Iowa Department of Natural Resources

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Effluent Data Trends –

Total Nitrogen and Total Phosphorus Data from the Iowa Nutrient Reduction Strategy

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Topics for Today

- Brief overview of the Iowa Nutrient Reduction Strategy (NRS)
- Evaluation of Total Nitrogen (TN) and Total Phosphorus (TP) data gathered under the NRS
- 1992 Nutrient Loading Baseline
- Comparison of TN and TP data with Iowa rainfall averages

Background – Iowa Nutrient Reduction Strategy

- The Iowa Nutrient Reduction Strategy (NRS) is a science- and technology-based approach to assess and reduce nutrients delivered to Iowa waterways and the Gulf of Mexico.
- The strategy outlines efforts to reduce nutrients in surface water from point sources, such as municipal and industrial wastewater treatment plants, and nonpoint sources, including farm fields and urban areas, in a scientific, reasonable and cost-effective manner.
- The Iowa NRS was finalized in May of 2013.

Iowa Nutrient Reduction Strategy Implementation

- The Strategy includes all major municipal wastewater facilities, major industrial facilities, and minor industrial facilities with biological treatment.
  - 106 current major municipal facilities
  - 34 current major industrial facilities
  - 20 minor industrial facilities with biological treatment
  - Total current facilities: 160
- Facility counts have changed slightly each year due to changes in design (municipal) and new information on nutrient discharges (industrial)

Iowa Nutrient Reduction Strategy Implementation

- Requirements in permits issued under the NRS:
  - 2 year feasibility study to document current nutrient discharge levels, establish baselines and evaluate the feasibility and reasonableness of installing nutrient removal.
  - The study needed to include a schedule for construction and implementation of new technology.
  - Reissued permits included 1/week raw and final monitoring for Total Nitrogen and Total Phosphorus.
- Began issuing NPDES permits with requirements from the Iowa NRS in 2013

Permits Issued with Iowa NRS Requirements

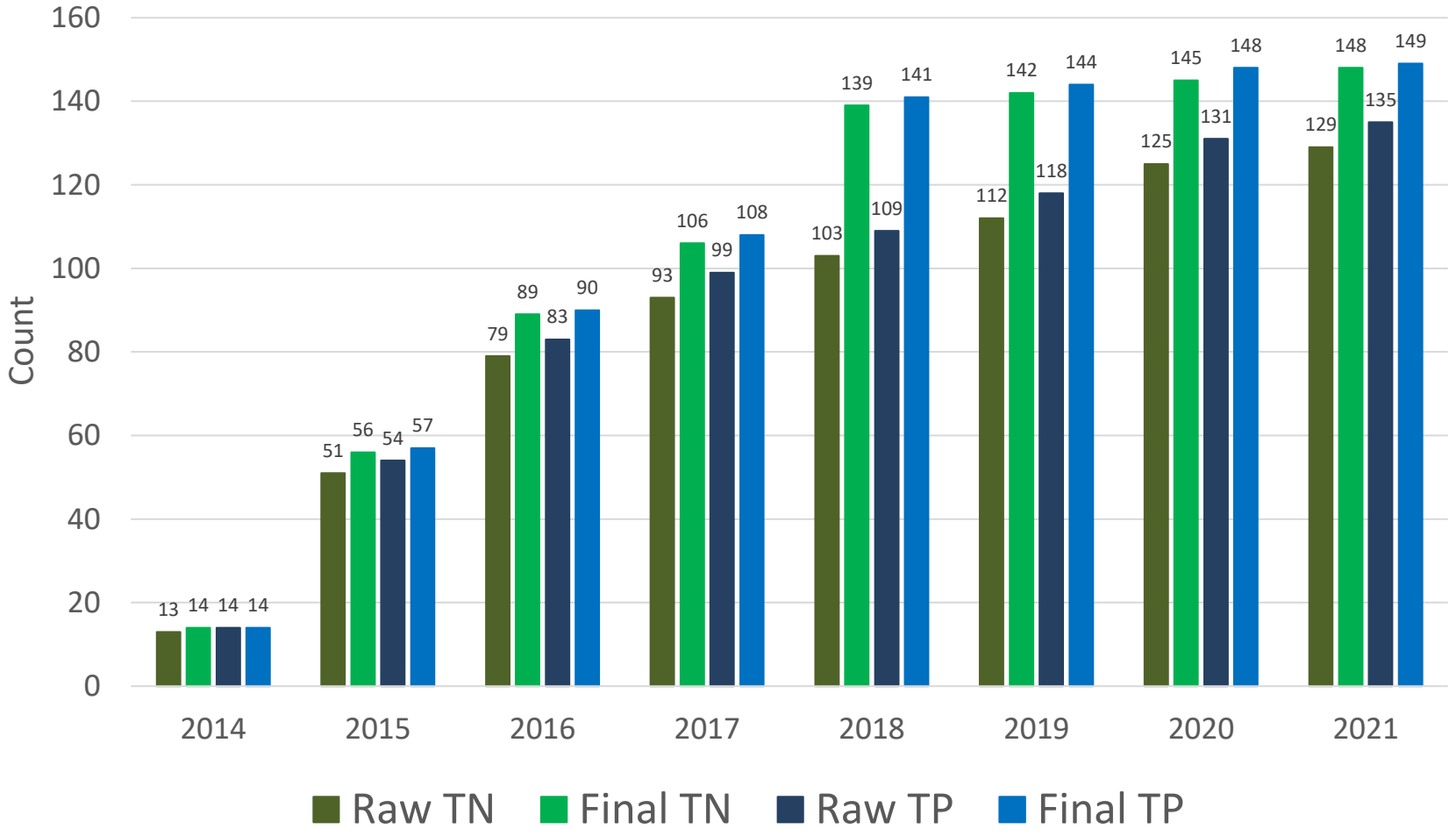
Issued Permits, Feasibility Study, and Construction Amendment Counts											
Metric	Time Period									Total*	Strategy Goal
	June 1 to May 31					Jan 1 to Dec 31					
	2013-14	2014-15	2015-16	2016-17	2017-18	2018	2019	2020	2021		
Permits issued under NRS	21	32	29	24	20	16	12	10	3	157	160
Feasibility Studies Submitted	0	0	19	31	32	26	19	15	12	141	160
Permits Amended with Construction Schedules	0	0	2	13	13	18	9	9	4	61	-

* The Totals reflect the entire period the NRS has been in place. The Totals are cumulative, but because the reporting switched from reporting year (June 1 to May 31) to calendar year (January 1 to December 31) in 2018, the Totals are not an exact sum of the values in each row.

Amount of Nutrient Data

- Since 2014, the number of NRS facilities with raw and final TN and TP data has increased each year
- Facilities with 10 months or more of data are included in each annual report
- In 2018, we established a nutrient loading baseline, and we began including load estimates in the yearly reporting

Count of Facilities with Total Nitrogen and Total Phosphorus Data Each Year



TN and TP Data Evaluation

- For each facility in the nutrient strategy, we evaluate the TN and TP data for each year and determine:
  - the average raw and final daily concentration and mass
  - the average raw and final yearly mass (the total influent and effluent mass/load)
  - The concentration and mass percent removal
  - The average mass removed during a year
- We also count how many final effluent samples are higher than the raw waste samples

TN and TP Data Variation

- We noticed that the nitrogen and phosphorus data could vary significantly from year to year
- The coefficient of variation of the total mass removed was calculated the for facilities with two or more years of data

CV Status	CV	Count of Facilities with 2 or more years of data			
		TN	CV %	TP	CV %
Very Good	1% - 9%	15	11%	7	5%
Good	10% - 19%	37	28%	26	19%
OK	20% - 29%	29	22%	37	28%
Somewhat High	30% - 49%	29	22%	36	27%
High	51% - 99%	14	11%	23	17%
Very High	100% - 199%	5	4%	3	2%
Extremely High	> 199%	3	2%	2	1%
	Total Count	**132**		**134**	
	Percent of High CVs		**39%**		**48%**

Data Variation - Example

Total Nitrogen Data – Grinnell
Trickling Filter (2014-2018), Oxidation Ditch (2019 on)

Year	TN Raw Waste Data			TN Final Effluent Data			Nitrogen % removal		Average lbs of N removed
	conc (mg/l)	mass (lbs/day)		conc (mg/l)	mass (lbs/day)				
	Avg mg/l	Avg lbs/d	Avg raw lbs one year	Avg mg/l	Avg lbs/d	Avg lbs disch one year	Avg conc mg/l	Avg mass lbs/d	lbs removed 1 yr (avg raw-avg final)
2014	16.9	239.7	87,482	12.5	183.1	66,819	26.3%	23.6%	20,663
2015	13.8	231.9	84,645	10.0	172.3	62,887	27.8%	25.7%	21,757
2016	14.1	203.3	74,195	11.1	156.2	57,018	21.7%	23.2%	17,177
2017	13.9	140.9	51,418	12.1	123.3	45,000	12.6%	12.5%	6,418
2018	16.7	204.6	74,695	12.8	161.0	58,777	23.3%	21.3%	15,918
2019	14.1	228.4	83,361	9.9	163.9	59,818	30.0%	28.2%	23,543
2020	17.0	229.5	83,762	5.2	80.0	29,201	69.5%	65.1%	54,560
2021	26.1	320.3	116,905	5.6	68.0	24,822	78.5%	78.8%	92,083
								std dev	26,350
								CV	83.6%

What Causes the Variations?

- Changes in treatment type and operation can lead to variations in effluent data
- Reporting errors could also lead to variations, but we check the data for high and low outliers, and we fix or redact outliers as necessary
- Rainfall could also lead to variations in the data
- We don’t have definitive reasons yet

1992 Nutrient Load Baseline

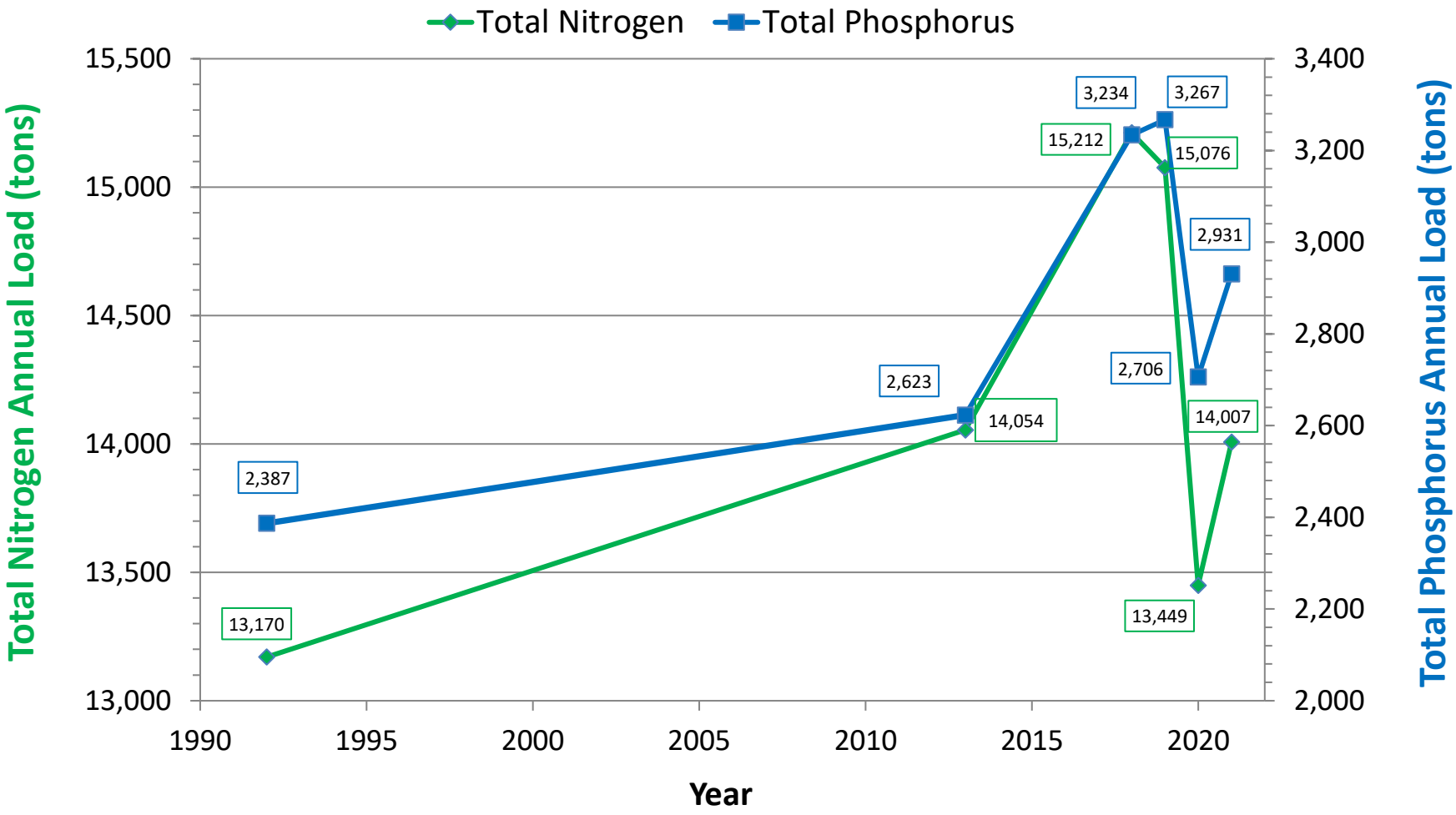
- In 2018, the Iowa Legislature required that the baseline nutrient condition be calculated to evaluate the progress towards the goals of the NRS
- 1992 annual TN and TP loads were estimated for Iowa's major municipal POTWs, minor domestic wastewater dischargers and industrial dischargers that provide biological treatment of process wastewater
- Where TN and TP effluent concentrations were not available, concentrations were estimated using a hierarchy of typical pollutant concentrations (TPCs)
- Nutrient loads were then estimated using the effluent flows from 1992 and the TPCs

Tracking Point Source Nutrient Loads

- In order to evaluate our progress in meeting the point source load reduction goals, we also estimated the total nutrient point source loads for 2013
- The total loads for 2013 were estimated with the same process used to develop the 1992 baseline
- To derive the total point source loads for 2018 and later years, we used
  - actual nutrient loading data from the NRS facilities,
  - estimates for the NRS facilities not yet sampling, and
  - estimates for minor domestic dischargers

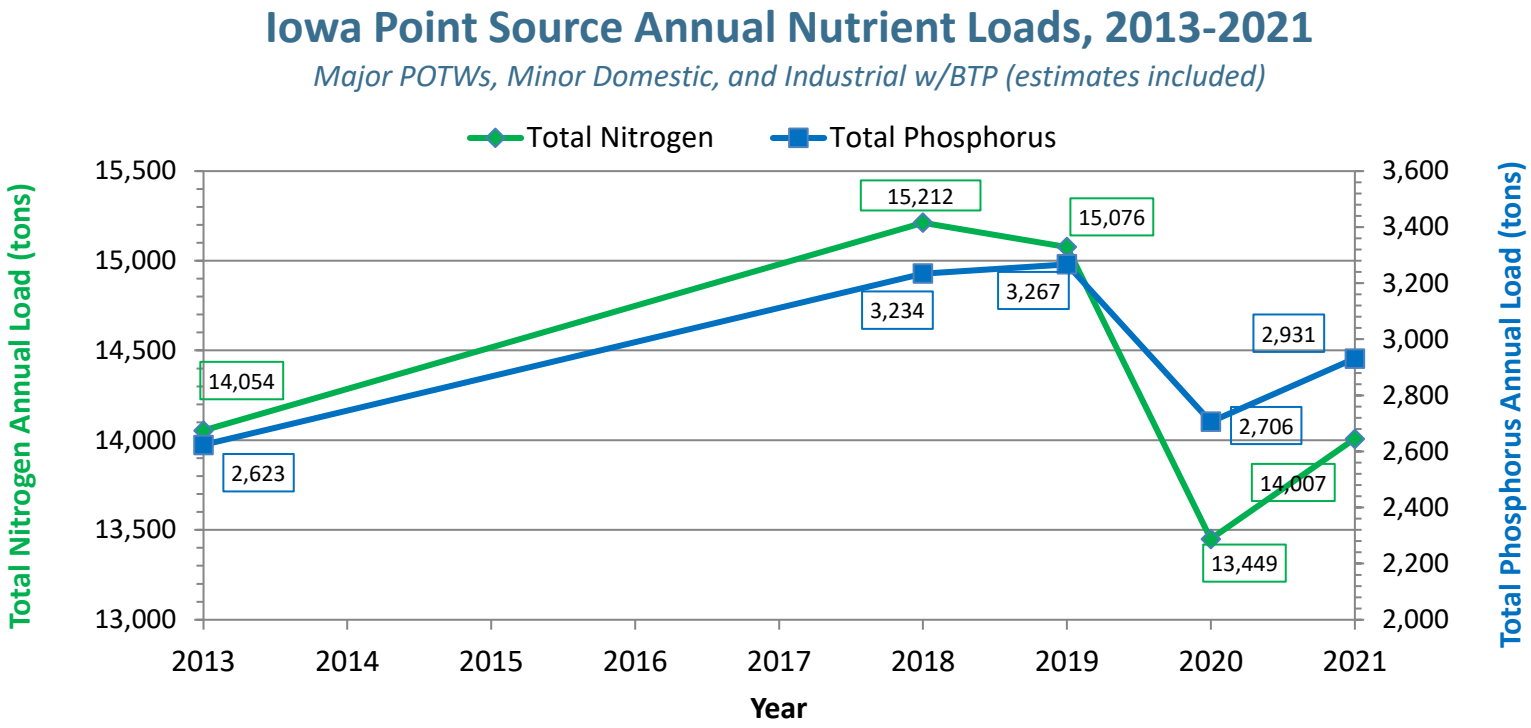
Iowa Point Source Annual Nutrient Loads

Major POTWs, Minor Domestic, and Industrial w/BTP (estimates included)



What Happened Between 2019 and 2020?

- Below is a closer look at the loadings from 2013 and 2018 to 2021
- The TN load dropped by 11% between 2019 and 2020, and the TP load dropped by 17%
- The loading increased again in 2021, but this drop is surprising



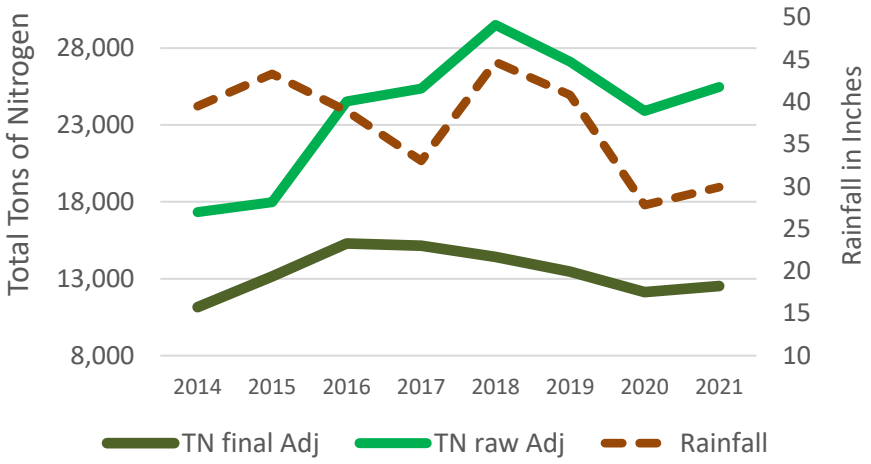
Rainfall Comparison

- In order to get a better understanding of the loading change between 2019 and 2020, we compared the loading data from the NRS facilities to the annual average rainfall in Iowa
- In order to compare the loading data over time, we had to adjust to total TN and TP loads by the number of NRS facilities with data each year
- The rainfall-loading comparison is ONLY for those facilities covered by the NRS; major municipal facilities, major industrial facilities, and minor industrial facilities with biological treatment
- Minor facilities are NOT included in the rainfall comparison

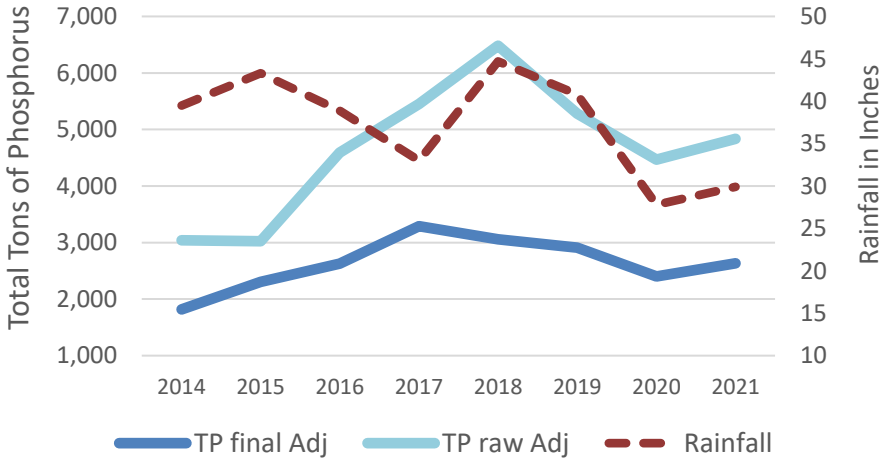
Rainfall Comparison Charts

- Beginning in 2017, the adjusted raw loading data corresponds well with Iowa's annual average rainfall totals
- Data from the two largest facilities in Iowa were added in 2016 (Des Moines) and in2017 (Cedar Rapids)

Rainfall, TN Raw & Final Load Discharged in Tons Adjusted by # of Facilities, 2014-2021



Rainfall, TP Raw & Final Load Discharged in Tons Adjusted by # of Facilities, 2014-2021



Conclusions

- **Good News:** Most of the facilities in the Iowa NRS are now submitting both raw and final TN and TP data, so we are beginning to have a robust dataset
- **Tentative Observation:** It appears that the total nitrogen and total phosphorus loads coming into wastewater treatment plants in Iowa are strongly influenced by rainfall
- **Data Questions:** More years of data are needed to confirm the influence of rainfall, and more investigation is needed to determine if the variations in TN and TP raw and final data are normal

Questions and DIscussion

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