Alaska Department of Environmental Conservation
Waterbody Field Report
Ketchikan Creeks, Ketchikan, Alaska

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Abstract

In 2018, Ketchikan Indian Community and the Alaska Department of Environmental Conservation sampled water and sediment from Ketchikan, Hoadley, and Carlanna Creeks to assess potential impacts to water quality from urban development and stormwater runoff. The creeks, located in Ketchikan Alaska, were sampled during spring runoff, summer base flow, and fall storm events at upstream reference sites and downstream urban locations. Source water samples were also collected during summer base flow from one outfall pipe in each creek watershed drainage. Alaska Water Quality Standards for acute aquatic life for copper were exceeded in Hoadley and Ketchikan Creeks. Fecal coliform bacteria criteria were exceeded in all three creeks, with the Escherichia coli criteria also being exceeded in Ketchikan Creek. Microbial source tracking analysis detected human fecal bacteria DNA markers in all three creeks. Copper and polycyclic aromatic hydrocarbons (benzo(a)anthracene and pyrene) in sediment were above the screening threshold in Ketchikan Creek, and metals and polycyclic aromatic hydrocarbons were found in water and sediment of all the creek outfall pipes. Additional water quality sampling is recommended for fecal coliform, Escherichia coli, and dissolved metals in the creek water column.

Basic Waterbody Information

Table 1. Basic Waterbody Information

	Carlanna Creek	Hoadley Creek	Ketchikan Creek
Assessment Unit ID	AK_R_1010204_001	AK_R_1010204_002	AK_R_1010204_003
Location description	Tongass Narrows-Frontal Clarence Strait; Hydrologic Unit Code 12: HUC 190101020403		Ketchikan; Hydrologic Unit Code 12: HUC 190101020402
Water Type	freshwater stream		
Length of beach segment sampled (miles)	0.75	1.70	3.14
Time of year sampled	spring, summer, fall 2018		

[1] Nonpoint Source Pollution,Water Quality, Division of Water, Department of Environmental Conservation

Water Quality Evaluation

Background

Carlanna, Hoadley and Ketchikan Creek watersheds are located in Ketchikan, Alaska. Figure 1 displays the three urban creeks and the monitoring locations. Tables 1 and 2 provide basic waterbody details and monitoring location descriptions. In 2013, the Alaska Department of Environmental Conservation (DEC) funded a project with the Aquatic Restoration and Research Institute to sample Carlanna, Hoadely and Ketchikan Creeks[2]. Sampling was conducted during summer base flow, one fall storm event in 2013, and during spring runoff in 2014. The primary study focus was on pollutants commonly found in stormwater runoff. Water quality samples were analyzed for alkalinity, hardness, ammonia-N, nitrate+nitrite-N, total and dissolved phosphorus, dissolved organic carbon, settleable solids, and dissolved copper, lead, and zinc.

Sediment samples at each stream site were collected during base flow and spring flow, and sediment samples at outfall sites were collected during the spring flow sampling event. All sediments were analyzed for metals, and the most downstream sediment sample in each stream was analyzed for polycyclic aromatic hydrocarbons (PAHs). Water samples for fecal coliform bacteria were collected on six dates from August through September 2013 and on four dates in May 2014.

The 2013-2104 water quality study results concluded that fecal coliform bacteria counts periodically exceeded criteria outlined in Alaska Water Quality Standards[3] (WQS) in all three creeks. The data analysis also showed elevated metal concentrations (cadmium, copper, zinc, and lead) in Ketchikan and Carlanna Creeks. Metal concentrations in sediment were above the acute and chronic toxicity screening levels in the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Table (SQuiRT). Data show a decreasing trend in stream health. Juvenile coho salmon were found with atypical parr markings (cause undetermined) [4].

In 2018 DEC partnered with the Kethikan Indian Community to collect additional water quality samples from Ketchikan, Hoadley, and Carlanna Creeks. The 2018 study is described below.

[2] Alaska Clean Water Actions grant project # ACWA-14-02 funded by DEC
[3] See 18 AAC 70 for State of Alaska Water Quality Standards
[4] See *Ketchikan Creeks: Stormwater Quality Assessment*. 2014. Aquatic Restoration and Resarch Institute https://dec.alaska.gov/water/water-quality/reports/

Figure 1. Map of Ketchikan Creeks Site Locations

Table 2. Site Locations

Site ID	Description	Latitude	Longitude	Site Name
CC01	Carlanna Lake outlet	55.36840	-131.69182	Carlanna Creek
CC02	Upstream of Tongass Avenue	55.35807	-131.69534	Carlanna Creek
HC01	Upstream of Jackson Street culvert at Jackson Heights	55.35881	-131.68045	Hoadley Creek
HC02	Upstream of Tongass Avenue	55.35390	-131.68747	Hoadley Creek
KC01	Upstream of powerhouse outflow	55.34450	-131.63203	Ketchikan Creek
KC02	Upstream of Harris Street Bridge	55.34401	-131.63951	Ketchikan Creek
KC03	Upstream of Tongass Avenue	55.34292	-131.64374	Ketchikan Creek
CCOUT	Drains residential area at Garden Lane and Tower Road	55.35984	-131.69478	Carlanna Creek outfall
HCOUT	Drains residential area from Baranof Avenue at Thatcher Way	55.35564	-131.68428	Hoadley Creek outfall
KCOUT	Drains residential area at Freeman Street and Park Avenue, just downstream of KE02	55.34368	-131.64008	Ketchikan Creek outfall

Objective

The objective of this project was to collect a second year of monitoring data to assess stream health and the potential impacts to water quality from urban development and stormwater runoff and compare the results to WQS criteria.

Methods

In 2018 water quality samples were collected in Carlanna, Hoadley, and Ketchikan Creeks for three sampling events during the spring runoff, summer base flow, and fall storm events at

upstream reference sites and 1-2 downstream urban locations. Water samples[5] were also collected during summer base flow from water inside an outfall pipe[6] in each creek watershed drainage to evaluate the incoming water quality that would eventually discharge to the creeks (Figure 1).

Water samples were laboratory analyzed for dissolved organic carbon, settleable solids, ammonia-N, nitrate and nitrite-N, dissolved phosphorus, total phosphorus, alkalinity, hardness, and dissolved metals (copper, cadmium, chromium, lead, and zinc). In situ water quality measurements included turbidity, specific conductivity, temperature, dissolved oxygen, and pH. Fecal coliform and Escherichia coli (E.coli) samples were collected five times within a 30-day period coinciding in the spring, summer, and fall sampling events at the most downstream sampling site in each stream. Water samples were collected for microbial source tracking (MST) at the most downstream sampling site in each stream during the summer sampling event. The MST samples were analyzed for human fecal indicator bacteroidetes Dorei by a laboratory to determine if the fecal bacteria was associated with human hosts.

Sediment samples were collected at each sample location from all three streams in the spring and summer sampling events, and from three outfall locations directly below the pipe during the summer base sampling event. All sediment samples were laboratory analyzed for metals (copper, cadmium, chromium, lead, and zinc), and PAHs.

Measures of pH, specific conductivity, dissolved organic carbon, alkalinity, and hardness were used to evaluate toxicity of metals and changes in water chemistry during runoff events.

Quality Assurance Review

Field staff followed procedures for sample collection as outlined in the project's Quality Assurance Project Plan[7] (QAPP). All samples met the requirements for handling and reporting outlined in the project QAPP, including the 6-hour field holding time. Samples were shipped to the lab with completed Chain of Custody forms. All field equipment used to collect in situ measurements were calibrated prior to use in the field. The project laboratories analyzed all samples within holding times.

Completeness data quality objectives were met. The project QAPP was adhered to with the modifications of resampling a portion of the spring monitoring event due to cooler shipping delays.

[5] Macroinvertebrate and juvenile fish collection were included in the 2013-2014 assessment but not in the 2018 assessment.
[6] Incoming source water was collected from water inside the outfall pipe (not in the stream water) therefore cannot be directly compared to water quality criteria and is used for informational purposes only.
[7] The project's approved Quality Assurance Project Plan is available from DEC upon request.

Results

Pollutants typically associated with urban development and stormwater runoff were present in the water and sediment of all three creeks sampled. Results for creek water, creek sediment, and outfall sampling are described below with associated tables and figures in the Appendix.

Creek water

Fecal coliform bacteria periodically exceeded criteria in all three creeks (Table 3 and Figure 2). E.coli bacteria at times exceeded criteria in Ketchikan Creek (Table 4 and Figure 3). Bacteria speciation with MST analysis found human bacteriodetes present in all three creeks (Table 5) indicating at least a portion of the bacteria measured is coming from humans. Dissolved metals exceedances were limited to copper in Hoadley and Ketchikan Creek (Figures 4-8). Nutrients and other lab analyzed parameters represent healthy stream concentrations in all three creeks (Table 6). Field measurements of turbidity, dissolved oxygen, pH and temperature in all three creeks show no exceedances of WQS (Table 7).

Creek sediment

Metals (copper and zinc) and PAHs (benzo(a)anthracene and pyrene) were above screening thresholds[8] in the sediment of Ketchikan Creek (Table 8).

Outfall water

The metals copper and zinc were elevated in outfall water for all three creeks. The Ketchikan Creek outfall also showed elevated cadmium levels (Table 9). Outfall water samples were collected from water inside the outfall pipe to evaluate the urban influences and whether outfalls are transporting pollutants. Because Alaska WQS apply to the creek water quality and not to the outfall water quality, these results are for informative purposes only to understand stormwater runoff conditions in the Ketchikan area.

Outfall sediment

Sediment samples collected in the receiving waters at the outfall discharge point in each of the three creeks had metals results above screening thresholds: copper (all 3 creeks), cadmium and chromium (Carlanna Creek), and zinc (Carlanna and Ketchikan Creeks). Several PAHs (acenaphthene, anthracene, benzo(a)anthracene, chrysene, fluoranthene, phenanthrene, and pyrene) were above screening thresholds in Hoadley Creek, whereas only pyrene was above screening thresholds in Ketchikan Creek (Table 10).

[8] NOAA SQuiRT threshold effects levels (TEL) and probable effects levels (PEL), (Buchman 2008). https://repository.library.noaa.gov/view/noaa/9327

Conclusion

Pollutants typically associated with urban development and stormwater runoff were present in the water and sediment of all three creeks sampled. Creek water samples showed periodic exceedances of fecal colifrom bacteria WQS in all three creeks; E.coli bacteria was also detected above WQS in Ketchikan Creek. Creek water samples additionally showed copper above WQS in Hoadley and Ketchikan Creeks.

Creek sediment samples showed copper and PAHs above screening thresholds in Ketchikan Creek. Nutrient measurements and field measurements show no exceedances of WQS in all three creeks.

Outfall water showed elevated metals (cadmium, copper, and zinc). Outfall sediment locations had metal (copper, cadmium, chromium, and zinc) concentrations above screening thresholds in all three creeks. Several sediment PAHs were above screening thresholds in Hoadley Creek, whereas only pyrene was above screening thresholds in Ketchikan Creek.

Recommended Next Steps

Conduct additional water quality sampling in all three creeks focused on fecal coliform, E. coli, and dissolved metals in the water column.

Appendix

Creek Water

Table 3. 2018 fecal coliform bacteria results summary – bold values exceed criteria

Sample site	# samples	Maximum individual sample		Maximum geomean		
		Max results	% exceedance	Max results	% exceedance 30-day rolling	% exceedance entire season
Carlanna	15	400	**27**	31	**20**	0
Hoadley	14	522	**20**	74	**50**	0
Ketchikan	15	400	**60**	106	**83**	**100**
Water quality criteria	(A) Water Supply, (i) drinking, culinary, and food processing: In a 30-day period, the geometric mean may not exceed 20 fecal coliform/100 ml, and not more than 10% of the samples may exceed 40 fecal coliform/100 ml.					

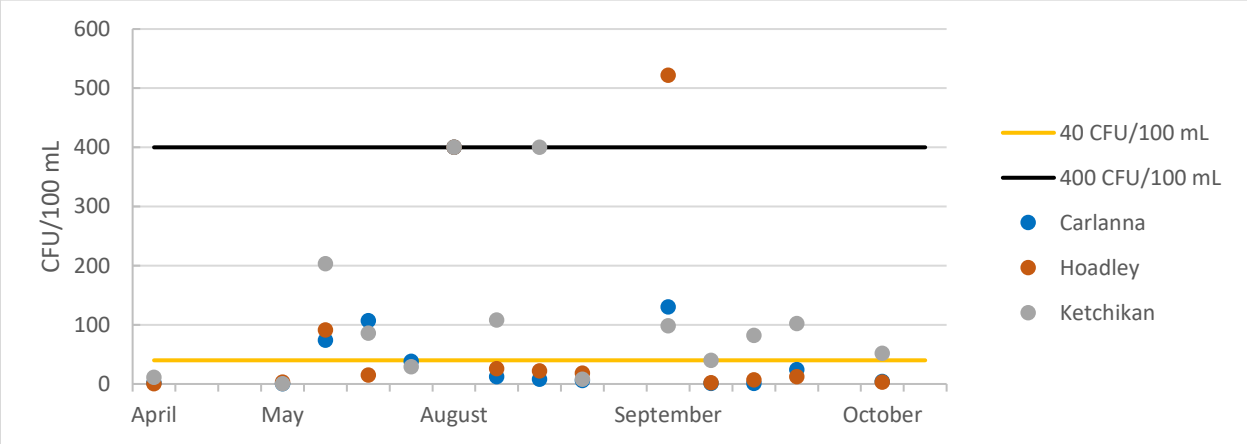


Figure 2. 2018 fecal coliform bacteria results

Table 4. 2018 E.coli bacteria summary – bold values exceed criteria

Sample site	# samples	Maximum individual sample		Maximum geomean	
		Max results	% exceedance	Max results	% exceedance
Carlanna	15	400	0	47	0
Hoadley	14	400	0	60	0
Ketchikan	15	400	0	**140**	**20**
Water quality criteria	(B) Water Recreation, (i) contact recreation: In a 30-day period, the geometric mean of samples may not exceed 126 Escherichia coli (E. coli) colony forming units (CFU)/ 100ml, and not more than 10% of the samples may exceed a statistical threshold value (STV) of 410 E. coli CFU/100 ml.				

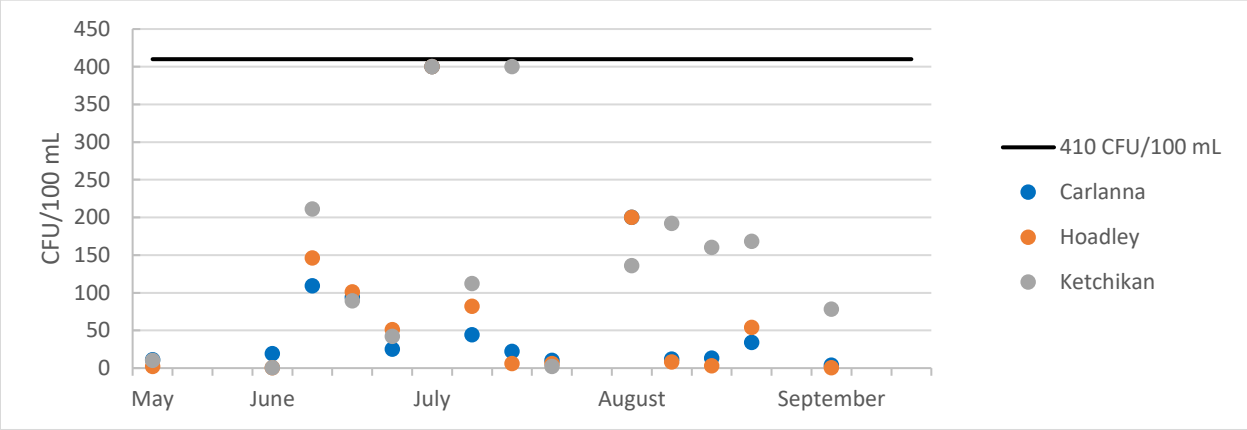


Figure 3. 2018 E.coli bacteria results. Water quality standards criteria for contact recreation is 410 CFU/100 ml.

Table 5. 2018 MST human fecal bacteria DNA marker results

Sample site	# samples	MST human marker (copies/100 ml)
Carlanna	1	Detected not quantified
Hoadley	1	Detected not quantified
Ketchikan	1	531

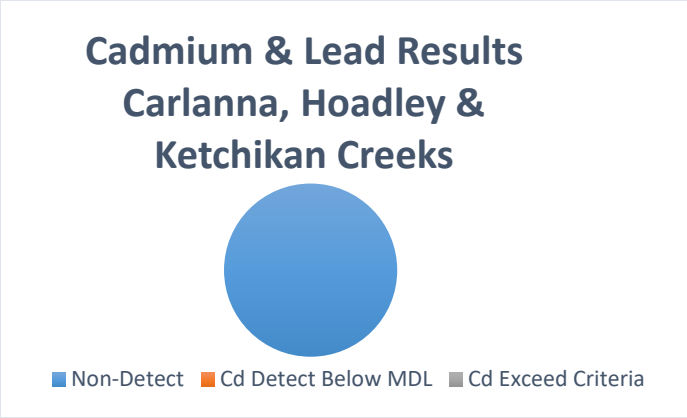


Figure 4. 2018 Dissolved Metals water data summary - Cadmium

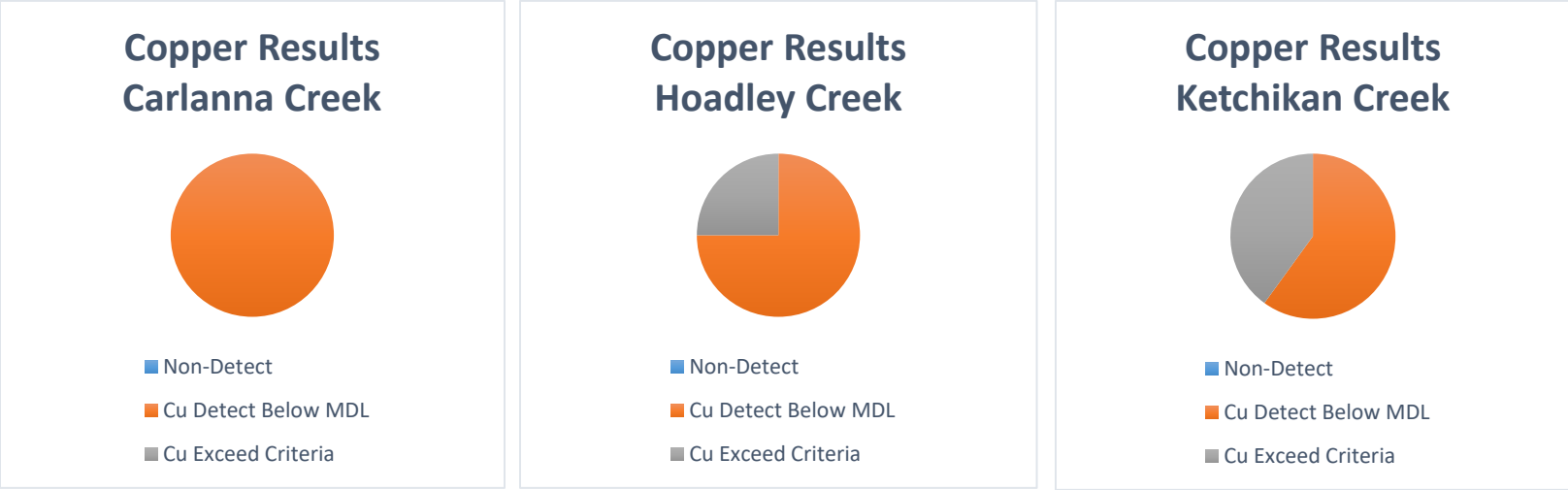
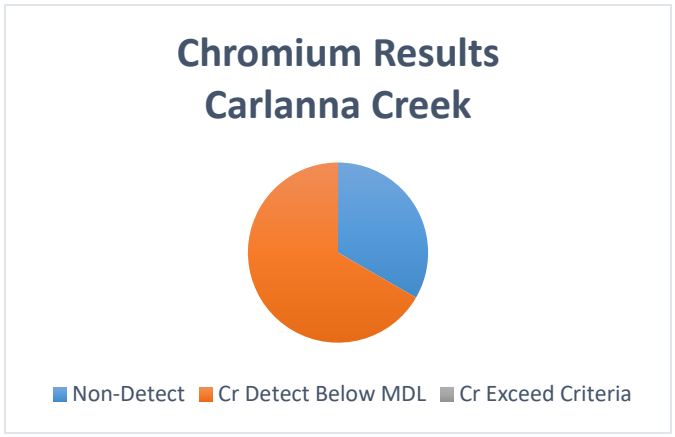


Figure 5. 2018 Dissolved Metals water data summary - Copper



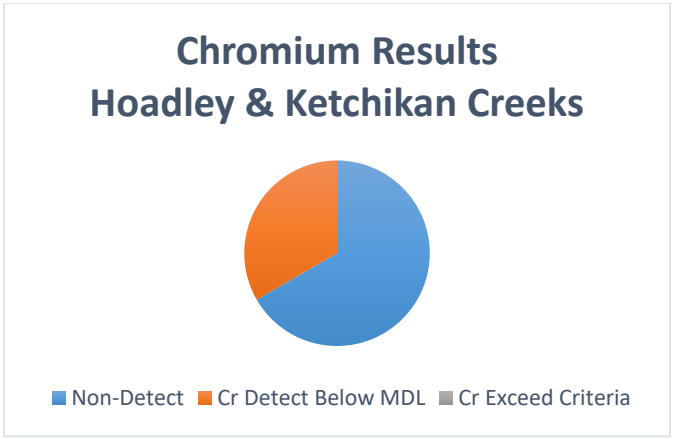


Figure 6. 2018 Dissolved Metals water data summary - Chromium

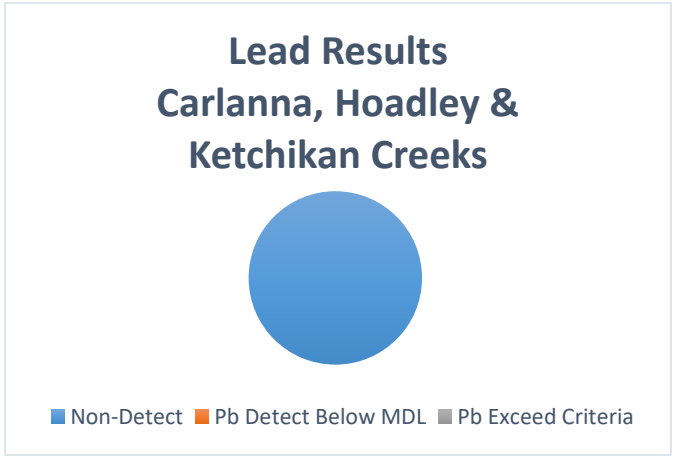


Figure 7. 2018 Dissolved Metals water data summary – Lead

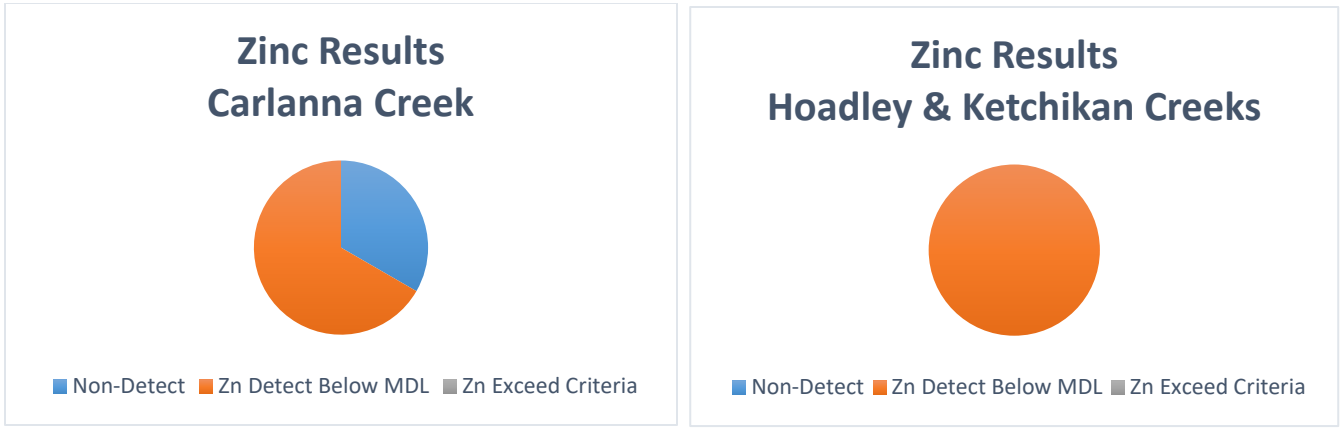


Figure 8. 2018 Dissolved Metals water data summary – Zinc

Table 6. 2018 nutrients and other lab analyzed water quality data summary – units in mg/l [9]

Parameter	Sample site	Range	Average
Dissolved organic carbon	Carlanna	4.1 – 4.5	4.3
	Hoadley	3.7 – 4.6	4.3
	Ketchikan	0.1 – 3.6	2.3
Settable solids	Carlanna	0.1 – 0.1	0.1
	Hoadley	0.1 – 0.1	0.1
	Ketchikan	0.1 – 0.1	0.1
Ammonia-N	Carlanna	0.0025 – 0.027	0.008
	Hoadley	0.0025 – 0.008	0.004
	Ketchikan	0.0025 – 0.154	0.043
Nitrate and nitrite-N	Carlanna	0.005 – 0.051	0.02
	Hoadley	0.005 – 0.076	0.022
	Ketchikan	0.054 – 0.14	0.085
Dissolved phosphorus[10]	Carlanna	0.0005 – 0.018	0.005
	Hoadley	0.0005 – 0.018	0.006
	Ketchikan	0.0005 – 0.018	0.005
Total phosphorus	Carlanna	0.0025 – 0.006	0.003
	Hoadley	0.0025 – 0.013	0.004
	Ketchikan	0.0025 – 0.028	0.008
Alkalinity	Carlanna	0.5 - 6	1.4
	Hoadley	0.5 - 8	4.2
	Ketchikan	0.5 - 12	3.9
Calcium	Carlanna	0.5 – 1.8	1.1
	Hoadley	0.8 – 6.1	2.9
	Ketchikan	1.6 – 7.1	3.8
Magnesium	Carlanna	0.2 – 0.4	0.3
	Hoadley	0.3 – 0.9	0.5
	Ketchikan	0.3 – 0.7	0.4
Sodium	Carlanna	1.2 – 1.5	1.3
	Hoadley	1.7 – 2.9	2.3
	Ketchikan	1 – 2.1	1.4
Hardness	Carlanna	2.1 – 6.3	2.9, 4.05, 4.9[11]
	Hoadley	3.1 – 19	5.8, 8.5, 13.85
	Ketchikan	5.1 – 20	12.63, 9.5, 10.77

[9] WQS do not exist for many of these conventional constituents, but the constituents are used to help evaluate other water quality parameters and general stream health.

[10] Dissolved Phosphorus is reported as Ortho-Phosphate and Sol-reactive on the project laboratory analytical data sheets from laboratory filtered project water samples.

[11] Hardness average is the three averages from the seasonal sampling events (spring, summer, and fall).

Table 7. 2018 Field measurements water data summary

Parameter	Sample site	Units	Range	Average	Aquatic Life criteria
Turbidity	Carlanna	NTU	0.535 - 2.455	1.2	May not exceed 5 above natural turbidity
	Hoadley		0.495 - 5.95	2.7	
	Ketchikan		0.495 – 2.07	1.09	
Specific conductivity	Carlanna	µS/cm	7.12 – 113.6	46.32	NA
	Hoadley		13.14 – 157.1	64.67	
	Ketchikan		15.52 – 92.7	42.79	
Temperature	Carlanna	C	7.6 – 16.2	10.83	May not exceed 20° C at any time. The following maximum temperatures may not be exceeded, where applicable: Migration routes 15° C Spawning areas 13° C Rearing areas 15° C Egg & fry incubation 13° C For all other waters, the weekly average temperature may not exceed site-specific requirements needed to preserve normal species diversity or to prevent appearance of nuisance organisms.
	Hoadley		6.2 – 13.8	10.47	
	Ketchikan		6.7 – 14.8	9.62	
Dissolved oxygen	Carlanna	mg/l	9.76 – 12.48	11.07	Must be ≥ 7.0
	Hoadley		10.52 – 12.39	11.19	
	Ketchikan		8.48 – 13.1	11.41	
pH	Carlanna	NA	6.3 – 10.89	7.88	Minimum 6.5 – Maximum 8.5
	Hoadley		6.19 – 9.28	7.76	
	Ketchikan		6.56 – 10.44	8.18	

Creek Sediment

Table 8. 2018 Metal & PAH creek sediment data summary – bold values above screening thresholds. Results with nondetected values are listed as ND.

Parameter	Sample site	Units	Range	TEL[12]	PEL
Copper	Carlanna	ug/kg	5,300 – 26,600	35,700	197,000
	Hoadley		6,890 – 32,800		
	Ketchikan		11,200 – **86,300**		
Cadmium	Carlanna	ug/kg	ND – 298	596	3,530
	Hoadley		ND – 40		
	Ketchikan		ND – 310		
Chromium	Carlanna	ug/kg	8,140 – 23,600	37,300	90,000
	Hoadley		6,050 – 17,400		
	Ketchikan		10,600 – 23,100		
Lead	Carlanna	ug/kg	ND – 23,200	35,000	91,300
	Hoadley		ND – 3,060		
	Ketchikan		ND – 17,300		
Zinc	Carlanna	ug/kg	22,600 – 64,500	123,000	315,000
	Hoadley		15,700 – 40,400		
	Ketchikan		38,600 – **126,000**		
PAHs	Carlanna & Hoadley	ug/kg	ND		
Benzo(a)anthracene	Ketchikan	ug/kg	**43.8**	31.7	385
Pyrene			**56.5 - 101**	53	875

[12] NOAA SQuiRT threshold effects levels (TEL) and probable effects levels (PEL), (Buchman 2008).

Outfall Water

Table 9. 2018 Metal results outfall water data summary

Parameter	Sample site	Units	Result
Copper	Carlanna	ug/l	1.37
	Hoadley		3.05
	Ketchikan		3.9
Cadmium	Carlanna	ug/l	ND
	Hoadley		ND
	Ketchikan		0.712
Chromium	Carlanna	ug/l	ND
	Hoadley		ND
	Ketchikan		ND
Lead	Carlanna	ug/l	ND
	Hoadley		ND
	Ketchikan		ND
Zinc	Carlanna	ug/l	11.3
	Hoadley		9.69
	Ketchikan		99.7

Outfall Sediment

Table 10. 2018 Metal & PAH outfall sediment data summary – bold values above screening thresholds. ND is Non-Detect

Parameter	Sample site	Units	Result	TEL[13]	PEL
Copper	Carlanna	ug/kg	**164,000**	35,700	197,000
	Hoadley		**40,300**		
	Ketchikan		**48,300**		
Cadmium	Carlanna	ug/kg	**12,100**	596	3,530
	Hoadley		531		
	Ketchikan		383		
Chromium	Carlanna	ug/kg	**49,300**	37,300	90,000
	Hoadley		26,200		
	Ketchikan		24,700		
Lead	Carlanna	ug/kg	ND	35,000	91,300
	Hoadley		ND		
	Ketchikan		21,400		
Zinc	Carlanna	ug/kg	**3,220,000**	123,000	315,000
	Hoadley		70,600		
	Ketchikan		**147,000**		
PAHs	Carlanna	ug/kg	ND		
Acenaphthene	Hoadley	ug/kg	**7.27**	6.71	88.9
Anthracene			**47.3**	46.9	245
Benzo(a)anthracene			**89.7**	31.7	385
Chrysene			**59**	57.1	862
Fluoranthene			**153**	111	2,355
Phenanthrene			**174**	41.9	515
Pyrene			**278**	53	875
Pyrene	Ketchikan		**79**	53	875

[13] NOAA SQuiRT threshold effects levels (TEL) and probable effects levels (PEL), shown in Table 22 (Buchman 2008).