Sand Branch Benthic TMDL Study

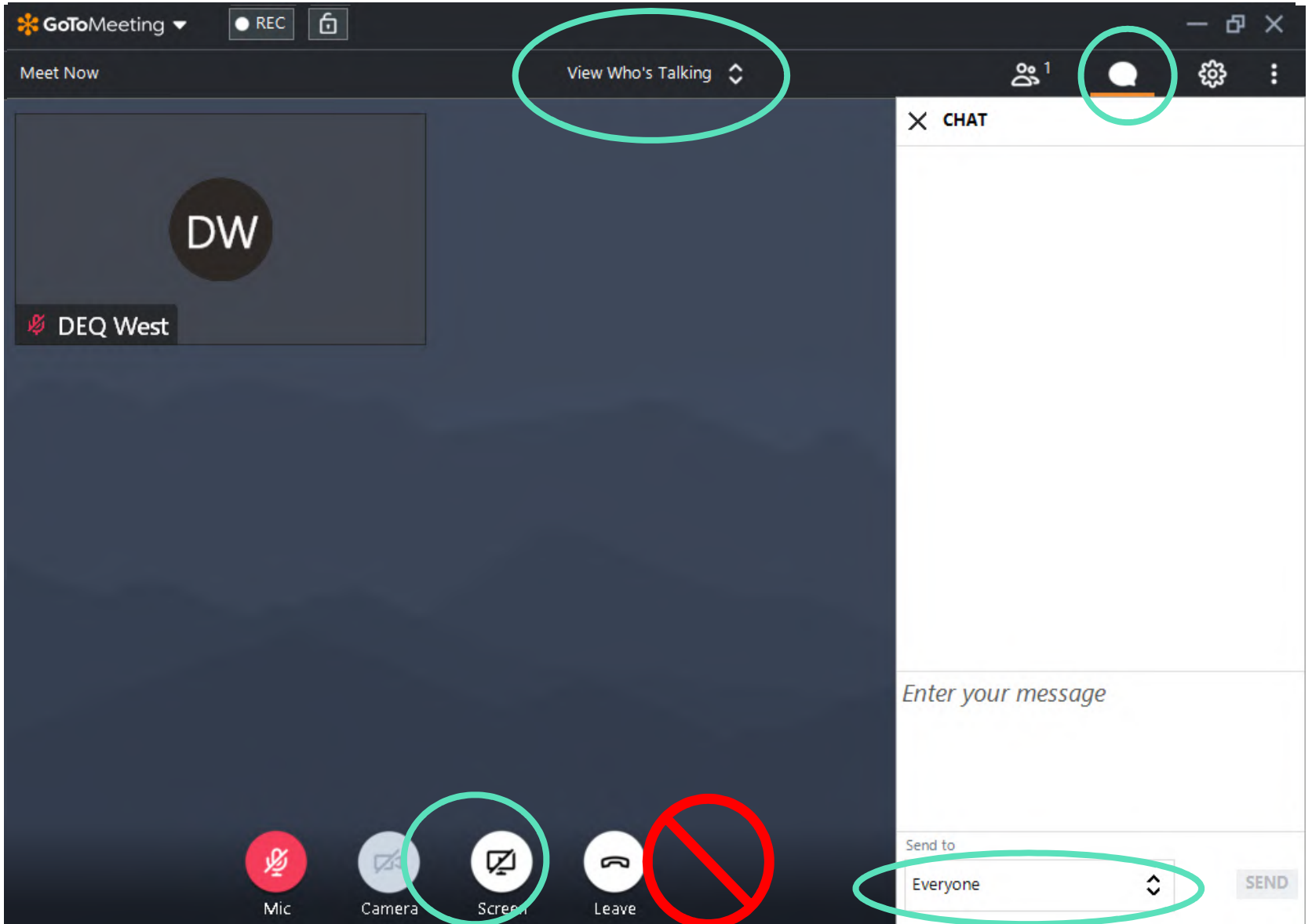
Third Technical Advisory Committee Meeting

Sarah K. Sivers
Water Quality Planning Team Lead
Virginia Department of Environmental Quality

Robert N. Brent
Professor of Integrated Science and Technology
James Madison University

April 21, 2021

Getting Familiar with GoToMeeting



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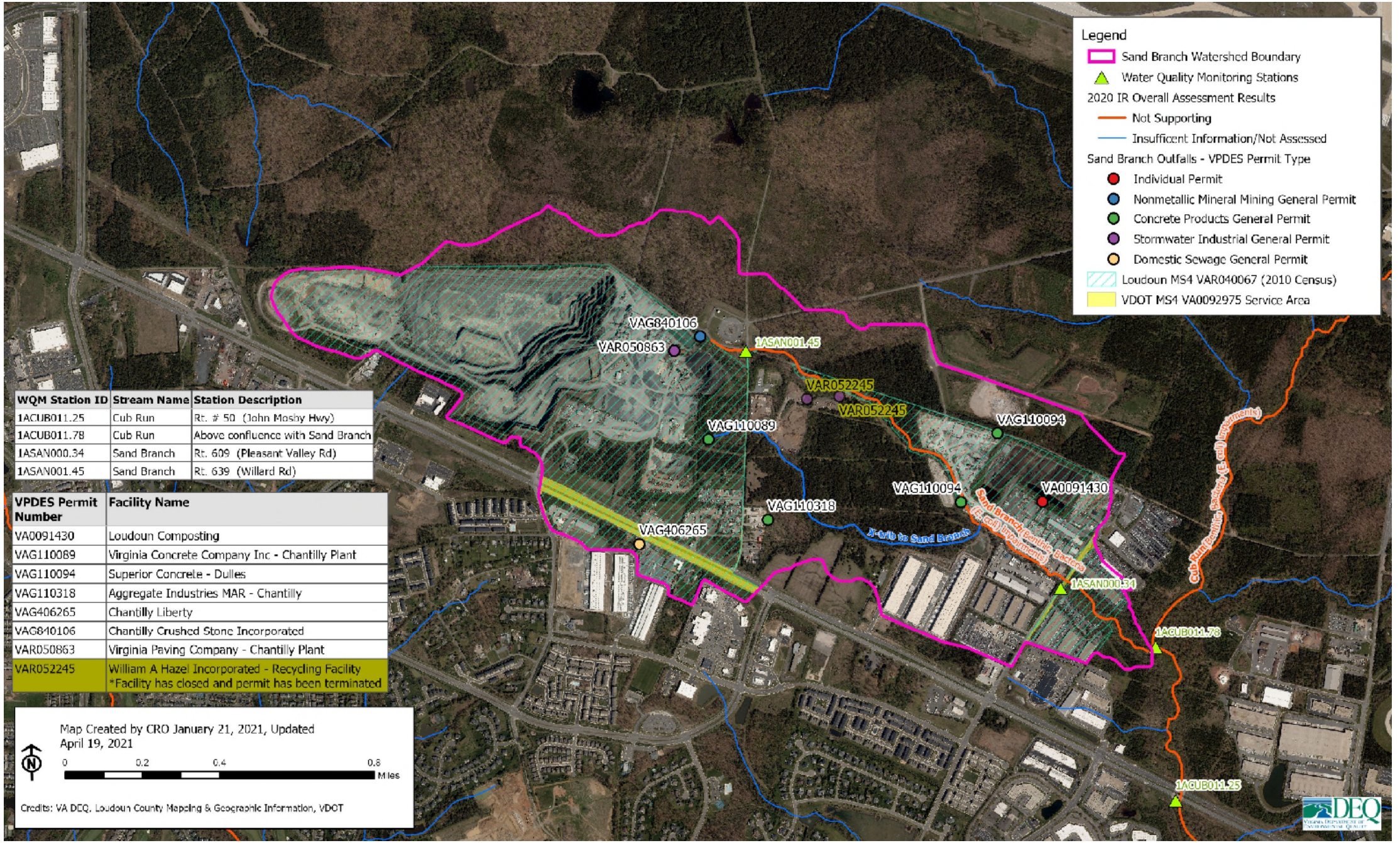
Agenda

- Brief Refresher
- Stressor Analysis
  - Updated Information
  - Biological and Habitat Data Analysis
  - CADDIS
  - Probable Stressors
- Planning for TMDL
  - TMDL Targets
  - Water Quality Monitoring
  - Project Timeline
- Wrap-up and Next Steps

Refresher

Material Covered in 2nd TAC Meeting



WQM Station ID	Stream Name	Station Description
1ACUB011.25	Cub Run	Rt. # 50 (John Mosby Hwy)
1ACUB011.78	Cub Run	Above confluence with Sand Branch
1ASAN000.34	Sand Branch	Rt. 609 (Pleasant Valley Rd)
1ASAN001.45	Sand Branch	Rt. 639 (Willard Rd)

VPDES Permit Number	Facility Name
VA0091430	Loudoun Composting
VAG110089	Virginia Concrete Company Inc - Chantilly Plant
VAG110094	Superior Concrete - Dulles
VAG110318	Aggregate Industries MAR - Chantilly
VAG406265	Chantilly Liberty
VAG840106	Chantilly Crushed Stone Incorporated
VAR050863	Virginia Paving Company - Chantilly Plant
VAR052245	William A Hazel Incorporated - Recycling Facility *Facility has closed and permit has been terminated

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Chemical / Physical Parameters Analyzed

Candidates <u>with</u> stressor thresholds[1,2]:	***pH***	***Dissolved Oxygen (DO)***	Total Phosphorus	Total Dissolved Solids (TDS)	Potassium
	Temperature	Specific Conductivity	Total Nitrogen	Sulfate	***Chloride***
	Sediment[3]	Sodium	Metal Cumulative Criterion Unit (Metals CCU)		***Individual Metals, Dissolved***
Candidates <u>without</u> stressor thresholds[2]:	Total Suspended Solids (TSS)		***Ammonia***	DO (Saturation)	Turbidity

[1]DEQ's Freshwater Probabilistic Monitoring Program (DEQ, 2017. Stressor Analysis in Virginia: Data Collection and Stressor Thresholds. DEQ Technical Bulletin WQA/2017-001)

[2]Where water quality criteria exists for a parameter, that value was also in the analysis (Water Quality Standards, 9VAC25-260). Those parameters with criteria are denoted in bold, italicized text.

[3] Sediment was evaluated using Log Relative Bed Stability (LRBS) index and Habitat.

Stressor Thresholds: Definitions of Stress Probabilities

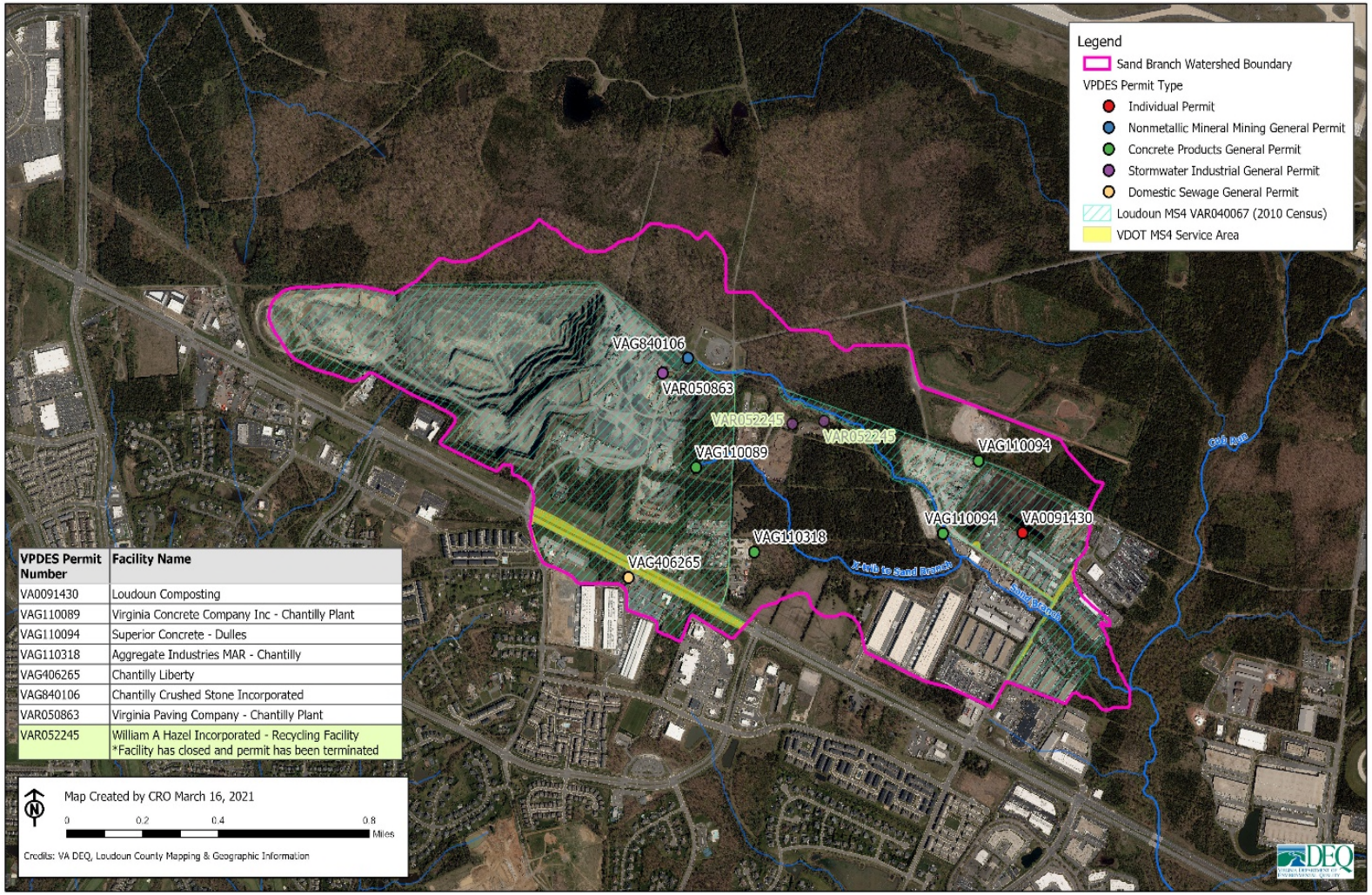
Probability of Stress to Aquatic Life	Definition
High Probability	Values that are the highest in Virginia, resulting in degradation of the benthic community.
Medium Probability	Noticeable evidence of harm causing a possible shift in benthic communities, changes noticeably above background conditions.
Low Probability	Slightly above background conditions, but unlikely to cause a major benthic community shift.
No Probability	Background conditions.

Stressor Analysis

Updated Information

Updated Permit Information

- VAR052245, William A Hazel Inc. – Recycling Facility
  - Stormwater Industrial GP
  - Permit terminated (3/2021)
- VA0092975, VDOT
  - MS4 Permit
  - Included



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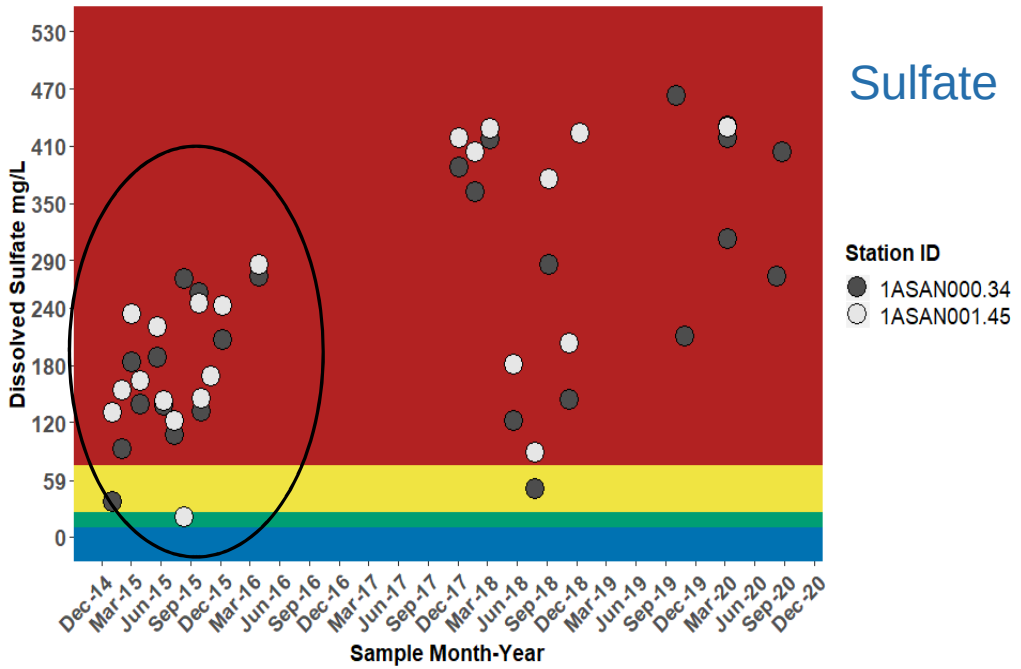
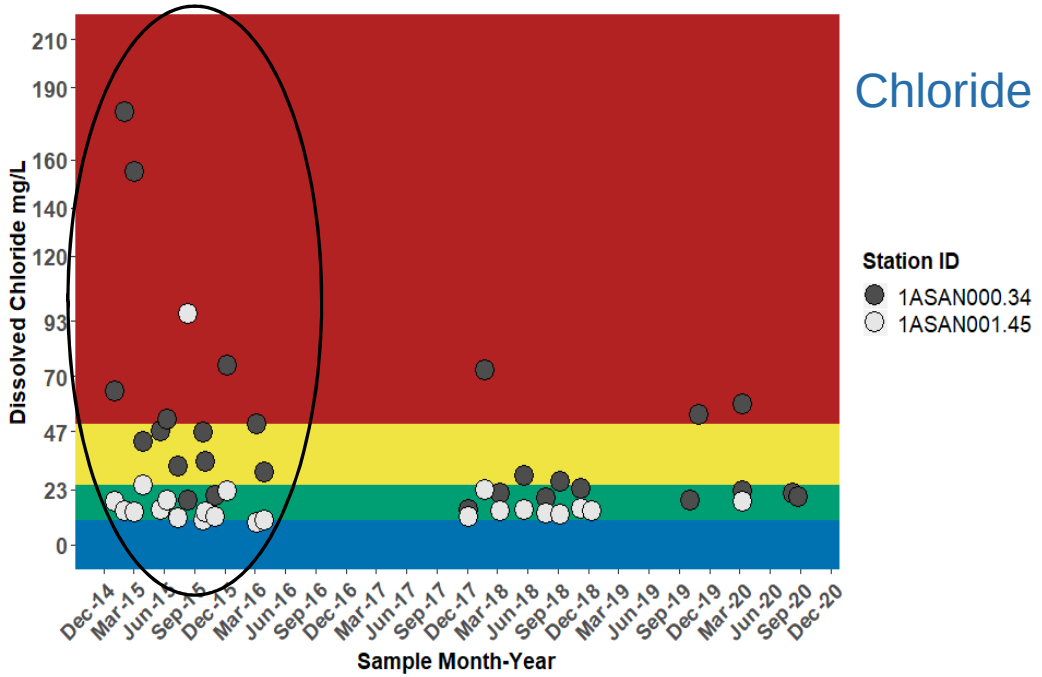
Water Quality Chemistry Data Updated

- Ions – Sulfate and Chloride
  - Added data collected prior to 2016



Sulfate



Chloride

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Water Quality Chemistry Data Updated (continued)

- Ammonia
  - Added 2 data points from August 2020 sampling effort
  - Revised evaluation to updated WQ criteria
    - No excursions of the acute criterion
    - Single sample excursion of chronic criterion on 5/22/18

	1ASAN000.34			1ASAN001.45		
Monitoring Date	Ammonia (mg/L)	Acute Criteria (mg/L)	Chronic Criteria (mg/L)	Ammonia (mg/L)	Acute Criteria (mg/L)	Chronic Criteria (mg/L)
12/5/2017	0.01 [a]	7.25	1.314	0.01 [a]	6.74	1.187
1/23/2018	0.01 [a]	5.94	1.070	< 0.008 [b]	6.57	1.165
3/12/2018	0.03 [a]	5.01	1.089	< 0.008 [b]	5.75	1.077
5/22/2018	1.5	5.86	1.042	0.06	3.34	0.688
7/26/2018	0.06	2.97	0.627	0.04	3.13	0.650
9/6/2018	0.36	3.21	0.657	0.02 [a]	2.60	0.564
11/8/2018	0.48	9.19	1.494	0.02 [a]	7.13	1.239
12/13/18[c]	--	--	--	0.01 [a]	--	--
10/3/2019	0.05	3.52	0.717	--	--	--
10/31/2019	0.02 [a]	7.55	1.265	--	--	--
3/9/2020	< 0.014 [b]	1.87	0.403	< 0.014 [b]	2.94	0.603
3/11/2020	< 0.014 [b]	6.34	1.130	< 0.014 [b]	3.33	0.667
8/10/2020	0.02 [a]	3.73	0.746			
8/26/2020	< 0.014 [b]	6.38	1.087			

[a] Analyte detected above the method detection level but below the method quantification limit.
[b] Material analyzed for, but not detected. Value is the limit of detection.
[c] pH and temperature data were not collected so acute/chronic criteria cannot be calculated

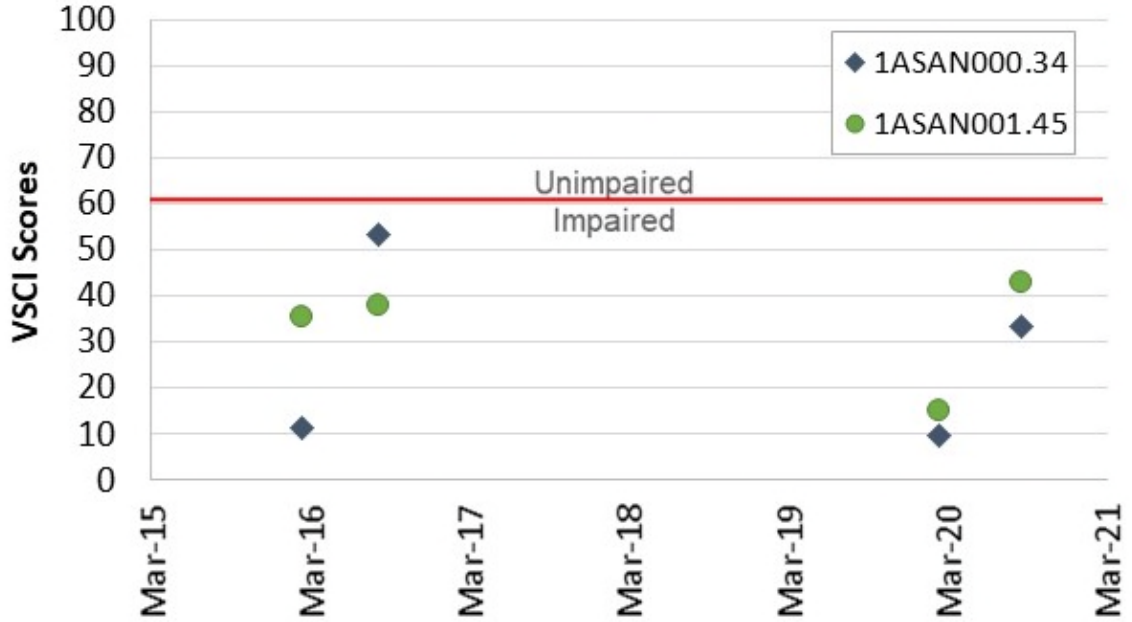
Stressor Analysis

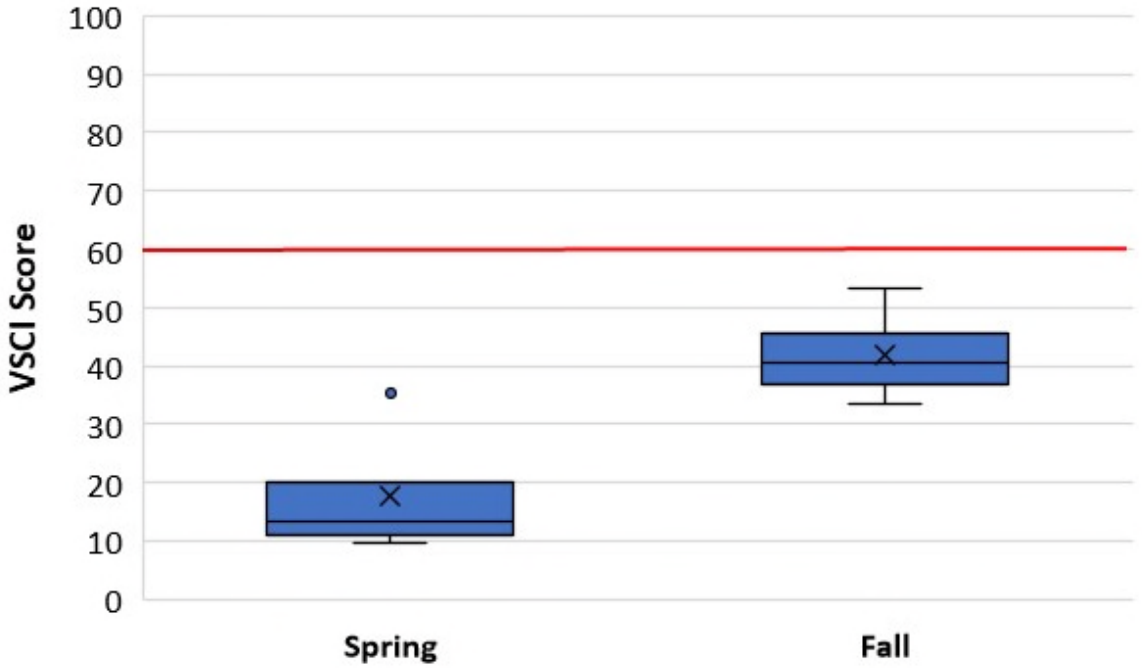
Biological and Habitat Data Analysis

Benthic Data

- VSCI scores averages:
  - 1ASAN001.45 = 32.9
  - 1ASAN000.34 = 26.9

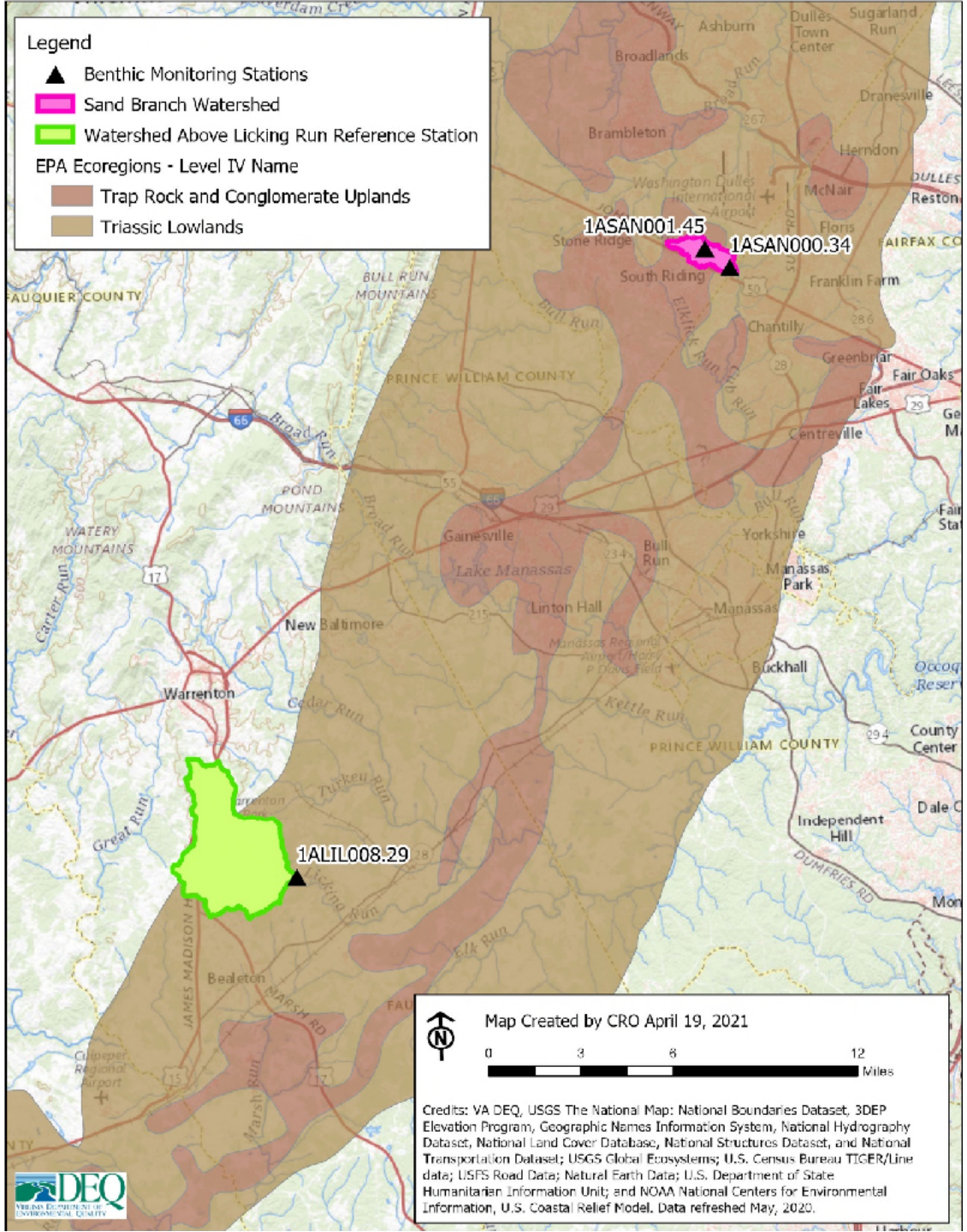
- Seasonal Difference
  - Spring scores much lower than fall





Reference Watershed

- Comparison to a reference condition is helpful in evaluating some parameters and biological conditions
- Licking Run
  - Same Triassic Basin ecoregion
  - Unimpaired benthic condition (VSCI = 62.26)
  - Ample water quality data



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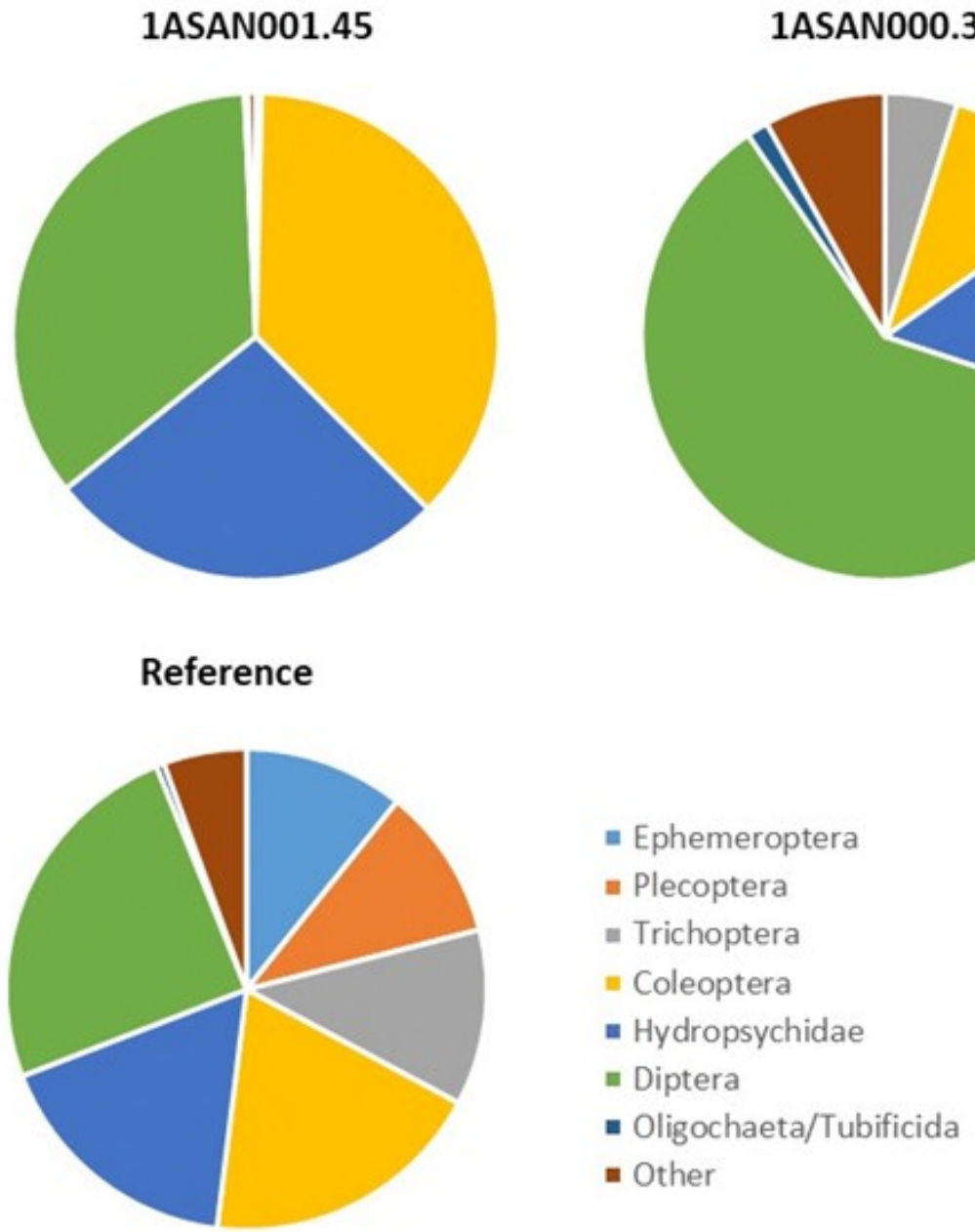
Benthic Data

- Community Composition Analysis
  - Compared to Licking Run (Reference)
  - Loss of almost all sensitive taxa
  - Dominance by a few tolerant taxa
    - Chironomidae
    - Hydropsychidae
    - Stenelmis



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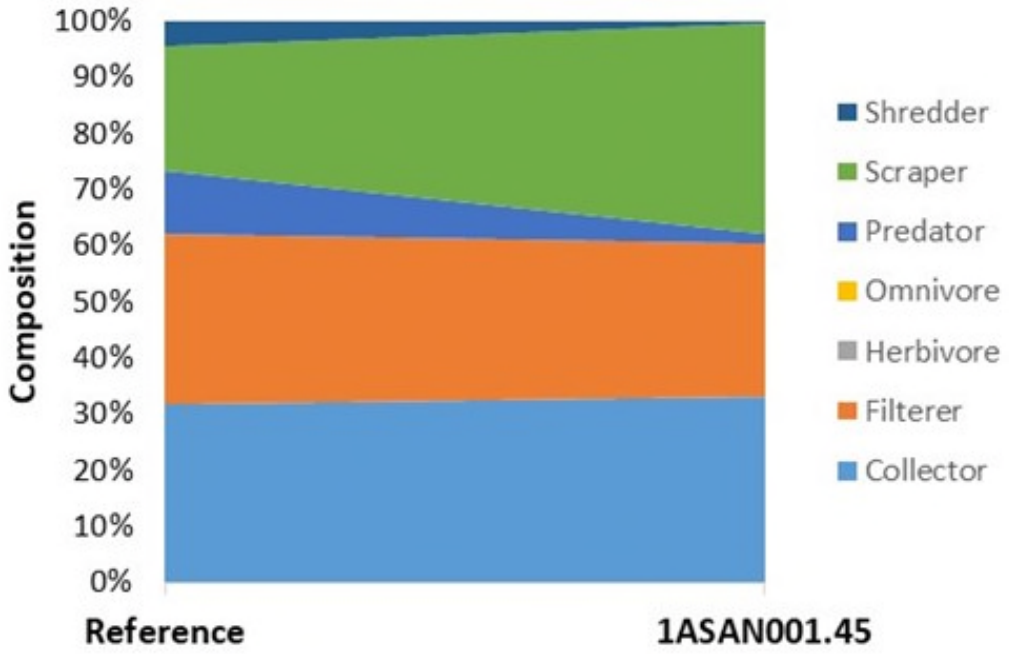
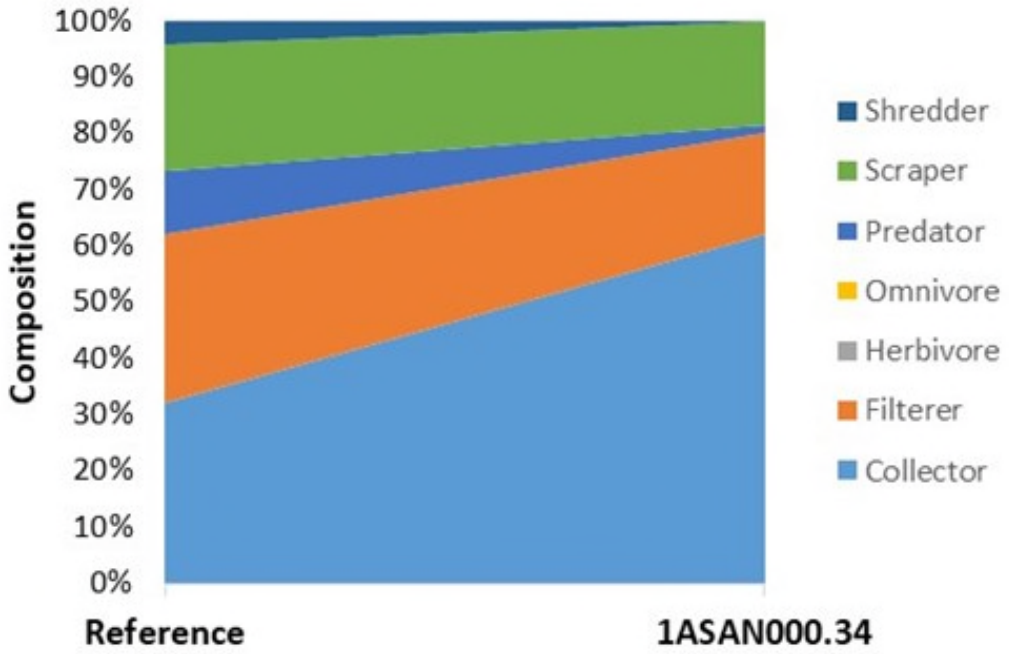
Benthic Data

- Functional Feeding Group Analysis
  - Upstream site: Increase in Scrapers
  - Downstream site: Increase in Collectors





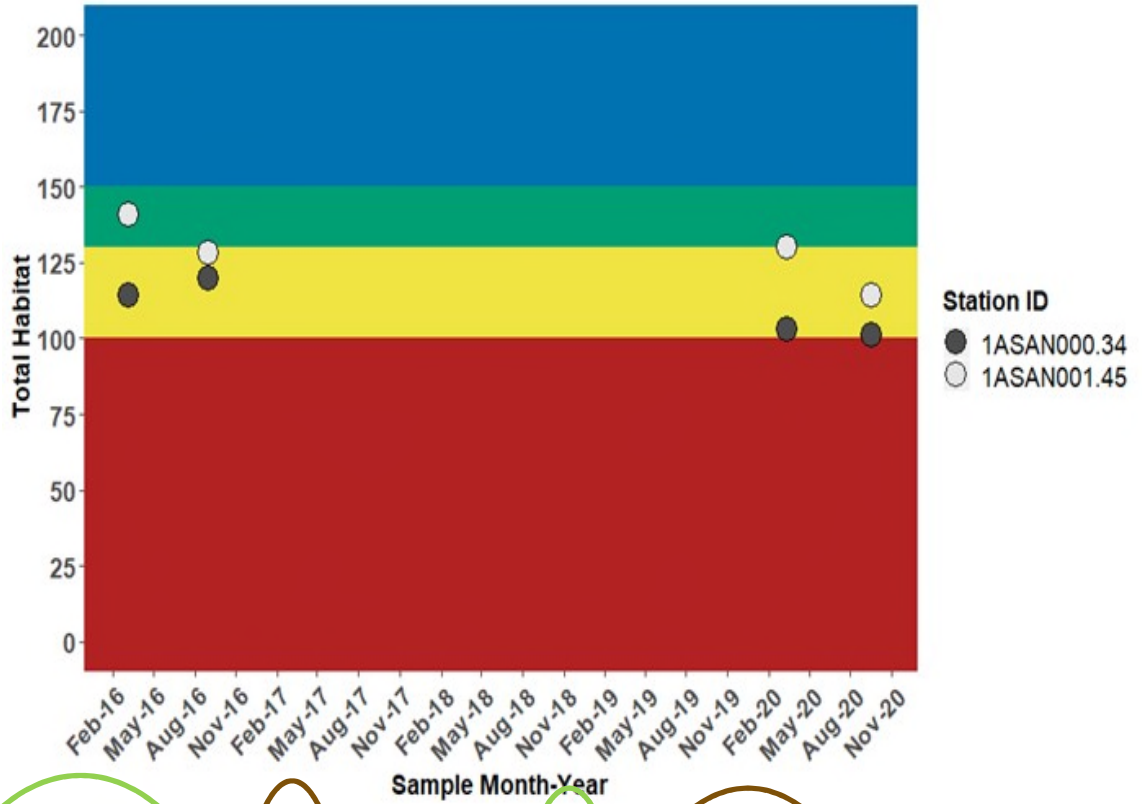
Benthic Data

- Biological Condition Gradient Analysis
  - Uses stressor-specific tolerance information from dominant taxa
  - Scores of 5 indicate dominance in presence of stressor

Genus Level	No. of Individuals	Functional Feeding Group	General Attribute[1]	Biological Condition Gradient (BCG) Attribute Assignments for Specific Stressors									
				DO	Acidity (pH[2])	Alkalinity (pH[2])	Specific Conductance	Chloride	Sulfate	Nutrients[3]	Total Habitat Score	Relative Bed Stability	Watershed % Impervious
Chironomidae (A)	451	Collector	4	4	4	4	4	4	4	4	4	4	4
Stenelmis	73	Scraper	4	4	4	4	5	4	4	4	5	4	5
Cheumatopsyche	68	Filterer	5	4	3	4	5	4	4	5	4	4	5
Hydroptila	37	Scraper	4	3	2	3	5	4	5	5	4	3	5
Hydropsychidae	26	Filterer	4	3	3	4	4	3	4	4	4	4	4
Physidae	25	Scraper	5	5	4	5	5	4	3	5	5	5	5
Corbicula	24	Filterer	6t	4	3	4	5	4	4	5	5	4	5
Hydropsyche	20	Filterer	4	3	3		5	4	5	5	4	4	5
Oligochaeta	11	Collector	5	4	4	3	5	4	4	5	5	5	5
TOTAL	735		**Rounded Average**	4	3	4	5	4	4	5	4	4	5

Habitat Data

- Qualitative Habitat Scores
  - Medium probability range for stressor effects
  - Individual metrics low for substrate quality and riparian quality



Station ID	Date	Channel Alteration	Banks	Bank Vege-tation	Embedd-edness	Flow	Riffles	Riparian Vege-tation	Sediment	Substrate	Velocity	Total Habitat
1ASAN000.34	2016-03-08	8	11	9	11	15	13	9	12	10	16	114
1ASAN000.34	2016-08-31	10	10	15	9	18	16	9	11	4	18	120
1ASAN000.34	2020-03-11	7	8	10	12	10	9	9	14	10	14	103
1ASAN000.34	2020-09-17	7	10	10	7	20	7	9	10	7	14	101

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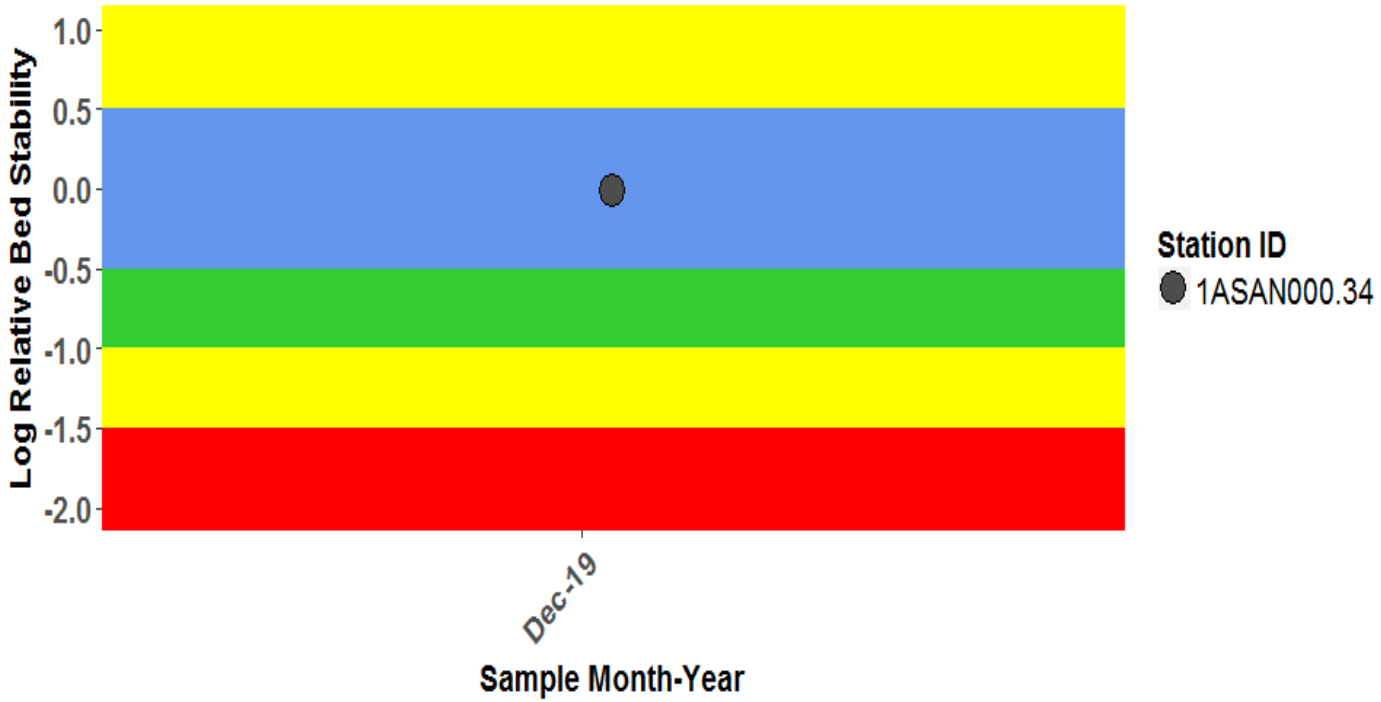
Habitat Data

- Relative Bed Stability
  - Quantitative assessment of stream habitat that compares observed sediment size to predicted
  - LRBS value in the no probability range for stressor effects
  - May indicate a hardening of the substrate (80%) from scour
  - May be experiencing cycles of sediment deposition then scour



LRBS Metrics	Value
% Sands and Fines	12%
Percentile Sands and Fines[1] (Northern Piedmont / Statewide)	12th / 14th
% Boulders, Cobbles, Gravel	43%
Percentile Boulders, Cobbles, Gravel[1] (Northern Piedmont / Statewide)	52th / 49th
% Hardpan	22%
% Concrete or Asphalt	15%
Average Embeddedness	38%
Percentile Embeddedness (Northern Piedmont / Statewide)	18th / 21th

[1] Based on DEQ Probabilistic Monitoring data

DEQ

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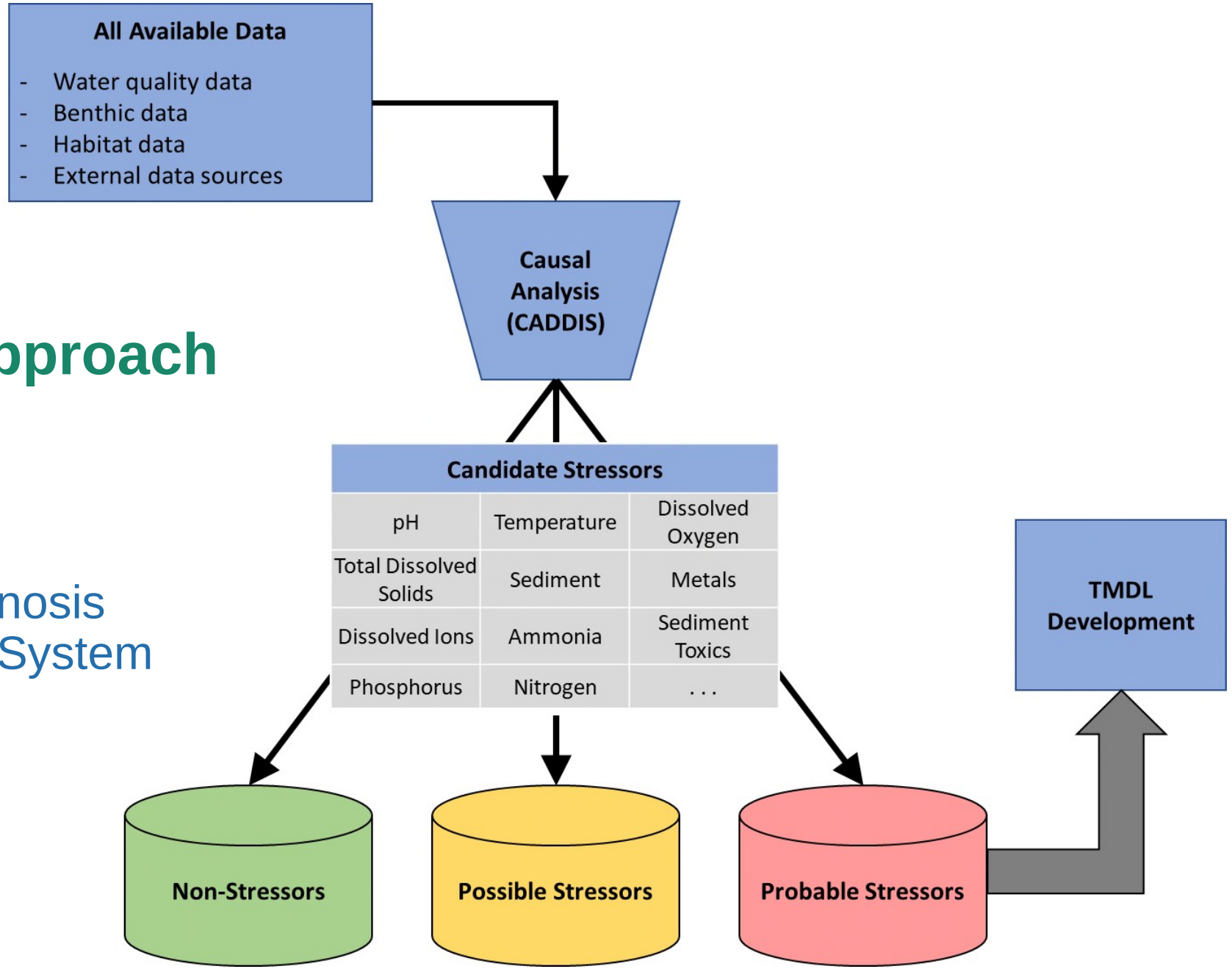
Stressor Analysis

CADDIS Overview

Stressor Analysis Approach

- CADDIS
  - Causal Analysis/Diagnosis Decision Information System



CADDIS Approach

- For each candidate stressor and stream
- 18 lines of evidence evaluated
- Scored on a relative scale of -3 to +3 for strength of support
- Scores summed
- Higher relative score, more probable the stressor

Ex: Candidate Stressor 1

Lines of Evidence	Stream 1	Stream 2	Stream 3	Stream 4	Stream 5	Stream 6
Spatial Co-occurrence	-3	-3	-1	-1	+3	+3
Temporal Co-occurrence	-2	-2	0	0	+2	+2
Causal Pathway						
Stressor-Response Relationships from the Field						
Temporal Sequence						
Symptoms						
Stressor-Response Relationships from Other Field Studies						
Stressor-Response Relationships from Laboratory Studies						
Stressor-Response Relationships from Simulation Models						
Mechanistically Plausible Cause						
Manipulation of Exposure at Other Sites						
Analogous Stressors						
Consistency of Evidence	-3	-2	0	0	0	0
Explanation of the Evidence	-2	-2	0	0	0	0
SUM	**-32**	**-27**	**+1**	**+3**	**+12**	**+10**
	Non-Stressor		**Possible Stressor**		**Probable Stressor**	

Score	Explanation
+3	The line of evidence **strongly supports** the candidate stressor as the cause of the impairment
+2	The line of evidence **moderately supports** the candidate stressor as the cause of the impairment
+1	The line of evidence **weakly supports** the candidate stressor as the cause of the impairment
0	The line of evidence **does not support or refute** the candidate stressor as the cause of the impairment
-1	The line of evidence **weakly refutes** the candidate stressor as the cause of the impairment
-2	The line of evidence **moderately refutes** the candidate stressor as the cause of the impairment
-3	The line of evidence **strongly refutes** the candidate stressor as the cause of the impairment

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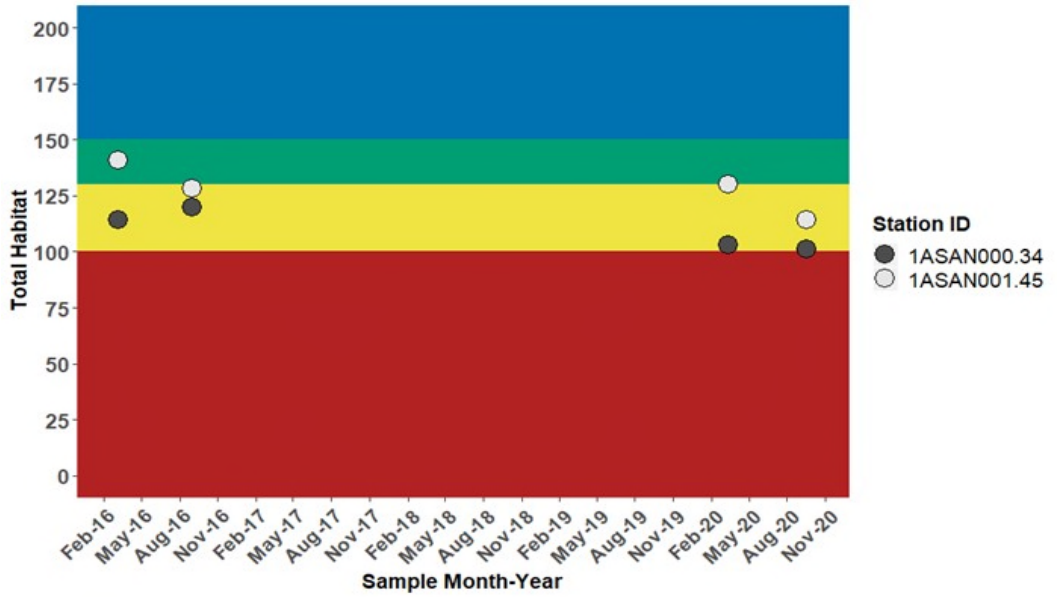
CADDIS Results

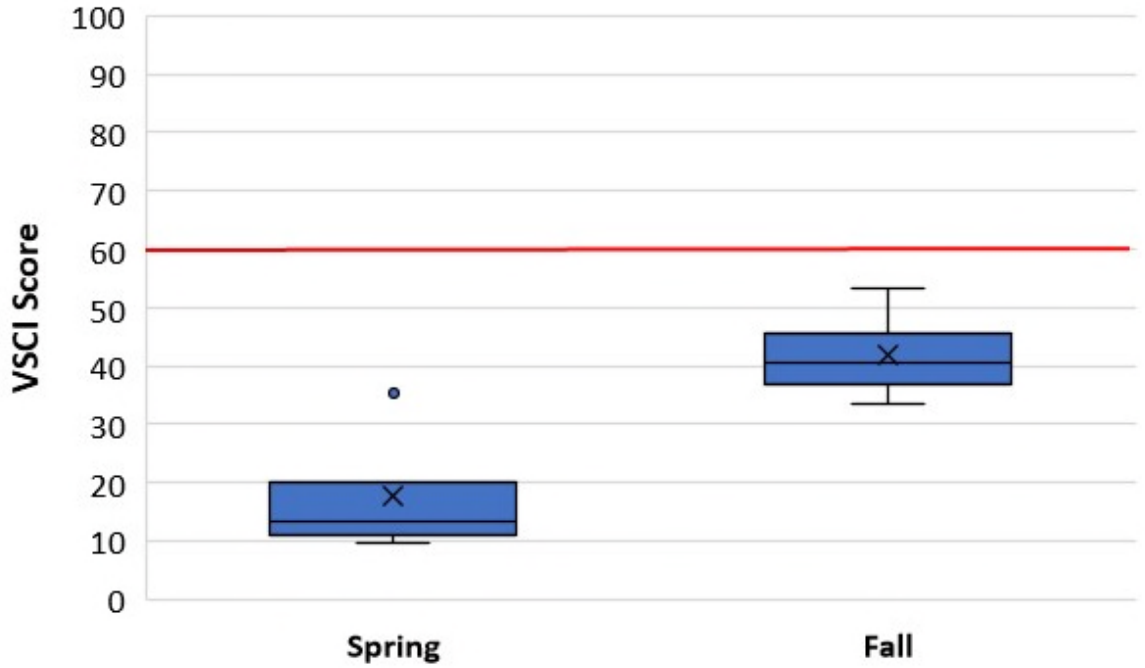
- Non-stressors
- Possible stressors
- Probable stressors

Candidate Stressor	CADDIS Score
pH	-24
Temperature	-13
Dissolved Oxygen	-12
Dissolved Metals	-9
Total Nitrogen	1
Chloride	1
Potassium	1
Ammonia	2
Sodium	3
Sediment	6
Total Phosphorus	16
Sulfate	16
Conductivity/TDS	31

Support for Sediment as a Stressor

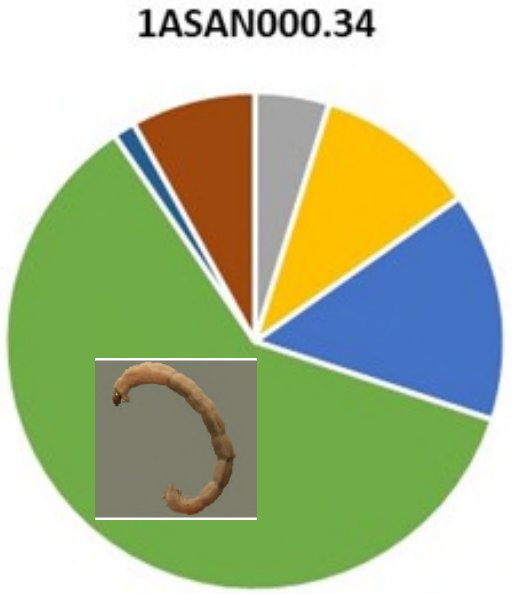
- Habitat scores in the medium probability range for stressor effects
- Seasonal pattern of benthic scores

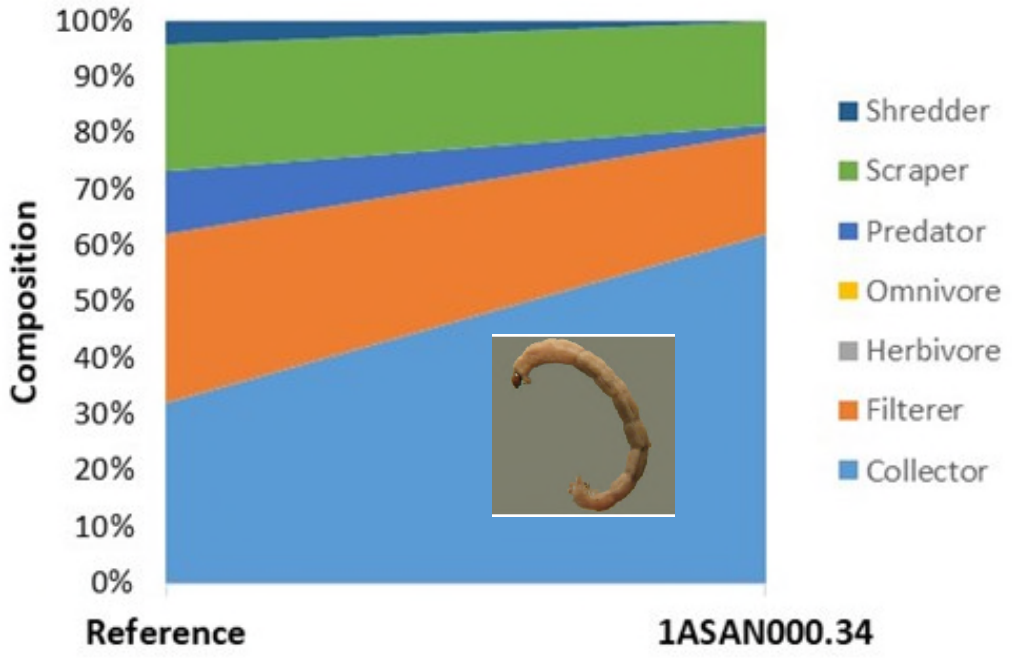




Support for Sediment as a Stressor

- Community composition
- Feeding group analysis





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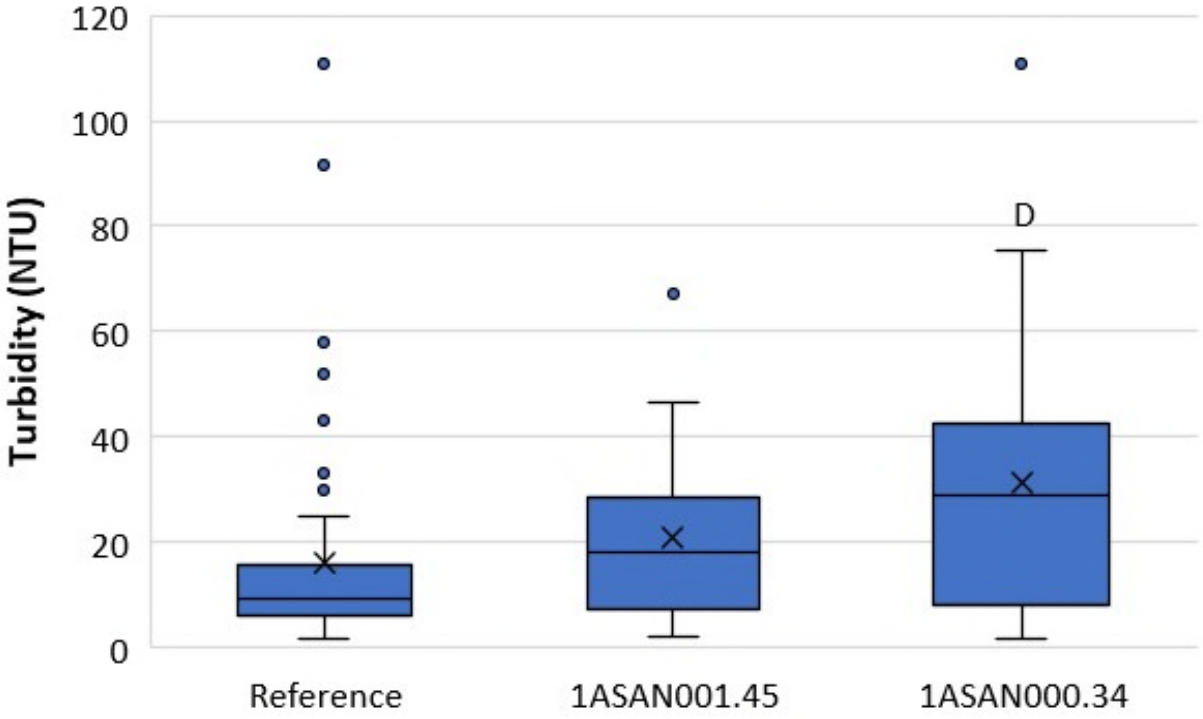
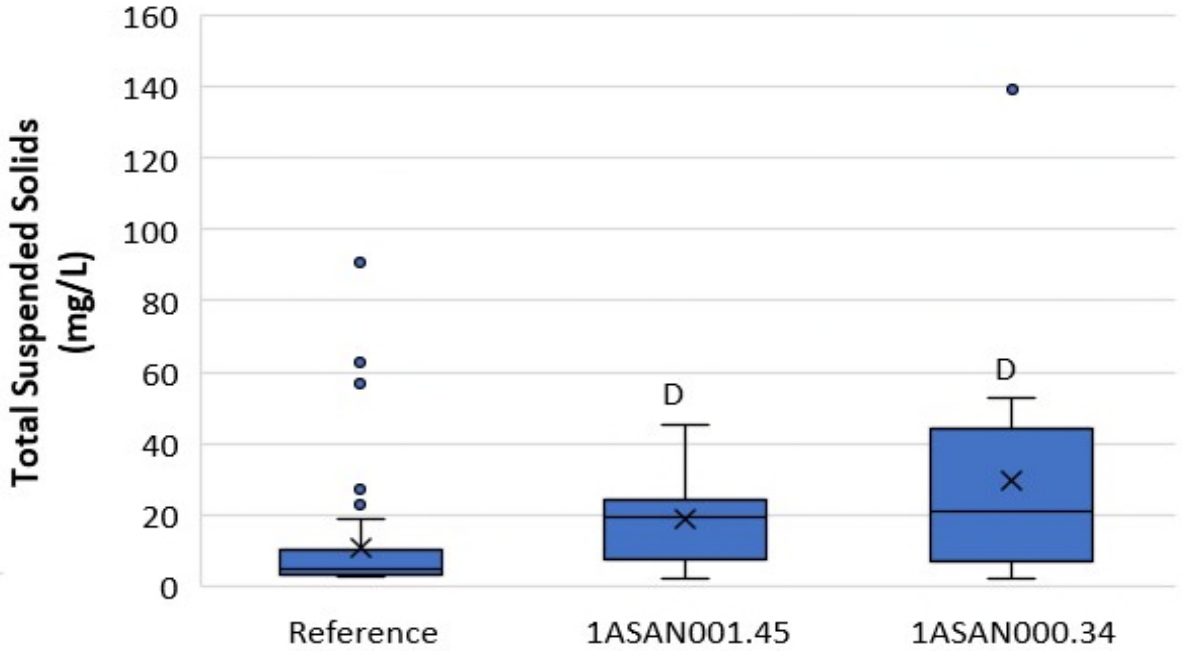
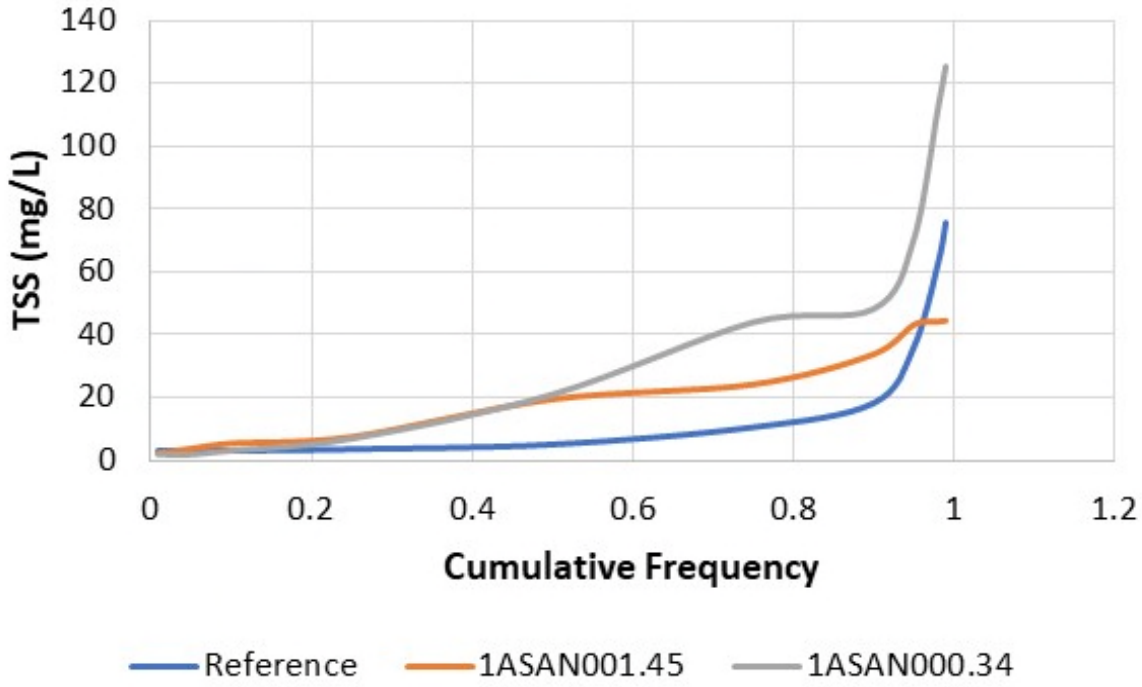
Support for Sediment as a Stressor

- Total suspended solids
- Turbidity data

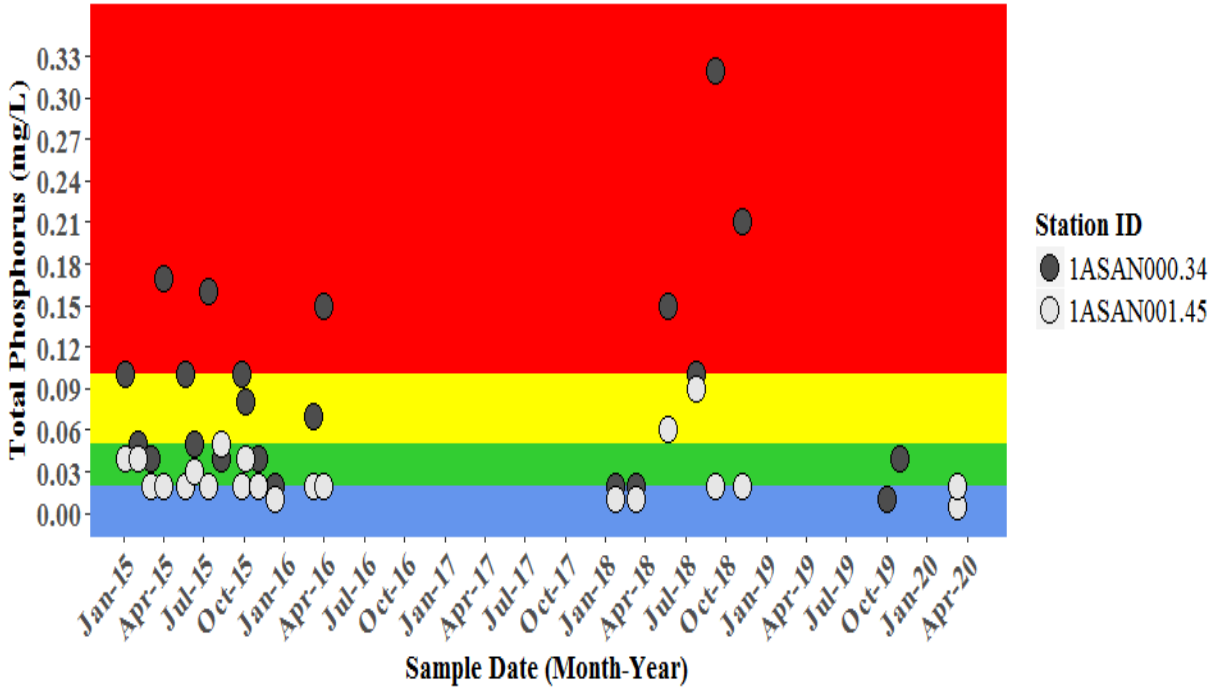


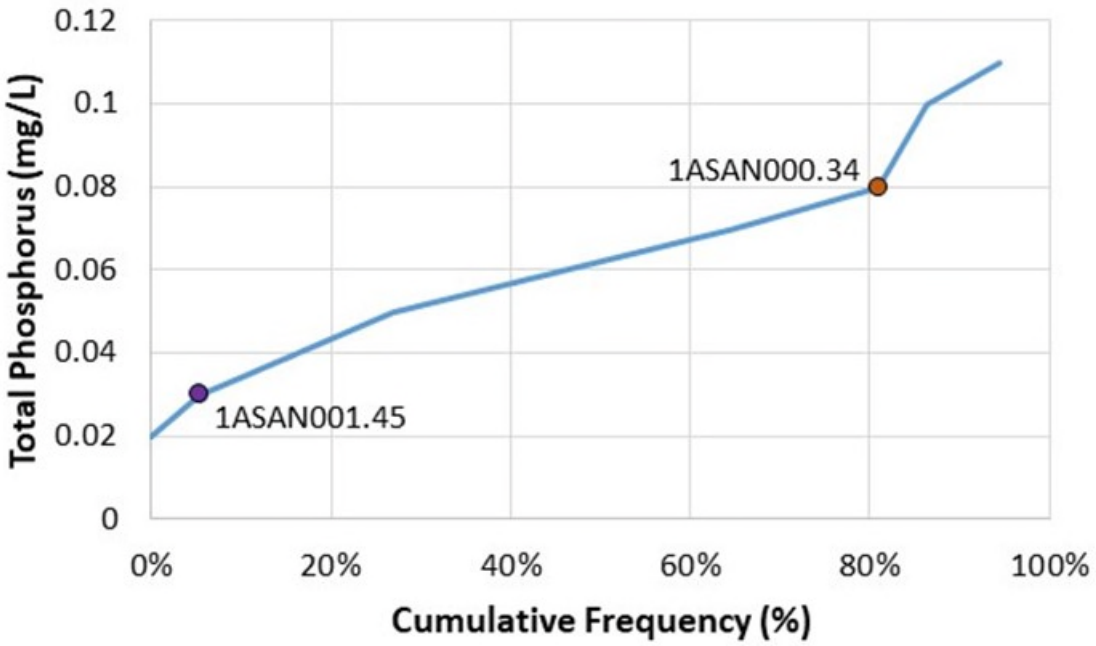




Support for Phosphorus as a Stressor

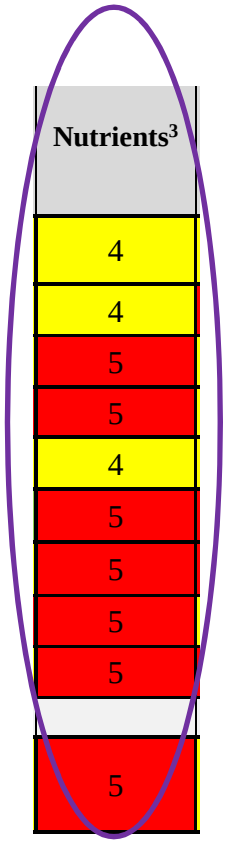
- Average phosphorus levels in the medium probability range for stress effects
- Levels exceeded recommended EPA criteria for ecoregion
- 81st percentile of Triassic Basin ecoregion

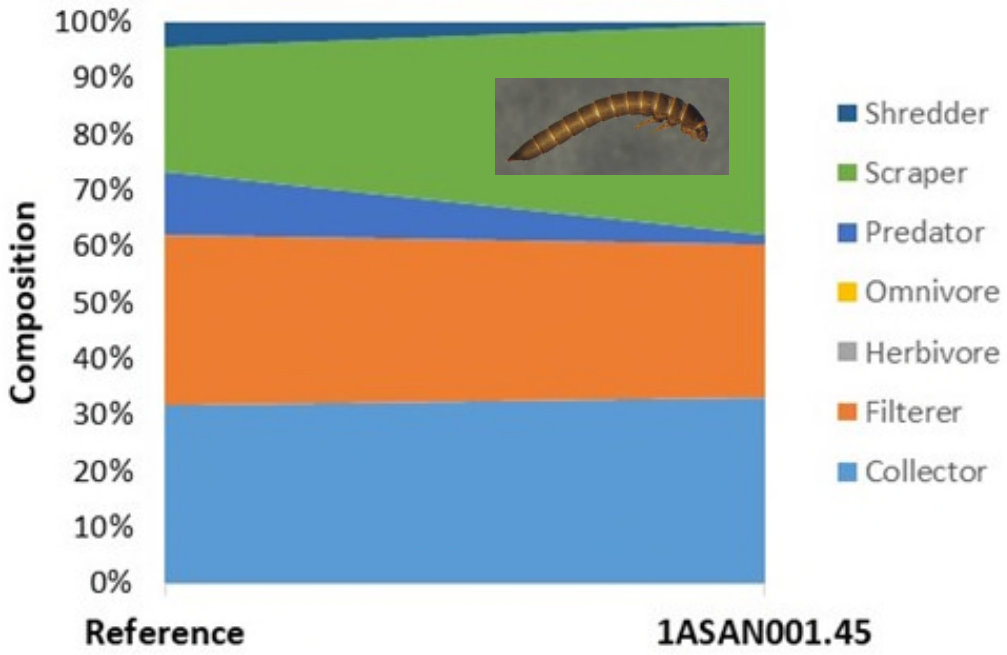




Support for Phosphorus as a Stressor

- Biological condition gradient analysis identified nutrients
- Feeding group analysis
- Observations of thick filamentous algae

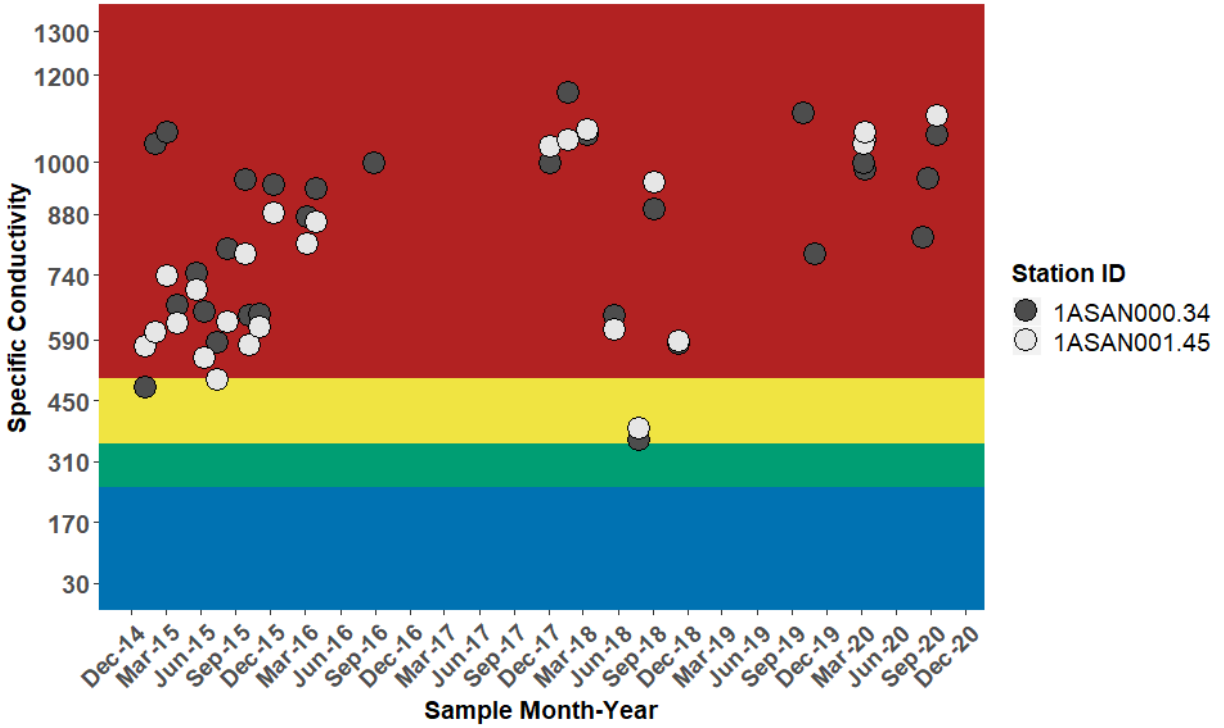


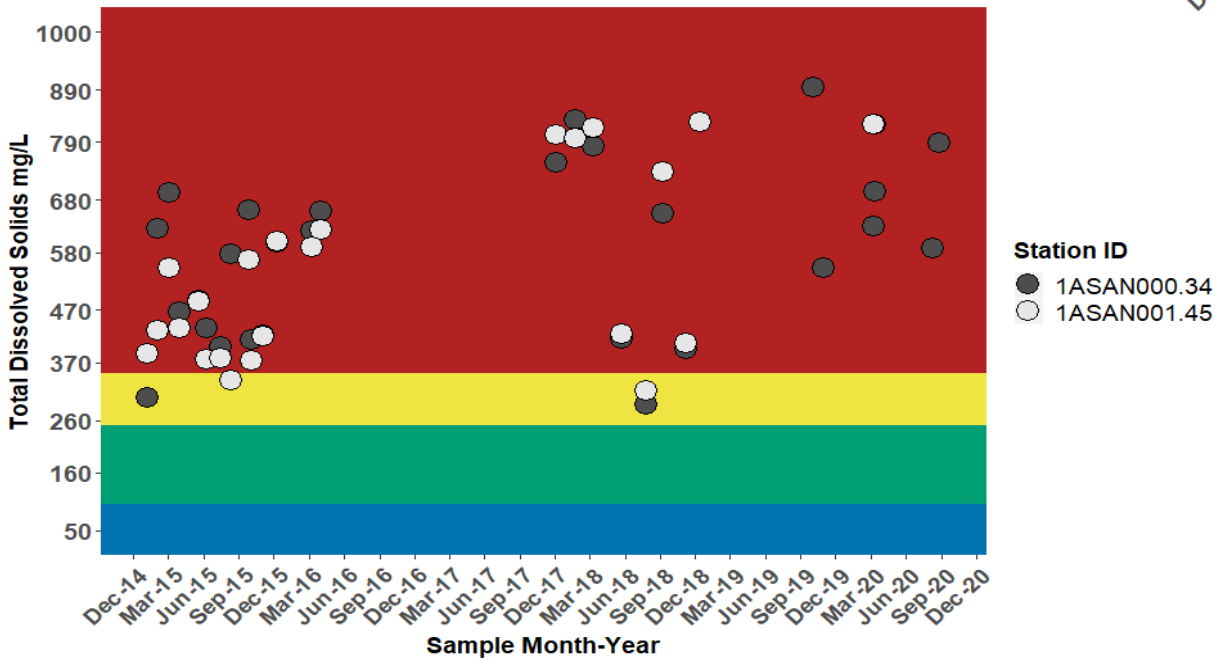


DEQ

Support for Total Dissolved Solids (TDS) as a Stressor

- Conductivity and TDS in the high probability range for stress effects

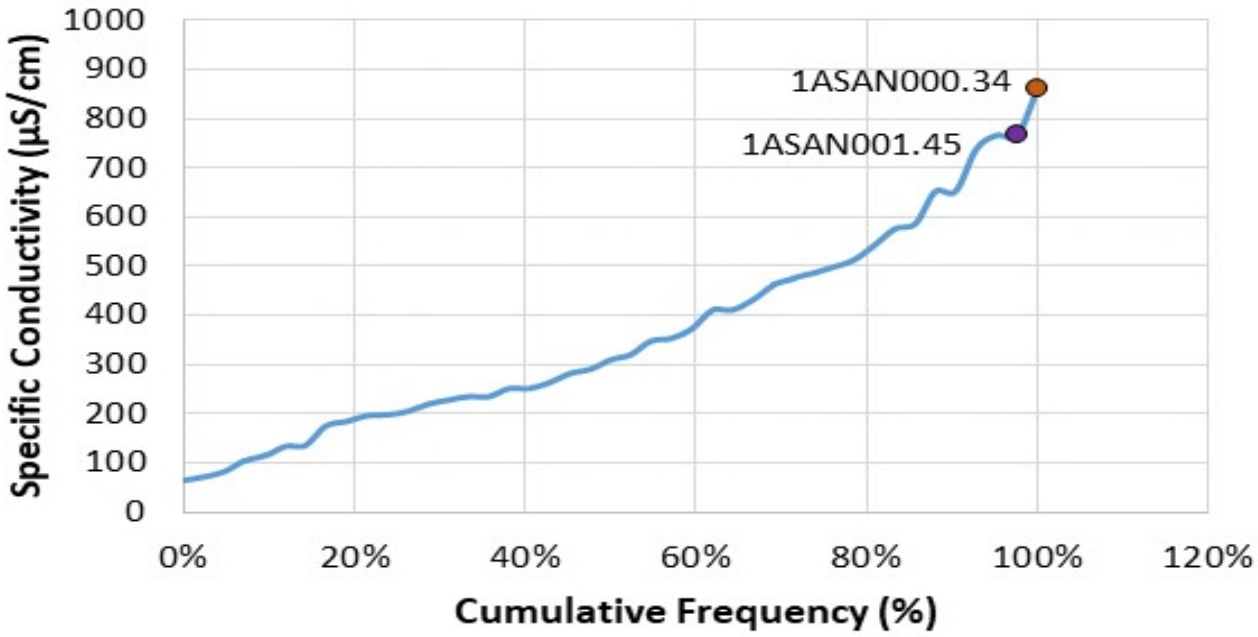


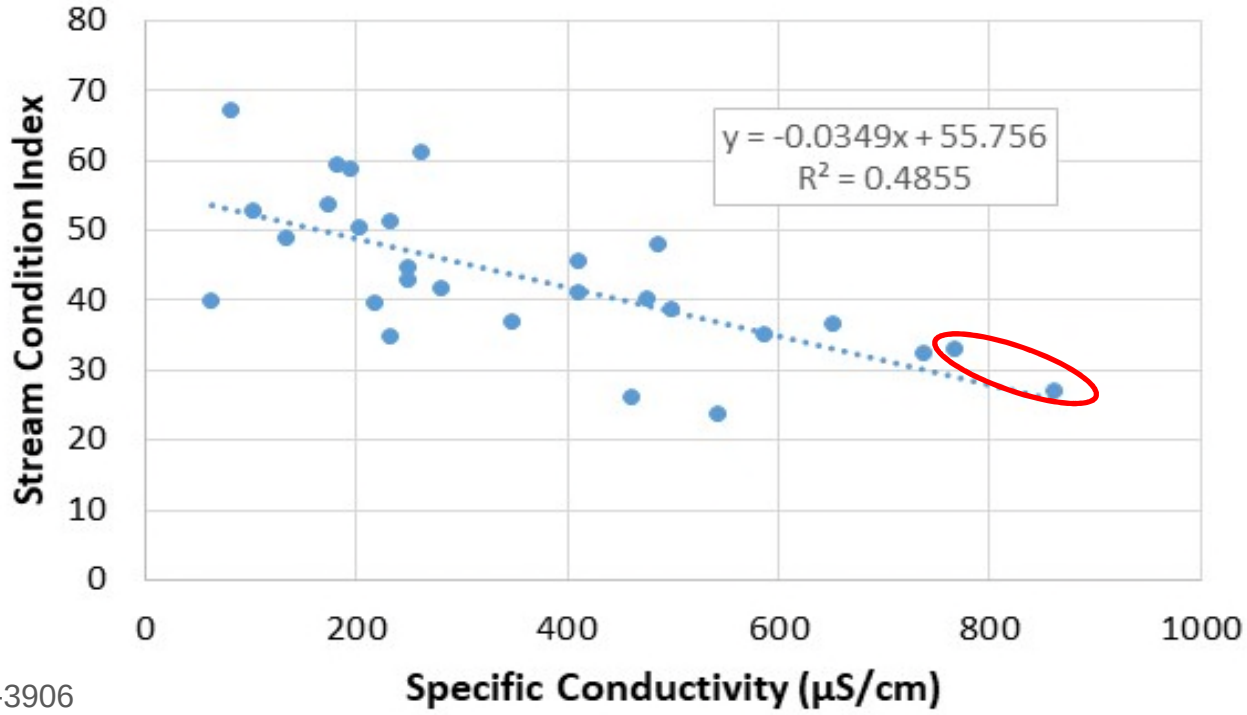


DEQ

Support for TDS as a Stressor

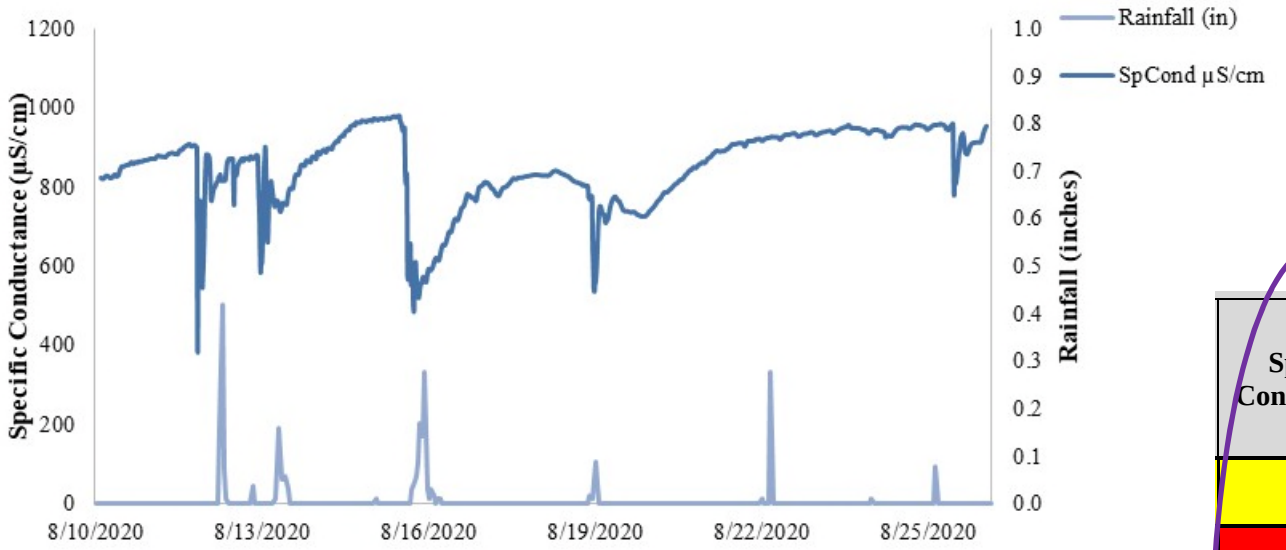
- 98th and 100th percentile of conductivity in Triassic Basin ecoregion
- Conductivity significantly correlated with VSCI in Triassic Basin

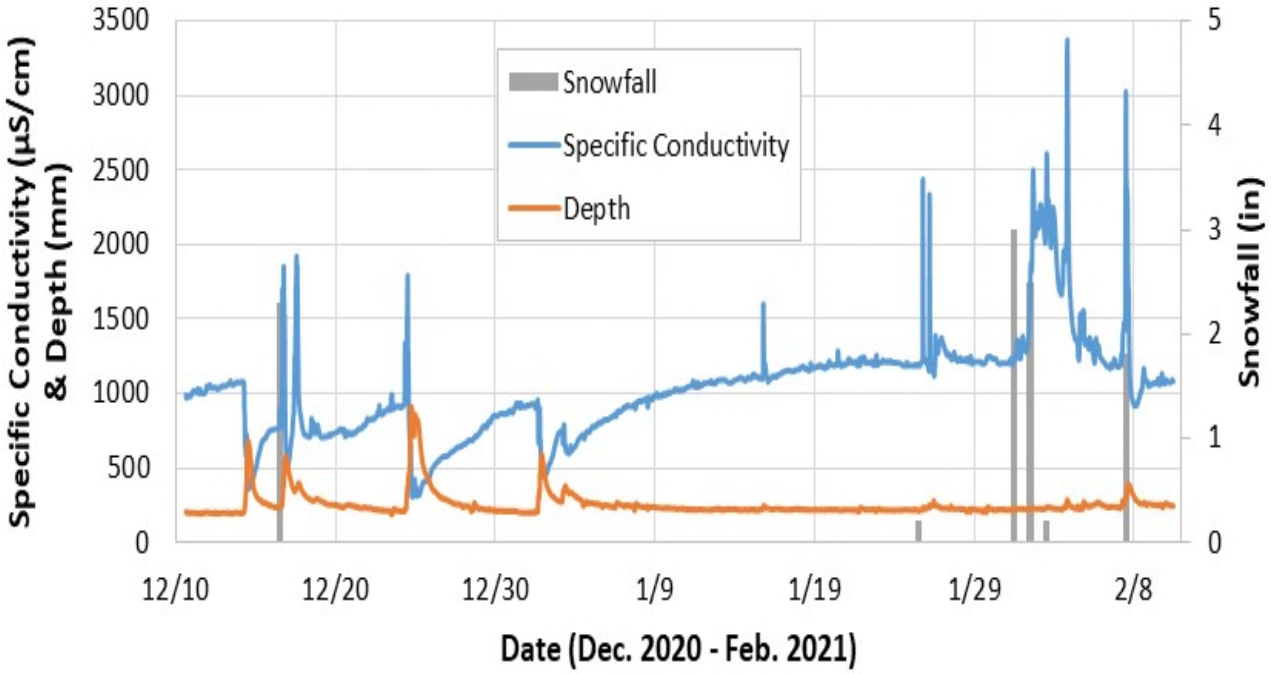


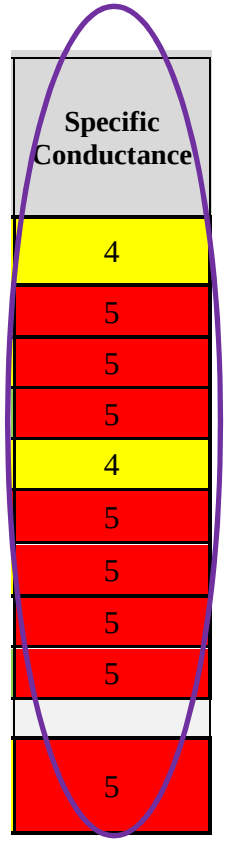


Support for TDS as a Stressor

- Biological condition gradient analysis identified specific conductivity
- Toxicity testing
- Continuous monitoring data identified high baseline conductivity with wintertime extremes







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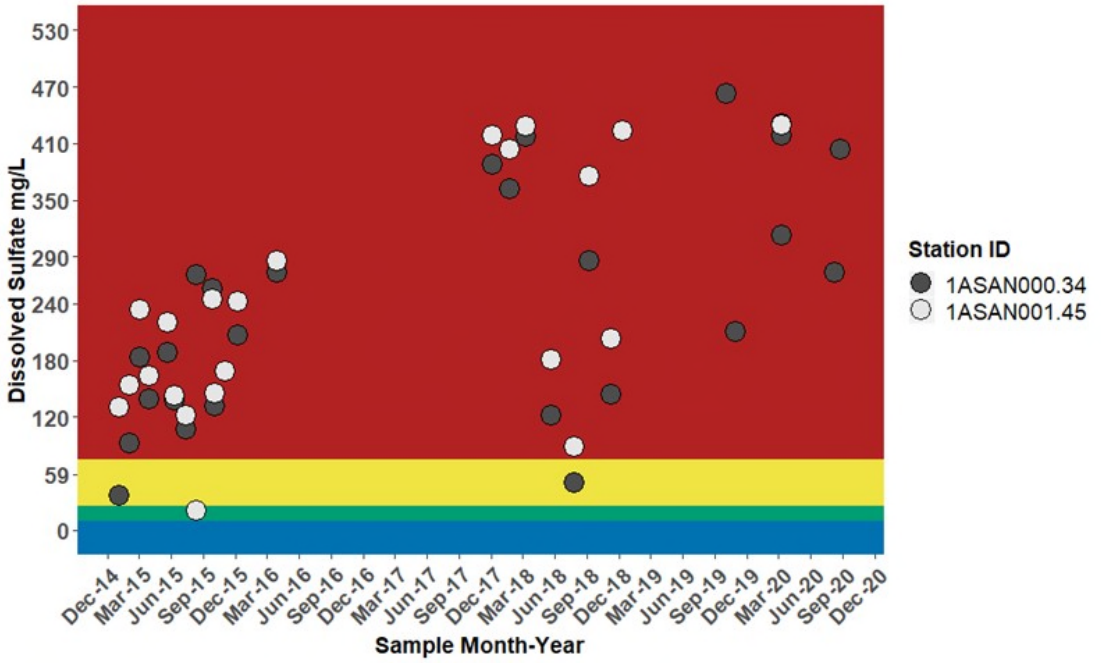
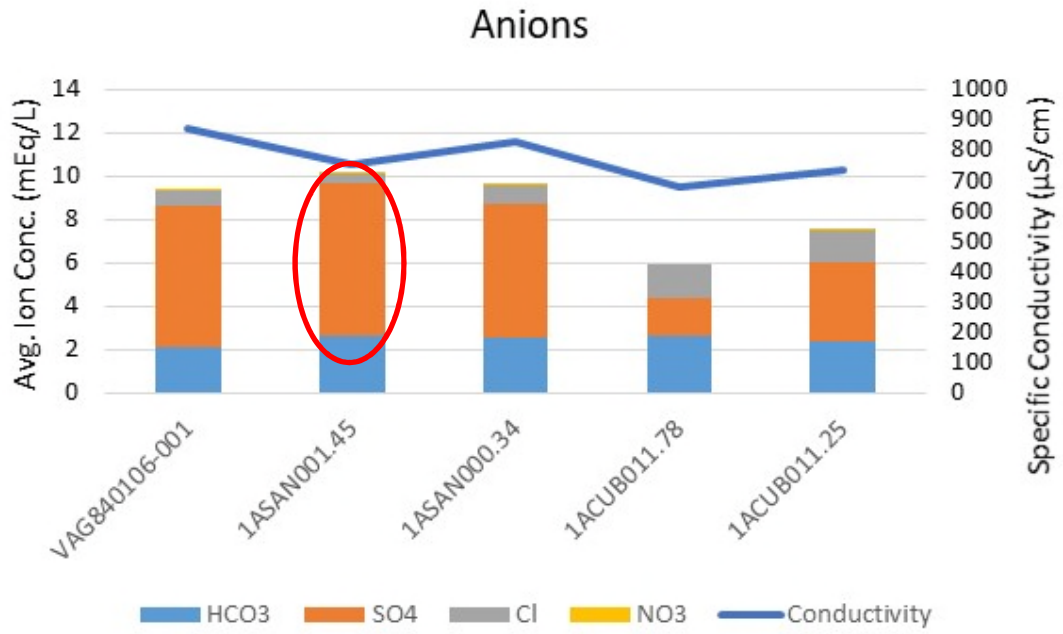
Support for Sulfate as a Stressor

- Sulfate levels averaged in the high probability range for stress effects
- Some literature threshold values for sulfate toxicity were exceeded
- Sulfate was the predominant anion contributing to TDS





Planning for TMDL Development

TMDL Targets, WQ Monitoring & Project Timeline

TMDL Targets and Contributing Factors

Stream	TMDL Target
Sand Branch	Total Dissolved Solids (TDS)
	Total Phosphorus
	Sediment

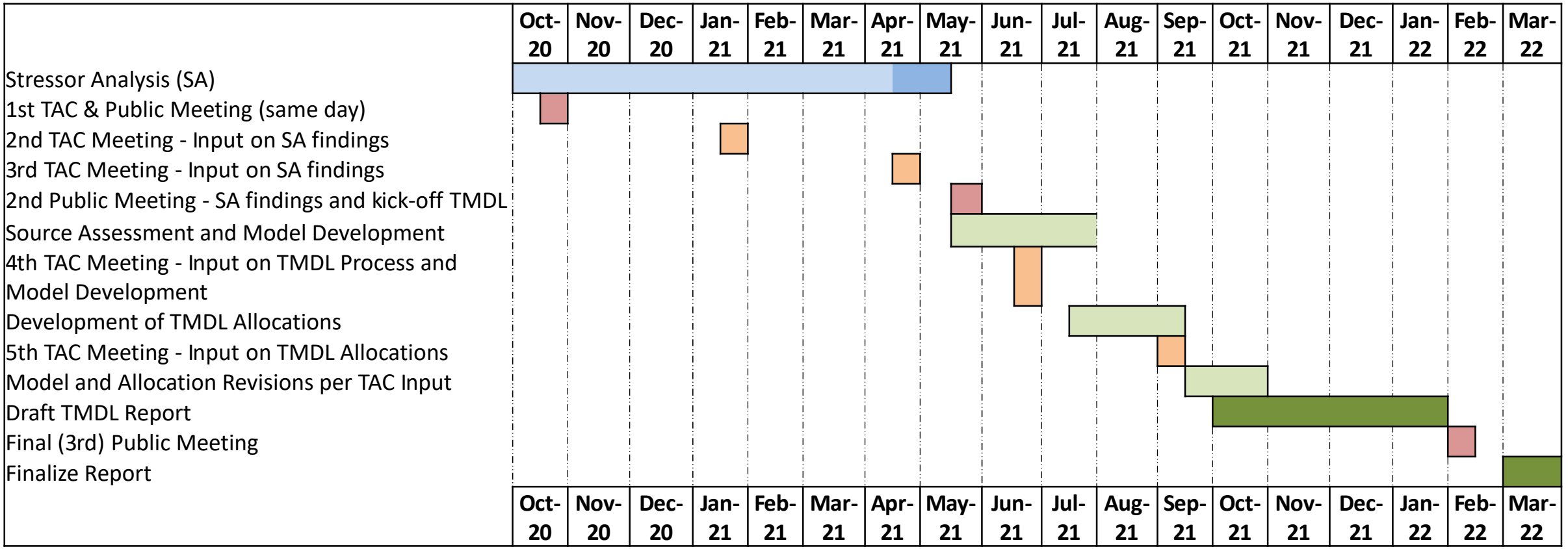
Stream	Contributing Factors
Sand Branch	Underlying Geology
	Land Disturbance
	Percent Imperviousness
	Degraded Riparian Buffer

- TMDL targets identified from multiple lines of evidence
- TDS will collectively address sulfate, and also ions classified as possible stressors (chloride, potassium, and sodium)
- Factors identified that contribute to the impaired benthic community, but not appropriate for TMDL development

Water Quality Monitoring

- In support of TMDL development
  - Source identification
  - Threshold development
- Review existing data to identify if additional monitoring data is needed to establish existing loads from all pollutant sources
- May / June: Ambient toxicity testing at downstream station (1ASAN000.34)

Project Timeline



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Next Steps

- Stressor analysis report
  - TAC review: provide comments by May 6th
  - Review / address comments
- Hold 2nd Public Meeting
  - May 26th, beginning at 4:30 P.M.
  - Finalizes Stressor Analysis
    - 30-day public comment period
  - Kick-off TMDL development
- Begin TMDL development to address 3 pollutants
  - Source identification
  - Model development

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Meeting Feedback

- Questions or Comments:
  - Sarah Sivers: (703) 583-3898 or Sarah.Sivers@deq.virginia.gov

- Meeting Feedback:
  - Virtual Meeting Public Comment Form (shared by email)
  - Submit to FOIA Board, external to DEQ

For technical support issues call: 703-583-3906

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