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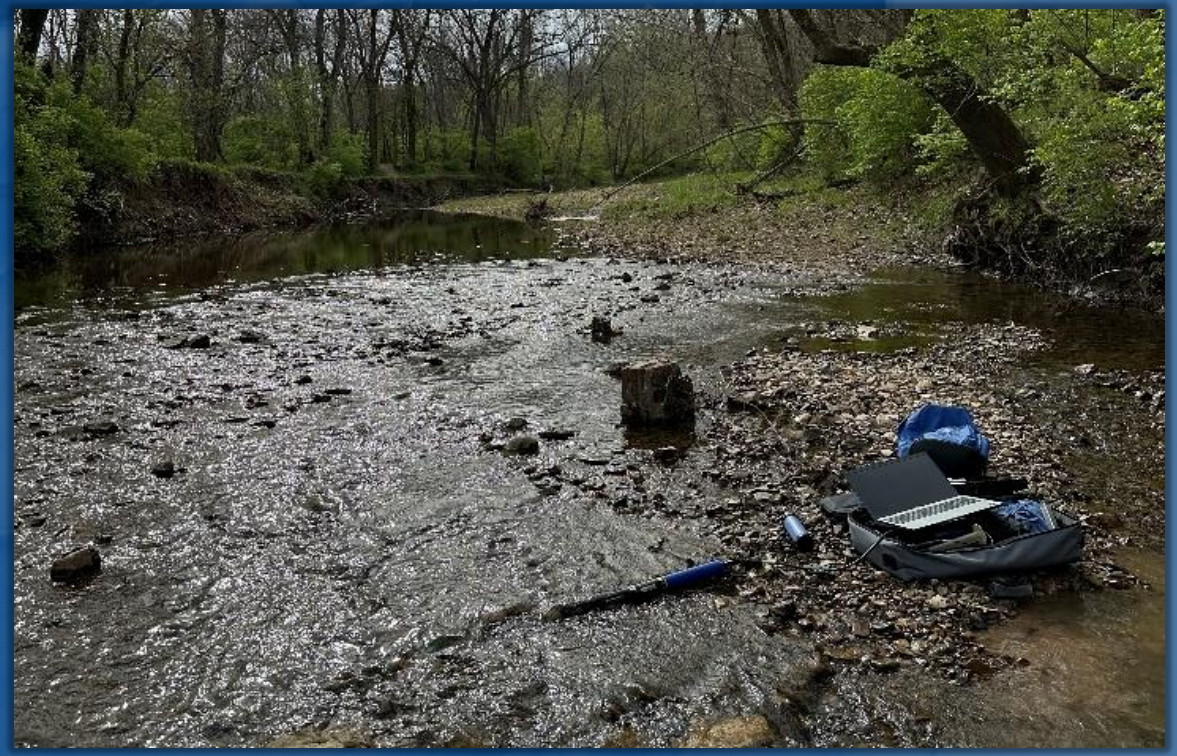
TAKING STEPS TO ADDRESS MS4'S BIGGEST WATER QUALITY CHALLENGE

July 31, 2025



About Me

Joshua Horne

- Water resources scientist at Geosyntec Consultants
- Field Services Department
- Long-term water quality monitoring studies
- Surface water sampling
- Clean Water Act compliance

Project Background

- Municipal Separate Storm Sewer Systems (MS4) manage urban stormwater through drainage systems
- Columbia's MS4 diverts stormwater runoff into the Hinkson Creek or it's tributaries
  - Drains ~88.5 square miles of land in Boone County
  - Local stream water quality is influenced by the MS4

Project Background

Road de-icing salt near St. Charles Road, Columbia, MO (1/13/25)

- Governments, businesses, and property owners use de-icing salt on roads and sidewalks throughout winter
  - Columbia Public Works estimated approximately 1,900 tons of road de-icing salt used by the city in January 2025
  - Chloride is a major component of de-icing salt
  - Winter de-icing materials enter local streams as stormwater runoff

Project Background

- Elevated chloride can cause aquatic life toxicity[1]
  - Long-term elevated concentrations - reduced size, lowers egg production, and altered behavior
  - Extreme concentrations result in mortality
- Missouri has aquatic life protection criteria for chloride[2]
  - 230 mg/L chronic (4-day)
  - 860 mg/L acute (1-hour)
- Pre-existing Hinkson Creek data does not characterize the winter season (critical period for de-icing materials)

Examples of aquatic life found in Hinkson Creek. From top to bottom: mayfly, orangethroat darter, bluegill.

[1]: Southeastern Wisconsin Regional Planning Commission Technical Report No. 62, Impacts of Chloride on the Natural and Built Environment

[2]: Code of State Regulations 10 CSR 20-7.031

Project Goals & Objectives

Hinkson Creek below Interstate 70

- Characterize chloride levels in Hinkson Creek and tributary inputs
  - Magnitude, duration, and frequency
  - Seasonal and annual comparisons (various climactic conditions)
- Identify major chloride sources or loading locations

Project Methods

- Began monitoring November 2023
  - 3-year study period
- Data collected at 15-minute intervals
  - Specific conductivity (surrogate for chloride)
  - Water level
- Long-term chloride data collection is not financially comparable to specific conductivity monitoring.
  - Levelogger 5 LTC: ~$1,500 /unit, requires relatively low maintenance

  vs
  - Chloride analyses: $30 /sample x 3 years at 15-min intervals = >$3 million

Solinst Levelogger 5 LTC

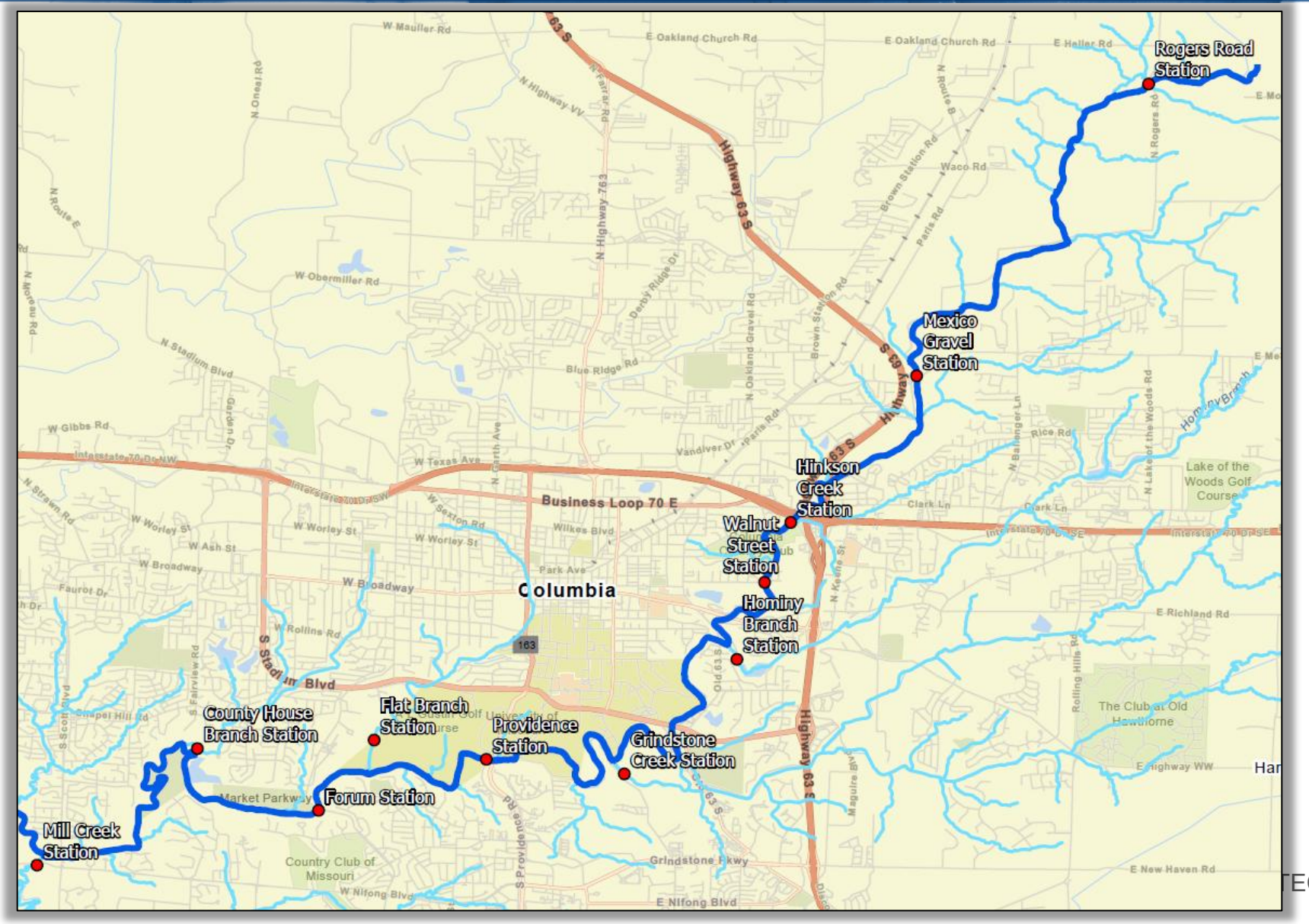
Project Methods

- 11 monitoring stations
  - 6 on the Hinkson Creek
  - 5 on tributaries
- Collect 10 samples at each site to determine ion concentrations
  - Chloride, sulfate, magnesium, & calcium
  - Will be used to develop models to correlate specific conductivity to chloride concentrations at each monitoring station

Cage mount monitoring station, Grindstone Creek

Post mount monitoring station, Mill Creek

Monitoring Station Locations



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Project Methods

- Monthly station operations:
  - Sensor cleaning
  - Quality assurance testing
  - Equipment calibration
  - Complete maintenance records
  - Water quality measurements
  - Data retrieval

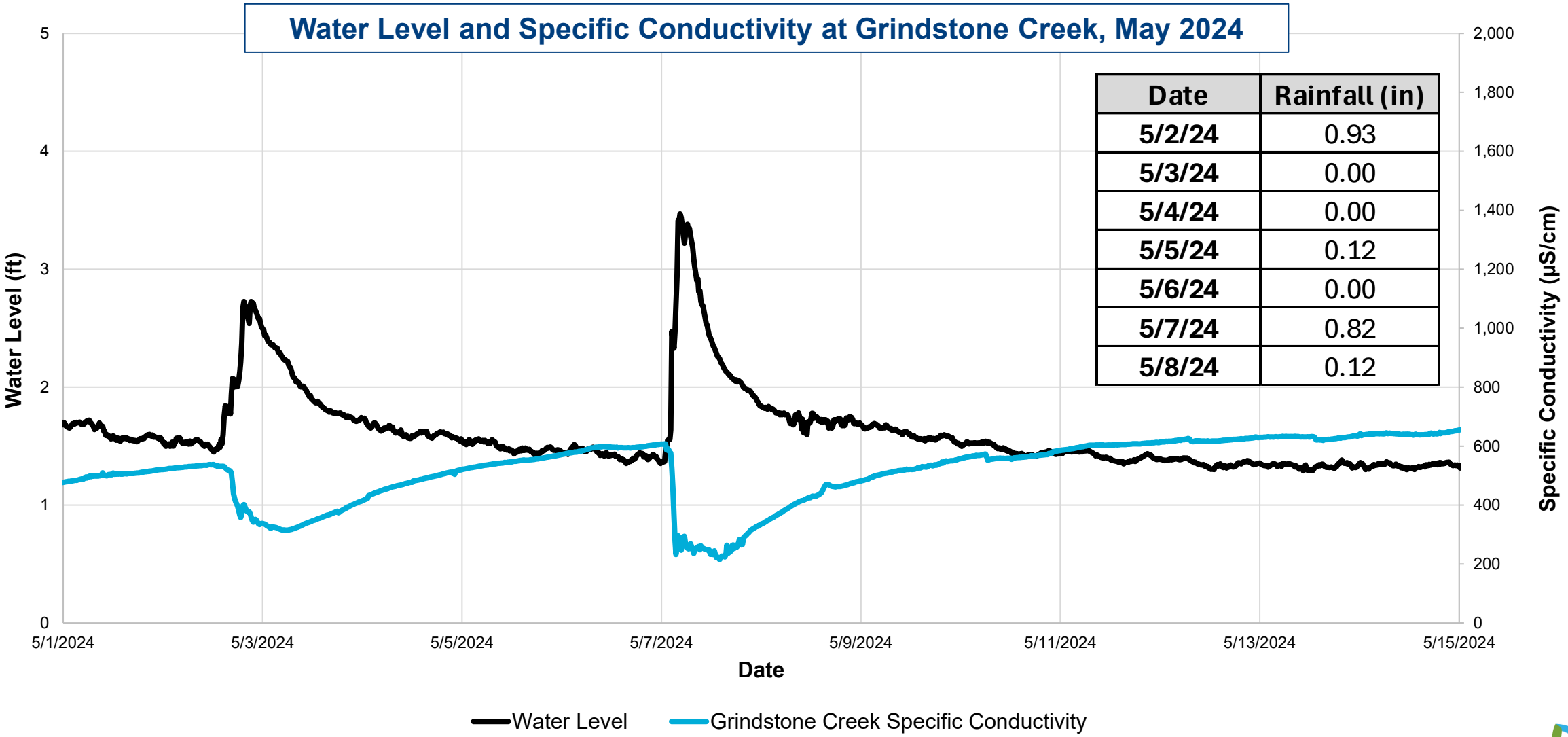
Grindstone Creek monitoring station monthly maintenance

Project Methods

Storm event on 4/20/25 caused a 9.78 ft water level increase in the Hinkson Creek

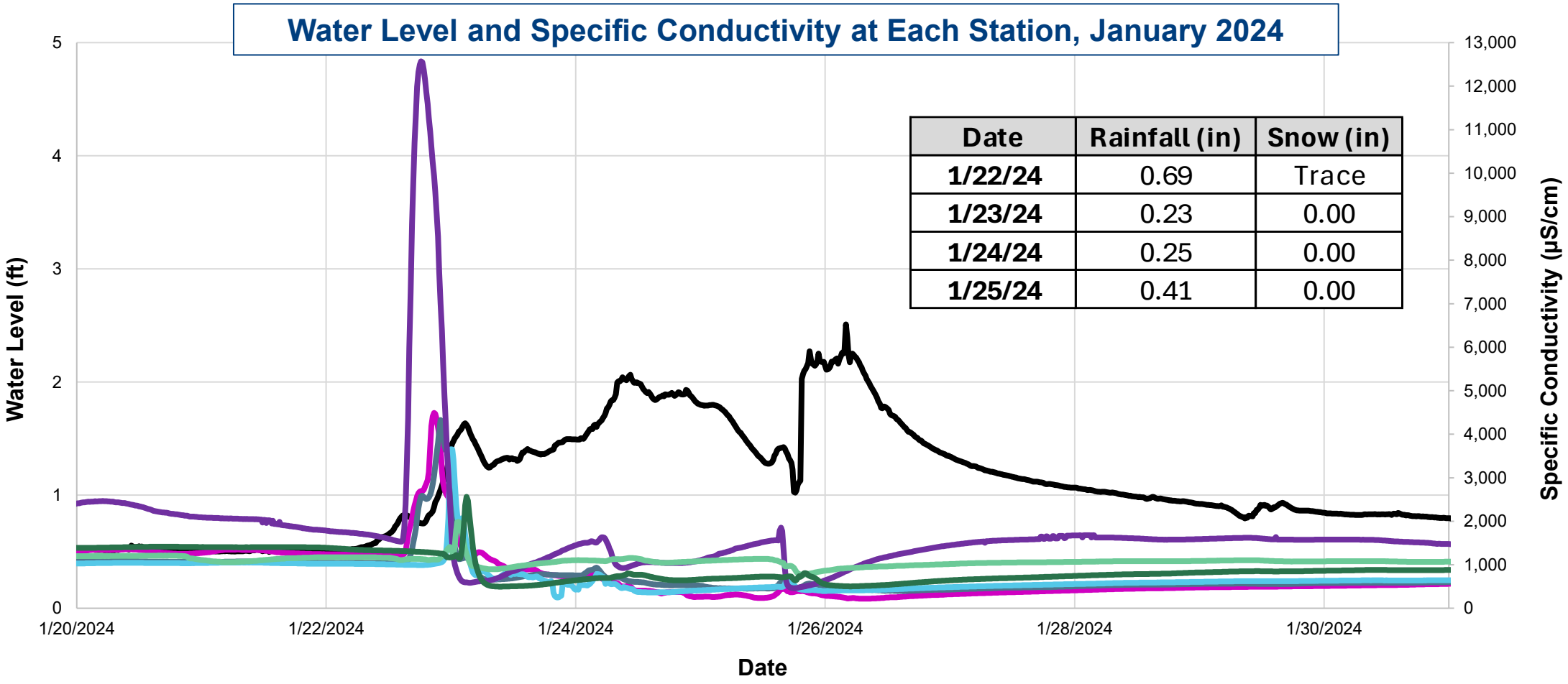
Hinkson Creek, Walnut Street station maintenance – 5/5/25

Summer Storm Event



Date	Rainfall (in)
5/2/24	0.93
5/3/24	0.00
5/4/24	0.00
5/5/24	0.12
5/6/24	0.00
5/7/24	0.82
5/8/24	0.12

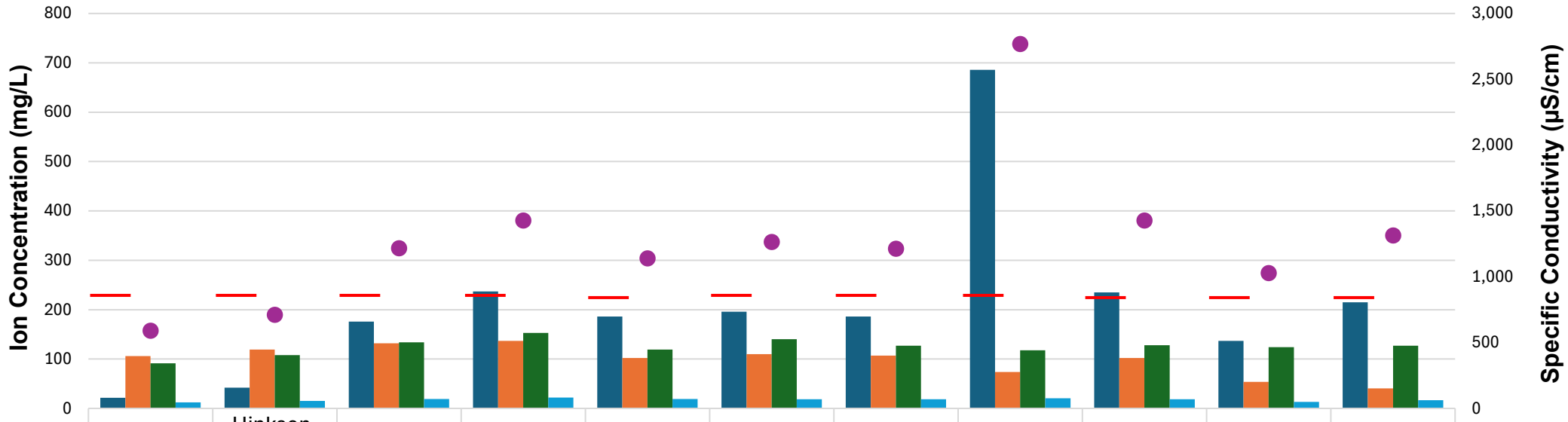
Winter Storm Event



Date	Rainfall (in)	Snow (in)
1/22/24	0.69	Trace
1/23/24	0.23	0.00
1/24/24	0.25	0.00
1/25/24	0.41	0.00

Analytical Samples

2/25/25 Sampling Event Results



	Hinkson, Rogers Road	Hinkson, Mexico Gravel Road	Hinkson, I-70	Hinkson, Walnut	Hominy Branch	Grindstone Creek	Hinkson, Providence	Flat Branch	Hinkson, Forum Blvd	County House Branch	Mill Creek
Chloride (mg/L)	21.7	42.1	176	237	186	196	186	686	235	137	215
Sulfate (mg/L)	106	119	132	137	102	110	107	74.0	102	54.0	40.8
Calcium (mg/L)	91.6	108	134	153	119	140	127	118	128	124	127
Magnesium (mg/L)	12.2	15.2	19.0	21.8	19.2	18.8	18.5	20.6	18.8	13.1	16.9
Specific Conductivity (uS/cm)	592	712	1,218	1,429	1,141	1,266	1,215	2,770	1,429	1,029	1,316

— Chloride Chronic Aquatic Life Protection Water Quality Criteria (230 mg/L)

Data Summary

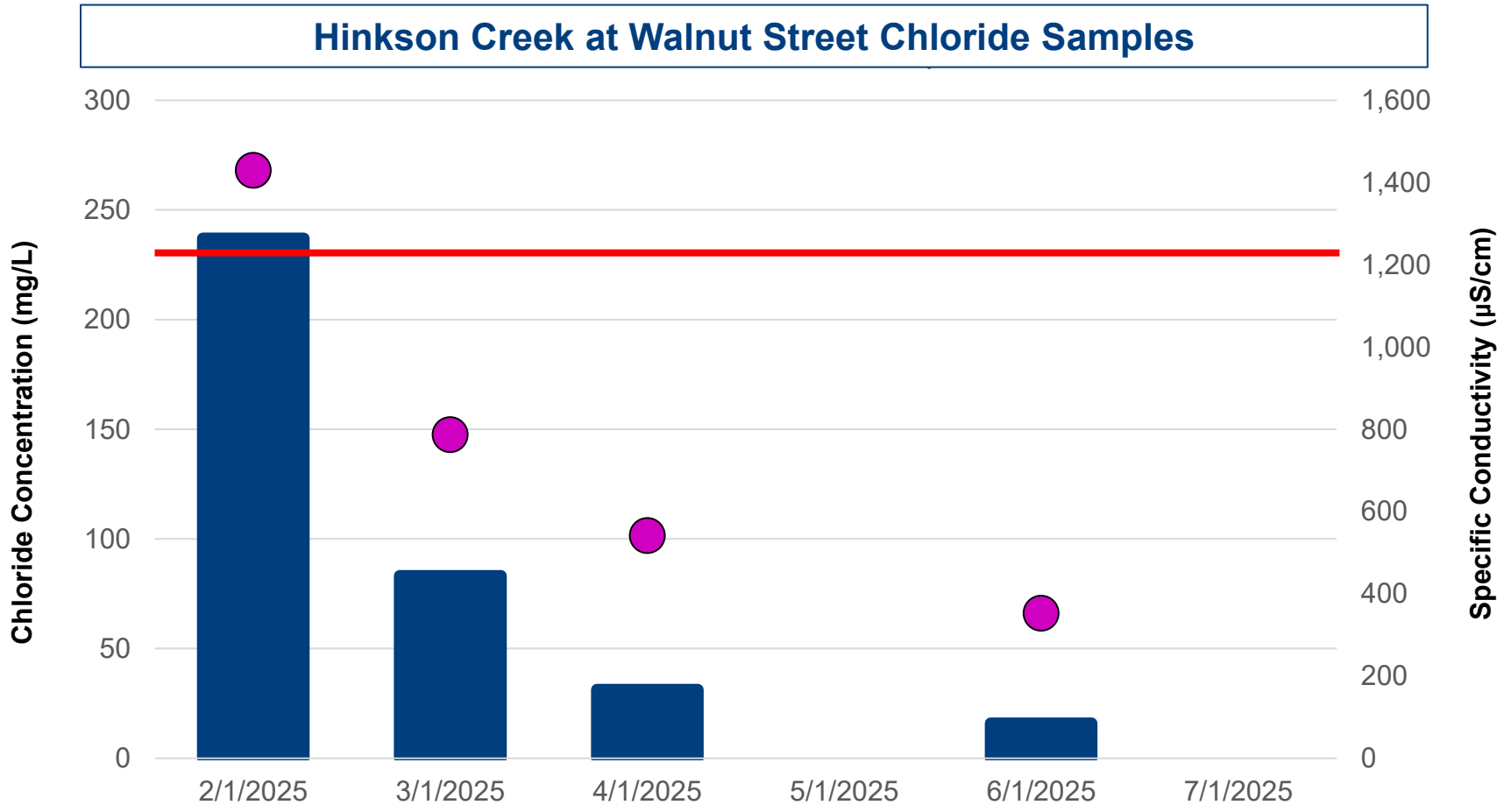
- Over 400,000 conductivity measurements collected so far

Statistic	Specific Conductivity (µS/cm)										
	Hinkson, Rogers Rd	Hinkson, Mexico Gravel Rd	Hinkson, I-70	Hinkson, Walnut St	Hominy Creek	Grindstone Creek	Hinkson, Providence Rd	Flat Branch	Hinkson, Forum Blvd	County House Branch	Mill Creek
Minimum	89	92	91	79	70	122	138	60	115	94	35
Median	414	526	660	605	732	675	692	938	665	710	598
Maximum	673	786	4,464	1,429	4,326	3,707	3,325	12,573	2,854	1,987	2,666
Count	13,619	8,628	55,277	12,408	58,335	53,624	14,958	58,355	14,949	58,346	58,343

- Specific conductivity varies by water composition[3]
  - Distilled water: 0.5 to 3 µS/cm
  - Missouri reference streams: 150 to 500 µS/cm
  - Industrial wastewater: >10,000 µS/cm
  - Seawater: 50,000 µS/cm

[3]: United States Environmental Protection Agency, Water Monitoring and Assessment, Conductivity

Analytical Samples

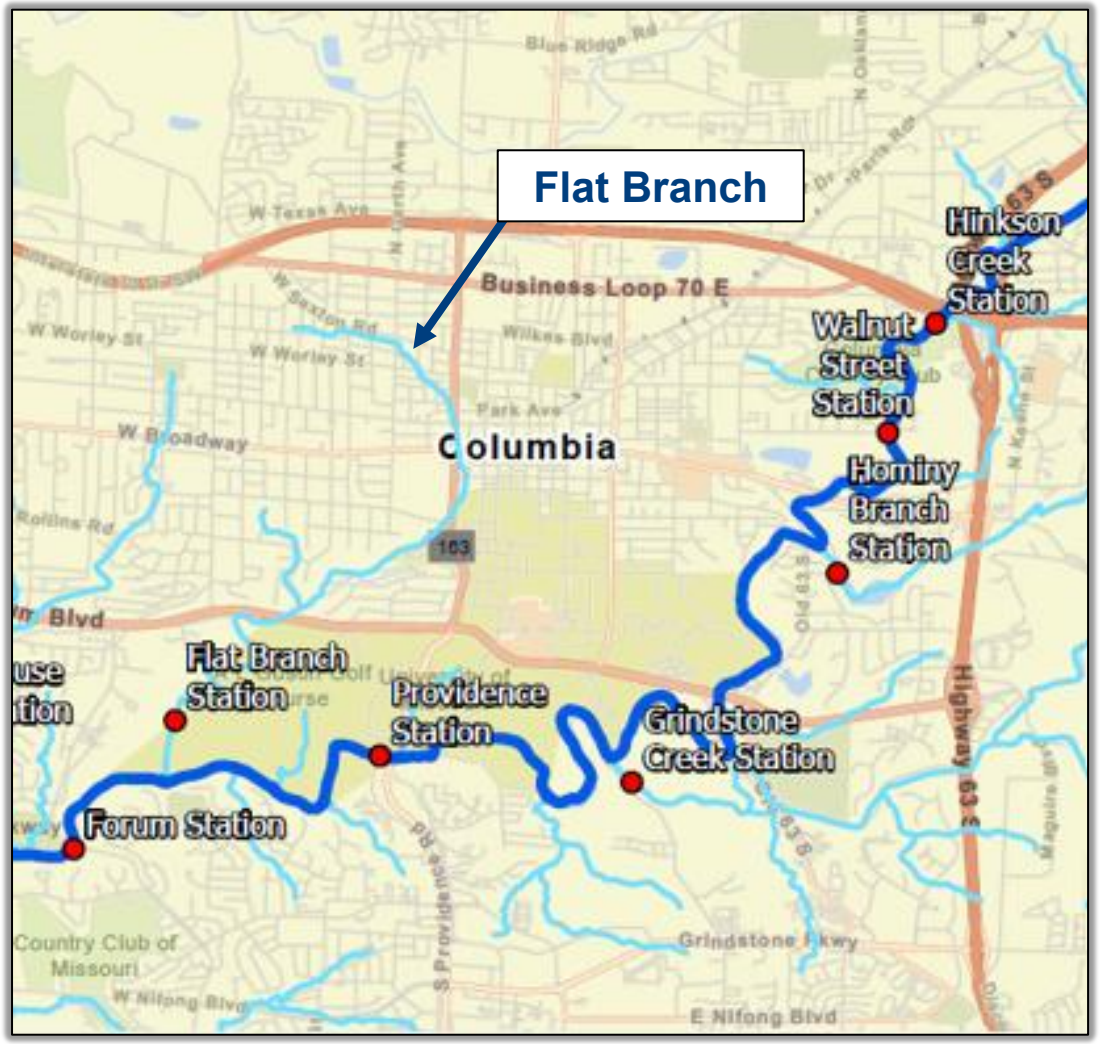


	2/25/2025	3/20/2025	4/11/2025	6/6/2025
Chloride (mg/L)	237	83.1	31.3	16
Specific Conductivity (uS/cm)	1,429	786	541	353

Chloride Chronic Aquatic Life Protection Water Quality Criteria (230 mg/L)

2024 Water Year Data

- Highest specific conductivity measured at Flat Branch
  - Only Hinkson Creek tributary that drains through downtown Columbia
  - Potential higher proportion of de-icing salt application
    - Greater amount of impervious surfaces (city, commercial, residential)
    - Greater urban inputs



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Study Findings to Date

- Road de-icing salt runoff correlates with elevated specific conductivity and chloride concentrations in the Hinkson Creek and its tributaries.
- During winter, chloride concentrations exceeded the chronic protection of aquatic life water quality standard value.
  - This does not mean aquatic life toxicity was caused, the chronic water quality standard is a 4-day average
- Additional data is needed to determine if the acute protection of aquatic life standard is exceeded.

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Municipal Considerations

There are practices that can mitigate elevated chloride levels in local streams.

- Determine amount and frequency of de-icing salt application to maximize public safety while minimizing environmental impact.
- Improved monitoring
  - Weather, road temperatures, etc.
- Consider use of de-icing alternatives such as calcium magnesium acetate (CMA) or abrasives such as sawdust or sand.
- Adequate maintenance of paved surfaces to maximize effectiveness of mechanical controls such as snowplows.

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Study Next Steps

- Continue monitoring and sampling through November 2026
- Develop site-specific regression models
  - Determine the relationship between specific conductivity and chloride at each site
  - Predict chloride concentrations in local streams based historic specific conductance monitoring data

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QUESTIONS?

THANKS FOR COMING!