Examination of Long-Term Nitrate Trends in the Missoula Aquifer

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MISSOULA VALLEY WATER QUALITY DISTRICT

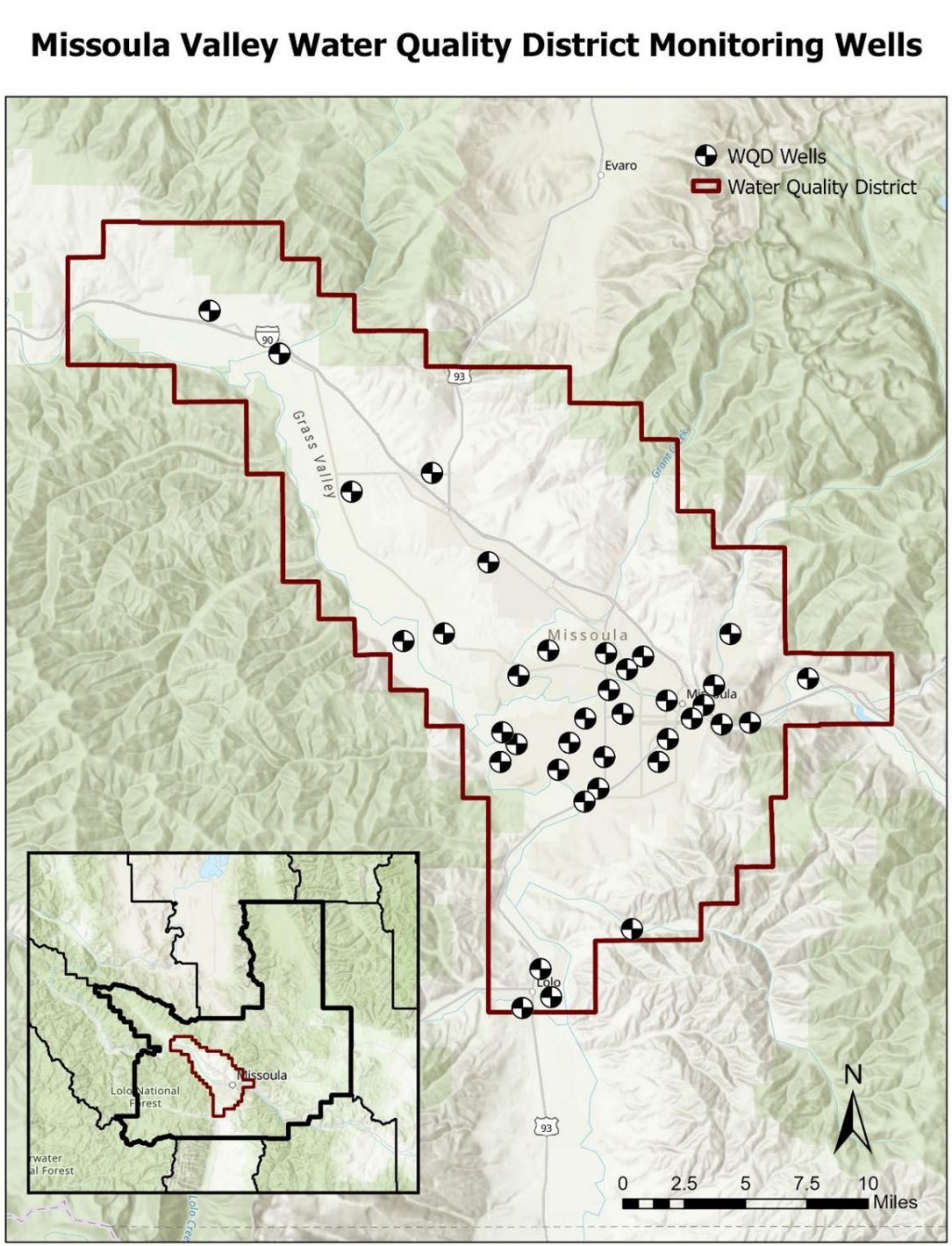
MISSOULA PUBLIC HEALTH

AmeriCorps Montana

MISSOULA VALLEY water quality district

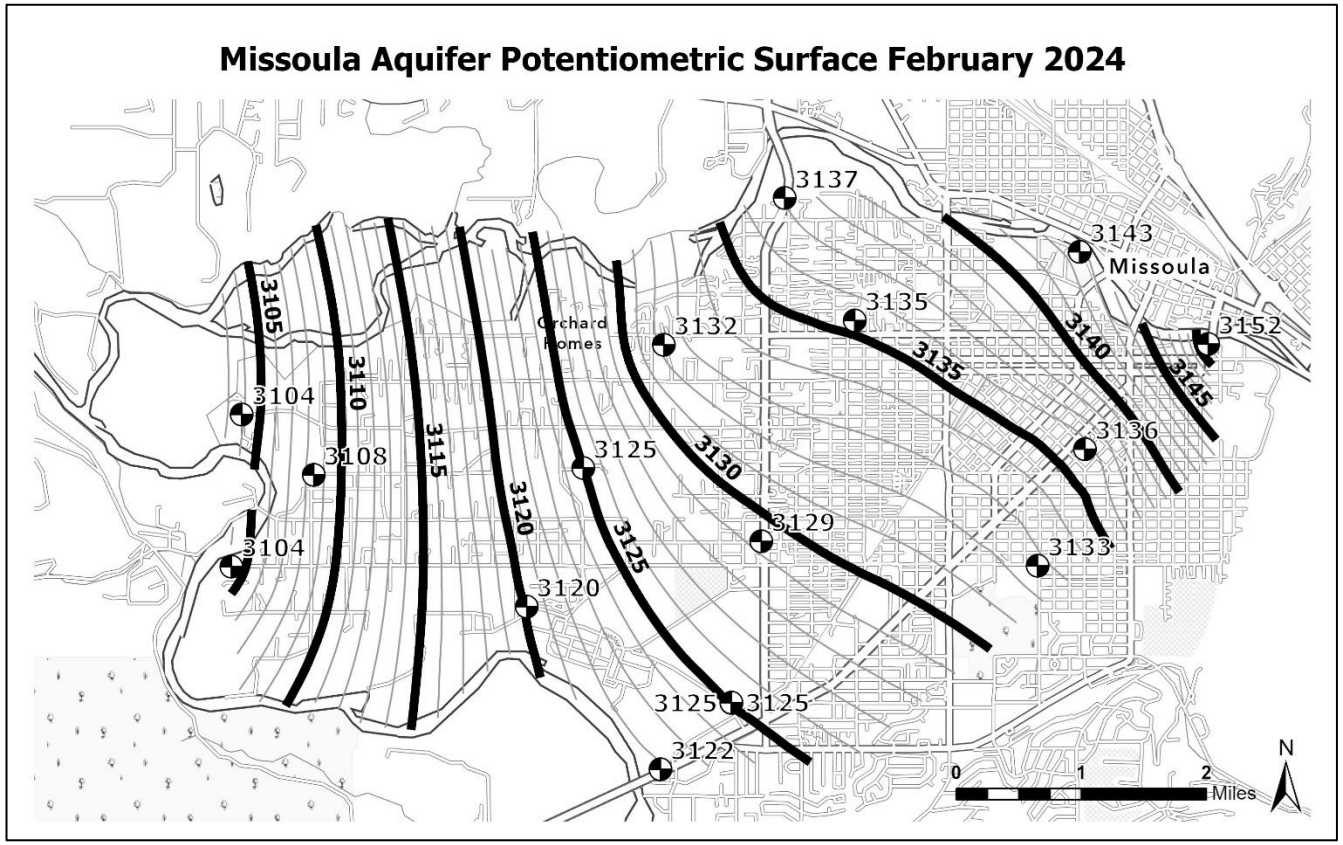
Missoula Valley Water Quality District

- Mission: "To protect and improve surface and groundwater quality within the Missoula Valley."
- Monitor with a network of 44 wells and major streams within the district.
  - Monthly water levels, hourly measurements from pressure transducers, and annual sampling.
- Advocate for management changes to improve water quality.

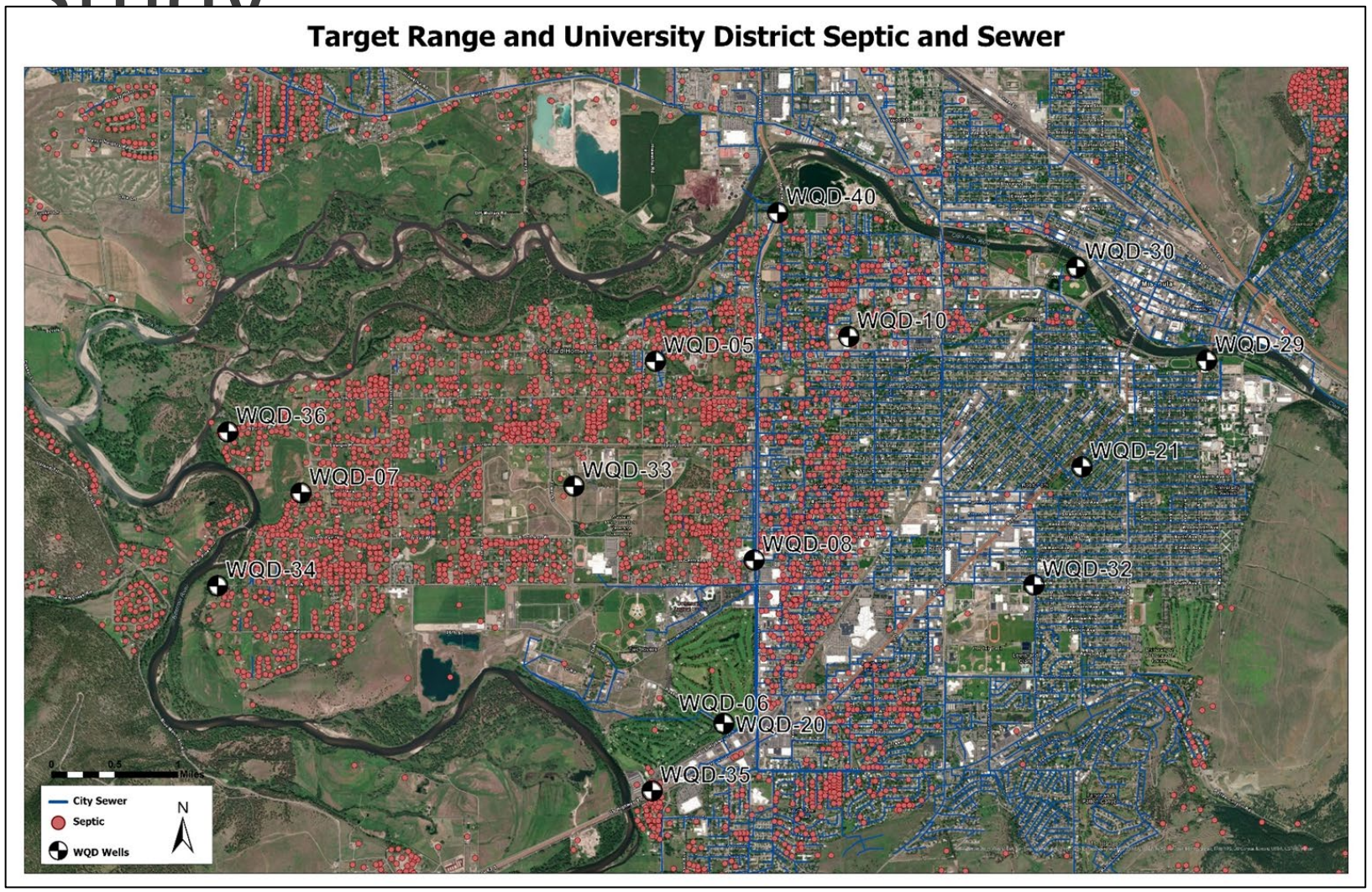


The Missoula Aquifer

- Alluvial, unconfined aquifer.
- Recharged by the Clark Fork River and Discharges to the Bitterroot and Clark Fork Rivers.
- EPA Designated Sole Source Aquifer.
  - Serves 40,000 households, many through private unregulated wells.



Scope of the Study



- Examination of Long-Term Nitrate Trends in the Missoula Aquifer.
- Sampled wells in network for ~30 years for a suite of analytes.
- Nitrate Trends in Target Range and the University District.
- Nitrate Loads to the Bitterroot River.

Mann-Kendall Test and Sen's Slope

- Mann-Kendall Test
  - Tests if y-values increase or decrease over time by comparing later and earlier measured data.
- Sen' Slope Estimator
  - Regression line of fit.

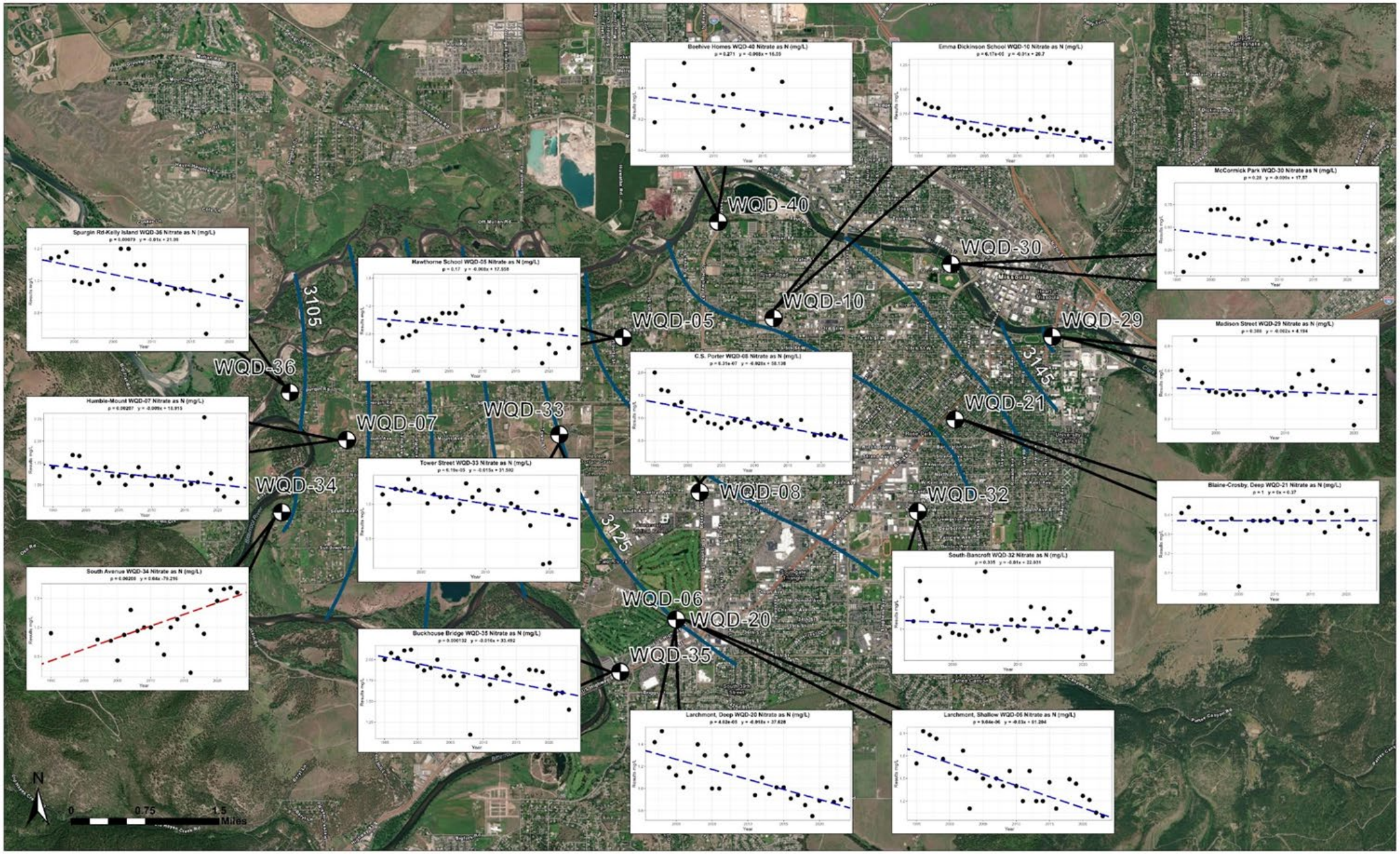
$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \text{sign}\,(y_j - y_i)$$

$$\tau = \frac{S}{n(n-1)/2}$$

$$H_0: S \text{ and } \tau = 0$$
$$H_1: S \text{ and } \tau \neq 0$$

$$\beta_1 = \text{median}\left(\frac{y_j - y_i}{x_j - x_i}\right)$$

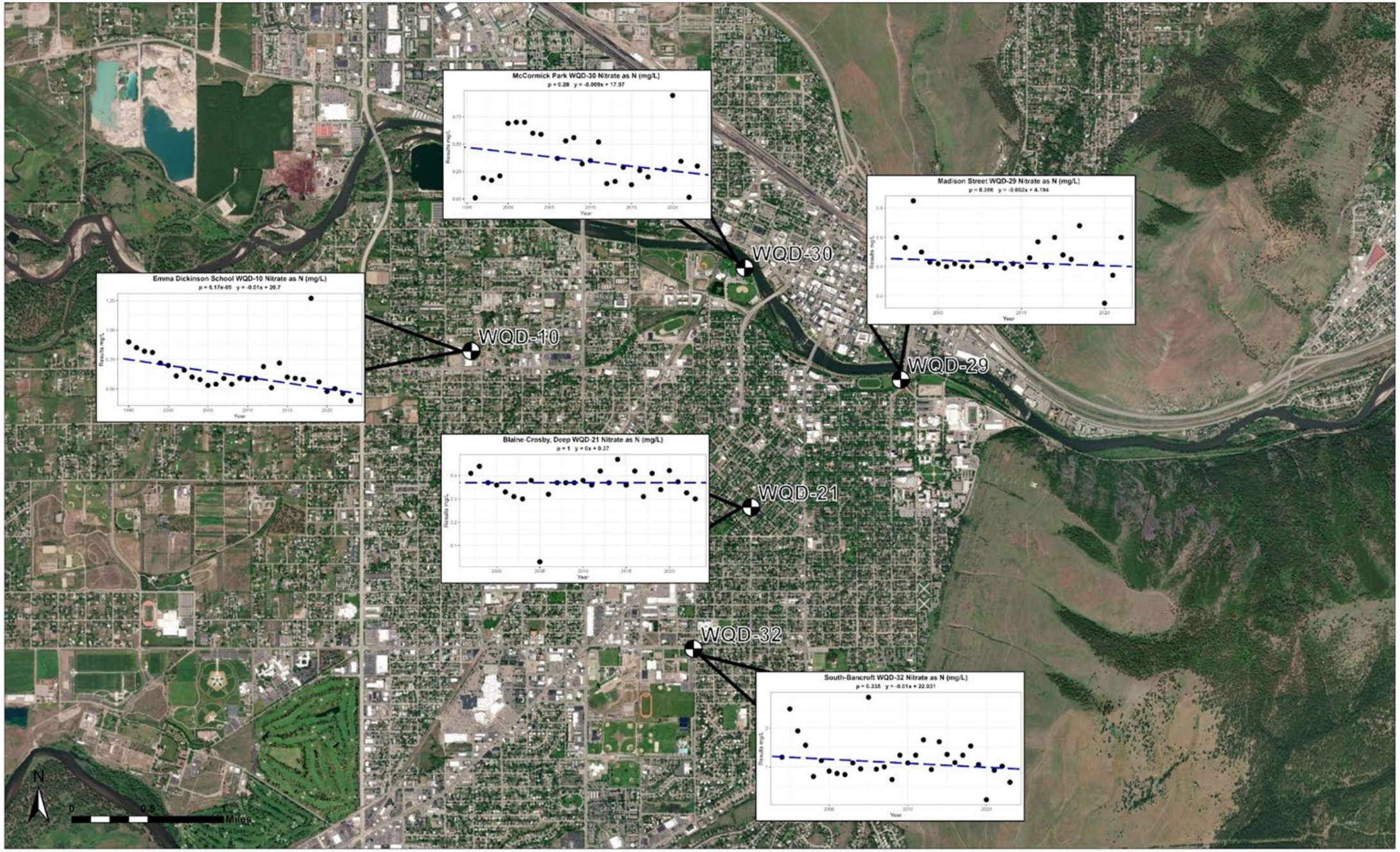
Target Range and University District 1994-2023 Nitrate Trends



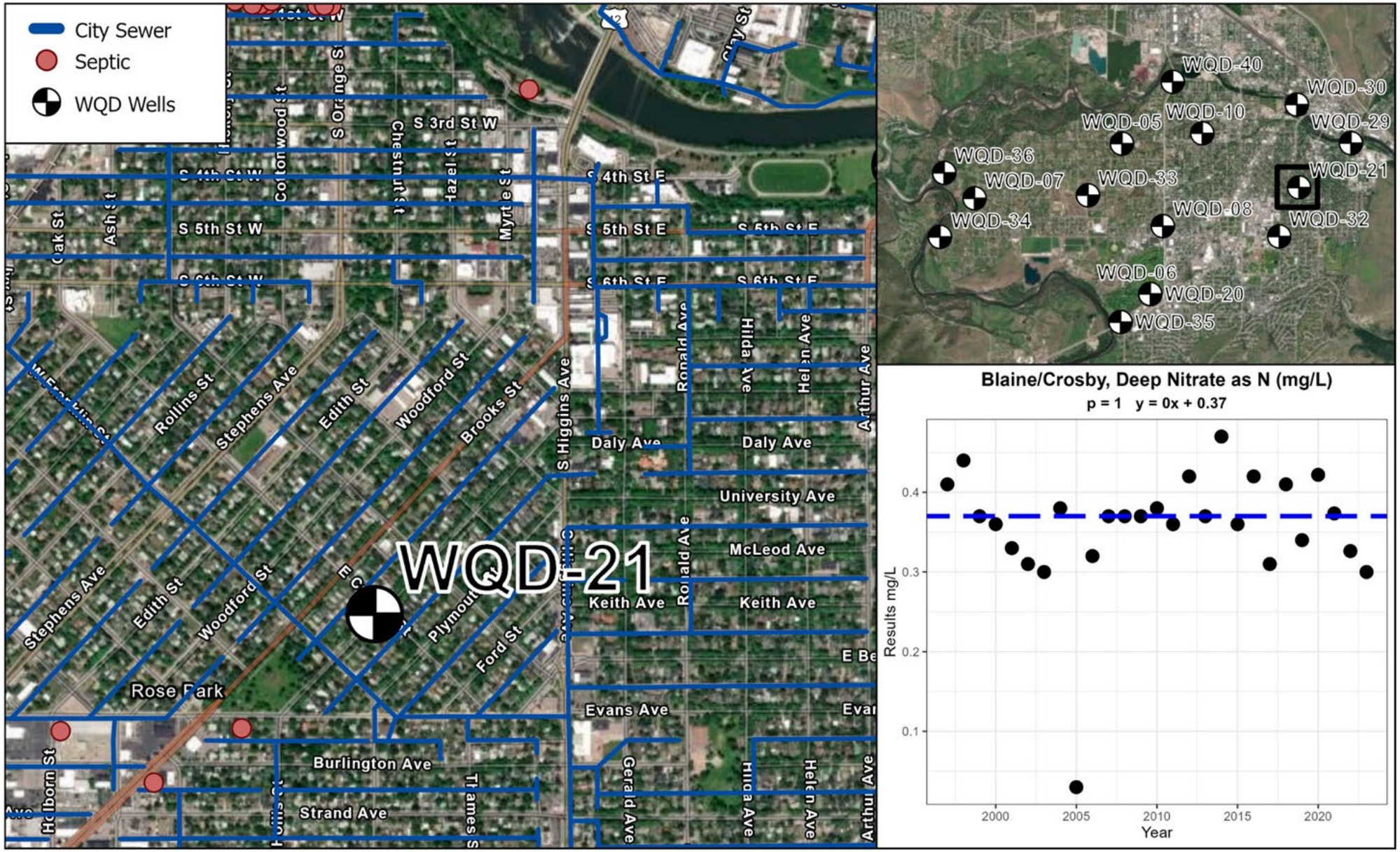
University District

- Developed primarily as residential with few new developments.
- Future wellhead reservation area.
- Met and exceeded VNRP goal of removing 50% of septic systems and sewering from 1998-2008.
- Nitrate trends are decreasing or holding steady.

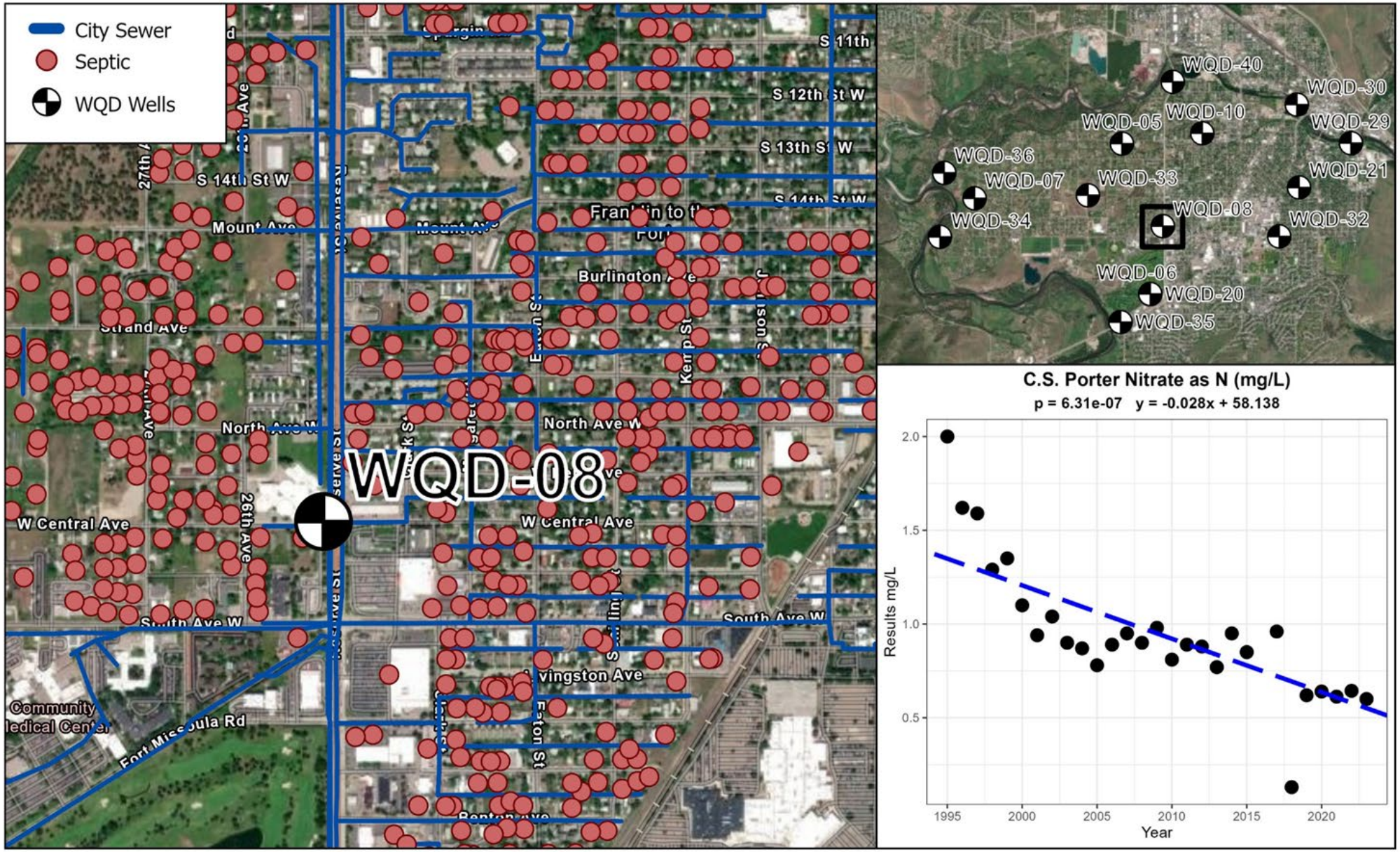
University District 1994-2023 Nitrate Trends



WQD-21 Blaine-Crosby Nitrate and Septic & Sewer



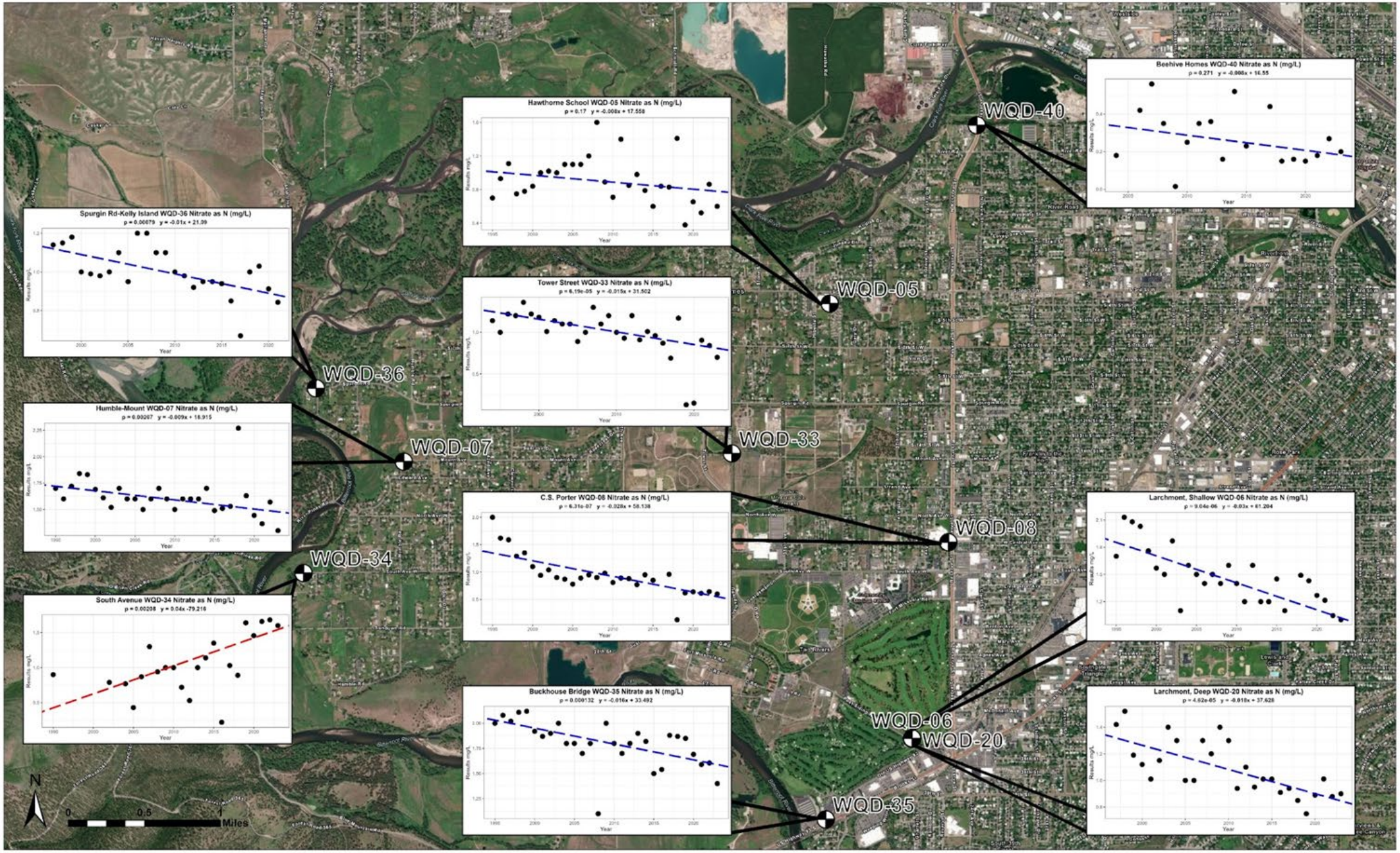
WQD-08 C.S. Porter Nitrate and Septic & Sewer



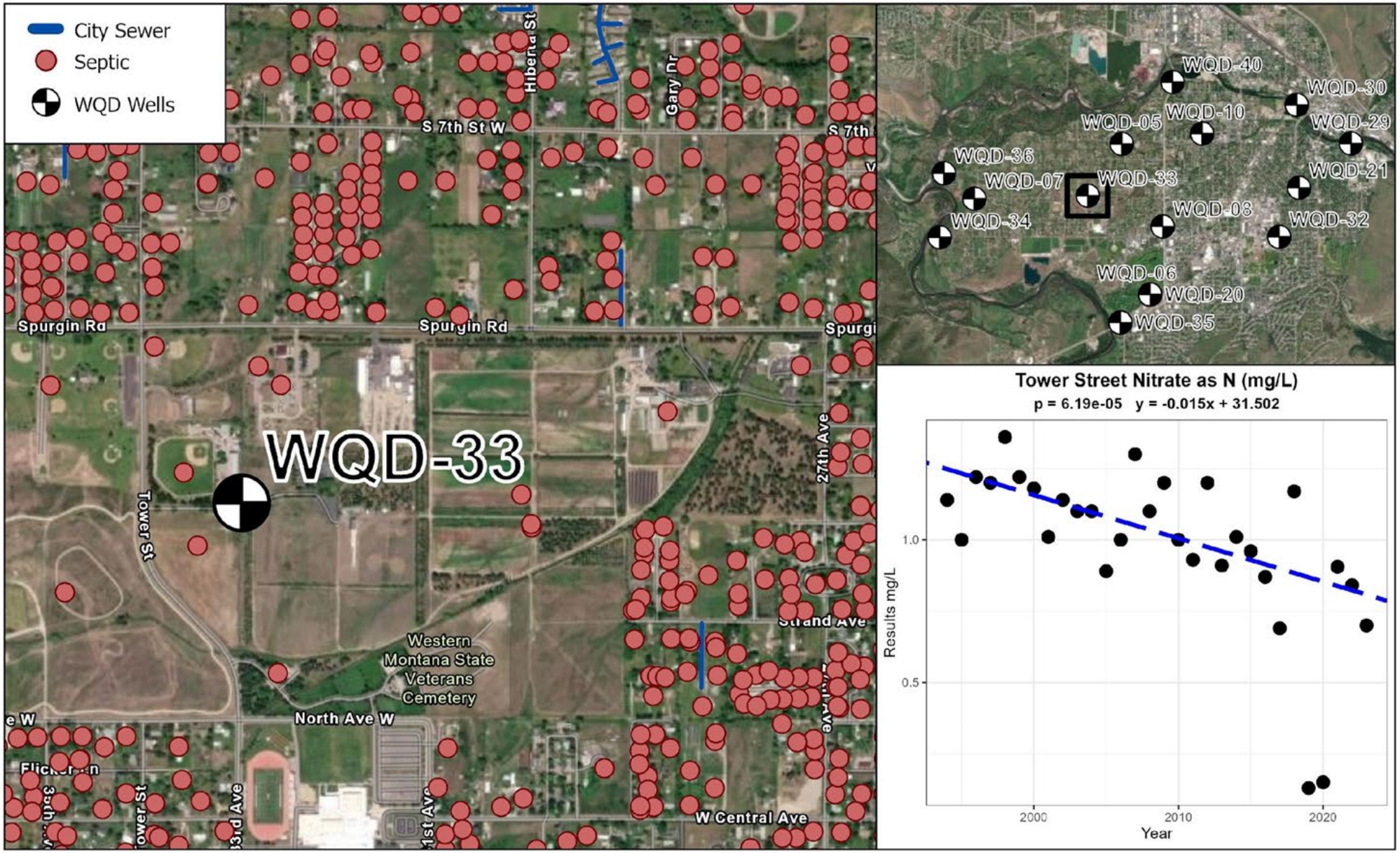
Target Range

- Semi-rural, small agricultural land transitioning to residential, public land.
- Onsite water and wastewater (septic and individual wells).
- Significant portion of the area has high groundwater.
- Land slopes to the Bitterroot River.
  - Picks up contaminants from wastewater.
- Nitrate trends are decreasing.

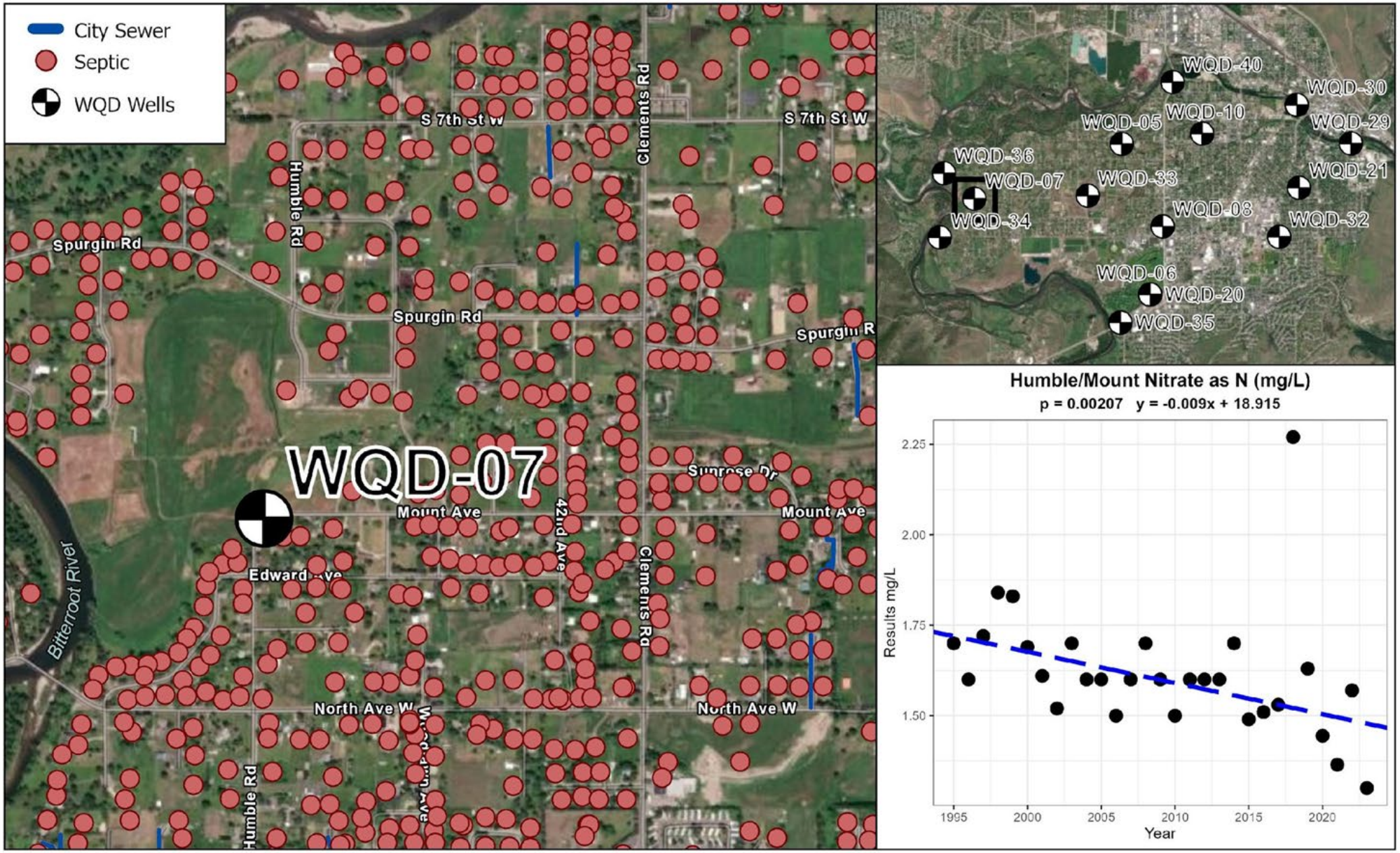
Target Range 1994-2023 Nitrate Trends



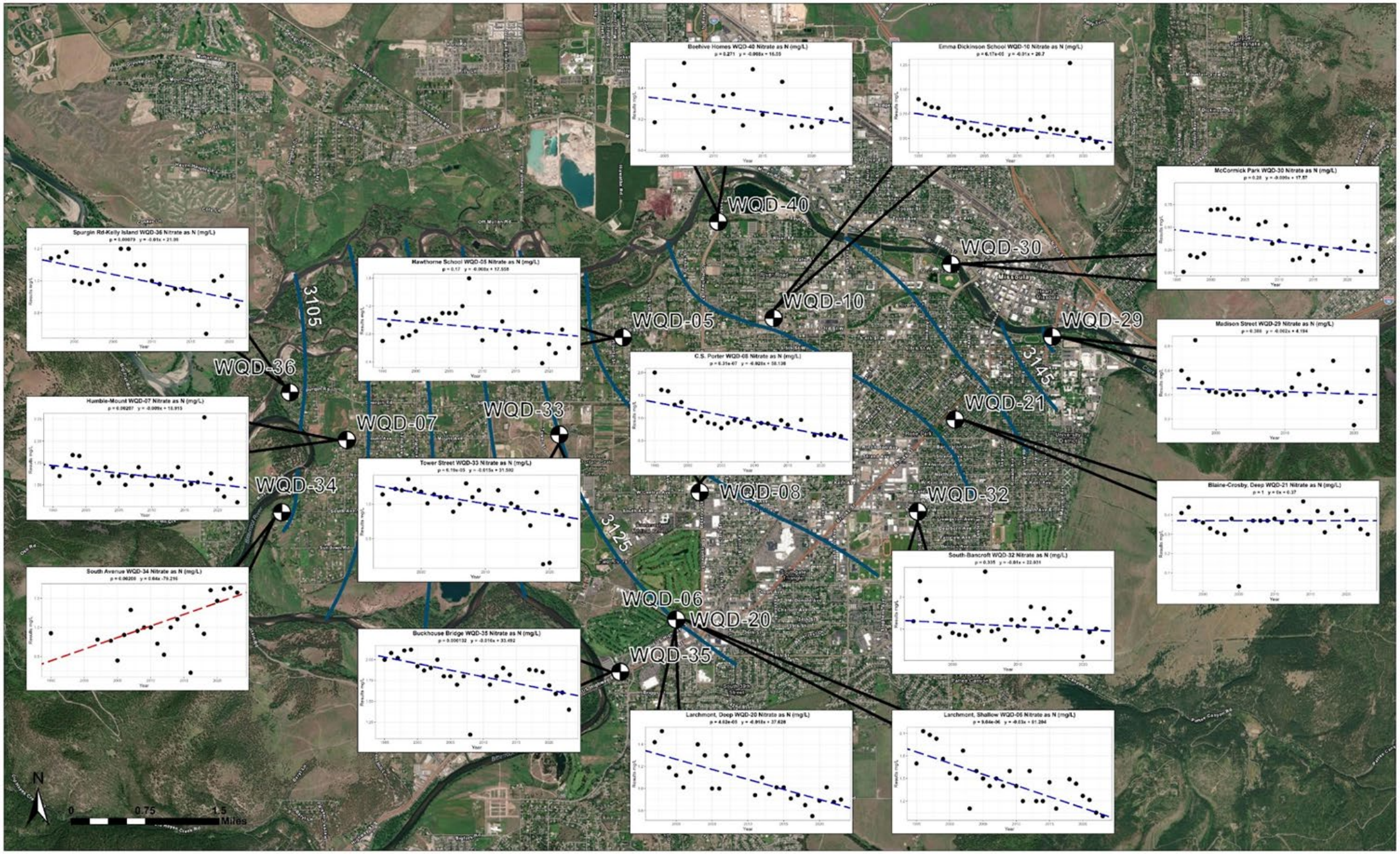
WQD-33 Tower Street Nitrate and Septic & Sewer



WQD-07 Humble-Mount Nitrate and Septic & Sewer



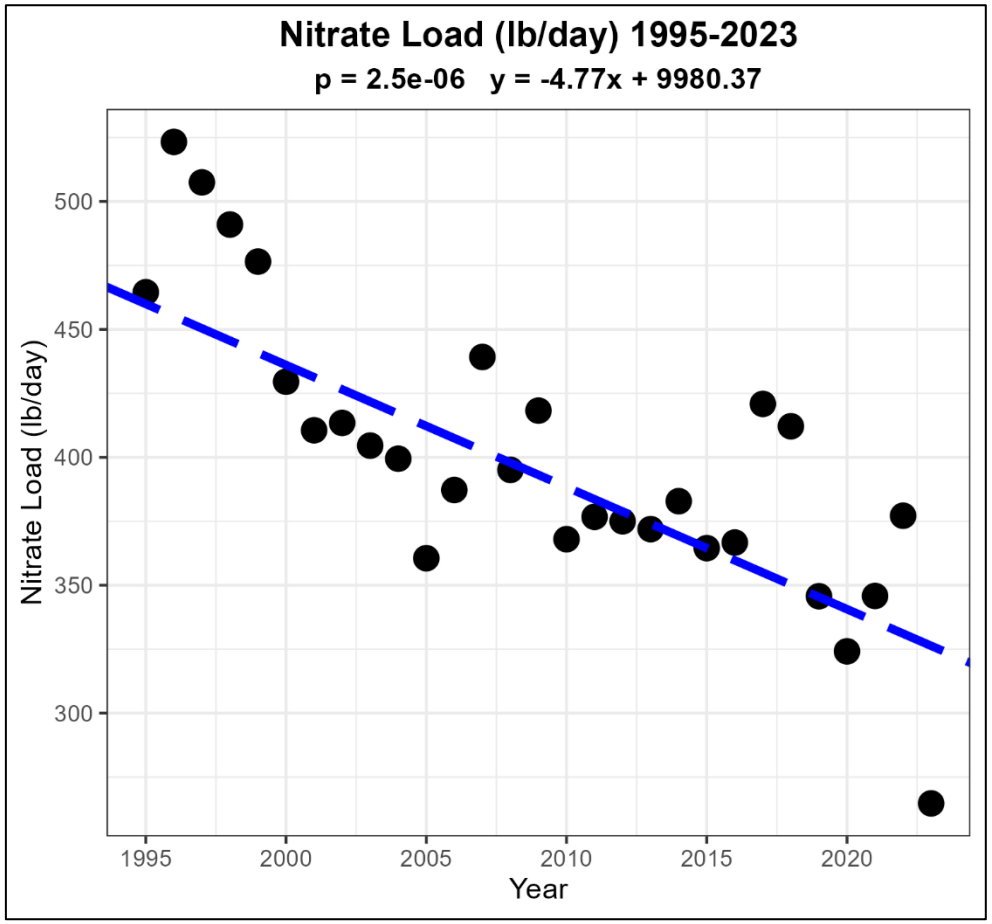
Target Range and University District 1994-2023 Nitrate Trends



Nitrate Loads

- Nitrate loads to the Bitterroot decreasing.
- Discharge to the Bitterroot 158,592 m^3/day
- Estimated to be ~265 lbs/day in 2023.

$$Nutrient\ Load = Concentration\ x\ Flow$$



Next Steps

- Identify and record data from other sources (subdivisions, public water supply)
  - Consistent with current trend analysis?
- Identify and incorporate other possible contributing factors.
  - Climate, geology, water quantity, localized sources, etc.

Conclusion

- Nitrate Trends holding steady or decreasing in the University District.
- Trends decreasing significantly in Target Range.
- Loads to the Bitterroot River, as a result, also decreasing.
- Management efforts to protect the Missoula Aquifer are effective.