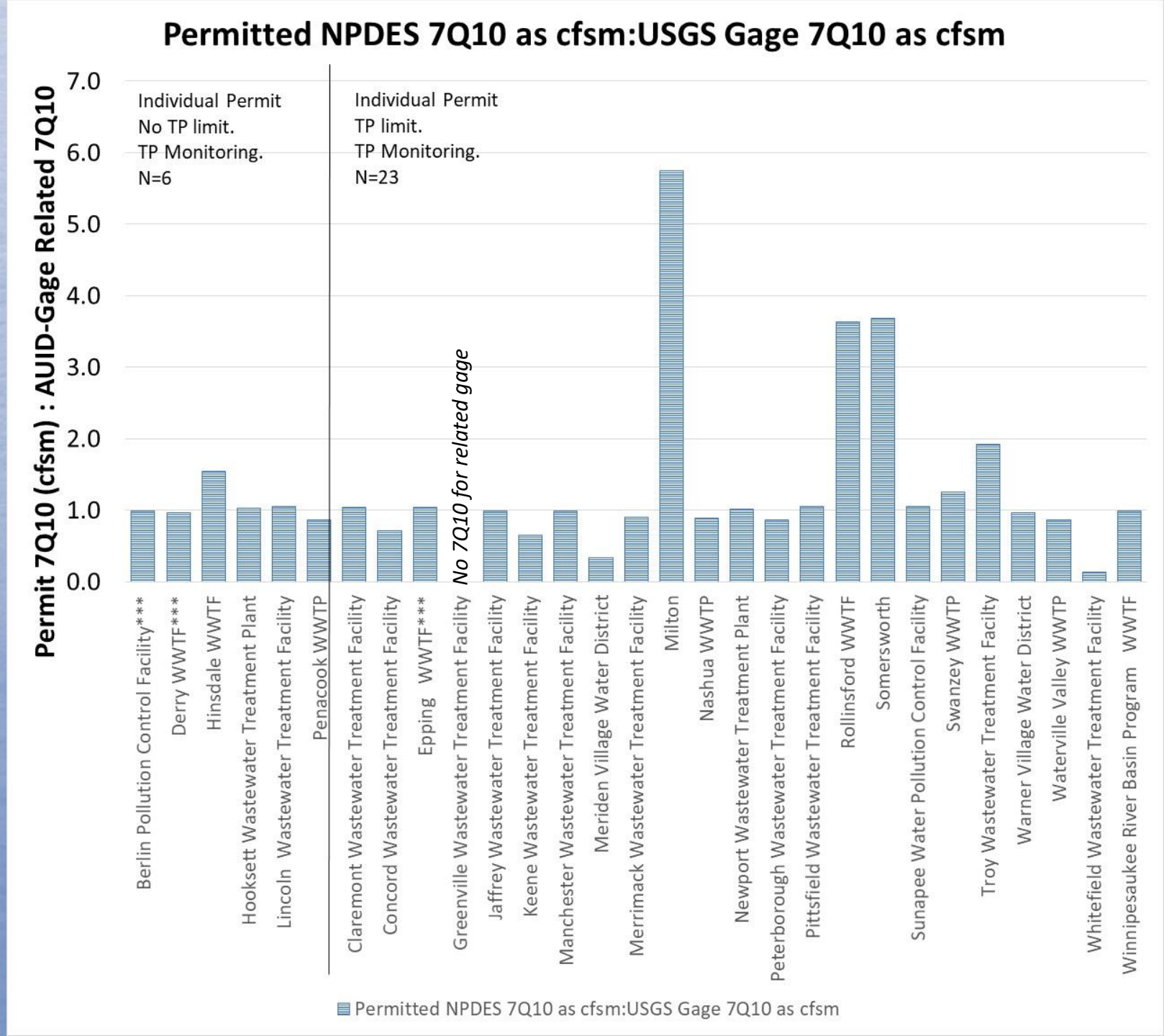
- If a flow other than 7Q10, flow statistics will need to be computed from USGS gages for all permits (which is different than has been done for some permits in part or in whole).
- *Step 1 here – how well does that work for 7Q10?*

07-CCH, Cocheco R



- Most facilities close to a 1:1 (i.e. a perfect match).

- Most facilities close to a 1:1 (i.e. a perfect match).
- Those where ratio is >1 well understood.
- Some would need additional research.

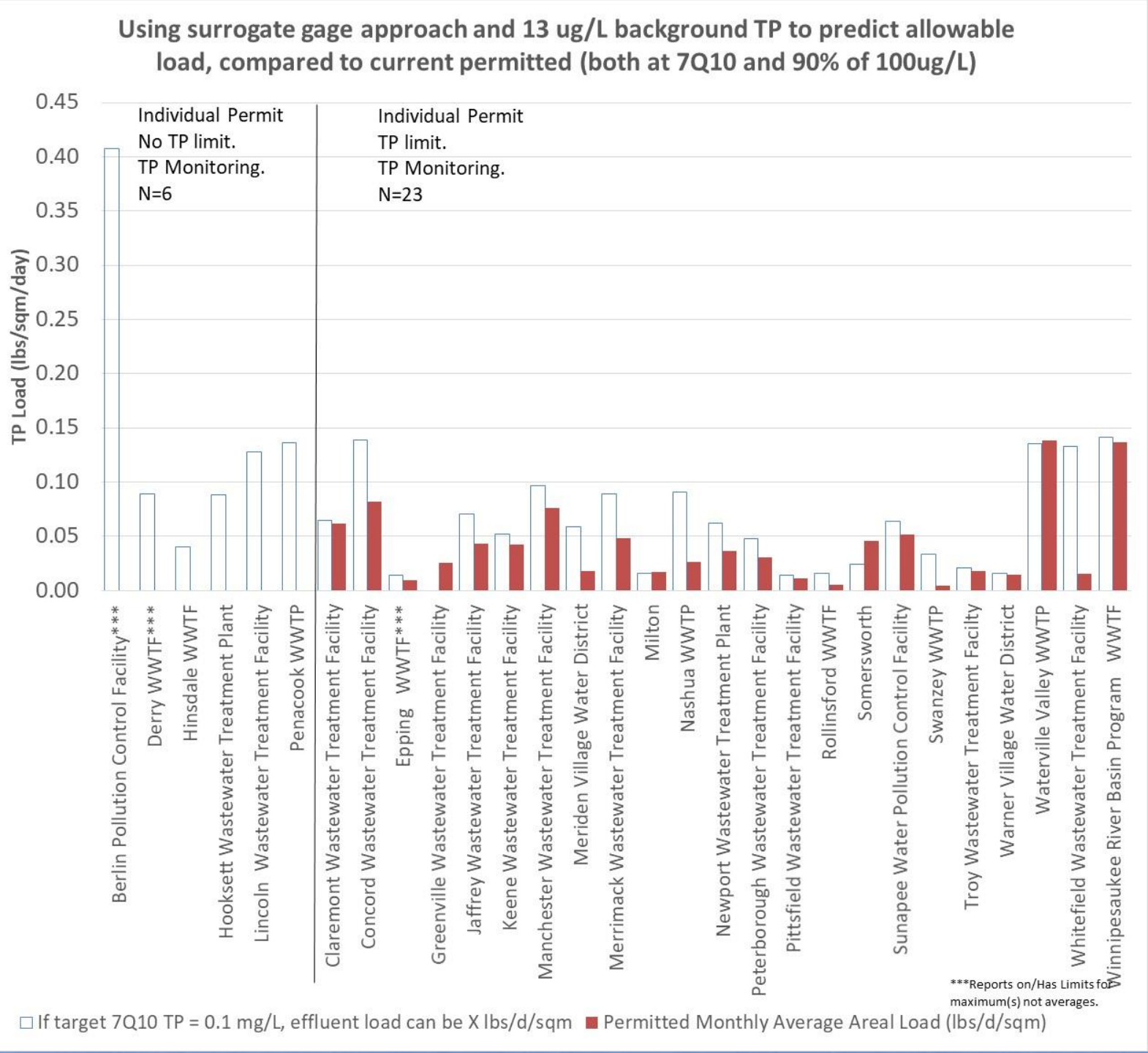


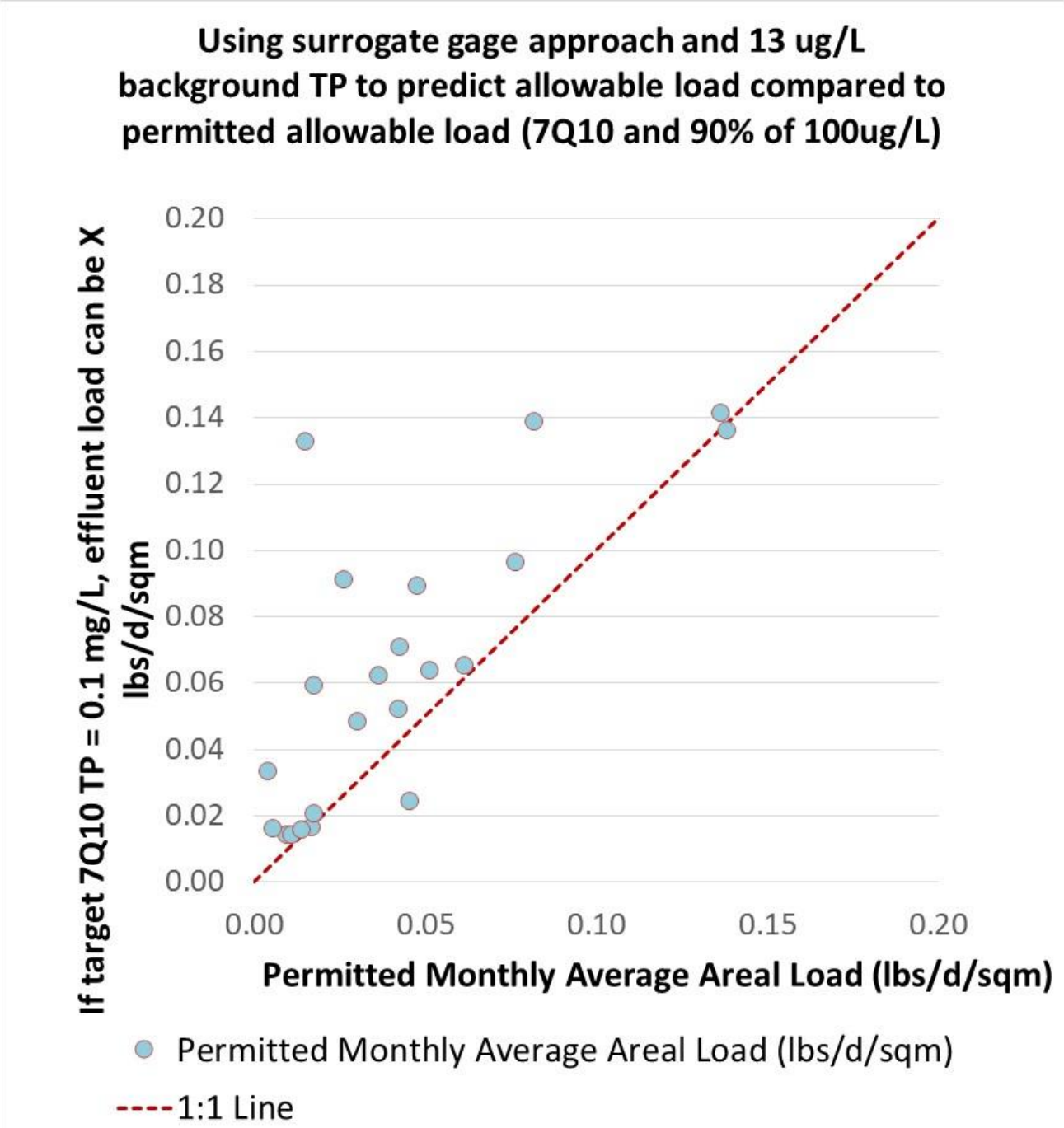
Potential effects of Using Flows Other than 7Q10 for Permitting

- *Step 2 - Applying the related gages, what are the predicted permit loads at a fixed background of 13 ug/L?*

- RED - Permitted load
- WHITE – Predicted permit load from related gage 7Q10 and background of 13 ug/L.

- Equal or higher allowable loads predicted.



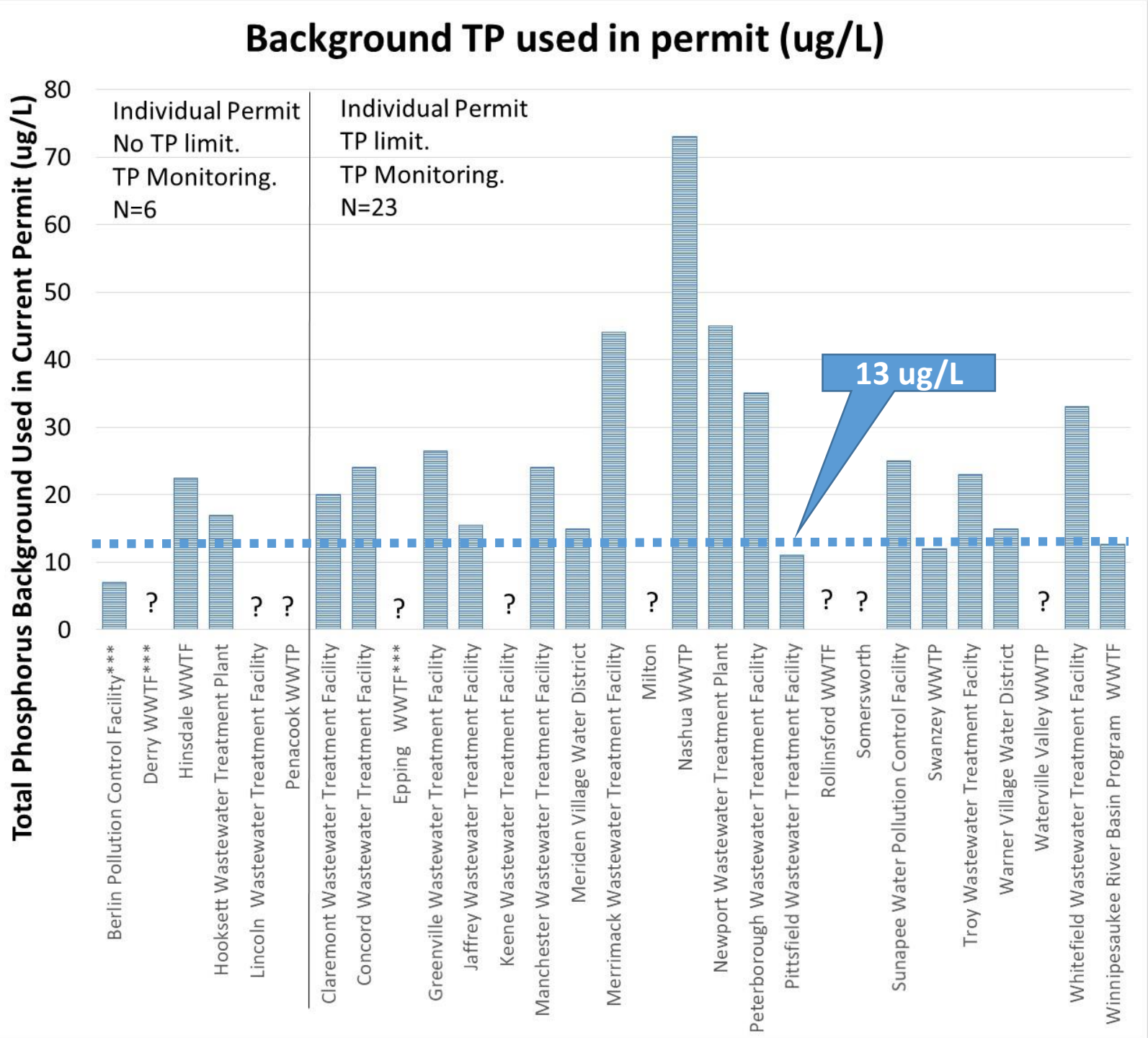


- Equal or higher allowable loads predicted in all but one case.
- This step uses a background that is low for many facilities → not shocking that we predict higher allowed load.

Potential effects of Using Flows Other than 7Q10 for Permitting

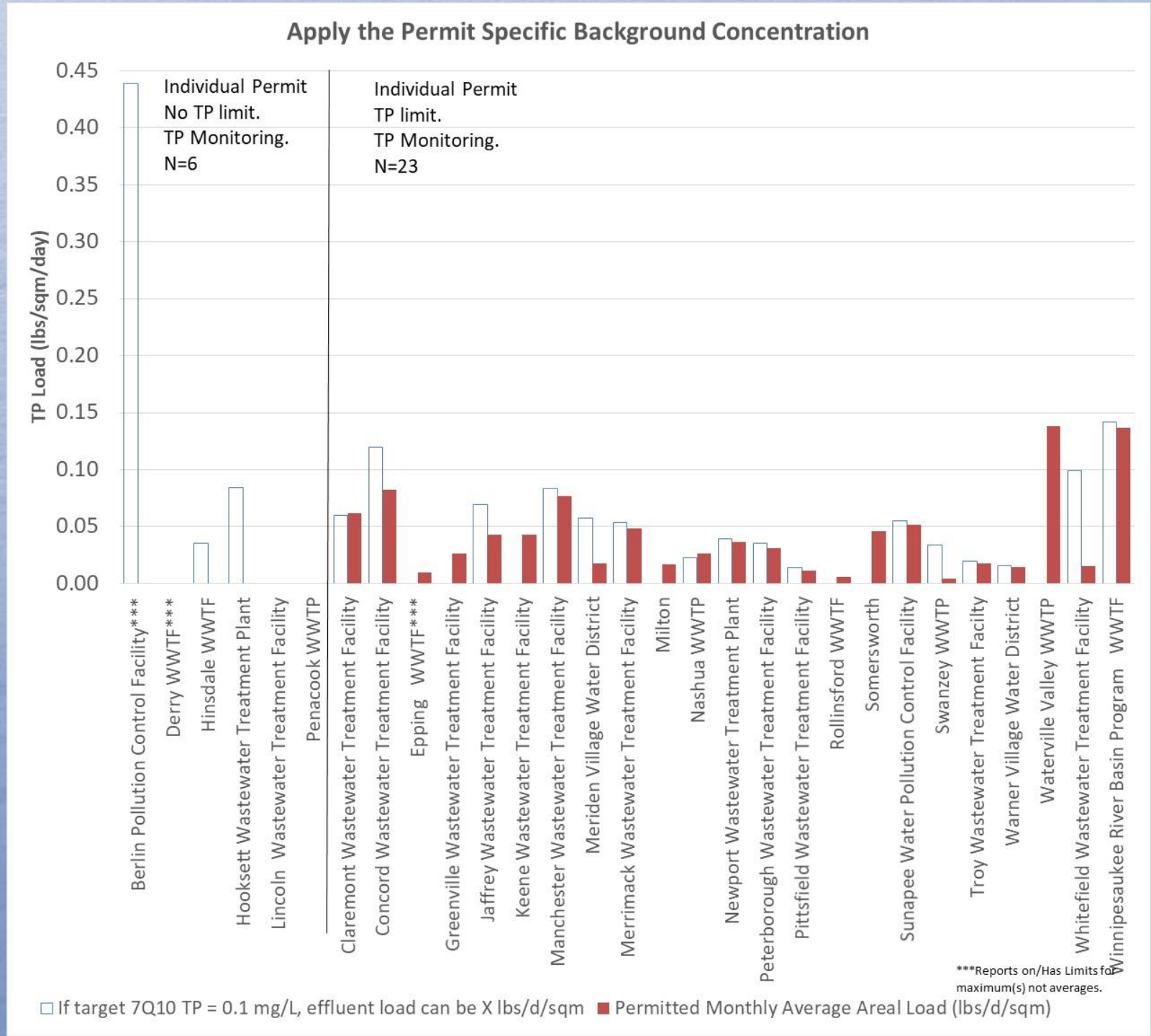
- *Step 3 - Applying the related gages, what are the predicted permit loads using the background used for the permit?*

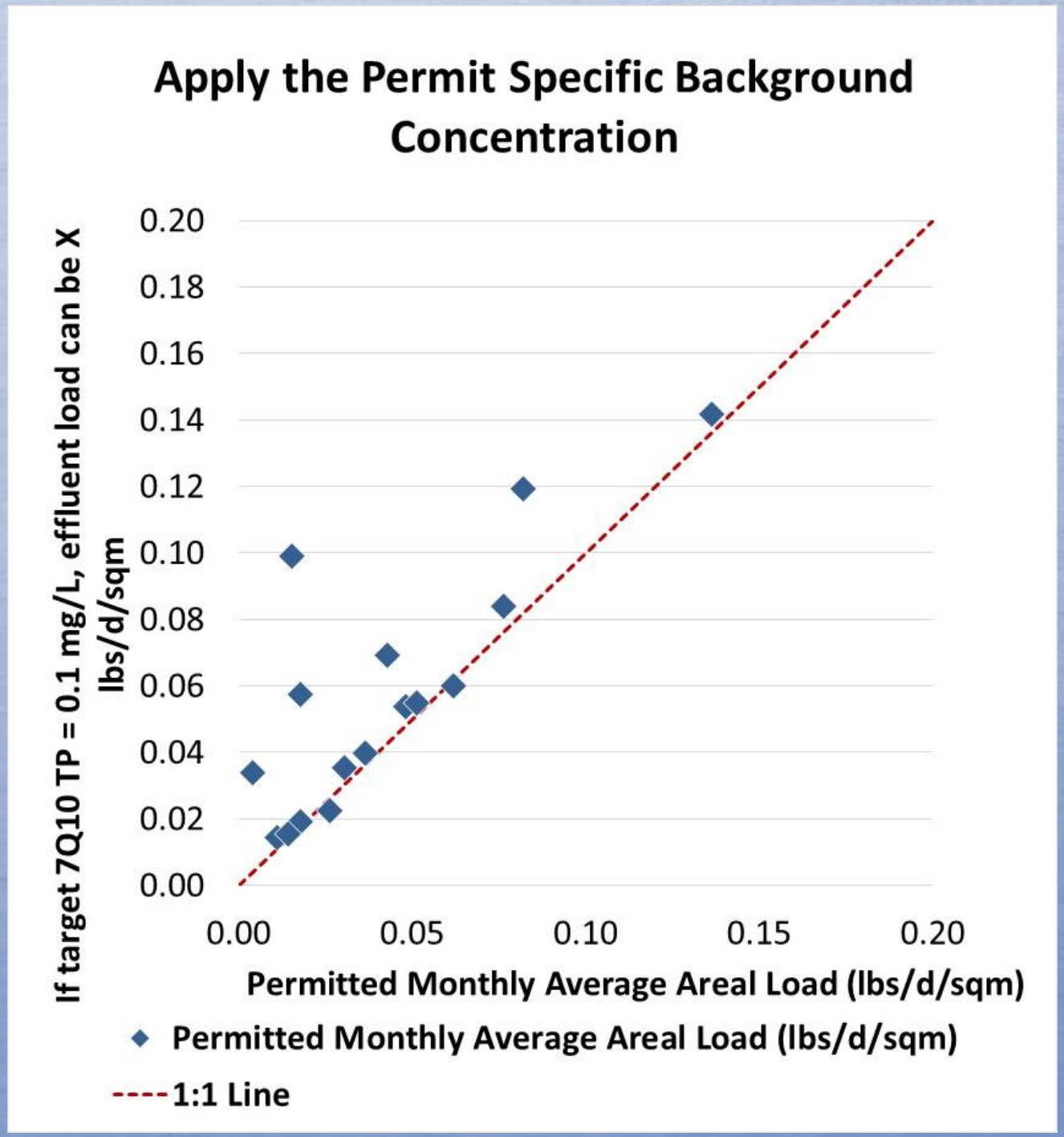
- For those facilities that have other facilities in the upstream watershed, the background used in the permit is over the 13 ug/L.
- Those facilities part of a TMDL are part of a different process.



- RED - Permitted load
- WHITE – Predicted permit load from related gage 7Q10 and background used in the permit.

- Equal or higher allowable loads predicted.





- Those sites for which a higher allowable load is predicted are sites where the related gage approach predicts a higher 7Q10 than the 7Q10 used in the permit.

Potential effects of Using Flows Other than 7Q10 for Permitting

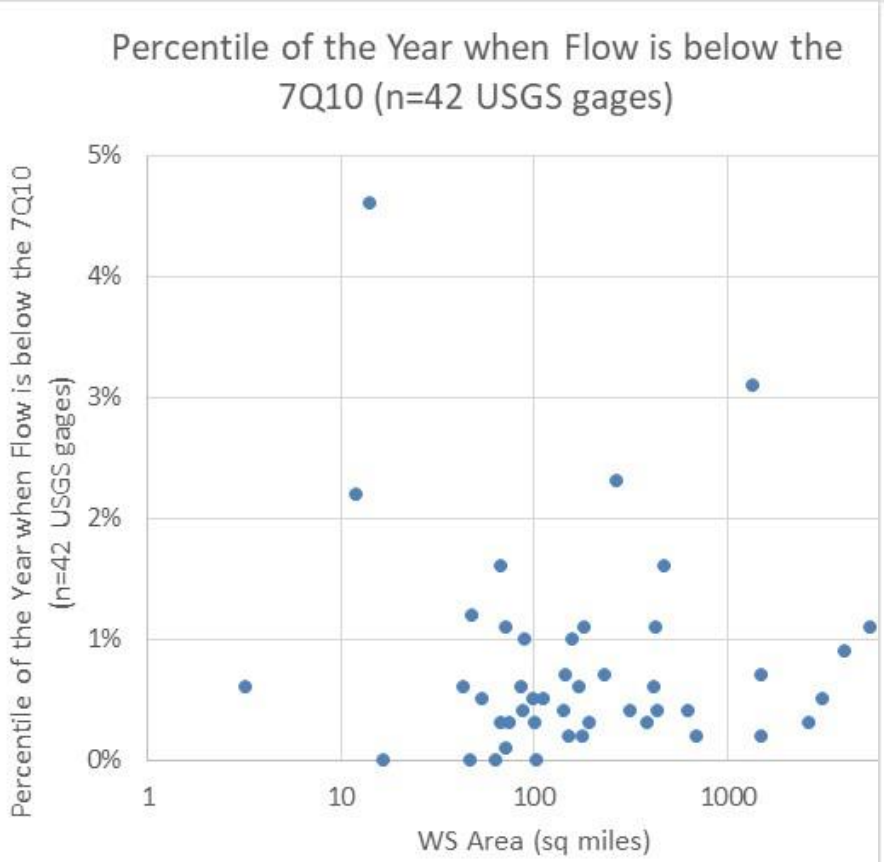
I. Frequency of flows <7Q10 and < August medians.

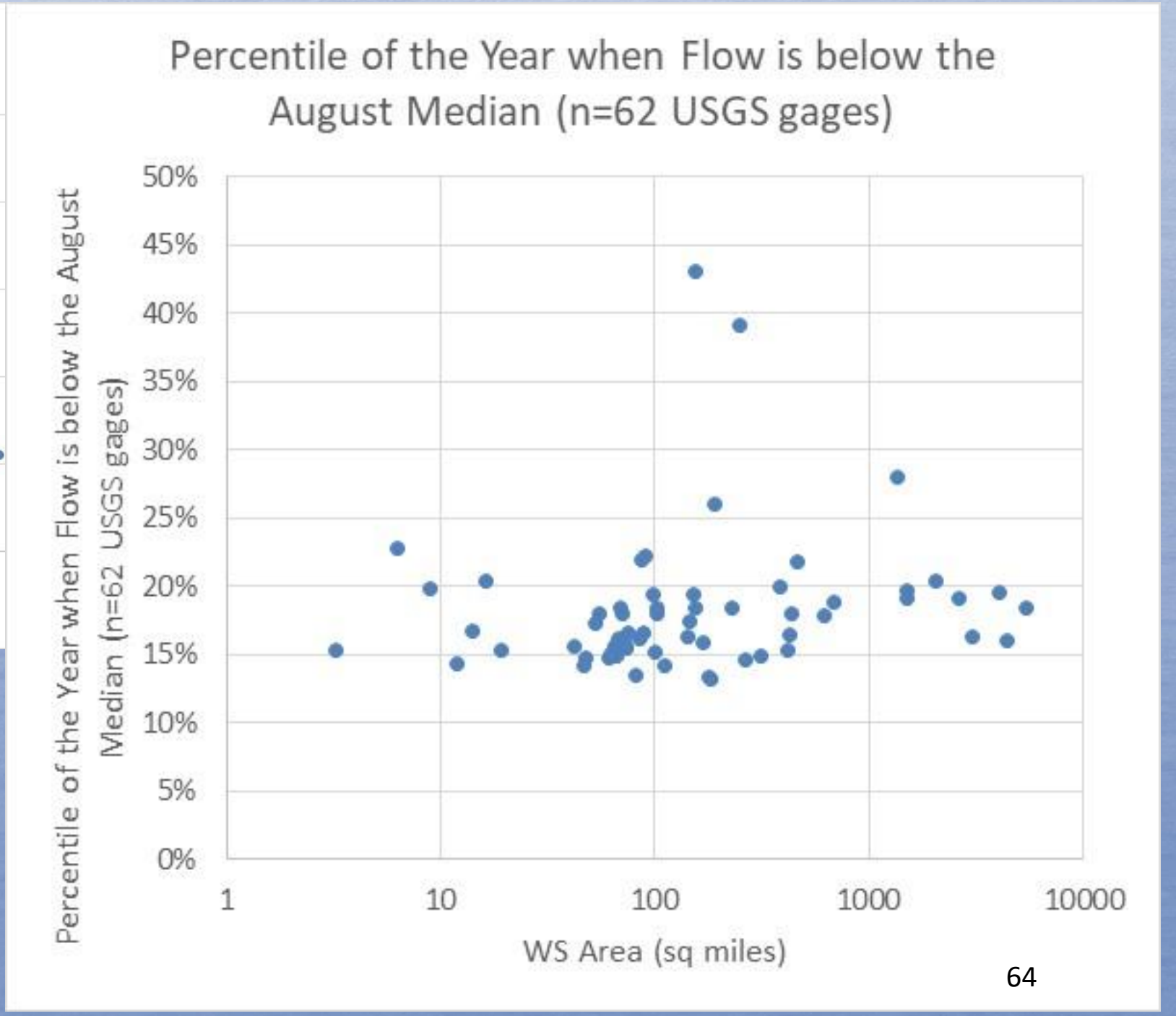
II. Compare the WWTF areal loads based on different ambient flows and existing permit load limits.

02-DNB, Dean Br.

Potential effects of Using Flows Other than 7Q10 for Permitting – Flow Frequency

- What percent of the annual is flow below the August median?
- What is the potential frequency of elevated TP concentration?

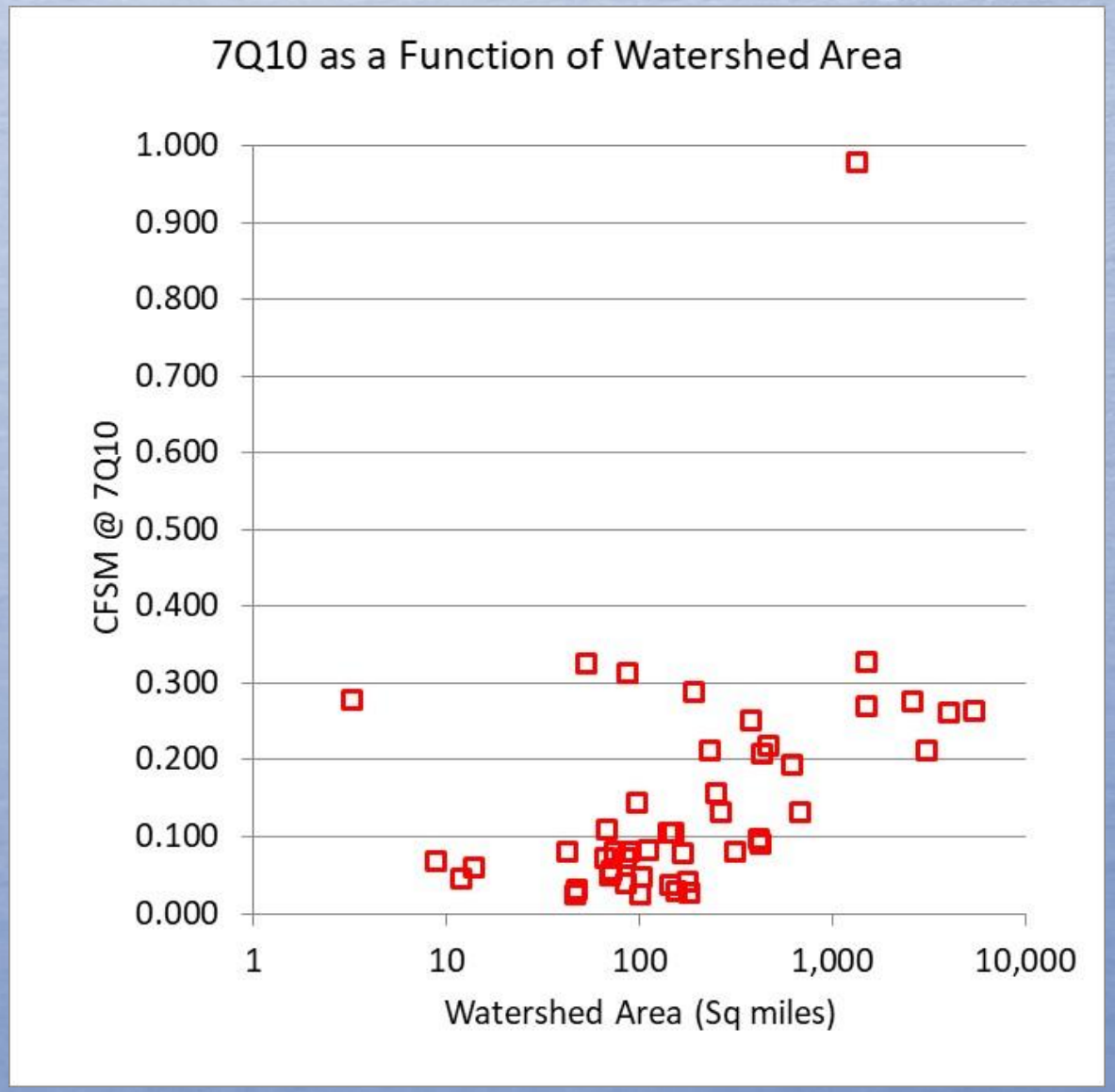


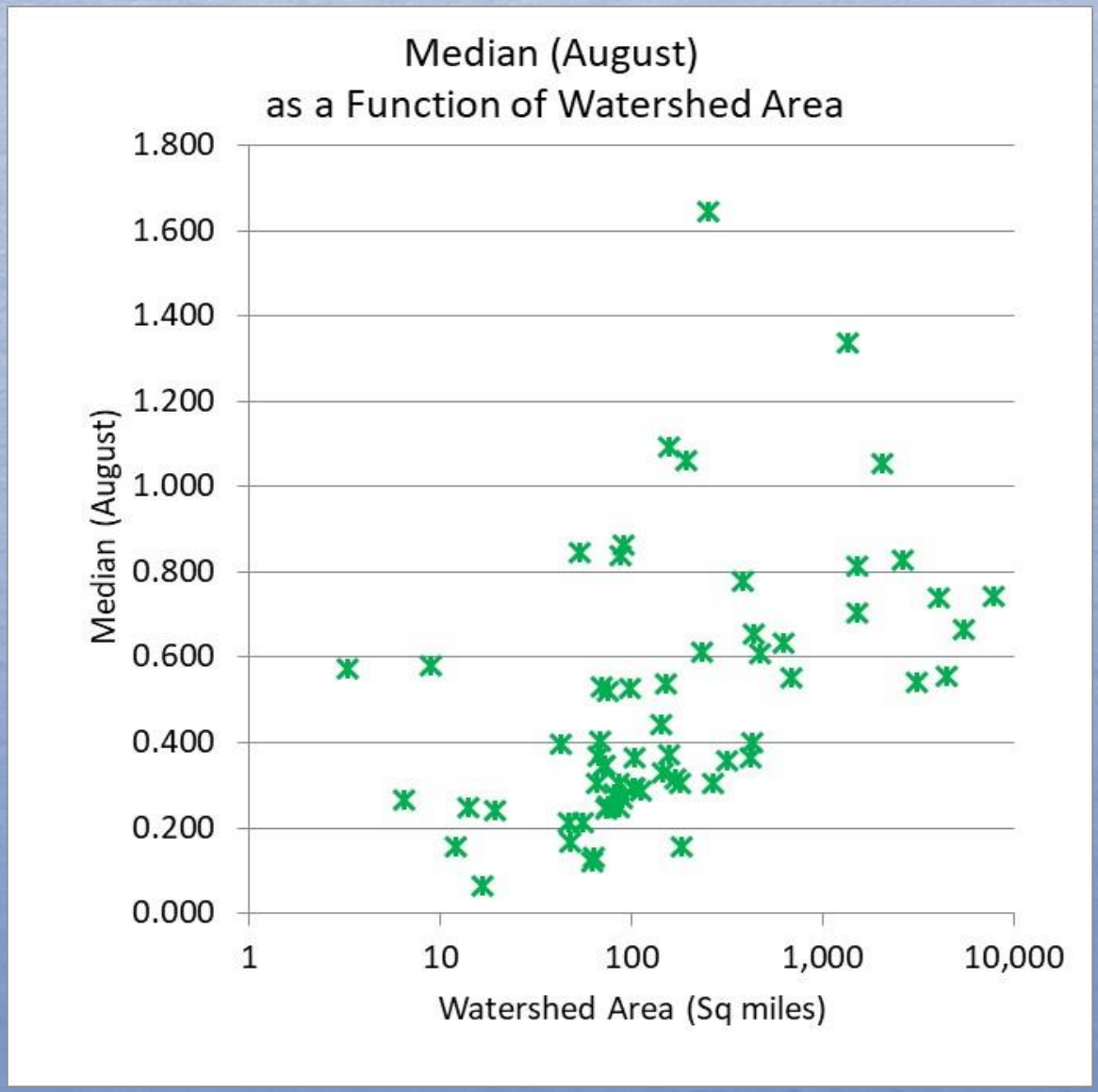


Common Frequency of Events

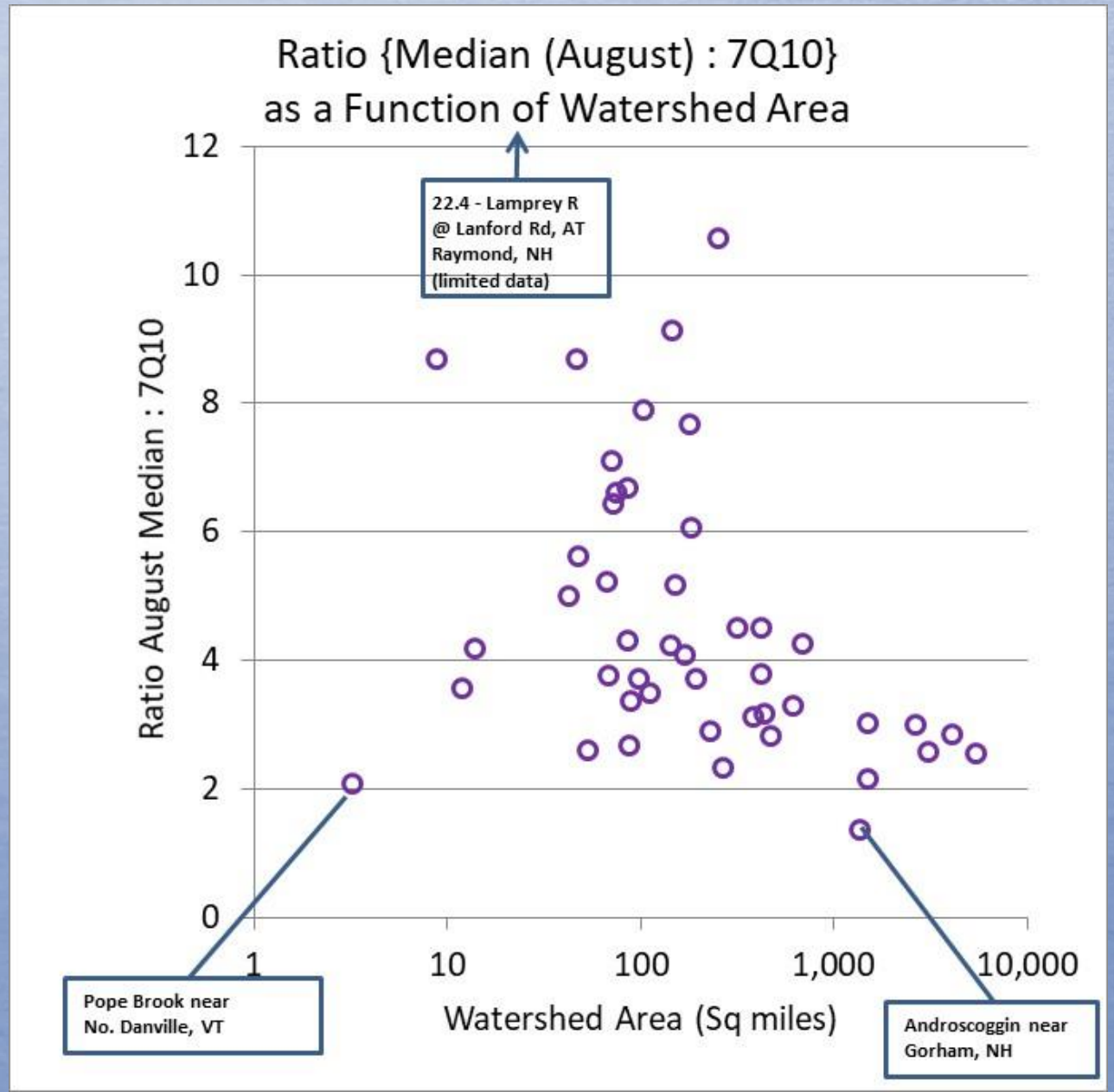
Flow	Percent (days) of year flow is below
7Q10	0.5% (2 days/year)
Aug. Med.	17% (62 days/year)

Is the switch from 7Q10 to August Median simple?





Is the switch from 7Q10 to August Median simple?



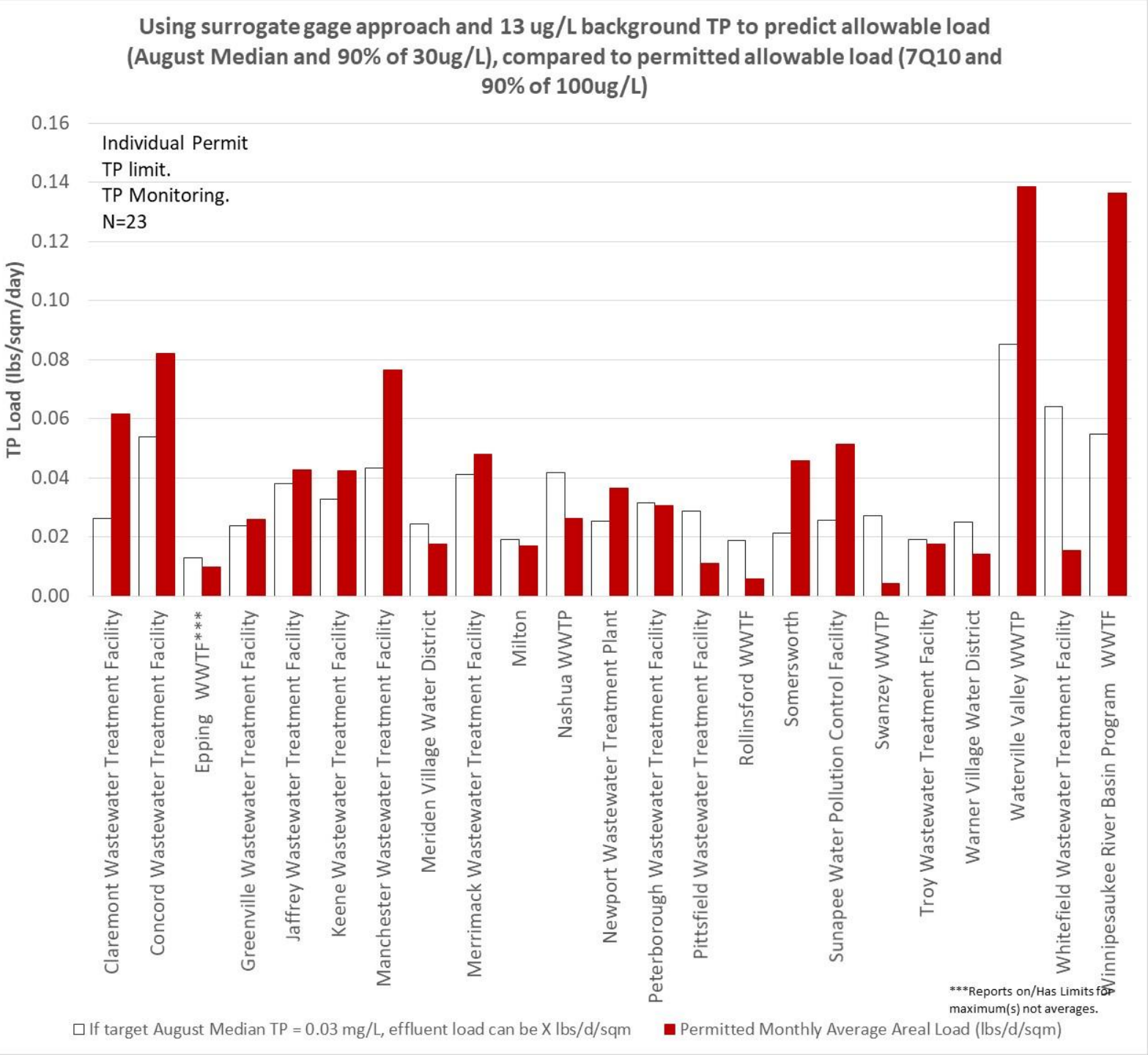
- A simple rule for all waters won't work.
- The river specific ratio of August median to 7Q10 will drive the impact to permit limits.

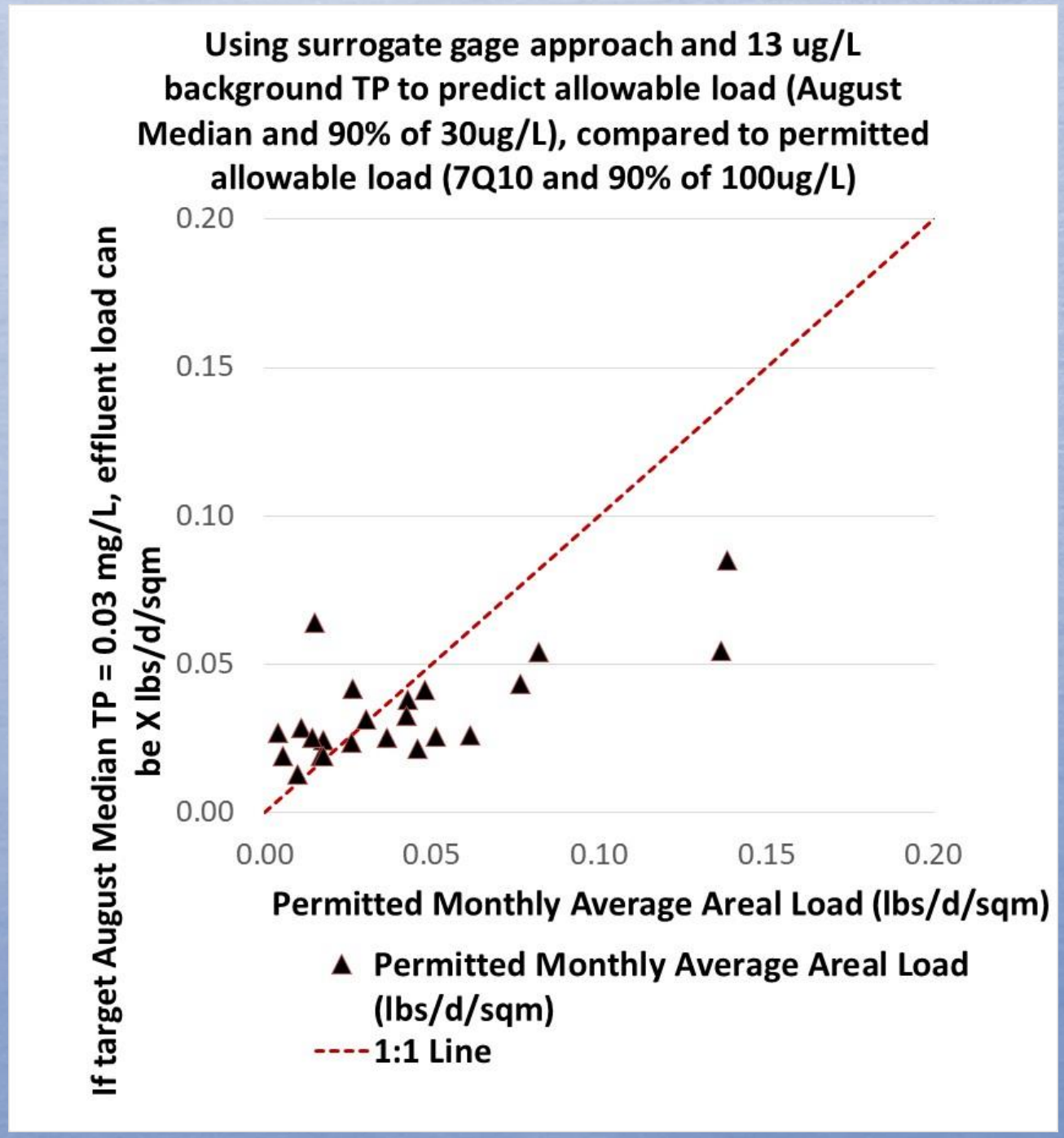
Potential effects of Using Flows Other than 7Q10 for Permitting

- Compare the WWTF areal loads based on different ambient flows and existing permit load limits.

- RED - Permitted Load
- WHITE – Predicted load at August median flow, 13 ug/L background, and 30 ug/L downstream target.

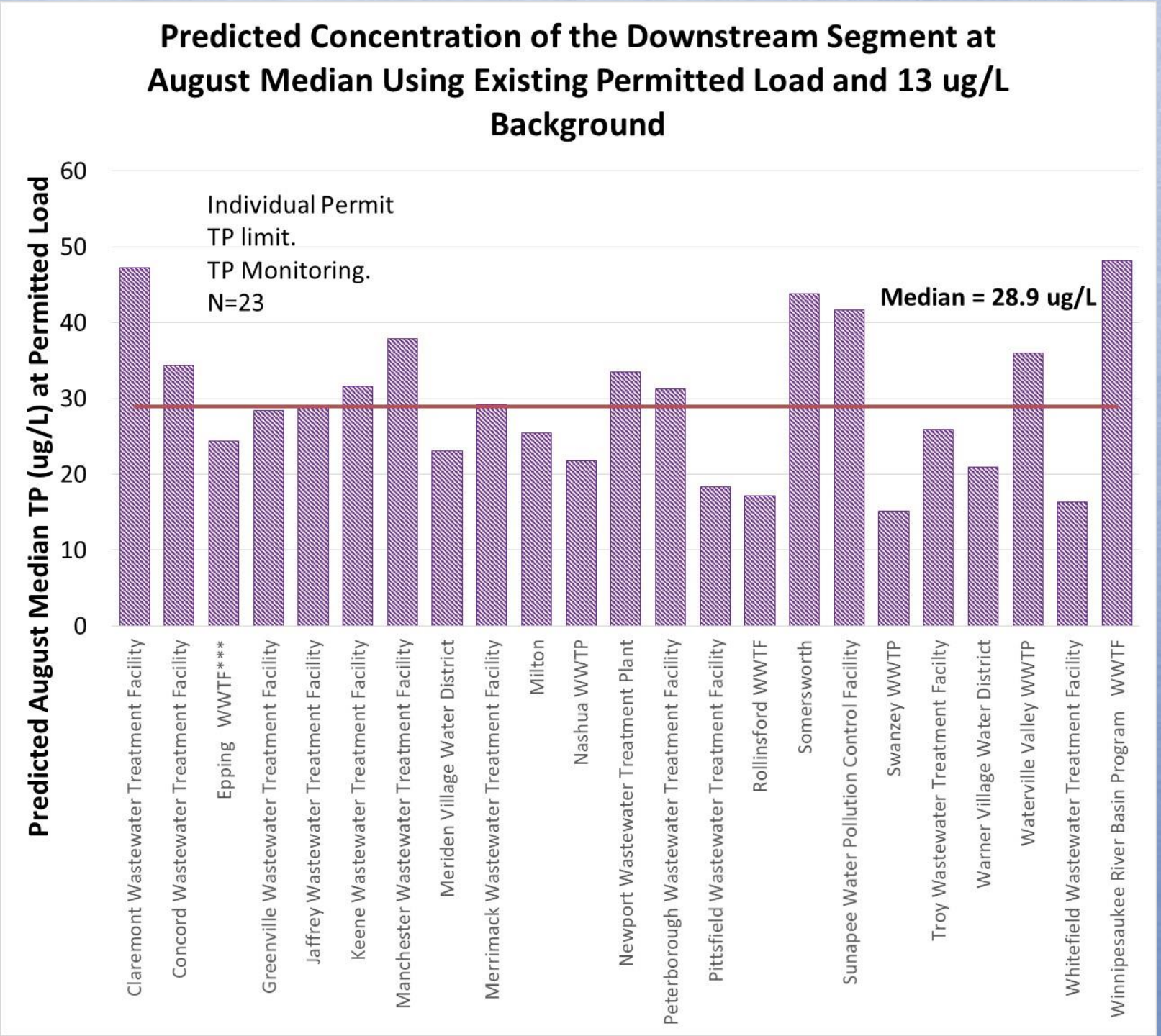
- Overall loads are comparable.





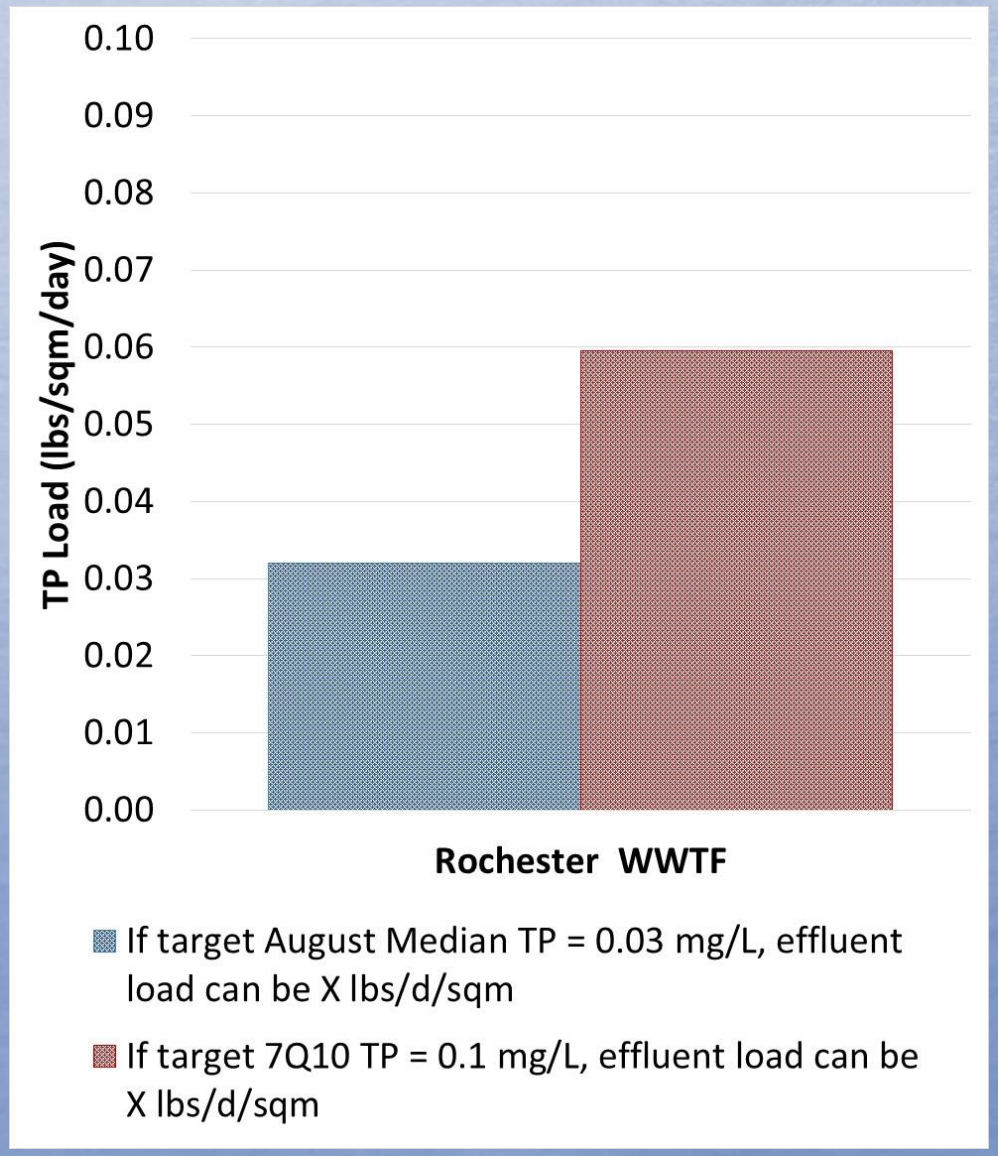
- Overall loads are comparable.
- Some facilities are predicted to have higher allowed loads (which would not be allowed due to anti-backsliding).
- Some facilities are predicted to have lower allowed loads.

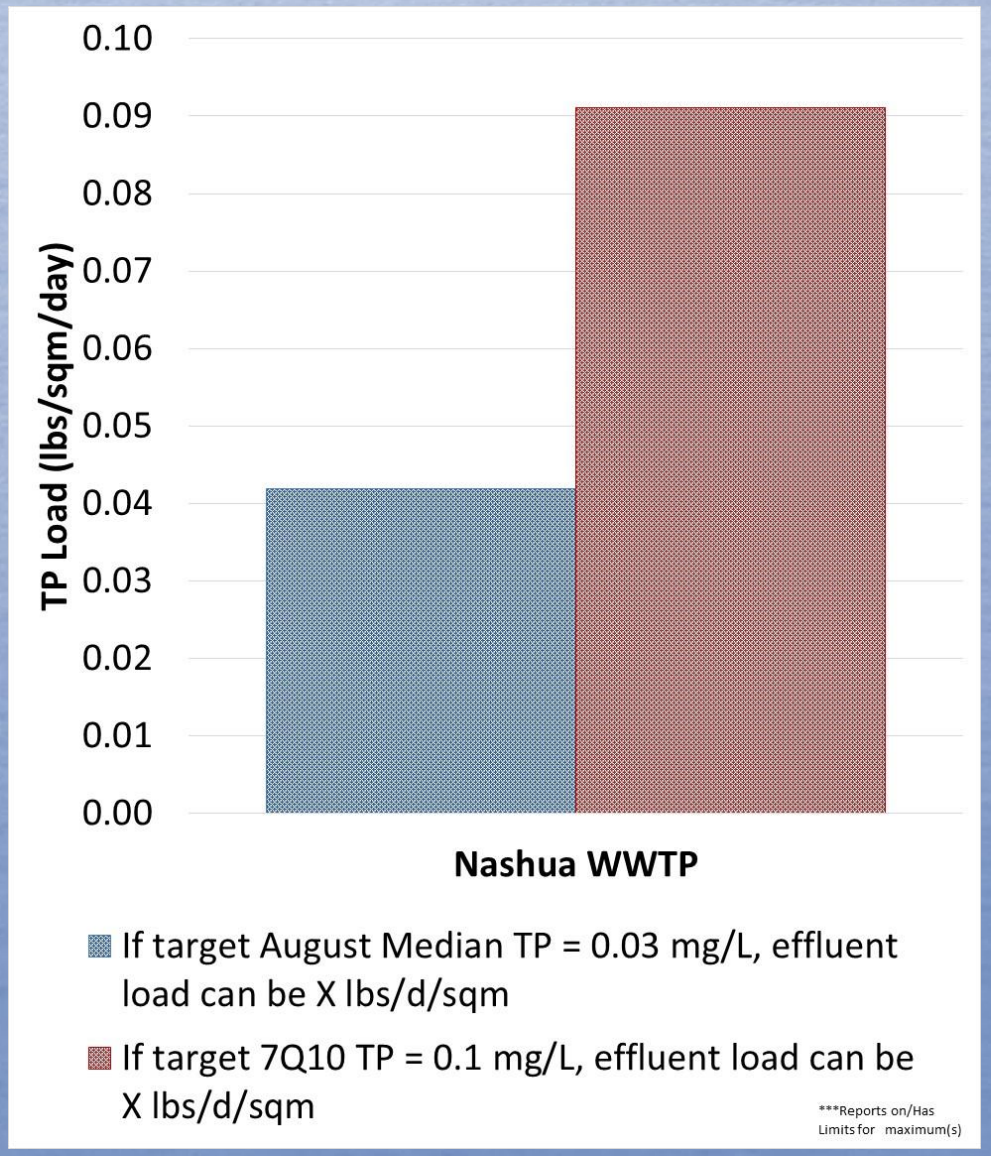
Reverse the logic and see what ambient TP would be at August median flow while holding the permitted loads and a background of 13 ug/L.



- Holding the existing permitted loads corresponds to an ambient August median TP target of around 30 ug/L.

Two comparison locations - August median flow & 30 ug/L (BLUE) verses 7Q10 &100ug/L (RED),13 ug/L background





Summary

- NPDES program is a preventative program; permits must comply with state water quality standards.
- If a change in the methodology to determine TP permit limits in NH resulted in less stringent TP limits for any of the 23 WWTFs that currently have TP permit limits, their current permit limit would not change due to antibacksliding.
- EPA has reported previously that if flows higher than 7Q10 are used, then the instream goal is likely to be lower than 100 ug/L.

Summary (cont.)

- August median flow may be appropriate for NH nutrient permitting because it:
  - Is similar to VT and ME (and other states).
  - Addresses duration concern with the 7Q10:
    - Flow is less than or equal to the August median flow ~ 17% of the year (62 days) and ~ 0.5% (2 days) for the 7Q10 flow. 62 days is sufficient time for a river to respond to nutrients.

Summary (cont.)

- If August median flow is selected, an ambient TP target in the range of ~ 30 ug/L could be appropriate as a screening level for permitting based on:
  - NH ecoregion TP values which range from 10 to 31.25 ug/L.
  - Ambient TP thresholds and criteria used in ME (30 ug/L) and VT (9-27ug/L).
  - Median of all NH samples taken near the August median flow in rivers is ~13 ug/L and ~ 20 ug/L in impoundments.
  - Assuming an August median flow and a background of 13 ug/L, and holding the current TP Permit loads (that are based on 7Q10 and an ambient target of 100 ug/L), the median ambient TP concentration of all WWTFs with TP permit limits, is ~ 30 ug/L.
- Ambient TP Target concentrations used for nutrient permitting are not intended to be numeric nutrient criteria.

Discussion

END