Alaska Department of Environmental Conservation
Attainment Determination

Bonanza, Porcupine, Mammoth and Mastodon Creeks
Central, Alaska (Crooked Creek Watershed)
Turbidity Attainment

Contents

Recommendation

Bonanza, Porcupine, Mammoth and Mastodon Creeks are recommended for inclusion in Category 2 on the 2018 IR 303(d) list for attainment of the turbidity standard for all designated uses.

Executive Summary

The purpose of this document is to describe the data collection, data analysis, and conclusions reached in evaluating Bonanza, Porcupine, Mammoth and Mastodon Creeks for the 2018 Integrated Report (IR). Bonanza, Porcupine, Mammoth and Mastodon Creeks were previously included in Category 5 for non-attainment of the turbidity criteria. The creeks were originally listed as impaired in 1992.

Bonanza, Porcupine, Mammoth and Mastodon Creeks are located in the Crooked Creek watershed near Central, Alaska. A watershed wide assessment was conducted from 2014-2017 to address turbidity impairments on these and other creeks (Crooked, Deadwood and Ketchem). Bedrock Creek, an adjacent un-mined waterbody, was selected to establish the natural condition, as required for comparison by the turbidity water quality criteria.

Based on the data analysis described below, Bonanza, Porcupine, Mammoth and Mastodon Creeks were found to be attaining the turbidity standard for all designated uses.

Basic Waterbody Information

Table 1. Basic Waterbody Information

Assessment Unit ID	AK-40402-010_07
Assessment Unit Name	Bonanza Creek
Location description	Lat/Long; Near Central, AK in the Crooked Creek watershed
Water Type	Stream
Water Size (units)	4.6 miles

Assessment Unit ID	AK-40402-010_08
Assessment Unit Name	Porcupine Creek
Location description	Lat/Long; Near Central, AK in the Crooked Creek watershed
Water Type	Stream
Water Size (units)	12.4 miles

Assessment Unit ID	AK-40402-010_04
Assessment Unit Name	Mammoth Creek
Location description	Lat/Long; Near Central, AK in the Crooked Creek watershed
Water Type	Stream
Water Size (units)	4.4 miles

Assessment Unit ID	AK-40402-010_03
Assessment Unit Name	Mastodon Creek
Location description	Lat/Long; Near Central, AK in the Crooked Creek watershed

Water Type	Stream
Water Size (units)	4.9 miles

Pollutant Status

Table 2. Turbidity for fresh water uses[1]

Use	Criteria	Status
12 (A) Water Supply (i) drinking, culinary, and food processing	May not exceed 5 nephelometric turbidity units (NTU) above natural conditions when the natural turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 25 NTU.	Supporting
12 (A) Water Supply (ii) agriculture, including irrigation and stock watering	May not cause detrimental effects on indicated use.	Supporting
12 (A) Water Supply (iii) aquaculture	May not exceed 25 NTU above natural conditions. For all lake waters, may not exceed 5 NTU above natural conditions.	Supporting
12 (A) Water Supply (iv) industrial	May not cause detrimental effects on established water supply treatment levels.	Supporting
12 (B) Water Recreation (i) contact recreation	May not exceed 5 NTU above natural conditions when the natural turbidity is 50 NTU or less, and may not have more than 10% increase in turbidity when the natural turbidity is more than 50 NTU, not to exceed a maximum increase of 15 NTU. May not exceed 5 NTU above natural turbidity for all lake waters.	Supporting
12 (B) Water Recreation (ii) secondary recreation	May not exceed 10 NTU above natural conditions when natural turbidity is 50 NTU or less, and may not have more than 20% increase in turbidity when the natural turbidity is greater than 50 NTU, not to exceed a maximum increase of 15 NTU. For all lake waters, turbidity may not exceed 5 NTU above natural turbidity.	Supporting
12 (C) Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife	Same as (12)(A)(iii).	Supporting

[1] Alaska Department of Environmental Conservation. 2018. 18 AAC 70.010 Water Quality Standards. Amended as of April 6, 2018.

Attainment Evaluation

Data Sources

Historic

Seven creeks in the Crooked Creek watershed, (Bonanza, Porcupine, Mammoth, Mastodon, Crooked, Deadwood and Ketchem), were placed on the 303(d) list in 1992, based on data from the 1980s. ADEC conducted a follow up water quality assessment of the watershed in 1996[2].

Recent

ADEC staff visited the Crooked Creek watershed in 2013 to observe current turbidity conditions and evaluate potential sampling locations for a re-evaluation of the turbidity impairments. An ADEC quality assurance project plan was approved in 2014. Site selection and study design were done in collaboration with the ADEC placer permitting and compliance and enforcement programs. In addition, the Bureau of Land Management and Department of Natural Resources were consulted prior to and during the assessment.

A total of six sites across the Crooked Creek watershed had continuous dataloggers, including Porcupine, Mammoth, Bedrock, Crooked, Deadwood and Ketchem, and several additional sites were monitored periodically with grab samples only. One continuously monitored site, Bedrock Creek, was selected to establish the natural condition, as required for comparison by the turbidity water quality criteria.

Table 3. Years with historic and recent data for Boulder Creek

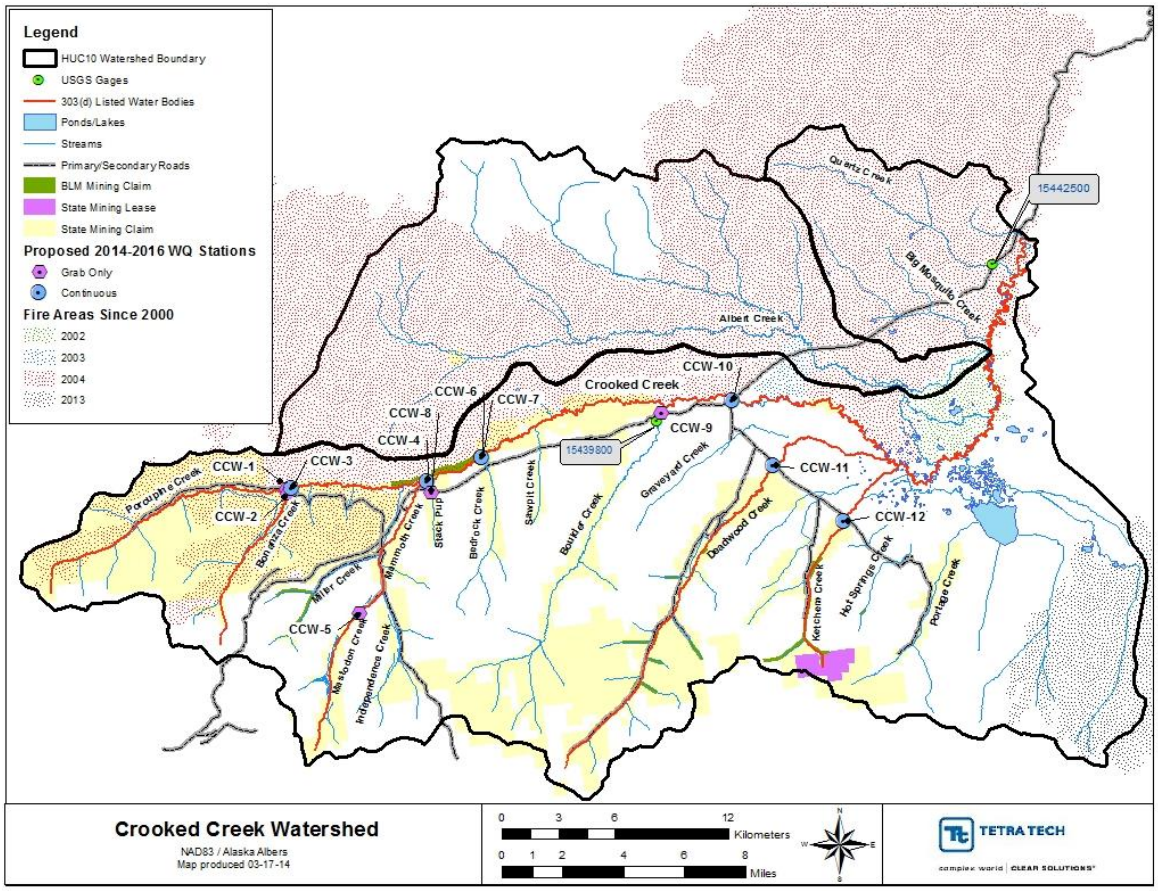
	Grab Sampling	Continuous Sampling	Source
Historic	1984 – 1994		ADEC and other state agencies
Recent	2014	2014	ADEC
	2016	2016	
	2017	2017	

Data used in turbidity impairment determination

The 2014, 2016 and 2017 datasets were used in the attainment determination.

[2] ADEC (Alaska Department of Environmental Conservation). 1995. Crooked Creek Water Quality Assessment – USGS Hydrologic Unit 19040402. Alaska Department of Environmental Conservation, Juneau, AK.

Figure 1. Monitoring locations for data collected in 2014-2017



Data Evaluation

Methods

The ADEC Turbidity Listing Methodology[3] was applied to the recent data collected in Bonanza, Porcupine, Mammoth and Mastodon Creeks to evaluate impairment.

A paired watershed approach was used to establish the natural condition. Bedrock Creek, an adjacent un-impacted waterbody, was selected to represent the natural condition. For this type of dataset, the listing methodology recommends a Distribution of Differences (DoD) statistical significance test:

> *"DoD can be used to describe the range of differences between two variables (Hogg et al. 2012; Ott and Longnecker 2015). In the case of evaluating the impairment threshold for turbidity, the two variables are daily average turbidity measurements from two locations (e.g., natural conditions and impacted sites). Given the allowable exceedance frequency for turbidity criteria is 10%, the location of interest on the DoD curve is the 90th percentile. On this basis, if the 90th percentile of the turbidity difference is greater than +5 NTU (magnitude threshold), an impairment may be present."*

[3] 2016. Alaska Department of Environmental Conservation. Listing Methodology for Determining Water Quality Impairments from Turbidity. Guidance, Final.

Table 4. Method Requirements

Description	Minimum Requirement (from Turbidity listing methodology)	Evaluation Dataset
Instrument	Must measure turbidity in nephelometric turbidity units and meet EPA method 180.1 requirements	Hach 2100 P and YSI EXO Sondes
Site selection	Select at least one each: natural conditions site and impacted site • The natural conditions site must be a nearby water with waterbody geomorphology similar to impacted site(s). • The impacted site should be representative of anthropogenic impacts and pollutant sources.	Natural condition site at Bedrock Creek, an adjacent un-mined waterbody.
Assessment period	Two years	Three years (2014, 2016, 2017)
Annual period of concern	Within each year, samples should be collected over a minimum three week time span.	Data was collected for approximately three months (open water season) within each year
Minimum sample size	Samples must be collected on at least 20 days at both the natural conditions and impacted sites.	Samples collected on over 20 days at all impacted creeks and Bedrock Creek (natural conditions)
Representative data	Samples collected must be spatially and temporally representative of the areas and period of concern and the natural conditions.	Samples were collected downstream of impacted areas throughout the watershed. A reference site was established on a non-mined creek to establish the natural condition. See ADEC QAPP[4] for more details. The period of concern was during the open water season, coinciding with the mining season.
Current data	Generally less than 5 years old	Data is less than 5 years old (2014-2017) as of 2018.
QAPP	Data collected in accordance with a QAPP	An ADEC QAPP was approved in 2014

Hypothesis Test

The ADEC Turbidity Listing Methodology was applied to evaluate the turbidity data. The impairment threshold criteria statement is:

- **The 24-hour daily average (duration)**
- **may not exceed 5 NTU above natural conditions (magnitude)**
- **during more than 10% of the days sampled (frequency).**

[4] Department of Environmental Conservation. 2014. Surface Water Monitoring of Crooked Creek for the Development of TMDLs. Quality Assurance Project Plan and Sampling and Analysis Plan.

Table 5. Null and alternate hypothesis tests

Null Hypothesis	Waterbody is impaired	90th percentile difference > 5 NTU
Alternative Hypothesis	Waterbody is not impaired	Upper confidence limit on the 90th percentile difference ≤ 5 NTU

For each waterbody:

- The continuous data was aggregated into daily averages.
- The three years of data were combined to form one complete dataset.
- Data was entered into the DoD excel template (from the ADEC Turbidity Listing Methodology) to run the statistical test.

Results

The Raw Results summary table shows the raw data comparison by year between the creeks. Below, the DoD results show the statistical tests with the three years combined.

Table 6. Raw Results Summary (grab turbidity samples)

	Year	Average Turbidity (NTU)	50th percentile	90th percentile	Total number of data points (daily averages)
Bedrock Creek	2014	4.57	1.49	13.02	47
	2016	5.27	2.00	14.14	
	2017	2.29	0.75	5.09	
Bonanza Creek	2014	9.13	1.51	21.70	38
	2016	6.70	0.79	1.70	
	2017	2.61	1.19	7.36	
Porcupine Creek	2014	19.68	5.59	52.51	35
	2016	4.15	3.58	4.57	
	2017	8.95	1.55	14.52	
Mammoth Creek	2014	33.30	2.30	8.80	43
	2016	6.70	3.58	12.69	
	2017	7.54	2.30	14.86	
Mastodon Creek	2014	4.70	4.99	7.40	21
	2016	12.03	9.35	20.83	
	2017	11.86	3.95	14.19	

Confidence limit differences around the 90th percentiles of the daily average turbidity data from each impacted creek and Bedrock Creek were compared to determine if there was a turbidity difference of greater than 5 NTU (most stringent criteria) more than 10% of the time (at the 90th percentile) with statistical significance (upper confidence limit). The table below shows the 90th percentile upper confidence limit difference compared to the water quality criteria for drinking water and contact recreation.

Data for all creeks shows attainment because the 90th percentile differences between all creeks are less than the maximum NTU difference over natural condition for the most stringent criteria (drinking water and contact recreation).

Table 7. DoD statistical test results for attainment of the drinking water and contact recreation designated uses

	90th percentile upper confidence limit of the difference between Bonanza and Bedrock Creeks	90th percentile upper confidence limit of the difference between Porcupine and Bedrock Creeks	90th percentile upper confidence limit of the difference between Mammoth and Bedrock Creeks	90th percentile upper confidence limit of the difference between Mastodon and Bedrock Creeks
	1.4	3.2	3.0	4.7
Criteria (maximum NTU difference over natural condition)	5	5	5	5
Attaining?	Yes	Yes	Yes	Yes

Conclusion

The results of the Distribution of Differences analysis found that the upper confidence limit on the 90th percentile difference was less than 5 NTU for Bonanza, Porcupine, Mammoth and Mastodon Creeks. This magnitude of difference does not exceed any turbidity water quality standards.

Bonanza, Porcupine, Mammoth and Mastodon Creeks are recommended for de-listing of the turbidity impairment in the 2018 IR. Recent data shows that all creeks are attaining water quality standards for all designated uses for turbidity.

Appendix:

Natural Condition Analysis

For turbidity, a natural background condition must be established. The most common method used to determine natural conditions is to compare in-stream data to data from a reference waterbody that has similar physical and geographical characteristics.[5] A reference site should be chemically, physically and biologically similar to the impaired watershed and also be relatively undisturbed by human activities.[6] Bedrock Creek was used as a reference watershed to represent natural conditions

[5] USEPA (United States Environmental Protection Agency). 2005. EPA Region 10 Natural Conditions Workgroup Report on Principles to Consider When Reviewing and Using Natural Conditions Provisions. Seattle, WA.
[6] See footnote 3

for the Boulder creek impairment determination. The bulleted list below presents the justification for Bedrock Creek to be considered an appropriate reference watershed.

- Similar physical characteristics (i.e., topography, geography, and geology)
- Minimal historical mining or other disturbances
- No current mining
- Low turbidity concentrations which are comparable to samples taken upstream of disturbance (current or historic mining) in the watershed

The Bedrock Creek subwatershed is located within the Crooked Creek watershed and is directly west of the Boulder Creek subwatershed. The physical characteristics of the reference watershed are very similar to those of the impaired watersheds. Both watersheds join Crooked Creek between 330-430 feet in elevation. In addition, both subwatersheds are dominated by shrub and evergreen forest and gravelly, hilly to steep D-type soils. While all three subwatersheds contain quartzite and granite, Bedrock Creek lacks the mafic schist common to those subwatersheds where gold mining has occurred. The Bedrock Creek subwatershed has minimal mining disturbance and no current mining activity. In addition, there are no currently active mining claims in the Bedrock Creek watershed.[7]

While Bedrock Creek may have had previous mining activity, the mines have not been active in recent years.[8] The only known mining in Bedrock Creek was work on claims between 1976 and 1978, which consisted of surface trenching on the slightly radioactive zone of the iron-stained schist.[9] Bedrock Creek is noted for its absence of gold, even though it is surrounded by gold-producing creeks.

A comparison of Bedrock Creek in 1986 and 2016 shows that the watershed has not changed much in 30 years and there is little to no disturbance, indicating that mining has not been occurring in the watershed.

Turbidity data also support the use of Bedrock Creek as a reference watershed. Data show that turbidity in Bedrock Creek is typically much lower than turbidity sampled downstream of mined areas in Crooked Creek or in the neighboring tributaries. However, Bedrock Creek turbidity is comparable to samples collected in Crooked Creek tributaries upstream of mining or historic disturbance. In addition, low turbidity values have been measured on Bedrock Creek after spring break-up; therefore, this station provides the best characterization of natural conditions in the watershed.

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[7] Alaska DNR (Alaska Department of Natural Resources). 2017. Federal and State Mining Claims. Accessed July 2017. http://www.asgdc.state.ak.us/

[8] Yeend, W. 1991. Gold Placers of the Circle District, Alaska – Past, Present, and Future. U.S. Geological Survey Bulletin 1943. Washington, DC.; Townsend, A.H. 1991. Distribution of fishes in Alaska's Upper Birch Creek drainage during 1984 and 1990. Technical Report No. 91-2. Prepared by Alaska Department of Fish and Game, Division of Habitat.

[9] Mindat. 2015. Bedrock Creek Prospect, Circle District, Yukon-Koyukuk Borough, Alaska, USA. Mindat.org Accessed September 25, 2017. https://www.mindat.org/loc-196443.html