Watershed Health and Data Assessment

Alaska Monitoring and Assessment Program

May 2020 – September 2022

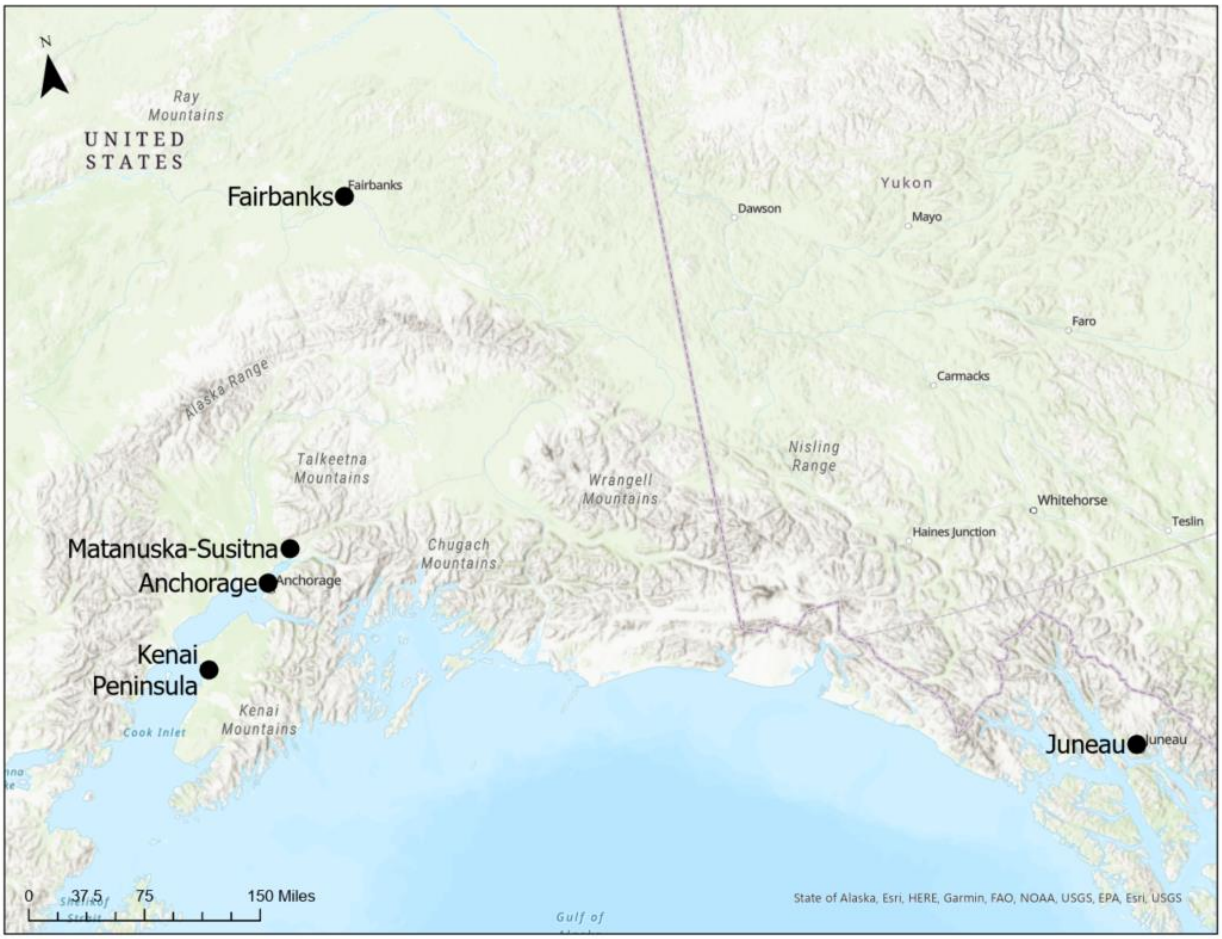

Figure 1. Watershed Health and Data Assessment monitoring regions 2020 – 2022.

Acknowledgements

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Introduction

The Alaska Department of Environmental Conservation (DEC) established the Watershed Health and Data Analysis (WHADA) program in 2020 to characterize environmental conditions of high priority watersheds. Nine watersheds in Alaska were selected to undergo two seasons each of monitoring during 2020 – 2022. The objectives of this project were to:

1. Compare water quality of urban streams to Alaska Water Quality Standards criteria.
2. Compare water quality upstream and downstream of urban impacts in Alaska.
3. Provide a baseline comparison for future monitoring.

In response to the COVID-19 pandemic, DEC greatly restricted travel and large field efforts to reduce individual and community transmission of pathogens. During this timeframe, a focus on local communities and waterbodies near staff offices emerged. With this focus in mind, waterbodies were selected based on several factors including DEC priority, data gaps, and access. All waterbodies are noted as High Priority Waterbodies by the Alaska Clean Water Actions (ACWA) program and are representative of the local area. The design of the project was similar to current and previous surveys completed throughout Alaska to ensure data comparability with other statewide efforts including the Bureau of Land Management's Assessment Inventory and Monitoring strategy and the U.S. Environmental Protection Agency's National Rivers and Streams Assessment (NRSA). Core parameters (water chemistry, biological, and physical habitat) and sampling procedures from national monitoring efforts were incorporated into the WHADA program.

Sites and sampling

The selected waterbodies included Chena River, Little Susitna River, Wasilla Creek, Ship Creek, Campbell Creek, Chester Creek, Little Campbell Creek, Soldotna Creek, and Jordan Creek (Table 1; Figures 2 – 6). Two sites, upstream (Upper) and downstream (Lower) of urban impacts, were selected on each waterbody (Table 2), and each waterbody was monitored for two open water seasons (May – October) during the 2020 – 2022 period. The only exception was Jordan Creek, which was only sampled in 2020 due to a restoration project that started there in 2021. Sampling teams of one to three members collected water and biological samples according to wadable NRSA methods. During each open water season, the following measurements and samples were collected (Table 3):

- In situ water quality measurements, metals, and nutrients were collected once per month from all sites. Samples were collected either at midstream or from the bank unless access, flow, or other factors necessitated sampling from another location. Laboratory analyses were completed for dissolved metals, cations, nutrients, and total suspended solids.
- Fecal coliform and *Escherichia coli* samples were collected at the Lower site for each waterbody five times within a 30-day period.
- Physical habitat was surveyed once per site and included riparian habitat, fish habitat, canopy cover, substrate, and human impacts.

Table 1. Nine priority waterbodies were sampled during two seasons each from 2020 - 2022, except Jordan Creek which was only sampled in 2020.

Borough	Waterbody	Years Sampled	Existing Impairment*
Fairbanks	Chena River	2020, 2021	None
Matanuska-Susitna	Little Susitna River	2020, 2021	Turbidity
	Wasilla Creek	2021, 2022	None
Anchorage	Ship Creek	2020, 2021	Bacteria
	Campbell Creek	2021, 2022	Bacteria
	Chester Creek	2021, 2022	Bacteria
	Little Campbell Creek	2020, 2021	Bacteria
Kenai Peninsula	Soldotna Creek	2020, 2022	None
Juneau	Jordan Creek	2020	Debris, Dissolved Oxygen, Sediment
*Impaired waters do not meet Alaska Water Quality Standards for identified parameters.			

Table 2. WHADA 2020 – 2022 monitoring locations.

Monitoring Location	Latitude	Longitude
Upper Chena River	64.7944	-147.1914
Lower Chena River	64.8404	-147.8175
Upper Little Susitna River	61.7169	-149.2316
Lower Little Susitna River	61.6265	-149.8060
Upper Wasilla Creek	61.6615	-149.1884
Lower Wasilla Creek	61.5673	-149.3143
Upper Ship Creek	61.2252	-149.6497
Lower Ship Creek	61.2234	-149.8740
Upper Campbell Creek	61.1778	-149.8251
Lower Campbell Creek	61.1394	-149.9218
Upper Chester Creek	61.2057	-149.7176
Lower Chester Creek	61.2048	-149.8910
Upper Little Campbell Creek	61.1134	-149.7089
Lower Little Campbell Creek	61.1474	-149.8531
Upper Soldotna Creek	60.5154	-150.9802
Lower Soldotna Creek	60.4827	-151.0599
Upper Jordan Creek	58.3665	-134.5773
Lower Jordan Creek	58.3582	-134.5748

Table 3. Category and frequency of sampling surveyed during WHADA.

Category	Parameters	Sample type and frequency*
Basic water quality	Dissolved oxygen, pH, temperature, turbidity	In situ measurements, once per month
Nutrients & DOC	Nitrate + nitrite, total phosphorus, dissolved organic carbon	Grab sample, once per month
Metals	Aluminum, cadmium, copper, lead, mercury, selenium, zinc	Grab sample, once per month
Bacteria	Fecal coliform, *E. coli*	Grab sample, five times in 30 days (Lower sites only)
Physical habitat	Riparian habitat, fish habitat, canopy cover, substrate, human impacts	Qualitative surveys, once per season
*Data that did not pass QA/QC were removed from analysis.		

Results

Objective 1: Compare urban stream water quality to Alaska Water Quality Standards criteria.

Water quality results for all waterbodies are summarized in Tables 4 – 8. State water quality standards often include multiple criteria for each parameter, depending on the use (e.g., a drinking water criterion would be more sensitive than an industrial water criterion). Criteria for the most sensitive uses that do not require a calculation (e.g., when they vary based on water hardness and cannot be summarized with a single number), are provided in Tables 4 – 8 for reference. Exceedances of those criterion refer only to single instances where the parameter exceeded the magnitude of the water quality criterion; further analyses that consider the frequency and duration of those exceedances are needed to determine whether they meet regulatory water quality standards overall. These waterbodies will be assessed in the 2024 Integrated Water Quality Monitoring and Assessment Report.

- **Basic water quality:** There were no exceedances for any of the nine waterbodies for temperature. All waterbodies had elevated turbidity (+5 NTU or greater) at Lower sites, except Jordan Creek, which had very limited turbidity data. Only Jordan and Soldotna Creeks had exceedances for dissolved oxygen, and Jordan and Wasilla Creeks had exceedances for pH.
- **Nutrients & DOC:** There were no exceedances for nitrate + nitrite, and Alaska does not have water quality standards for total phosphorus or dissolved organic carbon. Dissolved organic carbon was sampled to allow for a variety of sediment toxicity analysis methods.
- **Metals:** There were no exceedances of the most sensitive criteria for any metals except for Aluminum, which had exceedances at Chester, Campbell, and Wasilla Creeks.
- **Bacteria:** All waterbodies had exceedances for bacteria.

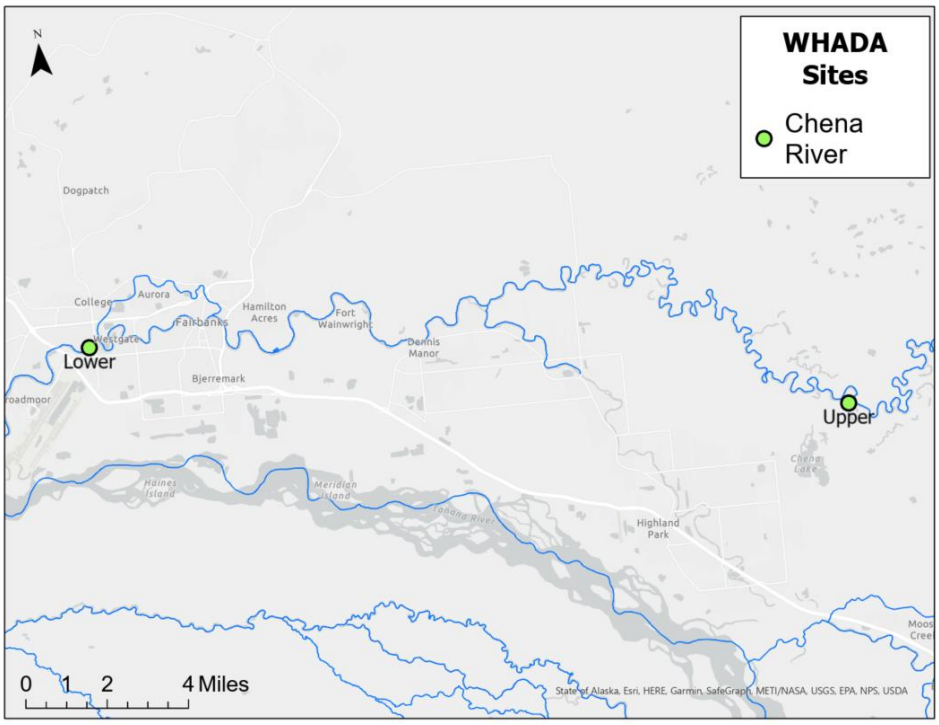

Figure 2. Fairbanks monitoring sites.

Table 4. Parameter ranges for Chena River (Fairbanks) 2020 – 2022. If the parameter was not detected for any samples for a waterbody, it is noted as "ND". The most sensitive water quality criteria (when available) are shown or summarized for reference, and ranges that exceed the most sensitive water quality criteria are bolded.

Parameter	Chena River	Most sensitive criterion
Dissolved oxygen (mg/l)	10.0 – 11.8	>7.0 and < 17.0
pH	7.0 – 7.9	> 6.0 and < 8.5
Temperature (°C)	4 – 12	15
Turbidity (NTU)	3 – 60	Background + 5 NTU
Nitrate + nitrite (µg/l)	292 – 388	10,000
Total phosphorus (mg/l)	.03 – .08	No criteria
Dissolved organic carbon (mg/l)	3.0 – 5.3	No criteria
Dissolved cadmium (µg/l)	ND	Hardness dependent
Dissolved copper (µg/l)	.80 – 2.0	Hardness dependent
Dissolved lead (µg/l)	.02 – .04	Hardness dependent
Dissolved selenium (µg/l)	.30 – .62	5.0*
Dissolved zinc (µg/l)	3.3 – 9.0	Hardness dependent
Total Mercury (µg/l)	ND	.012
Fecal coliform (cfu/100ml)	**1 – 80**	20
E. coli (MPN/100ml)	**9 – 147**	126
*There are no criteria for dissolved selenium, but the criterion for total selenium is provided for reference.		

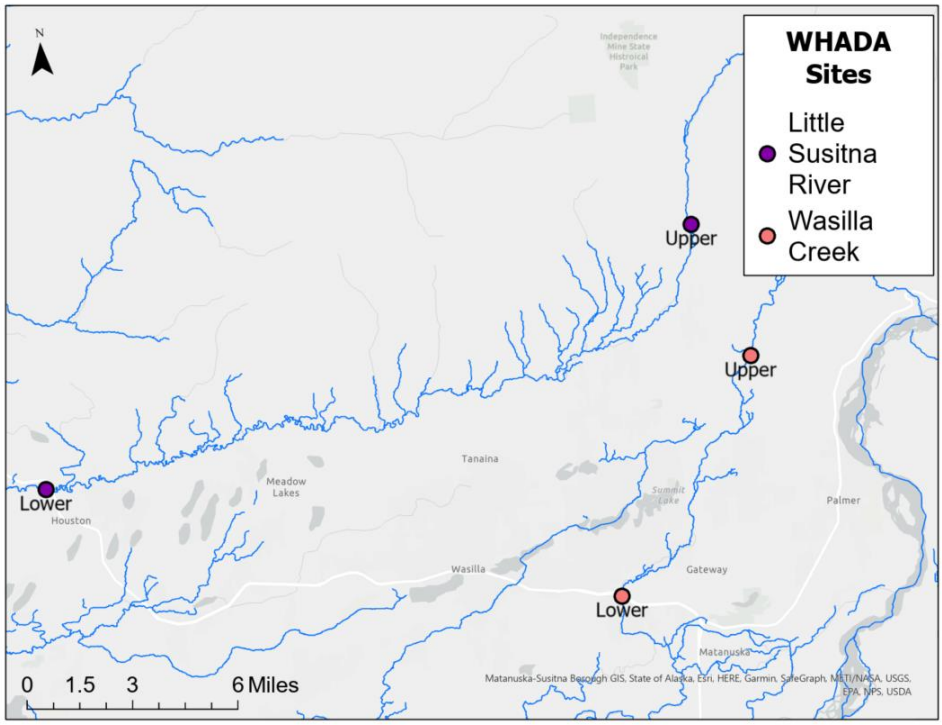

Figure 3. Matanuska-Susitna monitoring sites.

Table 5. Parameter ranges for Matanuska-Susitna sites 2020 – 2022. If the parameter was not detected for any samples for a waterbody, it is noted as "ND". The most sensitive water quality criteria (when available) are shown or summarized for reference, and ranges that exceed the most sensitive water quality criteria are bolded.

Parameter	Little Susitna River	Wasilla Creek	Most sensitive criterion
Dissolved oxygen (mg/l)	10.4 – 13.2	11.0 – 14.1	>7.0 and < 17.0
pH	6.3 – 8.0	6.8 – 8.5	> 6.0 and < 8.5
Temperature (ºC)	3 – 12	1 – 13	15
Turbidity (NTU)	2 – 245	1 – 108	Background + 5 NTU
Nitrate + nitrite (µg/l)	78 – 1350	260 – 811	10,000
Total phosphorus (mg/l)	.03 – .14	.02 – .06	No criteria
Dissolved organic carbon (mg/l)	.54 – 2.3	.93 – 7.3	No criteria
Dissolved aluminum (µg/l)	4 – 38	**9 – 1500**	87
Dissolved cadmium (µg/l)	.04 – .49	.01 – .02	Hardness dependent
Dissolved copper (µg/l)	.20 – 2.6	.25 – 4.6	Hardness dependent
Dissolved lead (µg/l)	.01 – .43	ND	Hardness dependent
Dissolved selenium (µg/l)	.03 – .23	.07 – 2.5	5.0*
Dissolved zinc (µg/l)	1.0 – 15	1.0 – 130	Hardness dependent
Total Mercury (µg/l)	ND	ND	.012
Fecal coliform (cfu/100ml)	**5 – 72**	**22 – 347**	20
E. coli (MPN/100ml)	2 – 125	**32 – 921**	126

*There are no criteria for dissolved selenium, but the criterion for total selenium is provided for reference.

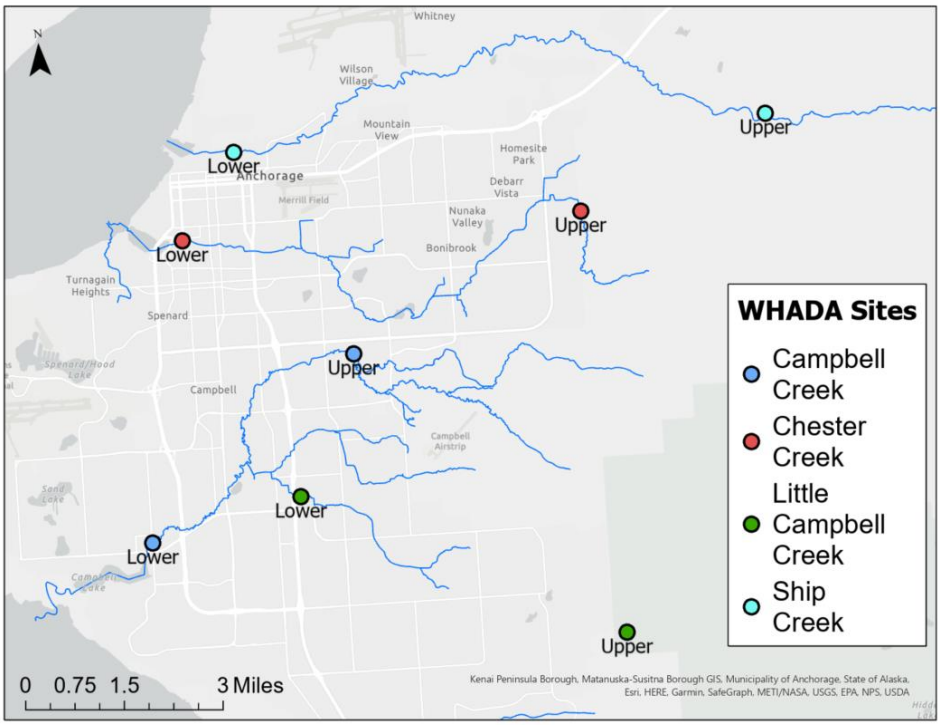

Figure 4. Anchorage monitoring sites.

Table 6. Parameter ranges for Anchorage WHADA sites 2020 – 2022. If the parameter was not detected for any samples for a waterbody, it is noted as "ND". The most sensitive water quality criteria (when available) are shown or summarized for reference, and ranges that exceed the most sensitive water quality criteria are bolded.

Parameter	Ship Creek	Campbell Creek	Chester Creek	Little Campbell Creek	Most sensitive criterion
Dissolved oxygen (mg/l)	11.2 – 13.7	10.6 – 14.2	9.8 – 13.2	9.4 – 12.5	>7.0 and < 17.0
pH	7.2 – 8.2	6.4 – 8.1	6.5 – 8.0	7.3 – 8.3	> 6.0 and < 8.5
Temperature (ºC)	4 – 13	3 – 13	3 – 13	4 – 13	15
Turbidity (NTU)	1 – 88	2 – 170	0 – 21	2 – 31	Background + 5 NTU
Nitrate + nitrite (µg/l)	91 – 221	100 – 1010	30 – 1150	1120 – 5740	10,000
Total phosphorus (mg/l)	.03 – .08	.02 – .07	ND	.03 – .08	No criteria
Dissolved organic carbon (mg/l)	.67 – 14	.50 – 5.4	1.9 – 10	9.4 – 13	No criteria
Dissolved aluminum (µg/l)	4 – 51	**3 – 1680**	**3 – 131**	17 – 32	87
Dissolved cadmium (µg/l)	.01 – .08	ND	ND	ND	5.0
Dissolved copper (µg/l)	.14 – .85	ND	.25 – 6.1	.19 – 3.5	Hardness dependent
Dissolved lead (µg/l)	.02 – .12	.04 – .38	.01 – .25	.01 – .21	Hardness dependent
Dissolved selenium (µg/l)	.22 – .65	.03 – .27	.14 – .75	.11 – .36	5.0*
Dissolved zinc (µg/l)	1.0 – 11	1.0 – 58	1.0 – 63	1.0 – 8.5	Hardness dependent
Total Mercury (µg/l)	.01 - .04	ND	.01 – .04	ND	.012
Fecal coliform (cfu/100ml)	**3 – 290**	**1 – 220**	**8 – 230**	**9 – 2500**	20
E. coli (MPN/100ml)	**11 – 579**	**8 – 613**	**10 – 727**	**5 – 2420**	126
*There are no criteria for dissolved selenium, but the criterion for total selenium is provided for reference.					

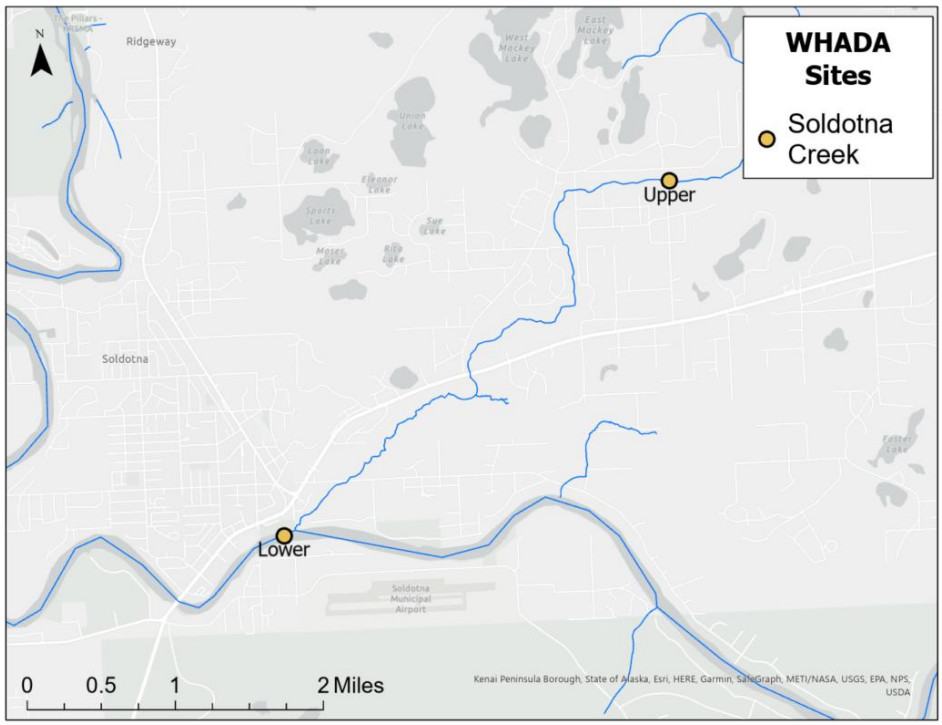

Figure 5. Kenai Peninsula monitoring sites.

Table 7. Parameter ranges for Kenai Peninsula sites 2020 – 2022. If the parameter was not detected for any samples for a waterbody, it is noted as "ND". The most sensitive water quality criteria (when available) are shown or summarized for reference, and ranges that exceed the most sensitive water quality criteria are bolded.

Parameter	Soldotna Creek	Most sensitive criterion
Dissolved oxygen (mg/l)	**5.5 – 11.3**	>7.0 and < 17.0
pH	6.3 – 7.9	> 6.0 and < 8.5
Temperature (ºC)	9 – 15	15
Turbidity (NTU)	1 – 10	Background + 5 NTU
Nitrate + nitrite (µg/l)	10 – 68	10,000
Total phosphorus (mg/l)	.06 – .14	No criteria
Dissolved organic carbon (mg/l)	5.5 – 11	No criteria
Dissolved aluminum (µg/l)	3 – 30	87
Dissolved cadmium (µg/l)	ND	Hardness dependent
Dissolved copper (µg/l)	.14 – 4.2	Hardness dependent
Dissolved lead (µg/l)	ND	Hardness dependent
Dissolved selenium (µg/l)	ND	5.0*
Dissolved zinc (µg/l)	1.2 – 306	Hardness dependent
Total Mercury (µg/l)	ND	.012
Fecal coliform (cfu/100ml)	**5 – 44**	20
E. coli (MPN/100ml)	1 – 96	126
*There are no criteria for dissolved selenium, but the criterion for total selenium is provided for reference.		

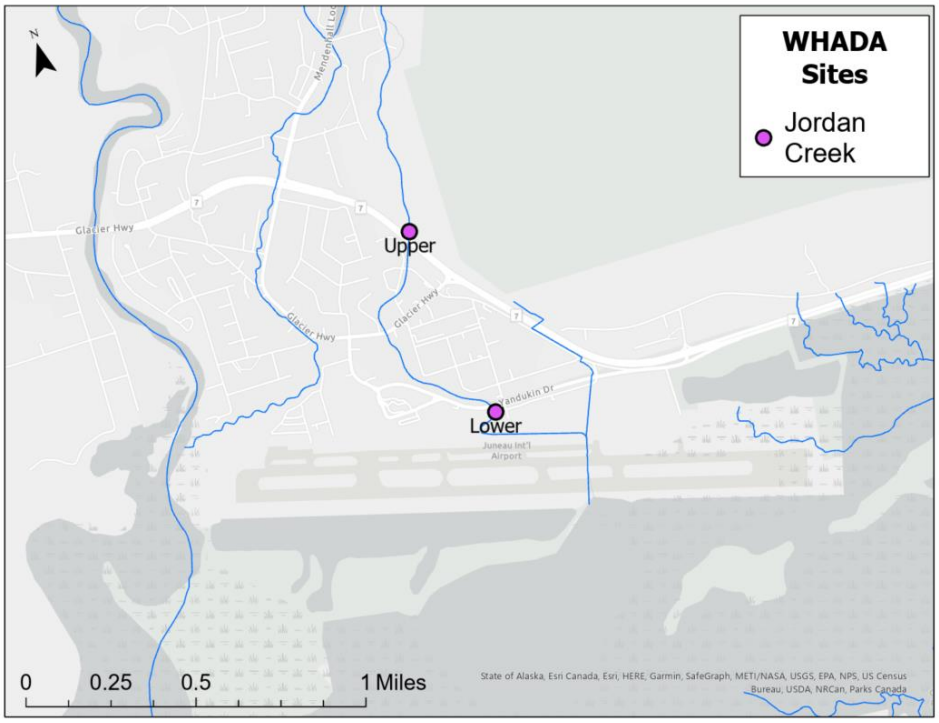

Figure 6. Juneau monitoring sites.

Table 8. Parameter ranges for Jordan Creek (Juneau) 2020. If the parameter was not detected for any samples for a waterbody, it is noted as "ND". The most sensitive water quality criteria (when available) are shown or summarized for reference, and ranges that exceed the most sensitive water quality criteria are bolded.

Parameter	Jordan Creek	Most sensitive criterion
Dissolved oxygen (mg/l)	5.5 – 12.5	>7.0 and < 17.0
pH	**5.9 – 8.0**	> 6.0 and < 8.5
Temperature (ºC)	3 – 11	15
Turbidity (NTU)	2 – 39	Background + 5 NTU
Nitrate + nitrite (µg/l)	77 – 279	10,000
Total phosphorus (mg/l)	ND	No criteria
Dissolved organic carbon (mg/l)	5.5 – 13	No criteria
Dissolved cadmium (µg/l)	ND	Hardness dependent
Dissolved copper (µg/l)	.38 – 2.7	Hardness dependent
Dissolved lead (µg/l)	.02 – .19	Hardness dependent
Dissolved selenium (µg/l)	.11 – .34	5.0*
Dissolved zinc (µg/l)	1.2 – 8.9	Hardness dependent
Total Mercury (µg/l)	ND	.012
Fecal coliform (cfu/100ml)	**17 – 980**	20
E. coli (MPN/100ml)	**16 – 460**	126
*There are no criteria for dissolved selenium, but the criterion for total selenium is provided for reference.		

Objective 2: Comparing water quality upstream and downstream of urban impacts.

To compare parameter differences between Upper and Lower sites across all nine waterbodies in this study, a Wilcoxon signed-rank test was used. The Wilcoxon test is a nonparametric hypothesis test that evaluates the difference between two paired samples with non-normal distributions. This test is the nonparametric equivalent of the commonly used paired Student's t-test (which requires normally distributed data) and can be used with a small sample size. Like many statistical tests, the Wilcoxon test results in a P-value, which is the probability of observing the sample data, given that the null hypothesis is true. In this case, the null hypothesis is that there is no difference between Upper and Lower sites, and a low P-value ($P < 0.05$ or 5%) means that there is a low probability you would see that result by chance alone.

The Wilcoxon signed-rank test takes the differences between Upper and Lower averages at each waterbody (9 pairs, in this case), and produces two rank totals. If there is a systematic difference between the two, the rank totals will be quite different. $P < 0.05$ is considered statistically significant, and means that the groups are significantly different. (Note: the unpaired version of the test was used for bacteria because not all waterbodies had Upper samples).

Across the nine waterbodies in this project, most differences between Upper and Lower sites were not significant, but there were significant differences in turbidity, temperature, and *E. coli*. Turbidity (Fig. 2d) and bacteria (Fig. 4) had the largest differences between Upper and Lower sites across all waterbodies. Differences in parameters between Upper and Lower sites are summarized below, and Wilcoxon test results are given in Appendix A.

- **Basic water quality:** Average dissolved oxygen (DO) and pH were not significantly different between Upper and Lower sites, but average temperature (P = 0.04, Figure 2c) and turbidity (P = 0.004, Figure 2d) were significantly different. Average temperature was 1° C higher at Lower sites, and average turbidity was 10.1 NTU higher at Lower sites.

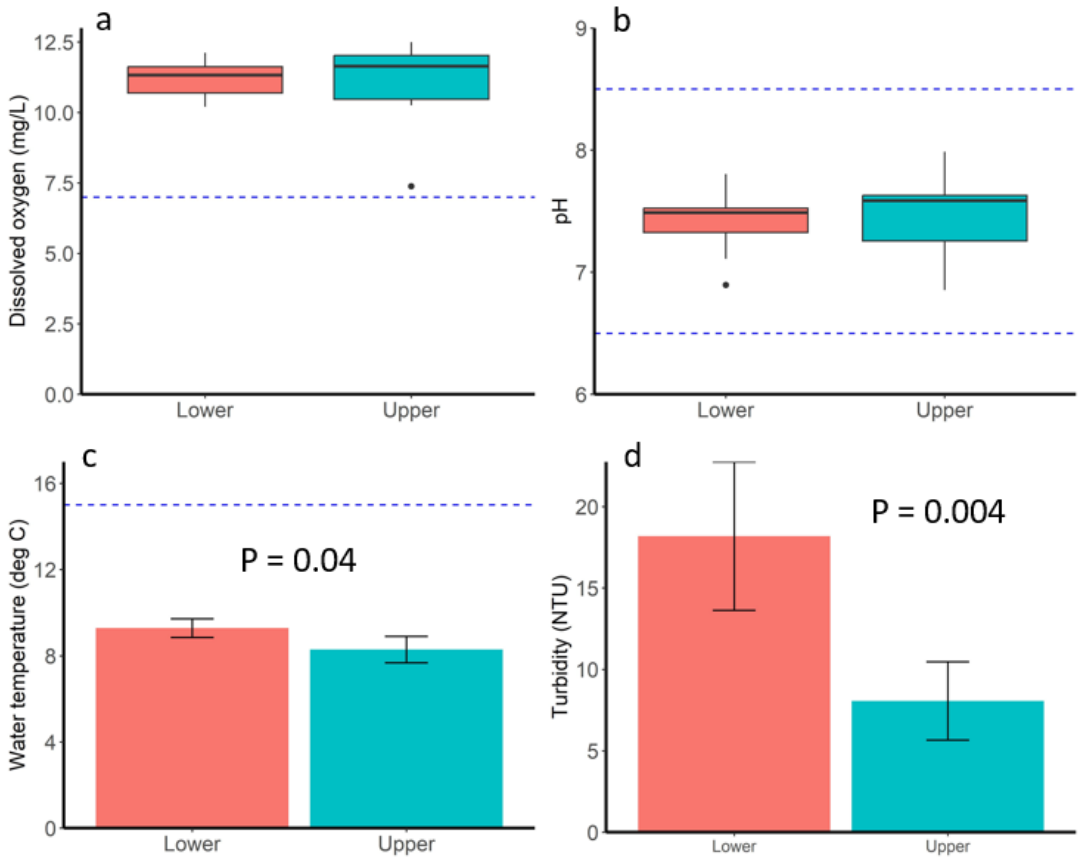

Figure 2. Average (± standard deviation) dissolved oxygen, pH, water temperature, and turbidity at Upper and Lower sites, with the most sensitive Alaska water quality criteria (blue dotted line) for reference, when available.

- **Nutrients, DOC, and metals:** Average nitrate + nitrite, total phosphorus, dissolved organic carbon, and metals (aluminum, cadmium, copper, lead, selenium, zinc, and mercury) were not significantly different between Upper and Lower sites. (Metals figures are not shown because most metals were not detected or were close to the reporting limit.)

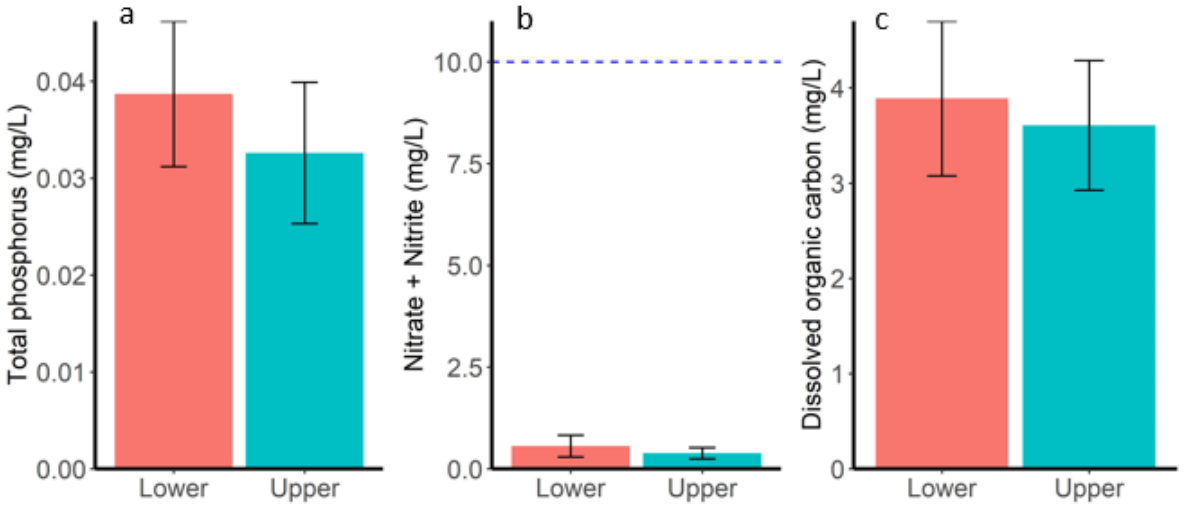

Figure 3. Average (± standard deviation) total phosphorus, nitrate + nitrite, and dissolved organic carbon at Upper and Lower sites, with the most sensitive Alaska water quality criteria (blue dotted line) for reference, when available.

- **Bacteria:** Average *E. coli* (P = 0.009) was significantly different between Upper and Lower sites (P = 0.009; Fig. 4b); average *E. coli* was 199 MPN/100 ml higher at Lower sites. Differences in fecal coliform were not statistically significant.

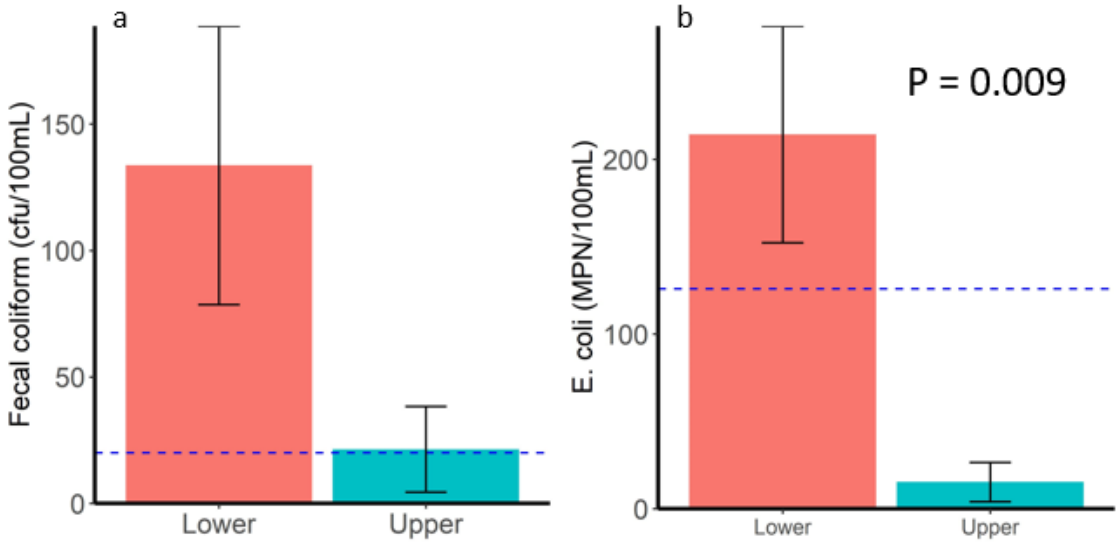

Figure 4. Average (± standard deviation) fecal coliform and *E. coli* at Upper and Lower sites, with the most sensitive Alaska water quality criteria (blue dotted line) for reference.

Objective 3: Provide a baseline for future monitoring.

WHADA data will serve as a baseline for future monitoring efforts in these watersheds. Baseline conditions provide a "starting point" that can be used to track changes over time, allowing managers to detect improvement or decline of water quality, and ultimately to support the protection and restoration of those watersheds.

Conclusions

While the nine urbanized waterbodies in this project were in geographically different areas of Alaska, the ranges for most water quality parameters were relatively similar. Across all waterbodies, most differences between Upper and Lower sites were insignificant and waterbodies appear to meet criteria for most parameters overall.

Of the 16 parameters evaluated, there were significant differences only in turbidity, temperature, and *E. coli* between upstream and downstream sites. For all three parameters, averages were significantly higher at downstream sites. Average *E. coli,* and turbidity appear to exceed water quality criteria at downstream sites only, and while temperature was also significantly higher at downstream sites, it did not exceed water quality criteria (e.g., the difference between Upper and Lower was significant, but still not large enough to exceed criteria; see Fig. 2c). There were a few aluminum exceedances during what appeared to be rain events, but overall, metals and nutrients were not elevated in any of the waterbodies sampled.

Our results suggest that turbidity and bacteria should be evaluated more closely at most waterbodies. The Lower sites were downstream of more urbanized locations, which tend to be associated with higher areas of impervious surfaces like concrete, and more impacted by human activities. It is likely that urban and stormwater runoff from those areas is contributing to higher turbidity and bacteria levels at Lower sites.

These waterbodies will be assessed in the 2024 Integrated Water Quality Monitoring and Assessment Report, which will be available on the ADEC website (https://dec.alaska.gov/water/water-quality/integrated-report/). These data will serve as a point of comparison for future monitoring efforts. Data are available through ADEC or from the Water Quality Portal (https://www.waterqualitydata.us/).

Appendix A.

Table A-1. Comparisons between Upper and Lower sites during 2020 – 2022. P-values less than 0.05 are bolded.

Parameter	Wilcoxon Signed-Rank Test	Lower mean	Upper mean	Unit	V	P
Dissolved oxygen	Paired	11.2	11.1	mg/l	14	0.36
pH	Paired	7.4	7.4	SU	24	0.91
Water temperature	Paired	9.3	8.3	ºC	40	**0.04**
Turbidity	Paired	18.2	8.1	NTU	45	**0.004**
Total phosphorus	Paired	0.039	.033	mg/l	25	*
Nitrate + nitrite	Paired	0.56	0.39	mg/l	35	0.16
Dissolved organic carbon	Paired	3.89	3.61	mg/l	28	0.57
Aluminum	Paired	55.6	37.1	ug/l	15	0.94
Cadmium	Paired	0.07	0.06	ug/l	15	*
Copper	Paired	0.97	0.81	ug/l	32	0.30
Lead	Paired	0.21	0.21	ug/l	22	*
Selenium	Paired	0.63	0.66	ug/l	1	*
Zinc	Paired	11.6	16.7	ug/l	21	0.91
Mercury	Paired	0.003	0.003	ug/l	17	*
Fecal coliform	Unpaired	134	21	cfu/100ml	24	*
E. coli	Unpaired	214	15	MPN/100ml	27	**0.009**

*P value cannot be calculated when values are the same between groups. The means are not different between Upper and Lower sites.