



Center for Comprehensive, optimal and Effective Abatement of Nutrients (CLEAN)



- *Implementation of Basin-Wide
Water Quality Solutions*

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Civil and Environmental Engineering
Colorado State University*

Feb 28, 2020



OUTLINE

1

Nutrient Levels Along the Poudre River

2

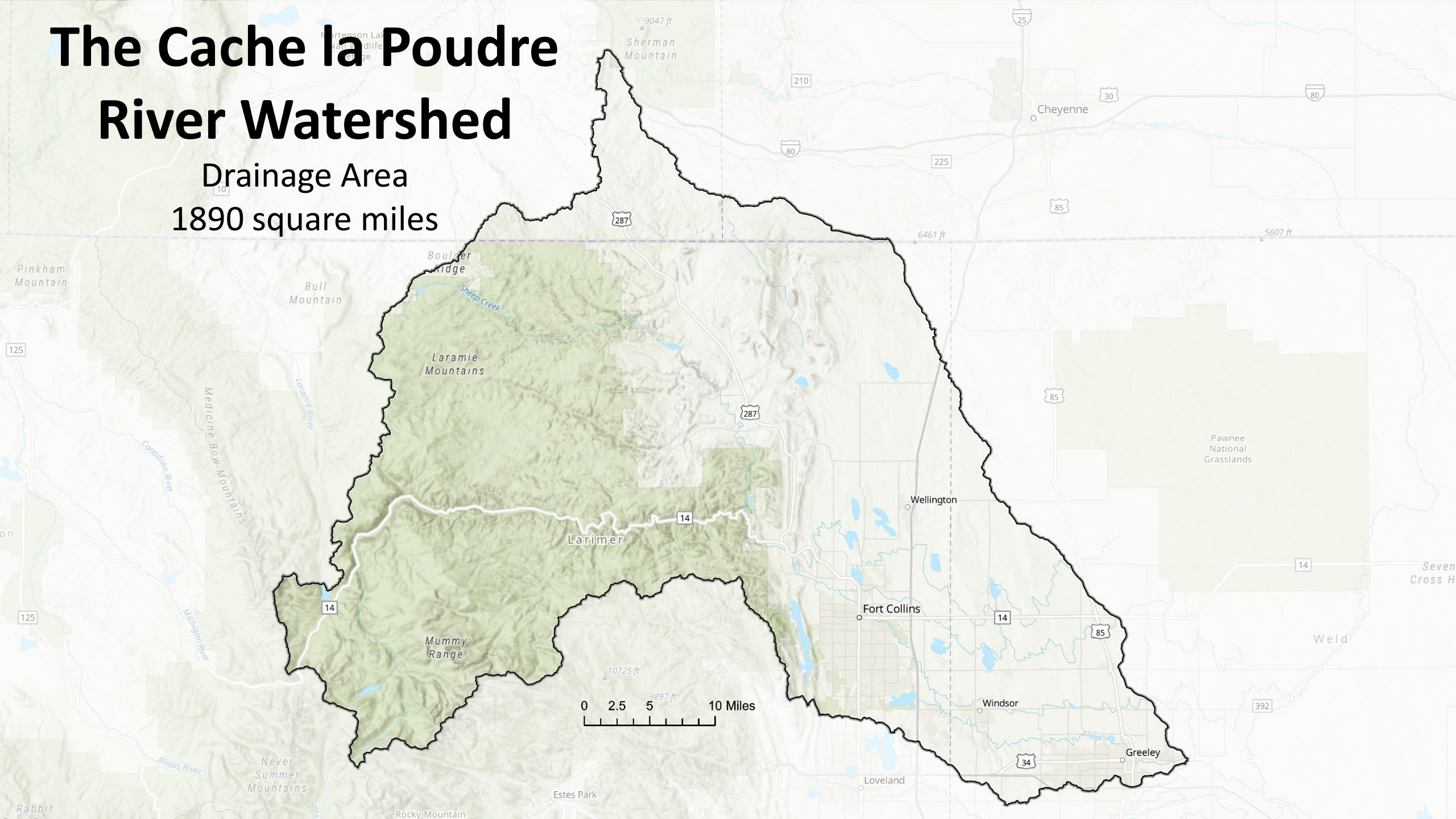
Basin-Wide Water Quality Assessments

3

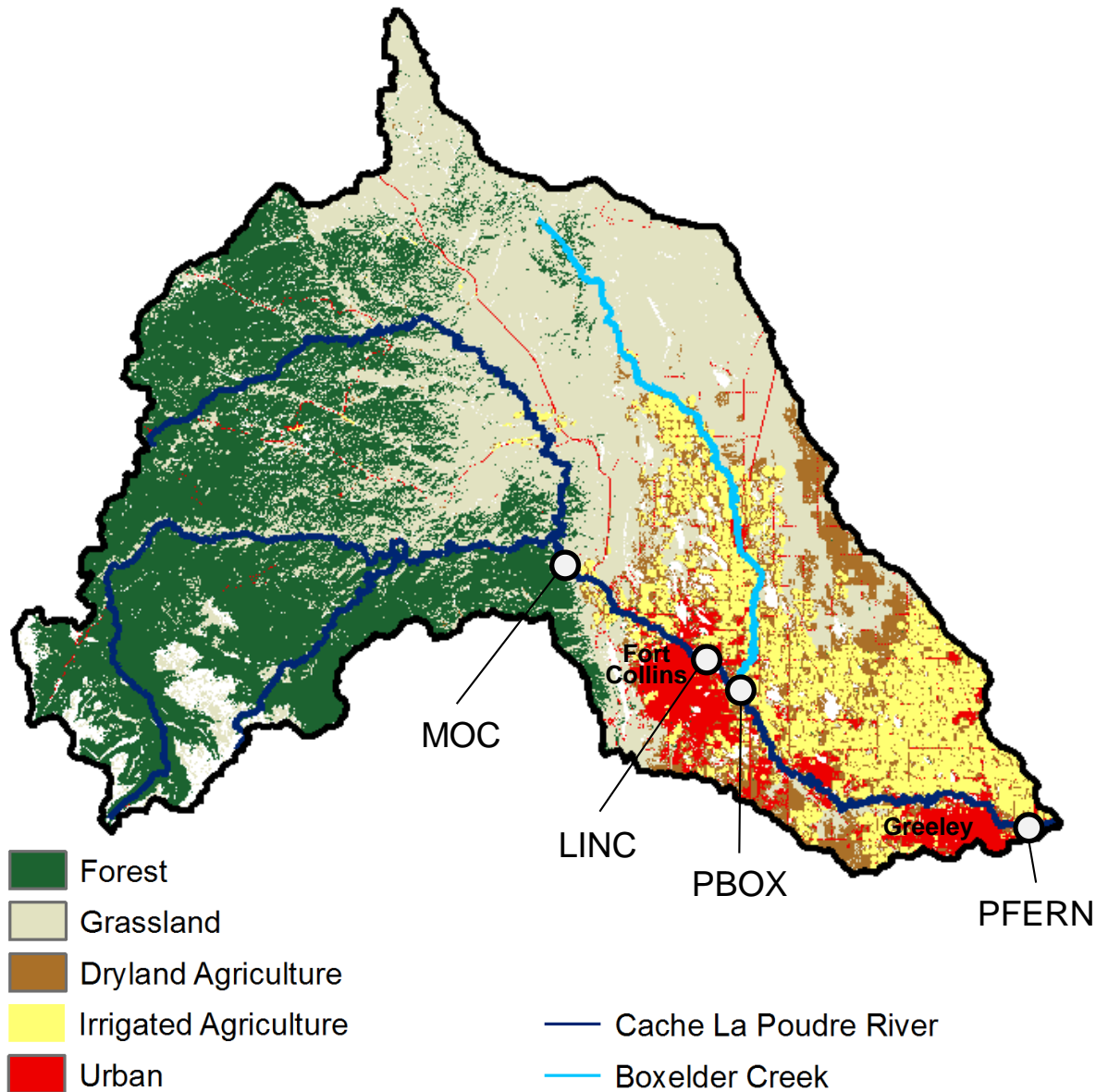
Nutrient Control Tradeoffs and Solutions

The Cache la Poudre River Watershed

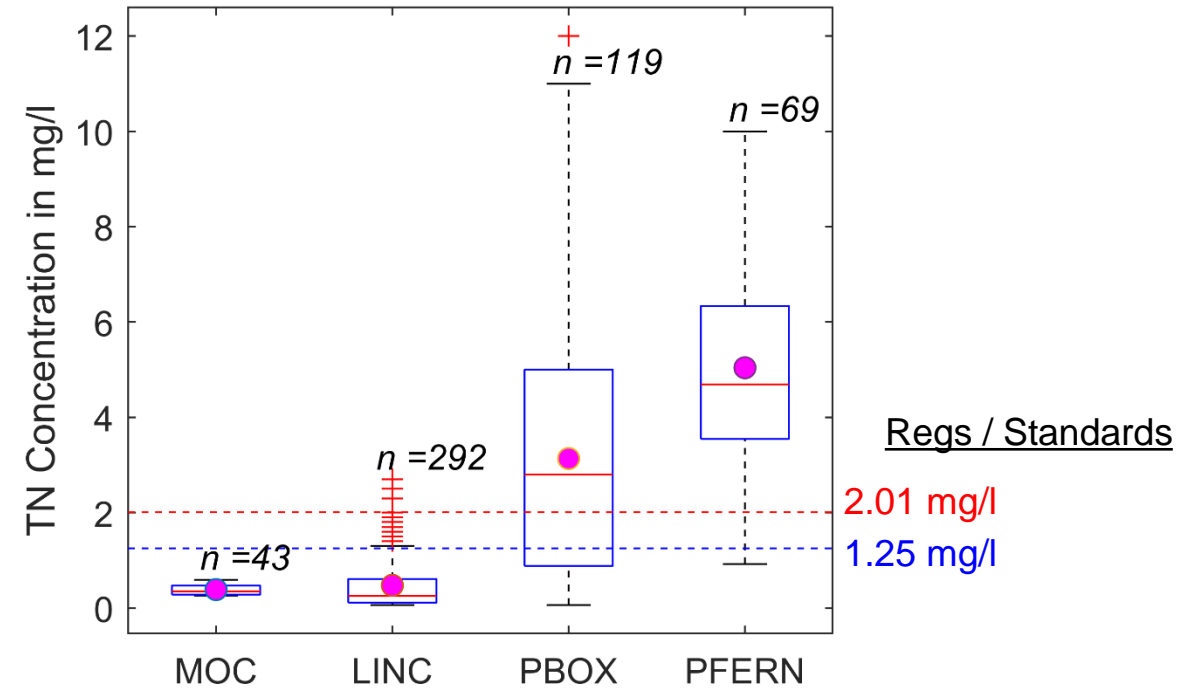
Drainage Area
1890 square miles



How do nutrient levels change along the CLP River?

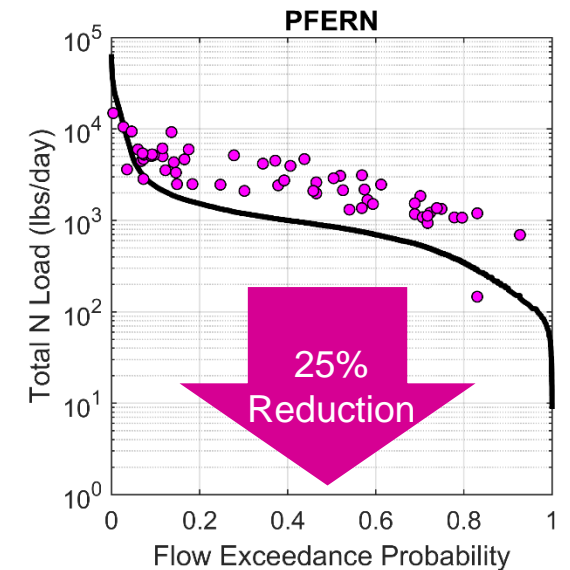
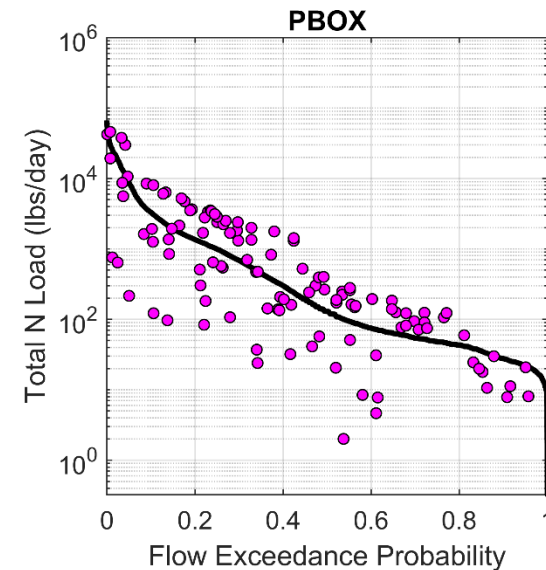
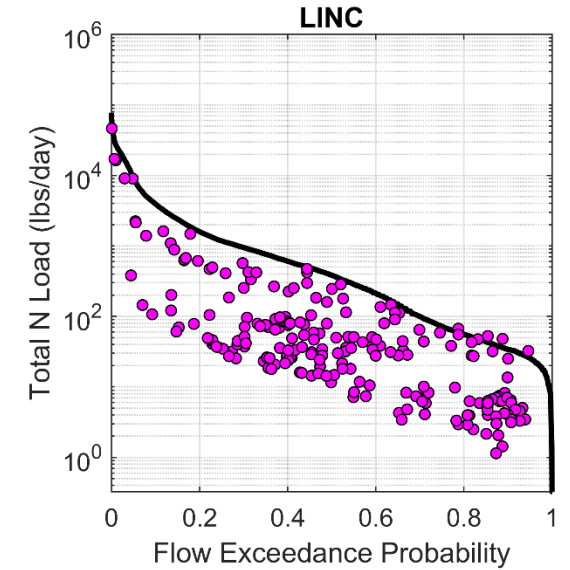
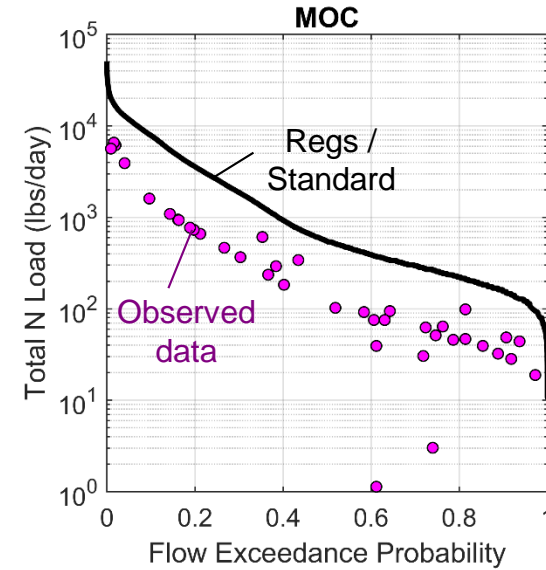
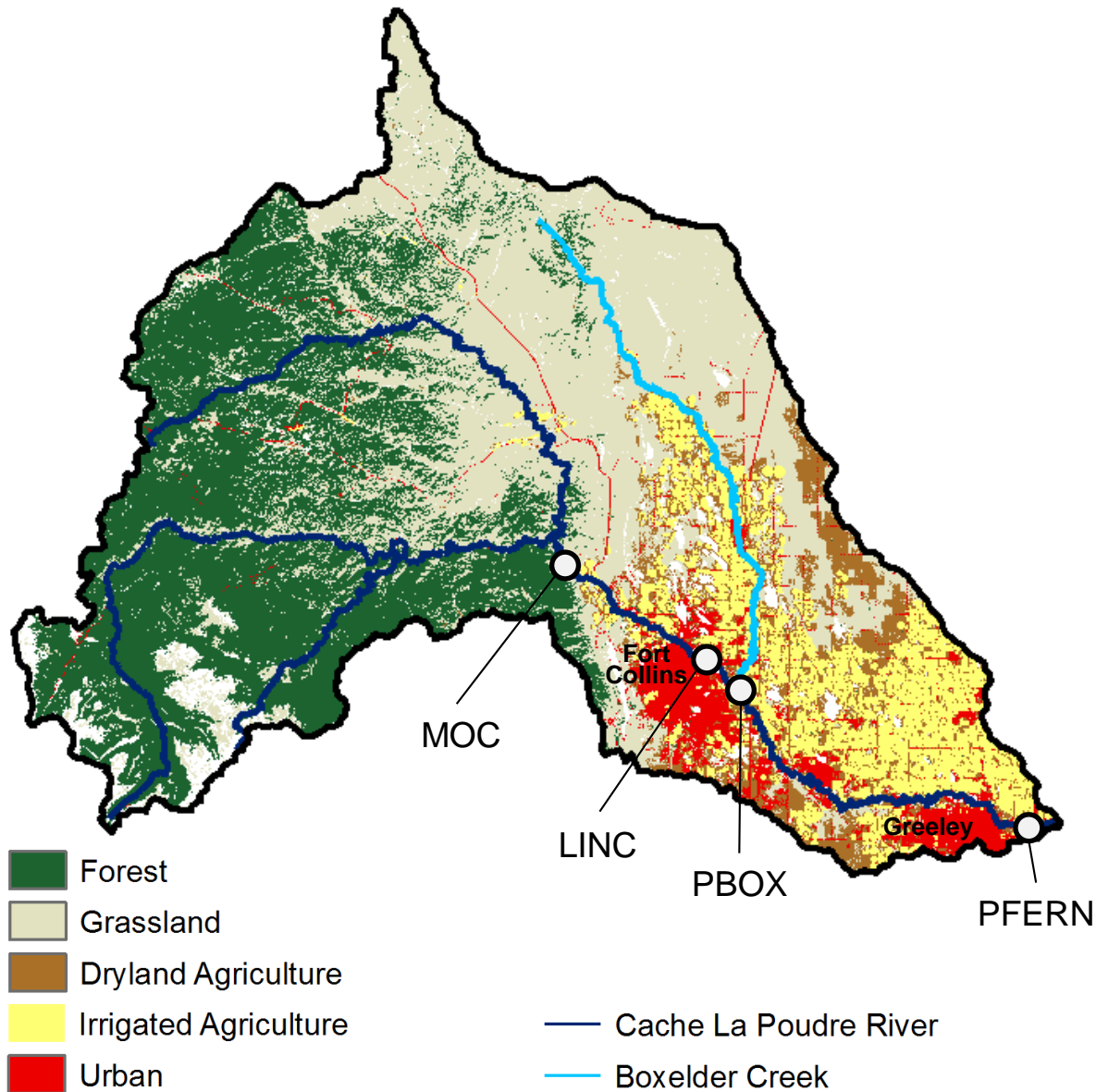


Nutrient levels along the
Cache la Poudre River



Data Courtesy of the Lower
Cache la Poudre Water
Quality Monitoring Program
(2007 – 2015)

How do nutrient levels change with river flows?



A Basin-Wide Approach to Nutrient Control

The Physical System

- Urban Wastewater
- Urban Stormwater
- Agricultural practices
- Fluvial Systems/Riparian Zones

People & Policy

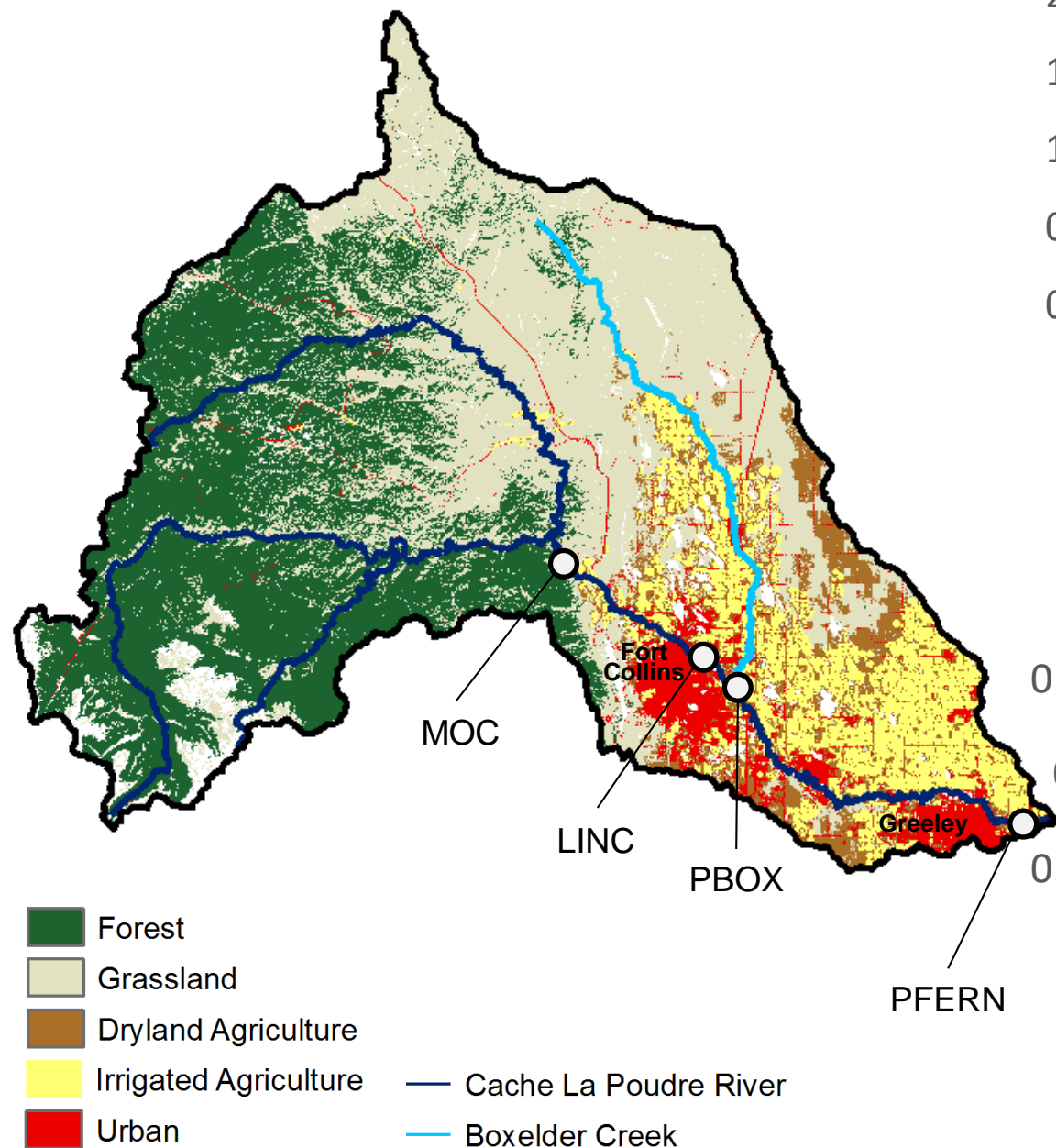
- Regulations and Institutions
- Incentives
- Trading

Assessment & Decision Making

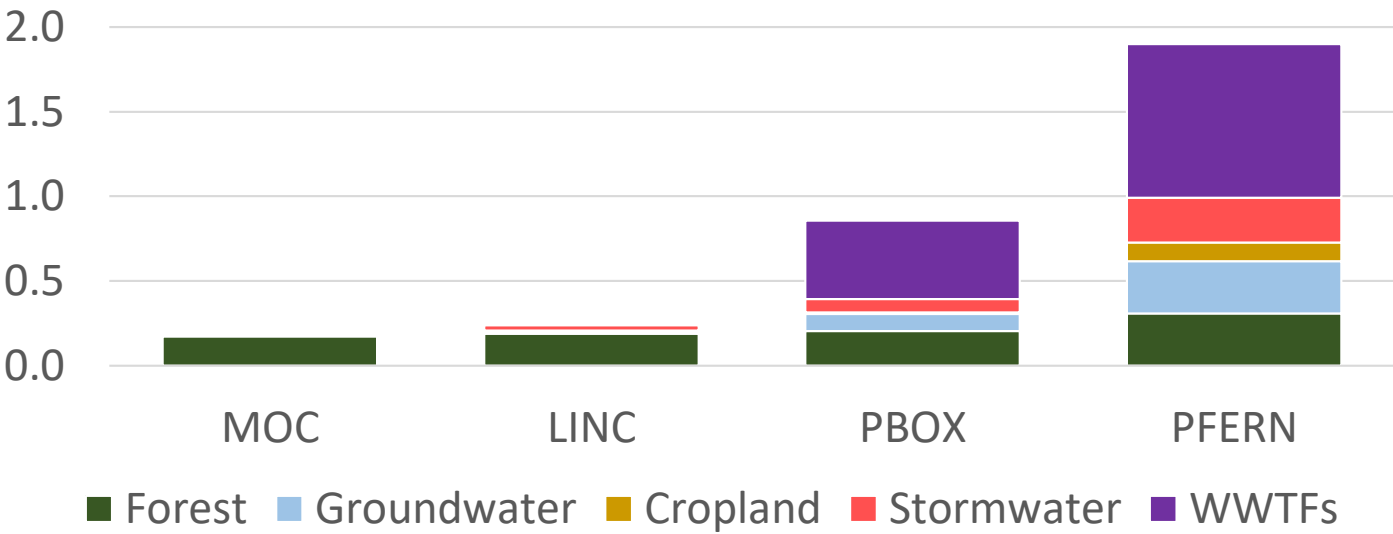
- Sources
- Indicators and Metrics
- Tradeoffs



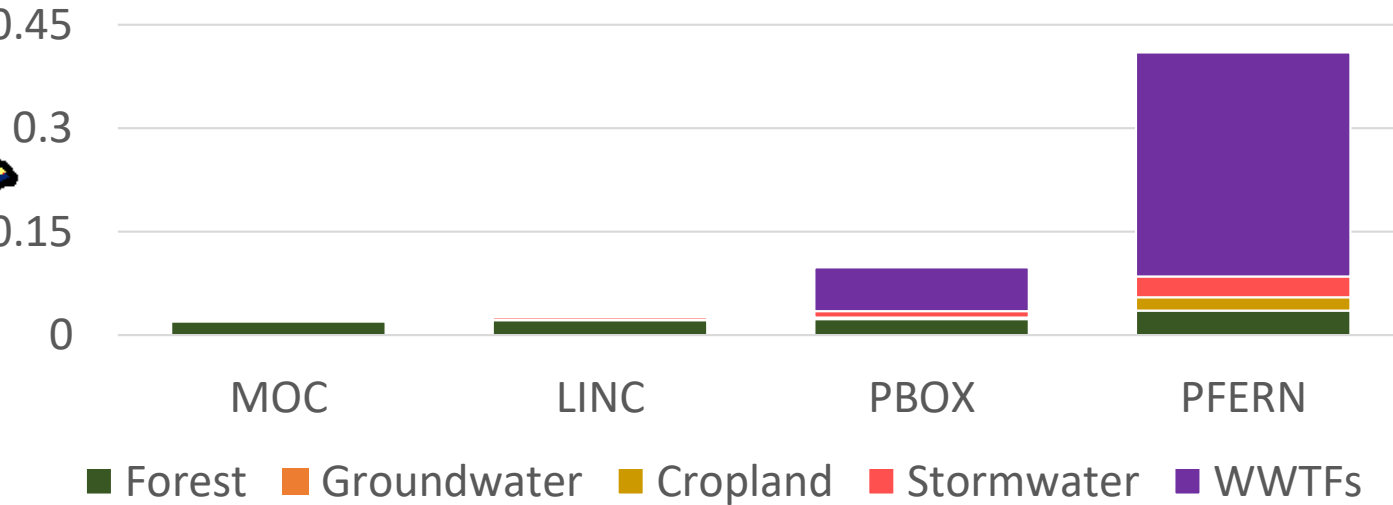
Nutrient Sources



Total nitrogen in million pounds per year



Total phosphorus in million pounds per year



Nutrient Control Technologies

Urban Wastewater

5 Stage Bardenpho; A2/O; MLE; Ammonia Stripping; CaRRB; Nitrite Shunt; PAD; Struvite Precipitation

Urban Stormwater

Bioretention; Permeable Pavements

Agricultural Conservation Practices

Tillage and residue management; Nutrient management; Irrigation water management (e.g., flood to sprinkler systems)

Fluvial Systems/Riparian Zones

Stream restoration



Assessment Metrics for Nutrient Control

System-Level Least-Cost and
Equitable Solutions



Metrics for Integration at The System Level

Total Performance Assessment



Maximized
Reliability &
Resilience

Maximized
Equity

Maximized
Likelihood
of Adoption

Minimized
Total Cost

Minimized
Nutrient
Pollution

Nutrient Control Tradeoffs

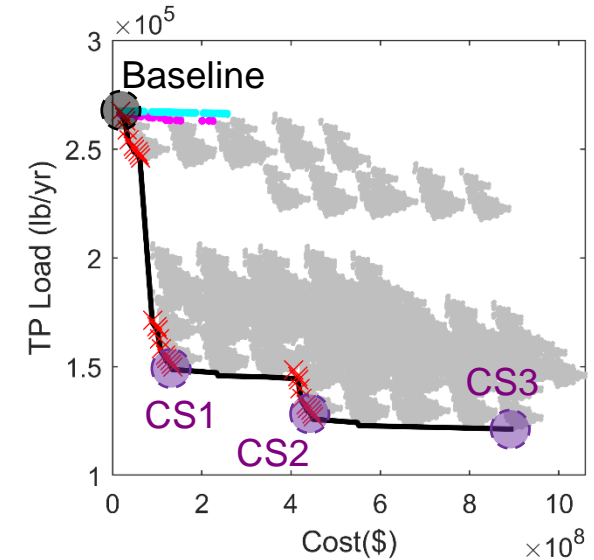
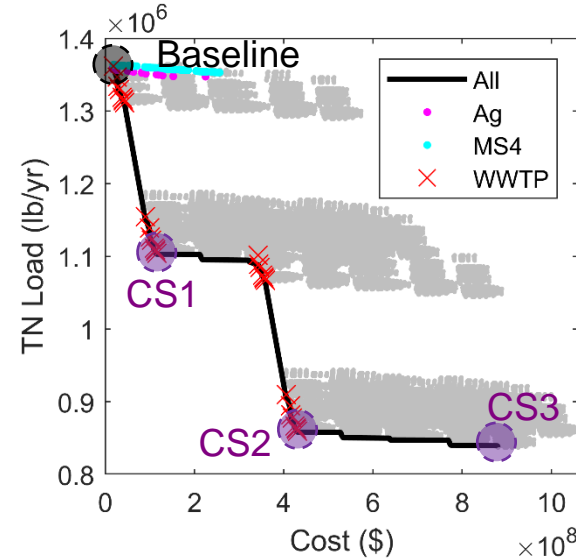
Corner Solution 1 (CS 1)

Estimated reductions: 13% TN, 38% TP

MLE with Nitrite Shunt and Struvite

Precipitation @ 3 WWTFs

No-till agricultural conservation practice



Corner Solution 2 (CS 2)

Estimated reductions: 24% TN, 45% TP

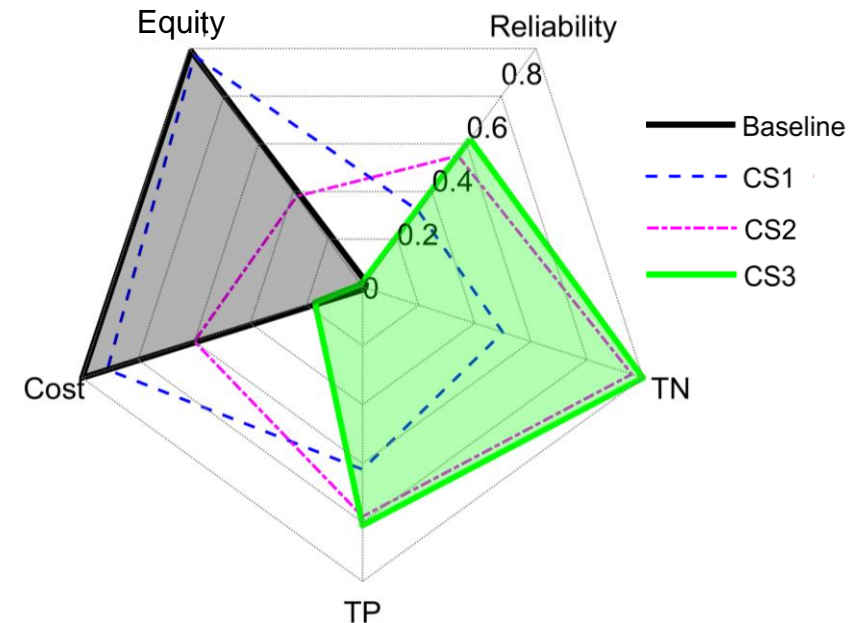
+ 5 stage Bardenpho in an additional WWTF

Corner Solution 3 (CS 3)

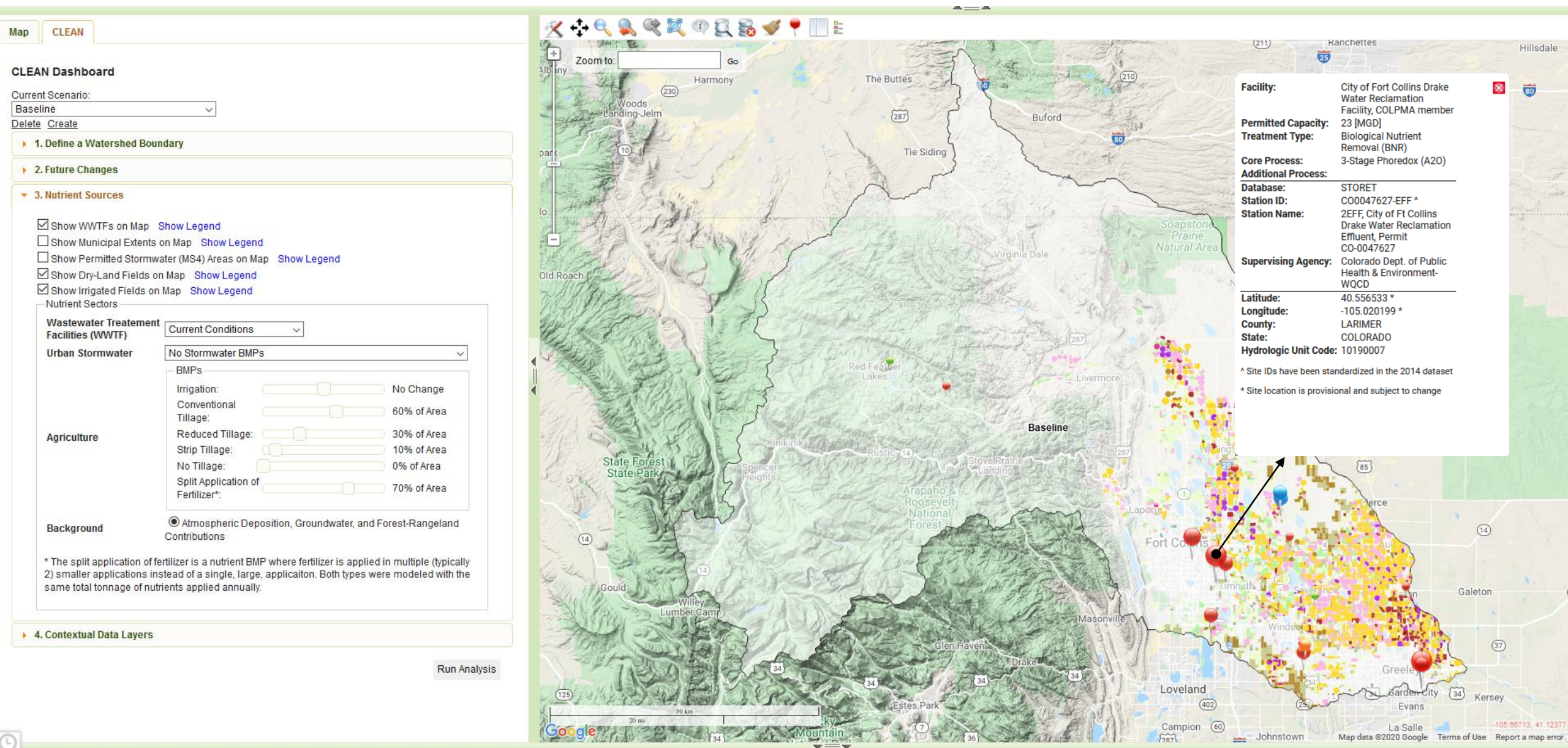
Estimated reductions: 26% TN, 47% TP

+ Center pivot irrigation in cropland;

Bioretention for stormwater control



CLEAN Water Quality Control Dashboard



CLEAN Water Quality Control Dashboard

Nutrient Sectors

Wastewater Treatment Facilities (WWTF) User Specified Reduction

Urban Stormwater Current Conditions

BMPs

Irrigation: 25% More Sprinkler/Drip Irrigation*

Conventional Tillage: 10% of Area

Reduced Tillage: 30% of Area

Strip Tillage: 10% of Area

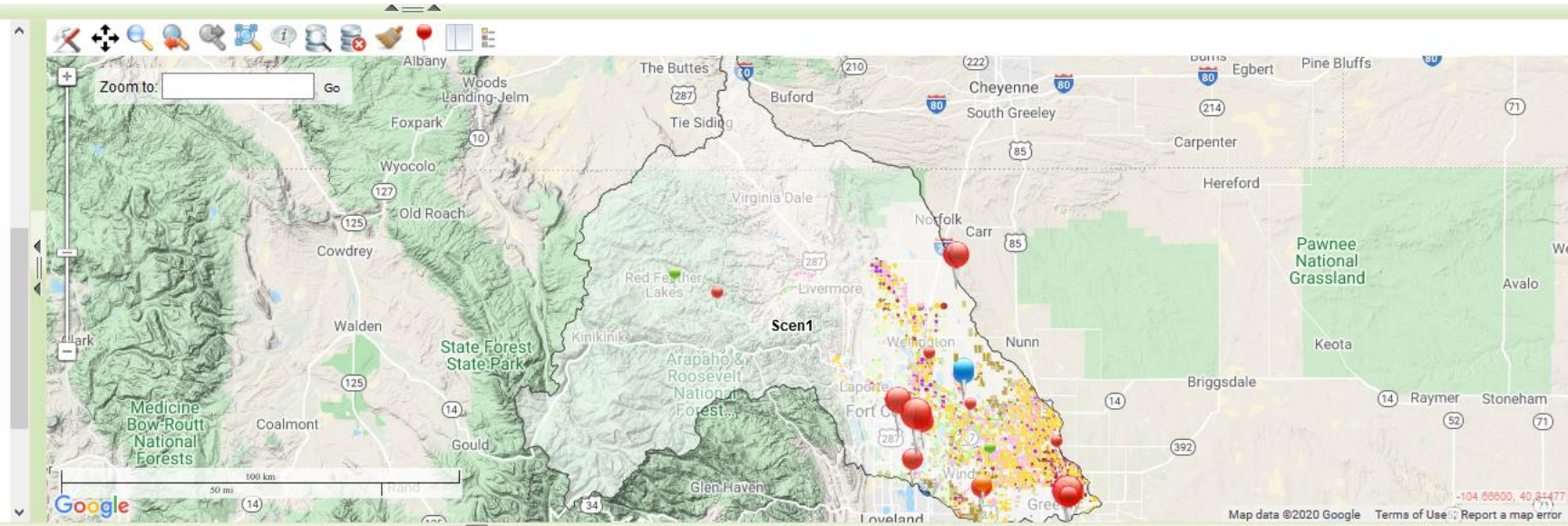
No Tillage: 50% of Area

Split Application of Fertilizer*: 70% of Area

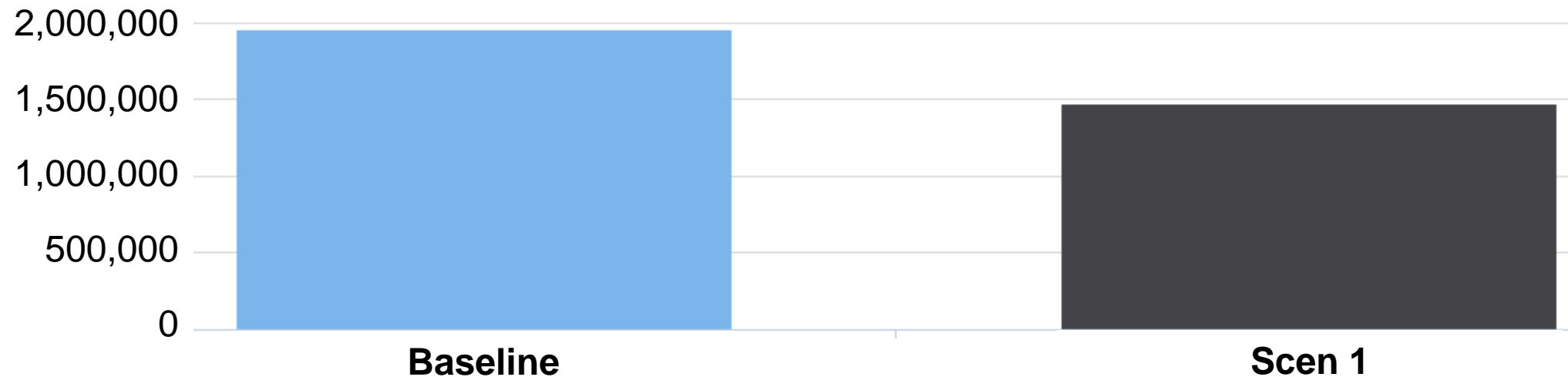
Agriculture

Background ☒ Atmospheric Deposition, Groundwater, and Forest-Rangeland Contributions

* The split application of fertilizer is a nutrient BMP where fertilizer is applied in multiple (typically 2) smaller applications instead of a single, large, application. Both types were modeled with the same total tonnage of nutrients applied annually.



Total N in lb/yr



CLEAN Water Quality Control Dashboard

Nutrient Sectors

Wastewater Treatment Facilities (WWTF)

User Specified Reduction

Edit Reduction(s)

Urban Stormwater

Current Conditions

BMPs

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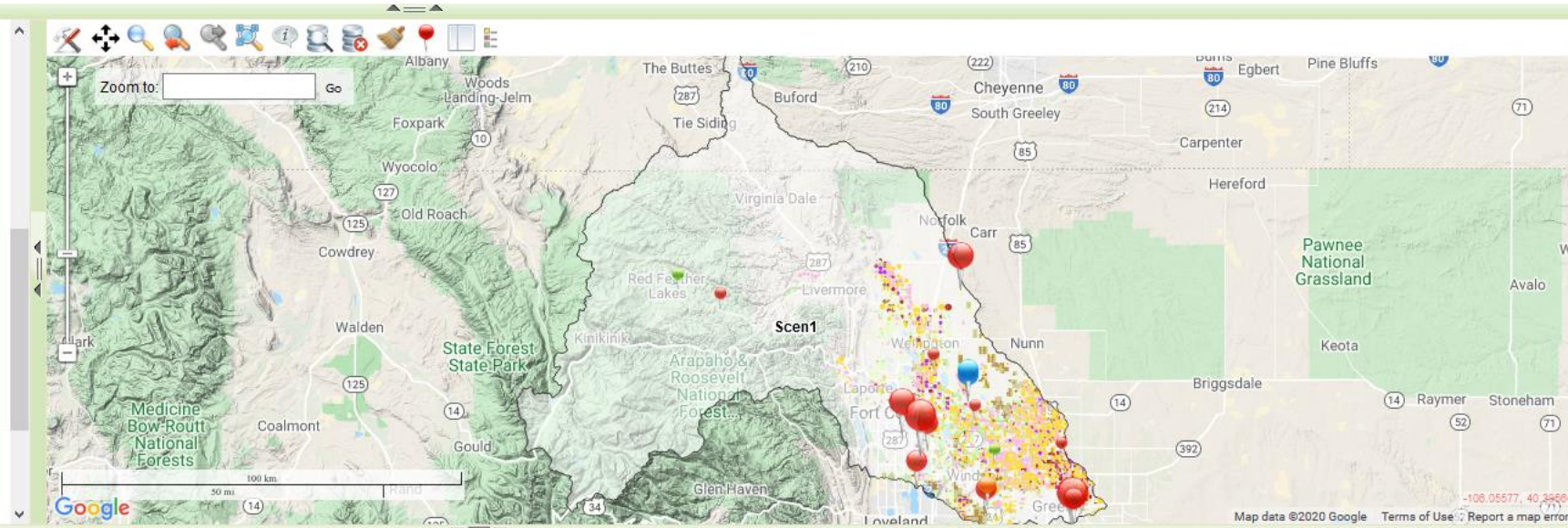
Split Application of Fertilizer*: 70% of Area

Agriculture

Background

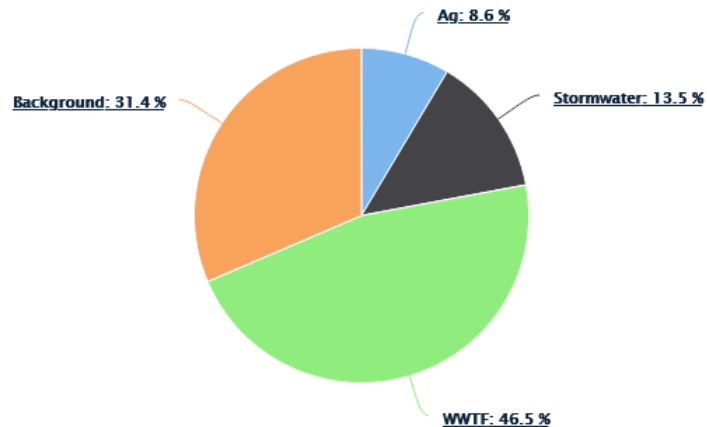
Atmospheric Deposition, Groundwater, and Forest-Rangeland Contributions

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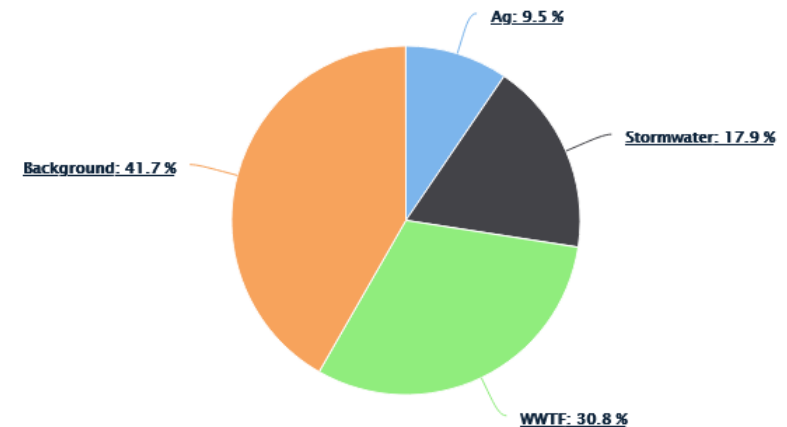
Baseline Total N

1,956,325 lb/yr



Scen1 Total N

1,474,905 lb/yr



CLEAN Water Quality Control Dashboard

Nutrient Sectors

Wastewater Treatment Facilities (WWTF) User Specified Reduction Edit Reduction(s)

Urban Stormwater Current Conditions

BMPs

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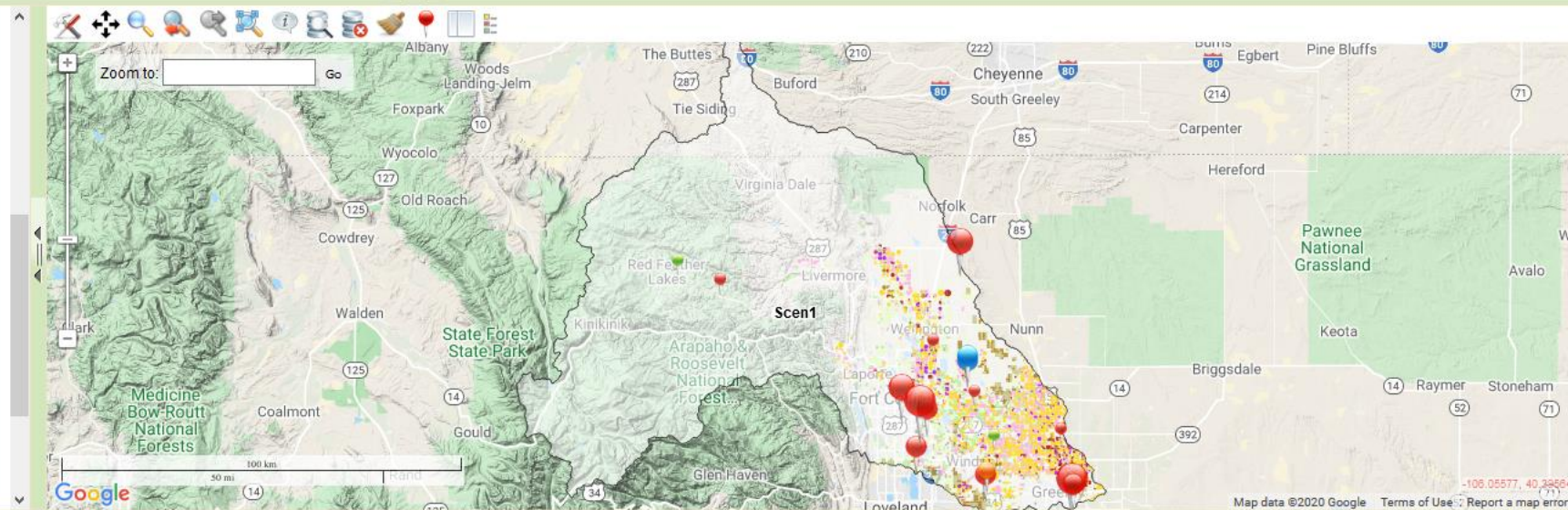
Strip Tillage: 10% of Area

No Tillage: 50% of Area

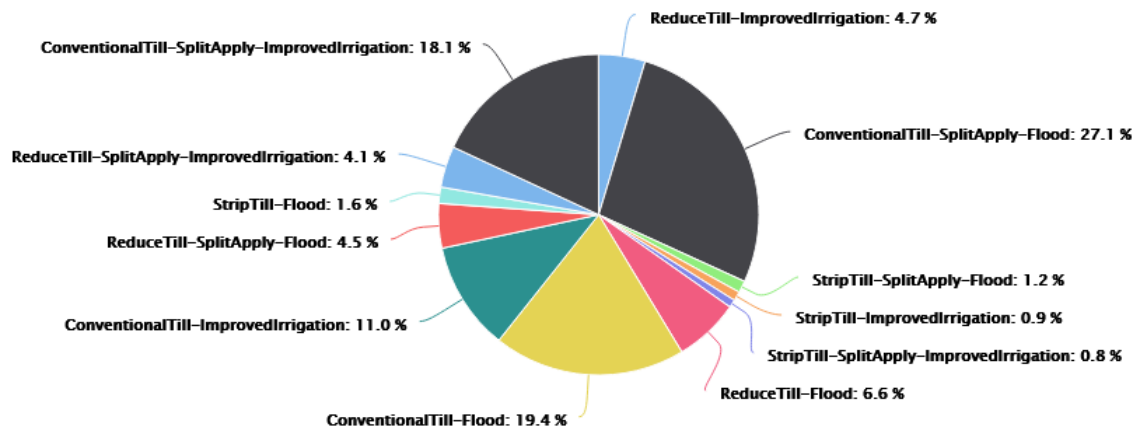
Split Application of Fertilizer*: 70% of Area

Background Atmospheric Deposition, Groundwater, and Forest-Rangeland Contributions

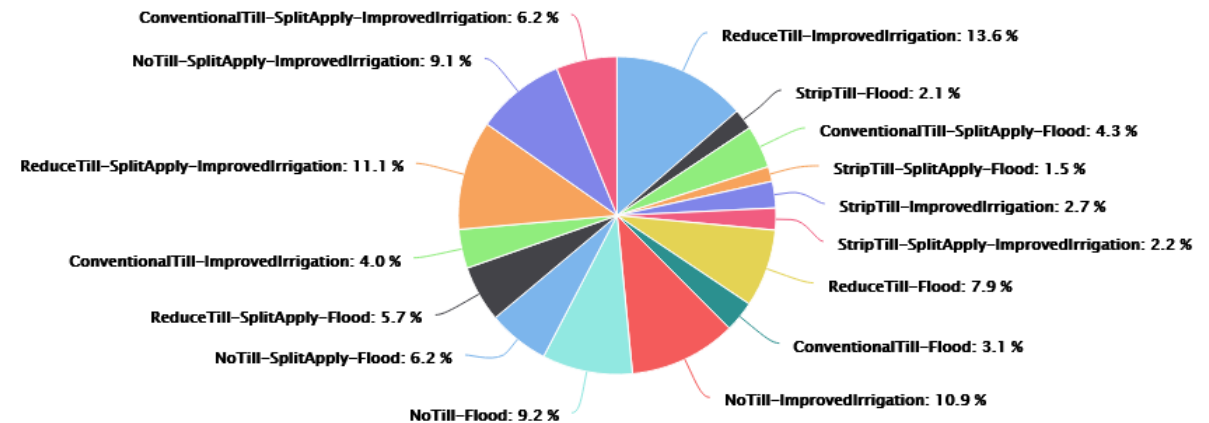
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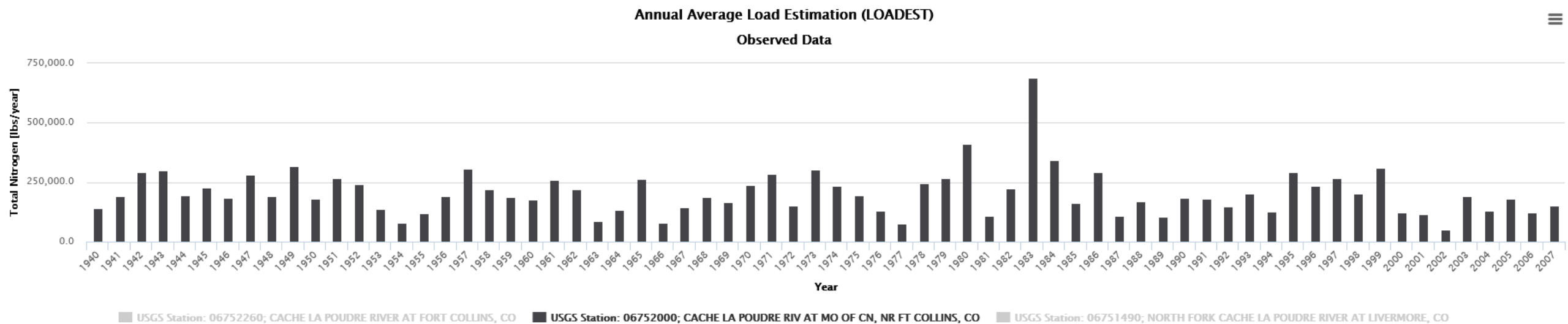
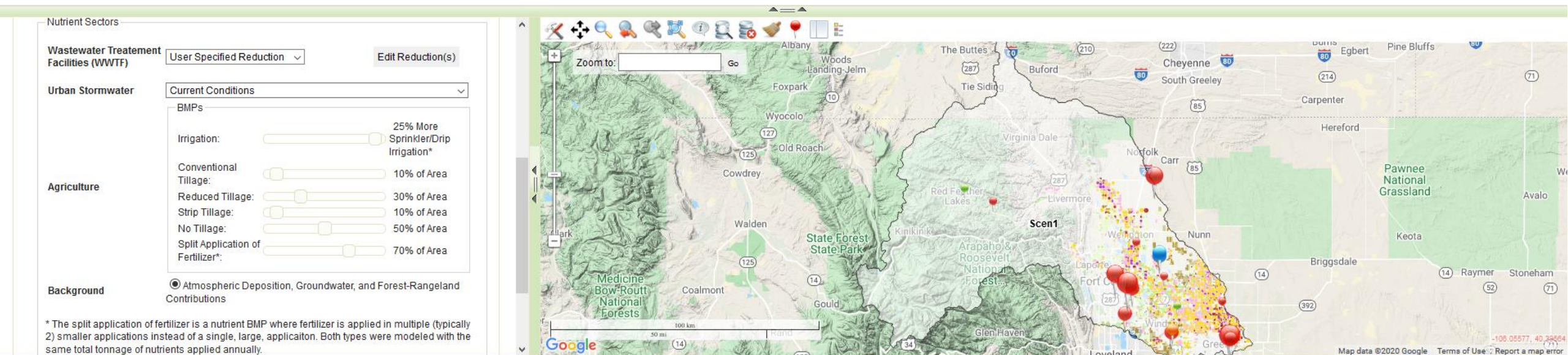
Baseline Total N - Ag
167,335 lb/yr



Scen1 Total N - Ag
140,588 lb/yr



CLEAN Water Quality Control Dashboard



Contributors

Tyler Wible

Dave Patterson

Troy Bauder

Erik Wardle

Tyler Dell

Sybil Sharvelle



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Thank you.

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