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NATURAL RESOURCES

Battery Recycling- Missouri's Experience

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ACWA Industrial Permit Conference

April 8, 2026

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Battery Recycling

- 1 ton of battery grade lithium = 250 tons of ore or 750 tons of brine or 28 tons of batteries recycled
- 1 ton of battery grade cobalt = 300 tons of ore or between 5 to 15 tons of batteries recycled
- 136 lbs of lithium in 1 electric vehicle battery (1 ton of lithium = ~15 batteries)
- 44 lbs of cobalt in 1 electric vehicle battery (1 ton of cobalt =~ 24 batteries)

Source: U.S. Department of Energy Vehicle Technologies Office.

Battery Manufacturing & Recycling

- In Missouri, no general permits cover manufacturing or recycling of lithium-ion batteries
- Multiple types of batteries covered under lithium-ion, including
  - Lithium-Cobalt (consumer electronics)
  - Lithium nickel cobalt aluminum (electric vehicle battery)
  - Lithium iron phosphate (energy storage systems, portable power tools)
- Current recycling capacity and infrastructure not well developed
  - Fire safety, public health, and water quality concerns
  - Retail/consumer Li-Ion battery packs already prolific
  - Large volume of end-of-life EV batteries on the horizon
- US EPA Lithium- Ion Battery Recycling

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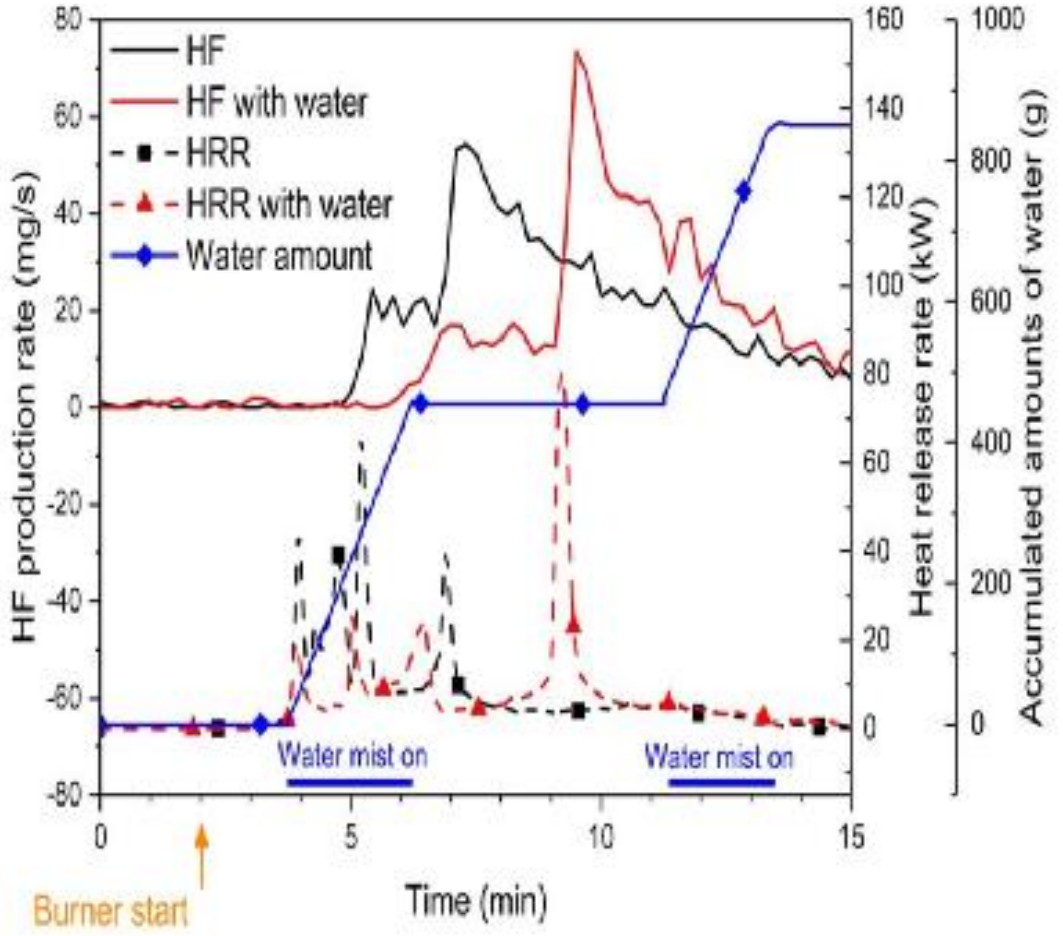
Lithium Fire Risks

There are several situations that can lead to lithium-ion batteries catching fire, including:

- Overcharging or use of non-compliant charging equipment
- Exposure to extreme temperatures
- Physical damage
- Short-circuiting, battery cell malfunctions
- Manufacturing defects or contamination
- Fire risks are elevated when using water
  - Significant increase in heat released
  - Hydrogen fluoride released



Fredericktown, MO

Site constructed in 2023
Operations began Spring 2024

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October 30, 2024

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Quick Stats

- 25 agencies responded
- Approx. 320 tons of energized lithium-ion batteries and other energized lithium containing batteries
- All methods available used to contain the fire- including firefighting foams, Class A and B
- Up to 3,000 gallons per minute of water applied on the structure
- Oct. 31– foam visible in stream more than 2 miles downstream in the Little St. Francis River
- Nov. 1- Confirmed fish kill for more than 2 miles downstream of site, along Village Creek and in the Little St. Francis River, approx. 17,700 aquatic organisms (more than 17,000 fish)
- Nov. 8- fire contained to smolder in 3 spots, still spiking more than 700°F

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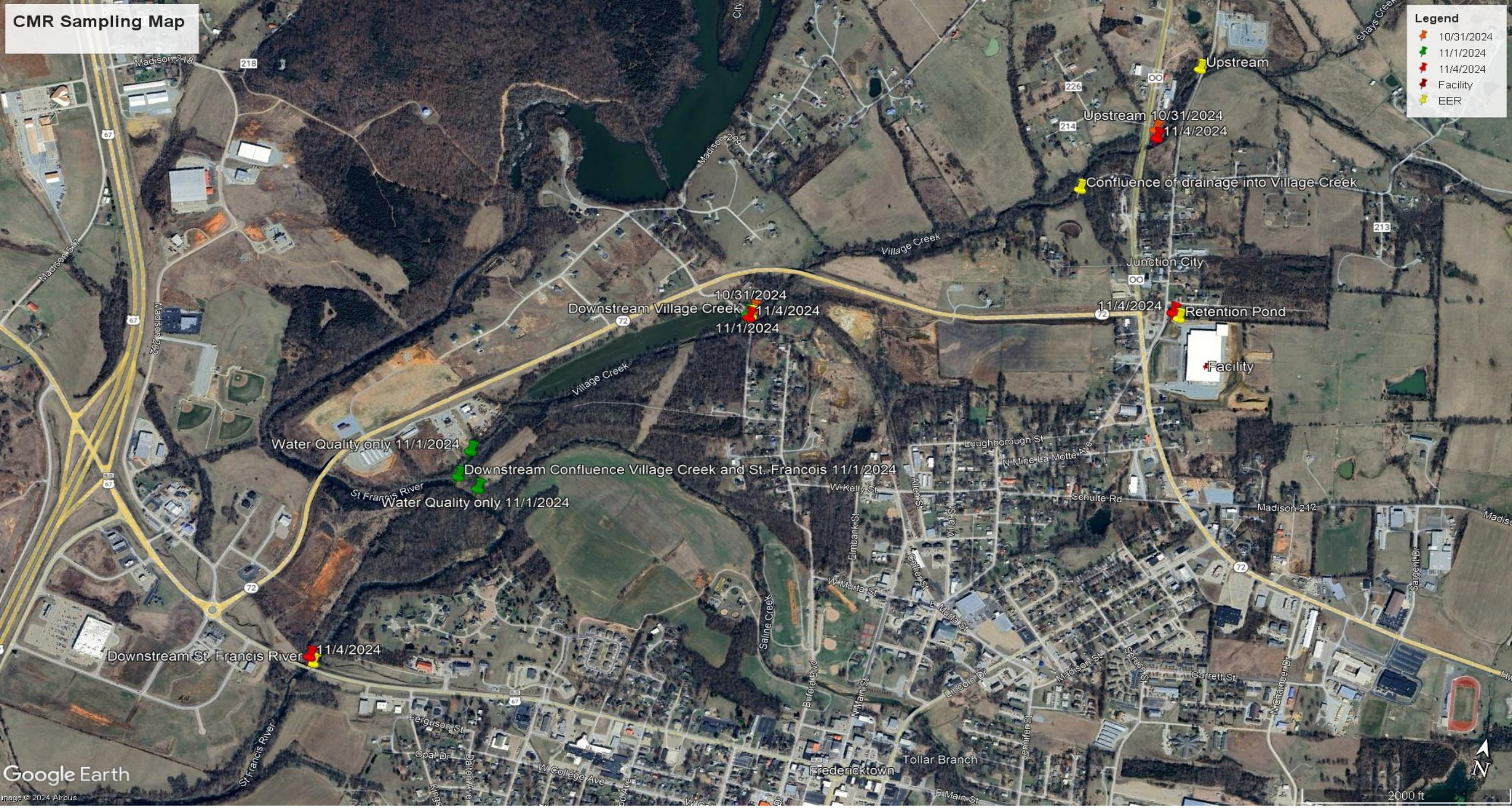
CMR Sampling Map
Legend
10/31/2024
11/1/2024
11/4/2024
Facility
EER
Upstream
Upstream 10/31/2024
11/4/2024
Confluence of drainage into Village Creek
10/31/2024
Downstream Village Creek 11/4/2024
11/1/2024
11/4/2024
Retention Pond
Facility
Water Quality only 11/1/2024
Downstream Confluence Village Creek and St. Francois 11/1/2024
Water Quality only 11/1/2024
Downstream St. Francis River 11/4/2024
Village Creek
Junction City
Fredericktown
Tollar Branch
Madison 218
Madison 212
Madison 213
Madison 214
Madison 226
Madison 217
Madison 222
Loughborough St
N Mine La Motte Ave
W Kelly St
Schulte Rd
Elmbank St
Allen St
Vidal St
Collier St
W Murta St
E Murta St
Saline Creek
Buford Blvd
N Main St
Lincoln Dr
Madison St
Spruce St
Garrett St
N Chamberlain Dr
Jennifer St
Ferguson St
Opal Dr
Dalton Ave
W College Ave
E Main St
St Francis River
Google Earth
Image © 2024 Airbus
2000 ft
N

Water Quality Sampling

Analyte	Acute Freshwater Screening Levels(ug/L)*	BG001 Village creek upstream of confluence with unnamed tributary	BG002 Little Saint Francis River under Hwy 72, near Madison County Ambulance District		W001 Outfall immediately south of Scoops.					W002 Confluence of unnamed tributary and Village Creek
		November 3, 2024	November 2, 2024	November 3, 2024	November 2, 2024	November 3, 2024	November 4, 2024	November 5, 2024		November 3, 2024
		FRMO1103BG001	FRMO1102BG002	FRMO1103BG002	FRMO1102W001	FRMO1103W001	FRMO1104W001	FRMO1105W001	FRMO1105W001	FRMO1103W002
Chemical Oxygen Demand	NA	17.8 mg/L	12.8 mg/L	18.2 mg/L	827 mg/L	704 mg/L	55.4 mg/L	51.4 mg/L	52.2 mg/L	37.2 mg/L
Calcium	NA	42700 ug/L	19500 ug/L	21000 ug/L	106000 ug/L	108000 ug/L	18200 ug/L	19800 ug/L	21000 ug/L	47200 ug/L
Iron	NA	125 ug/L	131 ug/L	187 ug/L	< 41,000 ug/L	257 ug/L	19900 ug/L	24300 ug/L	21800 ug/L	106 ug/L
Lithium	910	< 3,800 ug/L	< 3,800 ug/L	< 3,800 ug/L	2960 ug/L	7700 ug/L	1160 ug/L	917 ug/L	970 ug/L	133 ug/L
Magnesium	NA	24800 ug/L	11400 ug/L	12200 ug/L	54700 ug/L	56800 ug/L	10800 ug/L	11300 ug/L	11800 ug/L	26700 ug/L
Potassium	NA	4000 ug/L	2730 ug/L	2890 ug/L	7270 ug/L	6480 ug/L	16100 ug/L	9240 ug/L	9410 ug/L	4040 ug/L
Sodium	NA	3870 ug/L	3590 ug/L	3730 ug/L	27300 ug/L	24700 ug/L	< 475,000 ug/L	2080 ug/L	2150 ug/L	4810 ug/L
Aluminum	750	36.6 ug/L	56.1 ug/L	54.9 ug/L	64.2 ug/L	156 ug/L	16900 ug/L	19200 ug/L	18600 ug/L	26.9 ug/L
Antimony	900	< 0.190 ug/L	< 0.190 ug/L	< 0.190 ug/L	8.7 ug/L	7.2 ug/L	2.1 ug/L	< 0.190 ug/L	< 0.190 ug/L	< 0.190 ug/L
Cadmium	NA	< 0.020 ug/L	< 0.020 ug/L	< 0.020 ug/L	0.31 ug/L	0.32 ug/L	< 0.020 ug/L	< 0.020 ug/L	< 0.020 ug/L	< 0.020 ug/L
Chromium	NA	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L	2.6 ug/L	< 0.170 ug/L	21.9 ug/L	19.4 ug/L	19.3 ug/L	< 0.170 ug/L
Cobalt	120	< 0.045 ug/L	< 0.045 ug/L	< 0.045 ug/L	11.2 ug/L	10.9 ug/L	40.1 ug/L	49.8 ug/L	52.8 ug/L	< 0.045 ug/L
Copper	NA	1.4 ug/L	1.6 ug/L	2.4 ug/L	14.1 ug/L	12.4 ug/L	55.8 ug/L	72.8 ug/L	70.6 ug/L	1.6 ug/L
Lead	30.1	1.8 ug/L	15.0 ug/L	20.8 ug/L	1.7 ug/L	3.3 ug/L	24.8 ug/L	29.7 ug/L	27.0 ug/L	1.5 ug/L
Manganese	1680	87.8 ug/L	84.6 ug/L	104 ug/L	3060 ug/L	2770 ug/L	710 ug/L	979 ug/L	877 ug/L	123 ug/L
Nickel	260	3.6 ug/L	1.6 ug/L	1.9 ug/L	34.7 ug/L	31.1 ug/L	156 ug/L	189 ug/L	233 ug/L	3.6 ug/L
Tin	1600	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L	< 0.170 ug/L
Zinc	NA	< 1.600 ug/L	< 1.600 ug/L	< 1.600 ug/L	16.0 ug/L	15.8 ug/L	36.1 ug/L	39.8 ug/L	39.7 ug/L	< 1.600 ug/L

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Challenges

- More batteries onsite than originally known
  - Batteries were exposed to elements, which increases risk of fires
    - Missouri- extreme temperature changes
    - SE MO- averages more than 50 inches per year of rain
  - Batteries were not all de-energized when received, also increasing risk of fire
- Rural Missouri- lots of agencies responding and operating, took time to get the emergency management plan into operation
  - Limited experience with chemical or industrial fires
- Limited wastewater facilities available to receive the contaminated wastewater, increase cost and time to clean the site
- Contaminated sediment created with clean up measures

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Clean-Up

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Clean-Up through 2025

Clean-Up

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Clean-Up

- As water pumped out of the basins that were constructed to prevent stormwater from leaving site, a fire hydrant was discovered in one of the basins
  - Verified was not in use
  - Testing to ensure not backflowing into the drinking water system
- More than 951 loads (estimated 5.6 million gallons) of contaminated stormwater to American Bottoms in Illinois for treatment

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In-stream sample results, 1 year post event

Analyte	Acute Freshwater (ug/L)[1]	Max Background Concentration [2]	W001 Outfall immediately South of Scoops.						W002 Confluence of Unnamed Tributary and Village Creek					
			12/17/2025 W001		12/23/2025 W001		12/30/2025 W001		12/17/2025 W002		12/23/2025 W002		12/30/2025 W002	
Chemical Oxygen Demand	NA	27.3	<	50	<	50	<	50	<	50	<	50	<	50
Calcium	NA	42,700		81600		69700		58600		47400		40100		42300
Iron	NA	1,270		519		571		960		45.8		70.4		87.2
Lithium	910	36.1		766		887		2300	<	50	<	50	<	50
Magnesium	NA	24,800		42600		40800		27200		26600		26000		23100
Potassium	NA	4,000		1680		1720		3500		2580		2740		3100
Sodium	NA	3,910		13100		12100		15300		4180		3930		4150
Aluminum	750	1,640	<	25		28.4		269	<	25		53.1		60.4
Antimony	900	ND	<	1	<	1	<	1	<	1	<	1	<	1
Cadmium	NA	ND	<	1	<	1	<	1	<	1	<	1	<	1
Chromium	NA	2.2	<	1.5	<	1.5	<	1.5	<	1.5	<	1.5	<	1.5
Cobalt	120	1.6		3.8		3		5.3	<	1	<	1	<	1
Copper	NA	3.9		3.7		2.7		25.6		1.2		1.1		1
Lead	30.1	29.4	<	1	<	1		1.3	<	1		1.6		1
Manganese	1,680	174		2890		2220		1310		16.7		41.1		18.3
Nickel	260	4.5		5.5		5.4		20.4	<	1	<	1	<	1
Tin	1,600	ND	<	5	<	5	<	5	<	5	<	5	<	5
Zinc	NA	7.2	<	15	<	15	<	15	<	15	<	15	<	15
pH at 25 Degrees C	NA	8.3		7.84		7.59		7.58		8		7.98		8.1
BOD, 5 day	NA	ND	<	10	<	10	<	10	<	10	<	10	<	10

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Next Steps

- Continued recommendation to not use Village Creek for livestock watering
- Facility applied for a site-specific permit more than a year after the fire
  - Initial application was incomplete and more information has been requested from the facility
  - Developing a site specific NPDES permit for the current site conditions and planned future conditions, including the contaminated soils
- As general permits are renewed, stating explicitly if an activity or material is covered under that permit
- Continued work with our Water Quality Standards team to develop appropriate limits on a case-by-case basis and evaluate if statewide criteria is necessary

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Lessons Learned

- Remember chemistry - don't mix lithium and water
- Store batteries for recycling in climate-controlled locations
- Verify fire suppression systems are operational
- SIC codes may not adequately cover the activities and pollutants of concern
  - MO is starting to remove SIC codes from permits (still required on applications), but more description on covered activities and pollutants of concern
- Inform emergency responders to what is on site, how it is stored, and volume
- Battery recycling and the critical minerals are a national priority, and the landscape changes quickly and regulations and research may not keep up
  - NFPA standards in 2025 for lithium-ion batteries (NFPA 855)
- Trust, but verify and ask a lot of questions

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Other Lithium fires

- Multiple fires around Missouri at Salvage Yards and Transfer Stations
  - Lithium batteries improperly disposed
  - Lithium batteries still in vehicles being crushed
    - Picture- Fulton, MO March 2026, source KRCG
- Other fires have been smaller because it is often only 1 or 2 batteries
- “Plan for the fires”
- Educating the public, agencies, and multiple industries of the risks and how to minimize the issues

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Questions for Discussion

- Do other states have general permits covering recycling of lithium batteries?
- How are other states educating/informing the public to minimize risks?
- Besides the risk with recycling, how are other states developing permits or addressing concerns for battery energy storage systems, such as at power plants or data centers?
- How are other states developing effluent limits for parameters that may not be in Water Quality Standards or that EPA has not developed criteria for, including:
  - Pretreatment
  - Stormwater
  - Process wastewaters
  - Fire system waters

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Thank you

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