HAWK INLET MONITORING PROGRAM
2022 ANNUAL REPORT

Hecla Greens Creek Mining Company

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1. INTRODUCTION

1.1. Site Description

The Greens Creek Mine, located on Admiralty Island, is 18 miles southwest of Juneau, Alaska. Dense forests cover the mountain slopes up to an elevation of 2,500 feet, above which the vegetation is alpine. The climate is maritime, with precipitation averaging 60 to 70 inches per year at the mine site and 45 to 55 inches per year near the port facilities. The mine and mill facilities (920 area) are located over 6 miles from Hawk Inlet tidewater.

Zinc, lead, silver, and gold are the target recovery metals. The production of ore concentrate began in February 1989 and operated approximately four years before production was suspended in April 1993. The mine and mill were recommissioned, and operations restarted in mid-1996. A milling facility and support facilities are in place in the 920 area. Filter pressed tailings from the milling process are backfilled in the mine and deposited at a surface dry-stack tailings pile. Ore concentrate (concentrate) is transported from the mill to the Hawk Inlet port facilities area (Port) for storage until shipped. Support facilities for the mining and milling operation at the Port include rock core storage, concentrate storage, shift housing, and a domestic wastewater treatment plant.

One wastewater discharge outfall and ten stormwater discharge sites are authorized under the Alaska Pollutant Discharge Elimination System (APDES) Permit Number AK-0043206. This report fulfills the requirements of APDES Permit Number AK-0043206, effective 1 October 2015.

Hawk Inlet is a marine inlet formed during the late Holocene glaciation and is underlain by a series of late-Paleozoic to Mesozoic phyllitic-schist and greenstone formations. Hawk Inlet extends seven miles north from Chatham Strait to a tidal mudflat estuary about 0.6 miles in diameter. The narrow channel connecting the Inlet to Chatham Strait, located between the top of the Greens Creek delta and the western shore of Hawk Inlet, has a minimum low tide depth of 35 feet. The mid-channel depth ranges from 35 feet to 250 feet. Hawk Inlet has regular, twice-daily tides, with a maximum tidal variation of 25 feet. The surface 35-foot layer contains the bulk of the water transport entering the inlet on the flood tide, flushed out on the ebb tide. Flushing describes the rate and extent to which tidal or other currents replenish a body of water. Flushing rates indicate the length of time that mining effluent may remain in a water body and become incorporated into the physical and biological ecosystem through ingestion, adsorption, or other means. Dispersion dye testing in Hawk Inlet (the 1980s) determined that over each tidal cycle, an average of 13 billion gallons of water is flushed from the inlet (SEA 1983). At that rate, Hawk Inlet is estimated to flush once every five tidal cycles. Based on the average daily discharge rate, the effluent is approximately 0.007% of the total volume flushed daily.

Greens Creek geology exploration began in 1973, which led to the predevelopment of mining operations in 1986. Before this, the Hawk Inlet cannery was constructed in 1910 and operated until it burned in 1976. It is estimated that the summer population at Hawk Inlet during cannery operation was 500. Additionally, up until 1946, gold was mined near Hawk Inlet, beginning in 1919 at the Alaska Empire Mine (Forest Service 2013). “In September 2014, the Forest Service conducted a Preliminary Assessment/Site Inspection of the Alaska Empire Mine site. Elevated concentrations of metals were found in the soil, sediment, surface water, and groundwater at the Upper Camp and soil stained by petroleum hydrocarbons. Tailings piles with elevated concentrations remain adjacent to the creek and continue to erode tailings into the creek.” (Palmieri 2016).

1.2. Hawk Inlet Monitoring Program

In anticipation of the Greens Creek Mine development, government agencies, scientists, and biological consultants carried out surveys of marine life and baseline studies of heavy metals in the environment beginning in the early 1980s. The continual quarterly and annual monitoring programs have generated an extensive time-series data set of metal levels in the water, sediment, and marine tissue samples.

The Hawk Inlet monitoring program's primary objective is to document the water quality, sediment chemistry, and biological conditions in receiving waters and marine environments that the mine's operations may impact. Seawater is sampled quarterly at three locations in Hawk Inlet. Sediment and invertebrate samples are collected annually at three and seven spots, respectively (Figure 1-1). Additional sediment samples are collected at two locations every five years. Table 1-1 summarizes the requirements of the permit for sample parameters, sample preservation and holding time, sampling frequency, analytical method, and required method detection limits (MDL). Specific quality assurance/quality control (QA/QC) requirements (i.e., sampling procedures, documentation, chain of custody processes, calibration procedures and frequency, data validation, corrective actions, etc.) are outlined in the APDES Quality Assurance Project Plan: Project Monitoring Manual (HGCMC 2020).

This report presents information on each of the media sampled in Hawk Inlet: water column, sediment, and in-situ bioassay. Results for the samples collected are presented along with the associated QA/QC data. Statistical evaluation of the data showing averages, variations, and changes over time are included. The next section describes any deviations from the monitoring program that occurred and the reasons why.

1.3. Deviation(s) from Monitoring Program and Incidents

Samples were not analyzed for TSS at Site 108 and WAD Cyanide at Site 107 during the 2nd Quarter sampling event. There was a mistake during sample collection where the incorrect bottles were used so the samples were not properly preserved for these two analytes.

1.4. Outfall 002 Pipeline and Diffuser Inspection

Along with the annual environmental monitoring, the Outfall 002 pipeline is inspected annually. On October 17, 2022, Global Diving & Salvage, Inc., surveyed the pipeline and diffuser for corrosion and damage. The report and video from the survey are in Appendix B. The following recommendations summarize the notable findings of the inspection:

- The overall condition of the pipeline and diffuser is very good.
- Anode depletion should be monitored annually.
    - Based on previous inspection intervals and estimated anode depletion, the expected functional status of anodes could be 2-3 years.

Table 1-1 Summary of Permit Sampling Requirements for Hawk Inlet

APDES Requirement	Parameter	Frequency	Type	Sample Container	Sample Preservation	Laboratory	Hold Times	Analytical Method(s)	Minimum Required Method Detection Limit	Units
RECEIVING WATER COLUMN MONITORING										
1.6.1.1.3 Table 5	Dissolved Cadmium	Quarterly	Grab	1 ea. 500 ml Teflon bottle (1 bottle for Cd, Cu, Pb, Zn)	HNO_3 to pH <2 by lab	Battelle Marine Sciences	180 day	EPA 213.2/ 1638	0.10	µg/L
1.6.1.1.3 Table 5	Dissolved Copper							EPA 220.2/ 1638	0.03	µg/L
1.6.1.1.3 Table 5	Dissolved Lead							EPA 239.2/ 1638	0.05	µg/L
1.6.1.1.3 Table 5	Dissolved Zinc							EPA 289.2/ 1638	0.200	µg/L
1.6.1.1.3 Table 5	Total Mercury			1 ea. 250 ml Teflon bottle			28 day	EPA 245.1/ 1631	0.002	µg/L
1.6.1.1.3 Table 5	Total Suspended Solids			1 ea. 500 ml plastic bottle	Cool to 4°C	ACZ Labs	7 day	EPA 160.2/ SM 2540D	--	mg/L
1.6.1.1.3 Table 5	WAD Cyanide			1 ea. 500 ml plastic bottle	NaOH to pH >12, cool to 4°C		14 day	EPA 335.2/ SM 4500-CN-E	5.00	µg/L
1.6.1.1.3 Table 5	Turbidity			1 ea. 125 ml plastic bottle	Cool to 4°C	Field Measurement	2 day	EPA 180.1	--	NTU
1.6.1.1.3 Table 5	pH			NA	NA		15 min	EPA 150.1/ SM 4500-H, B	--	SU
1.6.1.1.3 Table 5	Conductivity			NA	NA		20	EPA 120.1	--	µmhos/cm
1.6.1.1.3 Table 5	Temperature			NA	NA		15 min	NA	--	°C
BIOACCUMULATION WATER SEDIMENT MONITORING										
1.6.1.2.3 Table 6	Total Cadmium	Annual	Grab	6 ea. 8 oz. plastic or glass jar	Chill and ice sample (not frozen)	ALS		PSEP/GFAA	0.30	mg/Kg
1.6.1.2.3 Table 6	Total Copper							PSEP/ICP	15.00	mg/Kg
1.6.1.2.3 Table 6	Total Lead							PSEP/ICP	0.50	mg/Kg
1.6.1.2.3 Table 6	Total Mercury							PSEP/ EPA 7471A	0.02	mg/Kg
1.6.1.2.3 Table 6	Total Zinc							PSEP/ICP	15.00	mg/Kg
BIOACCUMULATION WATER IN-SITU BIOASSAY MONITORING										
1.6.1.3.2 Table 7	Total Cadmium	Annual	Grab	6 ea. 8 oz. plastic or glass jar	Chill and ice sample (not frozen)	ALS		EPA 200.8/ 6020	not specified	mg/Kg
1.6.1.3.2 Table 7	Total Copper							EPA 200.8/ 6020	not specified	mg/Kg
1.6.1.3.2 Table 7	Total Lead							EPA 200.8/ 6020	not specified	mg/Kg
1.6.1.3.2 Table 7	Total Mercury							EPA 7471A	not specified	mg/Kg
1.6.1.3.2 Table 7	Total Zinc							EPA 200.8/ 6020	not specified	mg/Kg

2. WATER COLUMN MONITORING

The receiving water column monitoring requirements originate from Part 1.6.1.1 and Table 5 of the APDES permit. The receiving water column monitoring element of the sampling program aims to provide scientifically valid data on specific physical and chemical parameters for Hawk Inlet water quality. These data are used to evaluate potential changes in the Hawk Inlet marine environment.

Seawater samples are collected quarterly from the sites on an outgoing tide, with the Chatham Strait sample (Site 106) collected just after low, slack water. The two other sites are Station 107, located about mid-way east-west in Hawk Inlet, west of the ship loader facility, and Station 108, located proximal to the Outfall 002 diffuser at the edge of the mixing zone. Samples at these locations are taken at a depth of five feet. The sample timing in each quarter is tide and weather dependent. As required by Permit Part 1.6.3.2, quarterly receiving water sample collection occurs on the same day as effluent sample collection.

Water samples are sent to Battelle Marine Science Laboratory in Sequim, Washington, for low-level mercury and dissolved trace metals analyses (Cd, Cu, Pb, and Zn) and ACZ Laboratories in Steamboat Springs, Colorado for WAD CN and total suspended solids analyses. Temperature, pH, turbidity, and conductivity are measured in the field by HGCMC personnel.

2.1. Analytical Results

The tables in this section summarize the results for the quarterly water column monitoring.

Table 2-1 Hawk Inlet Field Parameters

Quarter	Sample date	Site Number	Sample Time	Water Temperature (°C)	pH (s.u.)	Conductivity (µmhos/cm @ 25°C)	Turbidity (NTU)
1	2022-03-08	106	10:30	3.7	7.8	51,400	1.0
		107	10:00	3.6	7.7	50,700	1.2
		108	10:20	3.6	7.7	50,600	1.1
2	2022-05-31	106	08:40	7.9	8.0	51,300	0.8
		107	09:30	9.1	8.3	48,300	0.7
		108	09:11	9.4	8.4	45,080	0.7
3	2022-08-02	106	11:10	13.5	8.3	36,140	0.6
		107	10:25	13.0	8.1	42,420	0.6
		108	10:45	12.6	8.3	43,270	0.7
4	2022-12-12	106	09:35	4.7	7.8	49,600	1.2
		107	10:25	3.9	7.8	49,600	1.2
		108	10:05	3.8	7.8	48,200	1.1

Table 2-2 Hawk Inlet Water Column Monitoring

Sample Quarter	Site	TSS (mg/L)	WAD CN (µg/L)	Cd (µg/L) Dissolved	Cu (µg/L) Dissolved	Hg (µg/L) Total	Pb (µg/L) Dissolved	Zn (µg/L) Dissolved
	Lab MDL	*(5.0)*	*(3.0)*	*(0.002)*	*(0.023)*	*(0.0001)*	*(0.005)*	*(0.042)*
	Req. MDL		*(5.0)*	*(0.10)*	*(0.03)*	*(0.002)*	*(0.05)*	*(0.20)*
1	106	20.00	<3	0.08	0.25	0.0003	<0.005	0.37
	107	21.00	<3	0.08	0.25	0.0005	0.01	0.48
	108	27.00	<3	0.08	0.24	0.0003	<0.005	0.50
2	106	46.00	5.30	0.07	0.20	0.0002	<0.005	0.09
	107	47.00	--	0.07	0.25	0.0003	<0.005	0.36
	108	--	7.30	0.06	0.28	0.0026	0.02	0.44
3	106	14.00	<3	0.04	0.38	0.0002	<0.005	0.21
	107	18.00	<3	0.05	0.38	0.0006	0.01	0.47
	108	21.00	<3	0.05	0.42	0.0005	0.01	1.27
4	106	31.00	<3	0.09	0.29	0.0002	0.01	0.35
	107	37.00	<3	0.10	0.38	0.0003	0.01	0.48
	108	36.00	<3	0.10	0.34	0.0003	0.01	0.90

Note

1. A '--' denotes the sample was not collected

2.2. Data Evaluation

Figures 2-1a, b, c through 2-7a, b, c show the time series plots of field pH, conductivity, cadmium, copper, lead, mercury, and zinc for stations 106 (2-1a through 2-7a), 107 (2-1b through 2-7b) and 108 (2-1c through 2-7c). The Alaska Water Quality Standards (AWQS) for marine aquatic life – chronic levels are shown or noted on the relevant graphs. The graphs show that Hawk Inlet water quality has remained within AWQS standards for all samples.

Figures 2-8a through 2-8f are the comparative time series plots of field pH, cadmium, copper, lead, mercury, and zinc from the last 10 years for station 108 and Outfall 002. The graphs demonstrate that the mixing zone authorized by the APDES permit is protective of the AWQS for all measured parameters.

Table 2-3 compares monitoring results averaged from the previous five years (n=20) and last year's (n=4) results at the three seawater monitoring locations. The results for the reporting period remained near the last five-year average.

Table 2-3 Hawk Inlet Water Column Average Dissolved Metal Concentrations

Site	Cd (µg/L)		Cu (µg/L)		Pb (µg/L)		Hg (Total - µg/L)		Zn (µg/L)	
	2017 through 2021	2022	2017 through 2021	2022	2017 through 2021	2022	2017 through 2021	2022	2017 through 2021	2022
106	0.072	0.069	0.24	0.28	0.008	0.01	0.0002	0.0002	0.42	0.26
107	0.075	0.073	0.28	0.32	0.010	0.01	0.0006	0.0004	0.44	0.45
108	0.075	0.073	0.42	0.32	0.014	0.01	0.0004	0.0009	0.63	0.78

2.3. Laboratory QA/QC Results

Battelle Marine Sciences Laboratory and ACZ Laboratories analyzed the required parameters (refer to Table 1-1) in the seawater samples. Complete QA plans and reports are kept on file in each laboratory's office and are available upon request. This section summarizes the relevant laboratory QA/QC results from each laboratory for the quarterly seawater samples. Elevated zinc levels in the field blanks, often at levels higher than all the other seawater samples, have been noted consistently by Battelle for this sampling program.

<u>Battelle Marine Science (low level dissolved trace metals analyses in saltwater matrices):</u>

1Q: The analytes of interest were found at detectable levels in all field samples with the exception of Pb at site 106-5 and 108-5, which were below the MDL. Concentrations in the method blank were less than the MDL for all metals. Concentrations in the field blank were less than the MDL for all metals with the exception of Cu, Zn and Pb, which were detected at 1.92, 2.85 and 1.30 times the MDL, respectively. No corrective action was taken considering this is less than 10 times the MDL. Trip blank results were below the MDL for all metals with the exception of Cu and Zn, which were detected at 1.77 and 1.02 times the MDL. No corrective action was taken considering this is less than 10 times the MDL. Target detection limits (TDLs) were met for all metals. Standard reference material (SRM), matrix spike and duplicate results were within our default criteria of 77-123%, 71-125%, and ±25%, respectively.

2Q: The analytes of interest were found at detectable levels in all field samples with the exception of Pb at sites 106-5 and 107-5, which were below the MDL. Concentrations in the method blank were less than the MDL for all metals. Concentrations in the field blank were less than the MDL for all metals with the exception of Pb and Zn, which were detected at 1.08 and 2.46 times the MDL, respectively. No corrective action was taken considering this is less than the reporting limit (i.e., 4 times the MDL). Trip blank results were below the MDL for all metals with the exception of Cu, which was detected at 1.28 times the MDL. No corrective action was taken considering this is less than the reporting limit. Target detection limits (TDLs) were met for all metals. Standard reference material (SRM), matrix spike and duplicate results were within our default criteria.

3Q: The analytes of interest were found at detectable levels in all field samples with the exception of Pb at site 106-5, which was below the MDL. Concentrations in the method blank were less than the MDL for all metals. Concentrations in the field blank were less than the MDL for all metals with the exception of Cu, Pb, and Zn, which were detected at 2.56, 4.04, and 48.0 times the MDL, respectively. This is not a concern for Cu and Pb since this is below the reporting limit (i.e., 4 times the MDL). The high levels of Zn in the field blank are potentially due to an issue that was previously identified when not enough water is passed through the filter prior to sample collection to rinse any residual cleaning acid. A larger bottle of DI will be sent for the next sampling. These results are not concerning for field samples considering large amounts of sample is rinsed through the filters prior to field sample collection. Trip blank results were below the MDL for all metals with the exception of Cu and Zn, which were detected at 1.28 and 8.61 times the MDL, respectively. This is not a concern for Cu since this is below the reporting limit. The elevated Zn levels in the trip blank were substantially lower than in the field blank, but may indicate a slight source of contamination at some point in the sampling or sample handling process. We will review laboratory sample handling procedures conducted to ensure contamination doesn't arise from lab handling. Target detection limits (TDLs) were met for all metals. Standard reference material (SRM), matrix spike and duplicate results were within our default criteria.

4Q: The analytes of interest were found at detectable levels in all field samples. Concentrations in the method blank were less than the MDL for all metals. Concentrations in the field blank were less than the MDL for all metals with the exception of Cu and Zn, which were detected at 1.61 and 4.61 times the MDL, respectively. No corrective action was taken considering this is less than the reporting limit (i.e., 4 times the MDL) for Cu and field samples had concentrations greater than 10 times the MDL with the exception of site 106-5. Trip blank results were below the MDL for all metals with the exception of Cu, which was detected at 1.11 times the MDL. No corrective action was taken considering this is less than the reporting limit. Target detection limits (TDLs) were met for all metals. Standard reference material (SRM), matrix spike and duplicate results were within our default criteria.

ACZ Laboratories (WAD cyanide analyses):

1Q: No certification qualifiers associated with this analysis.

2Q: No certification qualifiers associated with this analysis.

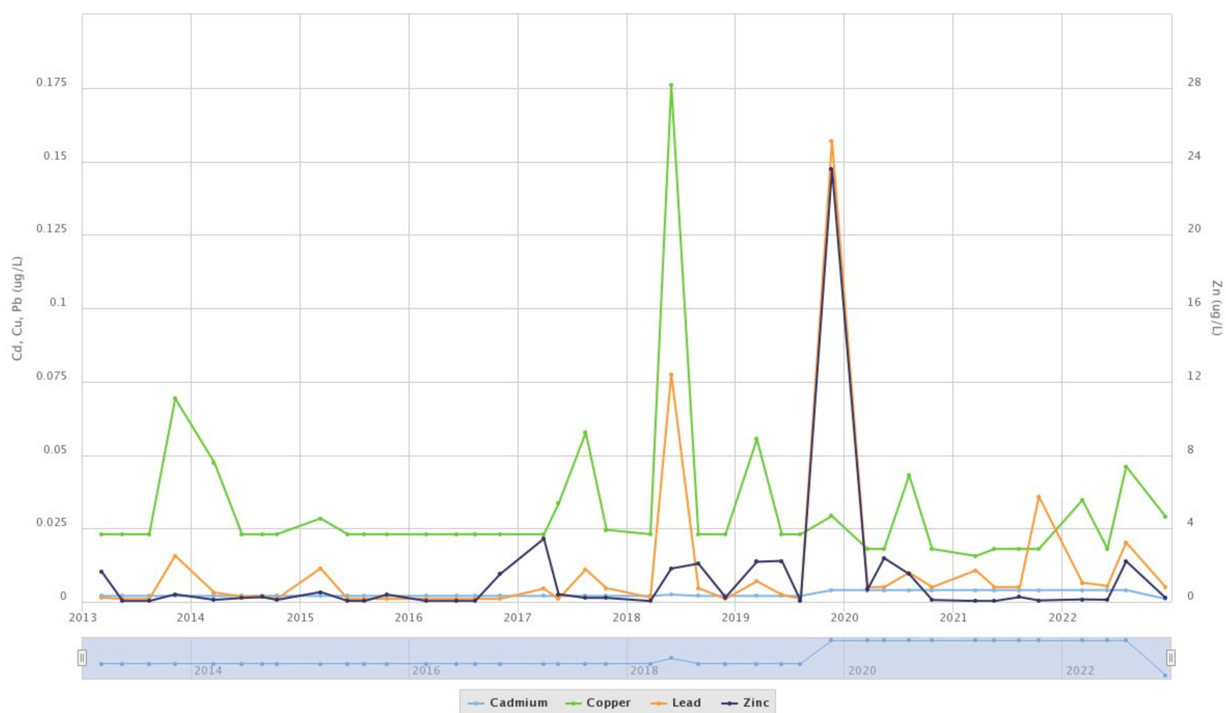
3Q: No certification qualifiers associated with this analysis.

4Q: No certification qualifiers associated with this analysis.

2.4. Field Blank Zinc Detection

As mentioned in section 2.3 and other Hawk Inlet monitoring reports, zinc is routinely detected in the field blank sample but not the actual seawater samples. HGCMC has always taken steps to minimize the potential contamination of the seawater and blank samples. Before 2009, Battelle provided water for the field blank locally sourced from the Pacific Ocean near Sequim, Washington, after which they began to provide deionized water. This switch is evident with the field blank data set (Chart 2-1).

Chart 2-1 2006-2022 Quarterly Field Blank Dissolved Metal Results



The average field blank value for dissolved zinc over the last 10 years is greater than the results for Site 106, Site 107, and Site 108. If HGCMC sampling procedures systematically introduce a contaminant into the field blank sample, the seawater samples should be similarly tainted. However, this is not the case.

All sampling supplies are provided by BML. Bottles and pump tubes are reused after acid-washing. The filter capsules are new but acid-washed. The bottles and tubes are not maintained to a specific sample. If they were the source of contamination, the errant zinc values would be randomly distributed. BML supplies the same deionized water for the field blank and trip blank samples, and rarely are metals detected in the trip blank. Removing these pathways leaves minimal possibilities for contaminating the field blank.

HGCMC speculates that the contamination is entering the sample from the filter capsule. The acid-washed filter capsules are necessary for the sub-microgram detection limits. However, the field blank filter capsules have not been as thoroughly rinsed as the actual seawater sample filter capsules. For years BML provided 1L of water for rinsing the filter, pump tubing, and sample bottle and then collecting a 0.5L and 0.25L sample. Recently, they have been sending 2L of water for rinsing and collection. Increasing the rinse volume on the filter to nearly 1L, whereas before, it was around 0.2L. Also, HGCMC has implemented controls to ensure that all filter capsules have an equal volume of seawater or DI water flushed through them before the sample is collected.

3. SEDIMENT MONITORING

The sediment monitoring requirements originate from Section 1.6.1.2, Sediment Monitoring, and Table 6 of the APDES permit. This monitoring program element aims to provide scientifically valid data on five specific trace metal parameters analyzed as the dry weight (dw) from sediments at four Hawk Inlet locations (see Figure 1-1 for locations). These data are used to evaluate potential changes in the Hawk Inlet marine environment over time.

Sediment samples were collected semi-annually through 2015. With the re-issuance of the permit, the sampling frequency was changed to annual. Samples are collected at the Greens Creek delta (Site S-1), Pile Driver Cove near the mouth of the inlet (Site S-2), ~400 feet south of the concentrate loading facility (Site S-4), and under the loading facility at Sites S-5N and S-5S. Sites S-5N and S-5S were established in response to the 1989 concentrate spill. These two sites are sampled every five years per permit condition 1.6.1.2. Sampling sites S-1, S-2, and S-3 were chosen to represent natural conditions. The results from these sites from September 1984 until January 1989 were used to calculate baseline values.

Station S-3 near the head of Hawk Inlet, established initially as a background site, has been sampled for sediment and biota since the 1980s. Though dropped from the official sampling program with the permit reissuance in 2005, HGCMC continued to monitor the site yearly and has included the data in this report.

3.1. Sediment Analytical Results

Marine Taxonomic Services, LTD collected all sediment samples. The sample locations, dates, times, weather conditions, and tides are shown in Table 3-1. Table 3-2 summarizes the total metals results for the sediment monitoring events. Sample replicates (reps) 1 through 6 were averaged for each sample site.

Samples are analyzed at ALS Environmental in Kelso, Washington, for total concentrations of cadmium, copper, lead, mercury, and zinc.

Table 3-1 Hawk Inlet Sediment Monitoring Field Parameters

Location	Date Sampled	Time Sampled (24 hour)	Air Temperature (°F)	Weather Conditions	Tide (ft MLLW)
S-1	10/11/2022	2045	47	Light rain, overcast	-1.3
S-2	10/10/2022	2000	46	Light rain, mostly cloudy	-1.3
S-3	10/8/2022	0628	50	Light rain and fog	-0.7
S-4	10/8/2022	0731	50	Light rain and fog	0.0

3.2. Data Evaluation

Before opening the Greens Creek Mine for full production in 1989, 5 locations were chosen for sediment sampling for heavy metal concentrations. This data is valuable to compare metal values after mining began and the current year's sampling results. Sampling sites S-4 and S-5N, and S-5S are located near the ore concentrate loading facility. They are thought to have been influenced by the old industrial cannery operation and not representative of natural conditions. However, these sites were used to establish a pre-operational baseline condition.

Figures 3-1 through 3-5 show the time series plots for cadmium, copper, lead, mercury, and zinc, including replicate samples for sample site S-1. Figures 3-6 through 3-10 show the time series plots for cadmium, copper, lead, mercury, and zinc, including replicate samples for sample site S-2. . Figures 3-11 through 3-15 show the metal time-series graphs for site S-4. Replicate samples are plotted with a single point, representing the mean value of the data and error bars to represent the distribution. In 2004, replicate sampling began, and all replicate samples were included, plotted by the mean with standard error bars unless otherwise noted.

Table 3-2 shows the average metal concentrations and the associated standard deviations for each sediment sampling site during pre-production, production, and the current year. At site S-1, located at the Greens Creek delta and closest to Outfall 002, average concentrations of heavy metals were less than or similar to the average production and pre-production period concentrations.

At site S-2, the background site in Pile Driver Cove located approximately three miles south of the port facilities, the average concentrations during the reporting period were higher than the production and pre-production period averages.

Site S-3 is located near Hawk Inlet's head and approximately four miles north of the Greens Creek Mine port facilities. The average concentrations for all metals during the reporting period were greater than the pre-production and production averages at this location. Furthermore, the average metals concentrations were higher than those at the other sediment monitoring locations. Given these data and the spatial distance between the monitoring locations, it is evident that all metal inputs to Hawk Inlet are not associated with the Greens Creek Mine.

Average concentrations of heavy metals at S-4 were less than or similar to the average production period and pre-production period averages.

Table 3-2 Sediment Data Comparison of Pre-Production, Production, and Current Year Values

Station	Period	Cd (mg/kg)		Cu (mg/kg)		Pb (mg/kg)		Hg (mg/kg)		Zn (mg/kg)	
		Avg	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*
S-1	**Pre-Production (9/1984 - 2/1989) (n=9)**	0.22	0.11	21.78	3.8	7.79	2.1	0.043	0.01	125.01	7.7
	Production (2/1989 - 12/2021) (n=142)	0.18	0.18	16.18	6.9	7.23	3.8	0.030	0.03	100.80	30.7
	Reporting Year 2022 (n=6)	0.12	0.01	15.15	0.8	6.29	0.2	0.020	0.00	114.00	5.0
S-2	**Pre-Production (9/1984 - 2/1989) (n=9)**	0.27	0.11	14.90	2.6	5.27	2.4	0.028	0.01	60.47	5.4
	Production (2/1989 - 12/2021) (n=142)	0.14	0.11	10.46	4.4	2.23	1.5	0.010	0.02	43.64	12.7
	Reporting Year 2022 (n=6)	0.41	0.10	31.28	8.7	6.07	1.7	0.040	0.01	74.25	14.2
S-3	**Pre-Production (9/1984 - 2/1989) (n=9)**	0.62	0.28	37.00	9.1	10.03	3.3	0.067	0.02	127.03	49.8
	Production (2/1989 - 12/2021) (n=142)	0.79	0.33	38.39	10.9	14.90	4.4	0.070	0.03	139.59	35.8
	Reporting Year 2022 (n=6)	1.26	0.31	61.30	6.9	22.77	3.6	0.110	0.01	207.67	27.9
S-4	**Pre-Production (9/1984 - 2/1989) (n=6)**	0.34	0.17	46.23	12.1	53.78	20.2	0.109	0.06	136.53	41.6
	Production (2/1989 - 12/2021) (n=142)	0.49	0.80	31.71	45.1	53.37	118.3	0.100	0.45	103.42	155.6
	Reporting Year 2022 (n=6)	0.40	0.06	33.50	22.5	24.48	8.7	0.050	0.03	79.27	9.4

Note:

1. Non-detects are averaged using half of the MDL

3.3. QA/QC Results

ALS Environmental analyzed the required parameters (see Table 1-1) in the sediment samples. Complete QA plans and reports are kept on file at the ALS Environmental office and are available upon request. The remainder of this section summarizes any relevant QA/QC results that were exceptions during the reporting period.

Replicate samples have been collected from each site, when possible, to address a National Marine Fisheries Service request since 2004. Replicate precision is evaluated using the Relative Standard Deviation (RSD).

RSD = (standard deviation * 100) / sample mean

The RSDs for the 2022 replicate samples are in Table 3-3.

The data quality objective for the RSD is that it is less than or equal to 30 percent when the values are at least four times the detection limit. All data met this criteria except for Site S-4 copper and lead results. High RSD values are the result of having one outlier replicate result.

Table 3-3 Relative Standard Deviation for Replicate Sediment Samples

Site	Rep	Sample Date	Cd (mg/kg dw)	Cu (mg/kg dw)	Pb (mg/kg dw)	Hg (mg/kg dw)	Zn (mg/kg dw)
S-1 Sediments	1	10/11/2022	0.13	14.40	6.11	<0.02	113.00
	2		0.11	15.30	6.40	0.02	112.00
	3		0.12	15.00	6.26	0.02	110.00
	4		0.14	16.50	6.67	0.02	125.00
	5		0.11	14.10	6.08	0.02	113.00
	6		0.11	15.60	6.21	0.03	111.00
		RSD (%)	***10.1***	***5.7***	***3.5***	--	***4.8***
S-2 Sediments	1	10/10/2022	0.41	21.00	3.95	<0.027	60.40
	2		0.35	30.50	5.86	0.04	71.10
	3		0.38	29.10	5.67	0.04	68.20
	4		0.32	26.90	5.26	0.04	68.90
	5		0.41	31.00	6.20	0.04	71.90
	6		0.62	49.20	9.50	0.06	105.00
		RSD (%)	***25.7***	***30.4***	***30.5***	--	***21.0***
S-3 Sediments	1	10/8/2022	1.24	59.60	22.20	0.10	206.00
	2		1.57	70.60	25.70	0.13	244.00
	3		0.95	53.30	19.00	0.12	178.00
	4		0.86	52.50	18.30	0.10	170.00
	5		1.24	63.70	22.90	0.11	208.00
	6		1.72	68.10	28.50	0.10	240.00
		RSD (%)	***26.5***	***12.3***	***17.1***	***10.9***	***14.7***
S-4 Sediments	1	10/8/2022	0.34	16.50	13.20	0.02	62.10
	2		0.40	22.60	20.30	0.07	82.50
	3		0.52	24.80	24.40	0.09	94.30
	4		0.39	83.10	42.10	0.03	78.40
	5		0.39	23.70	23.10	0.03	78.60
	6		0.38	30.30	23.80	0.04	79.70
		RSD (%)	***15.5***	***73.7***	***39.1***	--	***13.0***

4. IN-SITU BIOASSAYS

The bioassay monitoring requirements originate from Section 1.6.1.3, In-situ Bioassays, and Table 7 of the APDES permit. This monitoring element's objective is to provide scientifically valid data on five specific trace metal parameters analyzed at dry weight from the tissues of polychaete worms (*Nephtys*) and blue mussels (*Mytilus edulis*) at seven locations in Hawk Inlet for evaluating potential changes in the Hawk Inlet marine environment.

Bioaccumulation in-situ bioassay sampling in Hawk Inlet consists of annual testing of trace metal tissue burdens of selected species of invertebrate organisms with different feeding guilds. In the Hawk Inlet sill area, where no fine-grained sediments occur, monitoring trace metals in blue mussels occur at four sites (Stations STN-1, STN-2, STN-3, and East Shoal Light (ESL)). Data gathered from this area measures organisms' response near the Outfall 002 discharge. In most other regions of Hawk Inlet, the bottom is covered with sediment. Consequently, samples of sediment-dwelling polychaete worms (*Nephtys procera and Nereis sp.*) are collected at three additional sites (S-1, S-2, and S-4). *Nereis sp*. were not encountered in sufficient numbers for analysis during the reporting period, so only *Nephtys* were collected.

4.1. Analytical Results

Marine Taxonomic Services, LTD collected all tissue samples (Table 4-1).

Table 4-1 Hawk Inlet Tissue Sampling Field Data

Location	Sample Type	Date Sampled	Time Sampled (24 hour)	Air Temperature (°F)	Weather Conditions	Tide (ft MLLW)
S-1	Nephtys	10/11/2022	2045	47	Light rain, overcast	-1.3
S-2	Nephtys	10/10/2022	2000	46	Light rain, mostly cloudy	-1.3
S-3	Nephtys	10/8/2022	0628	50	Light rain and fog	-0.7
S-4	Nephtys	10/8/2022	0731	50	Light rain and fog	0.0
STN-1	Mussels	10/8/2022	1715	50	Light rain, mostly cloudy	3.4
STN-2	Mussels	10/10/2022	1748	46	Light rain, mostly cloudy	5.8
STN-3	Mussels	10/9/2022	1800	51	Light rain, mostly cloudy	3.2
ESL	Mussels	10/10/2022	1815	46	Light rain, mostly cloudy	3.6

4.2. Data Evaluation

Biota tissues were sampled for heavy metal concentrations before opening the Greens Creek Mine for full production in 1989. Results for mussels from sites STN-1, STN-2, STN-3, and ESL, and *Nephtys* from sites S-1, S-2, and S-3 from September of 1984 until January of 1989 were used to calculate baseline, pre-production values. These data are helpful as baseline values against which to compare metal values after mining began and the current year's sampling results.

As noted by the Oceanographic Institute of Oregon in the 1998 Kennecott Greens Creek Mine Risk Assessment (p 4-3),

> *"Sampling stations were selected to demonstrate a range of potential exposures including "worst case" exposure to Outfall discharges. Some of the test organisms placed in cages directly on the Outfall diffuser ports lived for six months. These results indicate that even maximum exposure to the Outfall discharge results in no acute effects."*

The average and standard deviation results for pre-production, production, and current year periods for mussels are provided in Table 4-2. In the reporting period, cadmium, copper, mercury and zinc concentrations were lower than or similar to the pre-production period. Lead concentrations were greater than the pre-production period for all sites.

Table 4-2 Average and Standard Deviation Values for Pre-Production, Production, and Current Year Mussel Data

Station	Period	Cd (mg/kg)		Cu (mg/kg)		Pb (mg/kg)		Hg (mg/kg)		Zn (mg/kg)	
		Avg	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*
ESL	**Pre-Production (9/1984- 2/1989) (n=9)**	6.67	1.60	8.16	0.68	0.42	0.11	0.03	0.01	91.40	8.38
	Production (2/1989- 12/2021) (n=92)	6.80	1.12	9.86	2.83	1.03	0.28	0.03	0.02	85.40	13.97
	Reporting Year 2022 (n=6)	4.83	0.06	6.11	0.12	0.68	0.02	0.04	0.01	66.05	0.88
STN-1	**Pre-Production (9/1984 - 12/1989) (n=9)**	7.41	1.80	7.96	1.20	0.62	0.41	0.07	0.09	94.92	11.21
	Production (2/1989- 12/2021) (n=92)	9.29	1.54	7.91	2.25	1.18	0.75	0.04	0.02	95.31	21.47
	Reporting Year 2022 (n=6)	7.63	0.08	5.79	0.08	0.67	0.01	0.04	0.01	85.78	0.93
STN-2	**Pre-Production (9/1984 - 12/1989) (n=9)**	8.60	3.10	7.71	1.05	0.37	0.19	0.04	0.01	82.36	11.20
	Production (2/1989- 12/2021) (n=92)	9.36	1.60	8.23	2.76	1.19	0.55	0.04	0.02	92.91	23.78
	Reporting Year 2022 (n=6)	8.08	0.11	6.05	0.11	0.56	0.29	0.04	0.00	84.83	1.02
STN-3	**Pre-Production (9/1984 - 12/1989) (n=9)**	9.27	3.05	8.50	1.69	0.59	0.21	0.04	0.01	95.73	17.80
	Production (2/1989- 12/2021) (n=92)	9.45	1.51	7.76	1.78	1.16	0.62	0.04	0.02	93.89	10.69
	Reporting Year 2022 (n=6)	5.48	0.15	7.68	0.13	0.77	0.05	0.04	0.01	82.53	1.33

Note:

1. Non-detects are averaged using half of the MRL/MDL.

The metal concentrations in *Nephtys* are shown in Table 4-3. Concentrations of cadmium and mercury in *Nephtys* show a general decline over time. Mercury concentrations were similar to or lower at all four sample stations relative to pre-production and production levels. Zinc concentrations were comparable to the pre-production and production levels. Cadmium concentrations were comparable to the pre-production and production levels. Copper concentrations were similar to or lower than pre-production. Lead concentrations at S-1 have been higher on average since production began relative to pre-production. Lead concentrations at the other stations were lower in the reporting period than the production and pre-production average concentrations. Figures 4-21 through 4-35 show the time series plots for cadmium, copper, lead, mercury, and zinc, including replicate samples in *Nephtys* for sample sites S-1, S-2, and S-4. Replicate samples are plotted by the mean and include standard error bars. Samples from site S-3 are being collected, although not required by the permit. This data is included to provide additional background information.

Table 4-3 Average and Standard Deviation Values for Pre-Production, Production, and Current Year Nephtys Data

Station	Period	Cd (mg/kg)		Cu (mg/kg)		Pb (mg/kg)		Hg (mg/kg)		Zn (mg/kg)	
		Avg	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*	*Avg*	*Stdev*
S-1	**Pre-Production (9/1984- 2/1989) (n=9)**	4.00	1.61	9.04	1.12	0.49	0.15	0.05	0.01	243.6	40.1
	Production (2/1989- 12/2021) (n=140)	2.92	0.79	10.23	3.04	1.00	0.68	0.04	0.02	213.2	22.5
	Reporting Year 2022 (n=6)	1.72	0.04	9.18	0.49	1.44	0.05	0.04	0.01	185.7	1.7
S-2	**Pre-Production (9/1984- 2/1989) (n=9)**	1.70	0.70	12.37	3.12	0.59	0.22	0.02	0.01	181.1	27.7
	Production (2/1989- 12/2021) (n=140)	1.09	0.18	8.75	2.04	0.69	0.20	0.02	0.01	172.8	20.7
	Reporting Year 2022 (n=6)	2.00	0.03	8.86	0.65	0.47	0.02	0.02	0.00	197.2	2.3
S-3	**Pre-Production (9/1984- 2/1989) (n=8)**	4.08	2.45	16.45	4.92	0.82	0.45	0.14	0.22	241.4	70.7
	Production (2/1989- 12/2021) (n=138)	1.99	0.51	14.12	5.90	0.88	0.50	0.04	0.02	237.0	25.2
	Reporting Year 2022 (n=6)	1.47	0.01	9.99	0.37	0.68	0.06	0.05	0.00	244.0	2.3
S-4	**Pre-Production (9/1984- 2/1989) (n=2)**	1.21	0.70	16.80	6.70	4.16	1.27	0.11	0.06	193.5	10.5
	Production (2/1989- 12/2021) (n=140)	0.78	0.26	17.92	10.19	6.55	1.17	0.02	0.01	193.2	22.4
	Reporting Year 2022 (n=6)	0.46	0.01	5.24	0.11	2.73	0.09	0.02	0.00	169.5	2.0

Note:

1. Non-detects are averaged using half of the MRL/MDL.

4.3. QA/QC Results

ALS Environmental analyzed the required parameters (see Table 1-1) for the bioassay samples. Complete QA plans and reports are kept on file at the ALS Environmental office and are available upon request. This section summarizes the relevant QA/QC results for the sampling completed during the reporting period.

No anomalies associated with the analysis of these samples were observed.

Since the fall of 2004, replicate samples have been collected from each site, where possible, to address a National Marine Fisheries Service request. Precision can be calculated from the results of replicative samples. In this case, RSD is shown for the replicate samples in Table 4-4. The data quality objective for the RSD is that it is less than or equal to 30% when the values are at least four times the detection limit. All RSDs calculated for the duplicate samples were within this data quality objective, except for lead in mussels at STN-2.

Table 4-4 Relative Standard Deviation for Replicate Tissue Samples

Sample ID	Rep	Date	Cd (mg/kg dw)	Cu (mg/kg dw)	Pb (mg/kg dw)	Hg (mg/kg dw)	Zn (mg/kg dw)
S-1 Nephtys	1	10/11/2022	1.76	10.20	1.54	0.04	186.00
	2		1.75	9.21	1.38	0.04	187.00
	3		1.72	9.19	1.45	0.04	184.00
	4		1.65	8.67	1.42	0.05	183.00
	5		1.73	8.89	1.43	0.03	188.00
	6		1.71	8.96	1.42	0.04	186.00
		RSD (%)	***2.3***	***5.8***	***3.8***	--	***1.0***
S-2 Nephtys	1	10/10/2022	1.97	8.41	0.45	<0.02	196.00
	2		2.04	8.72	0.47	<0.019	201.00
	3		2.03	8.54	0.47	<0.02	196.00
	4		1.98	10.30	0.51	0.02	199.00
	5		1.98	8.69	0.46	0.02	194.00
	6		1.97	8.50	0.46	0.03	197.00
		RSD (%)	***1.6***	***8.1***	***4.3***	--	***1.3***
S-3 Nephtys	1	10/8/2022	1.48	9.79	0.63	0.05	245.00
	2		1.48	9.90	0.64	0.04	243.00
	3		1.47	10.80	0.70	0.04	245.00
	4		1.46	9.74	0.79	0.05	241.00
	5		1.46	9.77	0.64	0.05	242.00
	6		1.49	9.95	0.69	0.05	248.00
		RSD (%)	***0.82***	***4.0***	***8.98***	--	***1.0***
S-4 Nephtys	1	10/8/2022	0.46	5.31	2.65	<0.02	170.00
	2		0.44	5.30	2.80	0.03	170.00
	3		0.47	5.29	2.77	0.02	171.00
	4		0.47	5.29	2.71	<0.019	172.00
	5		0.44	5.00	2.61	<0.019	166.00
	6		0.45	5.24	2.86	<0.019	168.00
		RSD (%)	***2.83***	***2.3***	***3.45***	--	***1.3***
ESL Mussels	1	10/10/2022	4.81	6.11	0.68	0.02	66.80
	2		4.82	6.20	0.70	0.04	66.20
	3		4.83	6.07	0.64	0.04	65.50
	4		4.95	6.30	0.65	0.04	67.40
	5		4.77	6.04	0.69	0.03	65.70
	6		4.81	5.93	0.70	0.04	64.70
		RSD (%)	***1.3***	***2.1***	***3.8***	--	***1.5***
STN-1 Mussels	1	10/8/2022	7.60	5.89	0.68	0.06	86.70
	2		7.68	5.85	0.69	0.04	86.70
	3		7.63	5.80	0.64	0.05	86.10
	4		7.45	5.80	0.65	0.06	85.20
	5		7.64	5.68	0.66	0.05	84.70
	6		7.57	5.84	0.65	0.04	85.00
		RSD (%)	***1.1***	***1.2***	***2.8***	--	***1.0***
STN-2 Mussels	1	10/10/2022	7.98	5.87	0.40	0.04	82.90
	2		8.13	6.09	1.20	0.04	85.20
	3		8.25	6.22	0.43	0.05	86.30
	4		8.05	6.02	0.42	0.04	84.50
	5		7.93	6.02	0.47	0.04	84.90
	6		8.13	6.09	0.41	0.04	85.20
		RSD (%)	***1.44***	***1.9***	***57.08***	--	***1.3***
STN-3 Mussels	1	10/9/2022	7.64	5.62	0.85	<0.02	81.80
	2		7.75	5.42	0.73	0.02	83.20
	3		7.55	5.43	0.70	0.04	81.70
	4		7.80	5.52	0.82	0.04	83.50
	5		7.83	5.68	0.75	0.07	84.50
	6		7.49	5.21	0.79	0.04	80.50
		RSD (%)	***1.81***	***3.1***	***7.2***	--	***1.8***

Notes:

1. A '--' indicates RSD was not calculated because three or more of the values was less than 4 times the MRL.
2. A '<' denotes the sample was analyzed for but was not detected above the MRL/MDL.

5. REFERENCES

Alaska Department of Environmental Conservation (ADEC). (2015). *Alaska Pollutant Discharge Elimination System (APDES) Permit AK-0043206*.

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Palmieri, Anne. (2016). *Site Report: USFS Empire Mine*. http://dec.alaska.gov/Applications/SPAR/PublicMVC/CSP/SiteReport/4198

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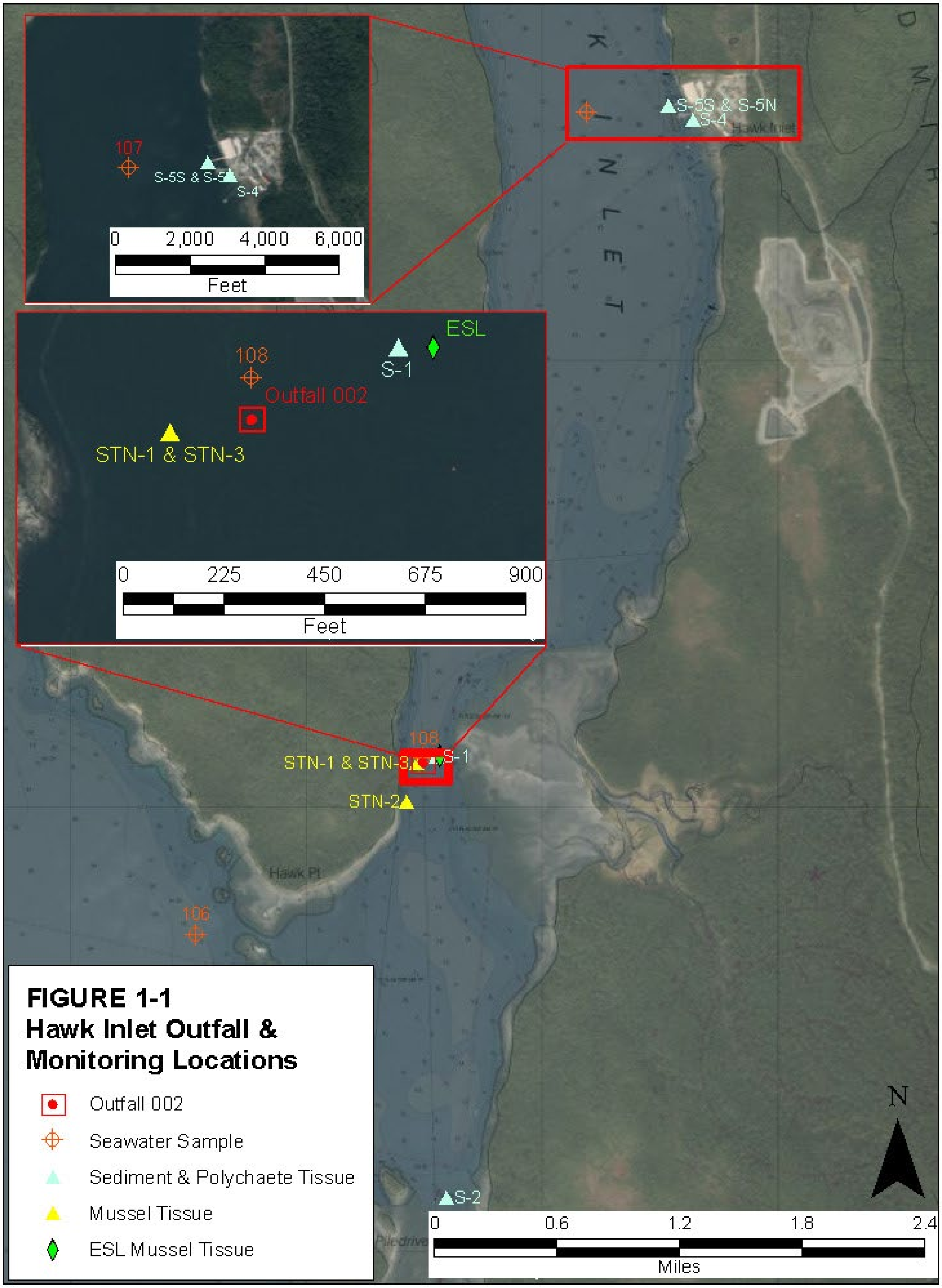
USDA Forest Service (2013). *Greens Creek Mine Tailings Disposal Facility Expansion: Final Environmental Impact Statement and Record of Decision*.

6. FIGURES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S-5S & S-5N
S-4
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S-1
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0 225 450 675 900
Feet
S-5S & S-5N
S-4
Hawk Inlet
108
STN-1 & STN-3
S-1
STN-2
Hawk Pt
106
S-2
N
0 0.6 1.2 1.8 2.4
Miles
FIGURE 1-1
Hawk Inlet Outfall & Monitoring Locations
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Seawater Sample
Sediment & Polychaete Tissue
Mussel Tissue
ESL Mussel Tissue

Figure 2-1a. Site 106 - Field pH

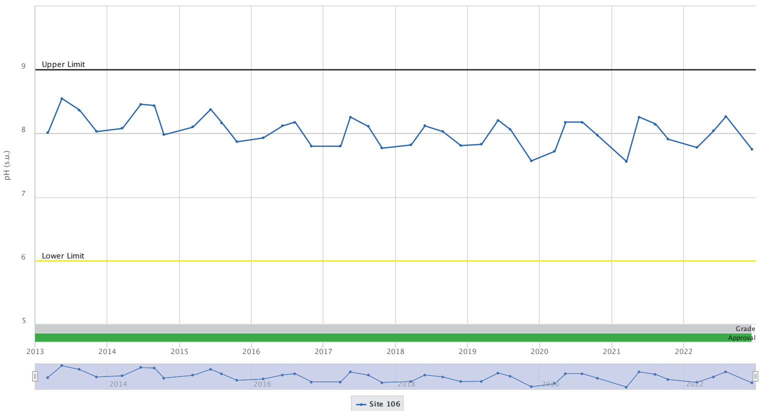


Figure 2-1b. Site 107 - Field pH

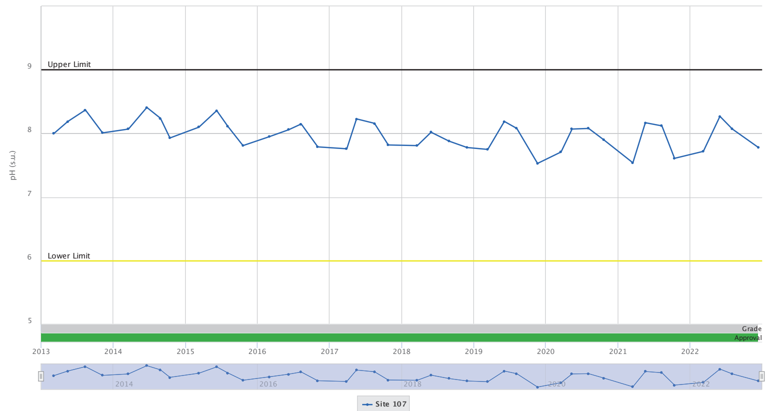


Figure 2-1c. Site 108 - Field pH

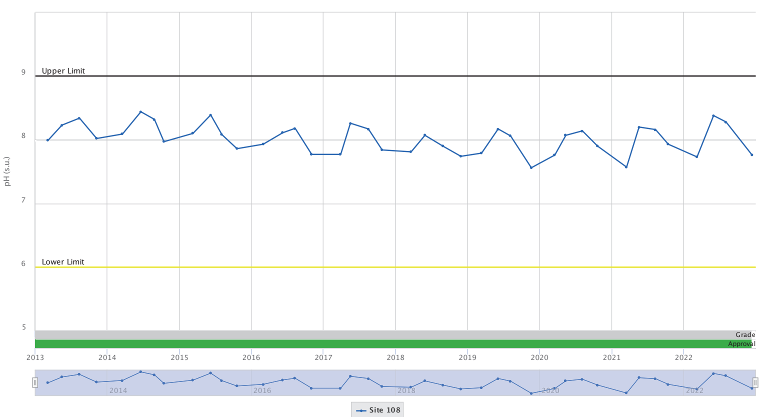


Figure 2-2a. Site 106 - Field Conductivity

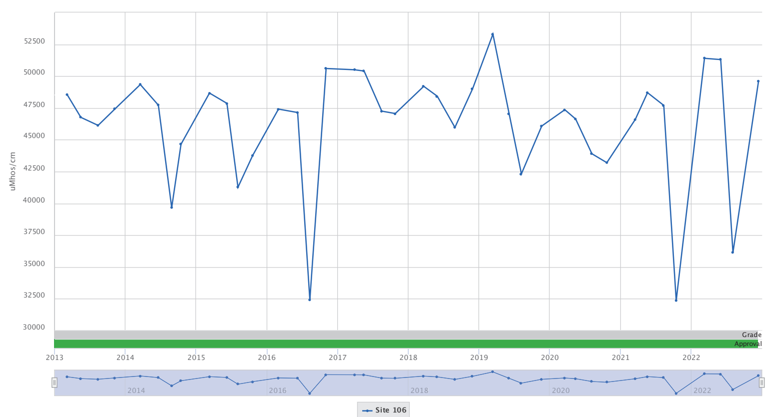


Figure 2-2b. Site 107 - Field Conductivity

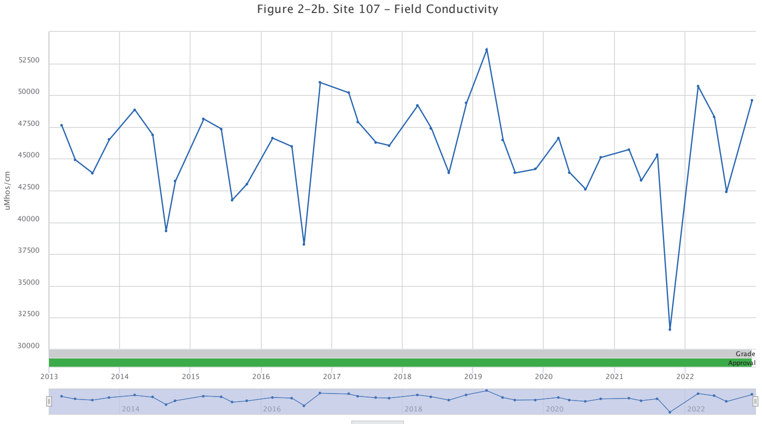


Figure 2-2ca. iSe t 10 - Fieб doCl ucSniSv

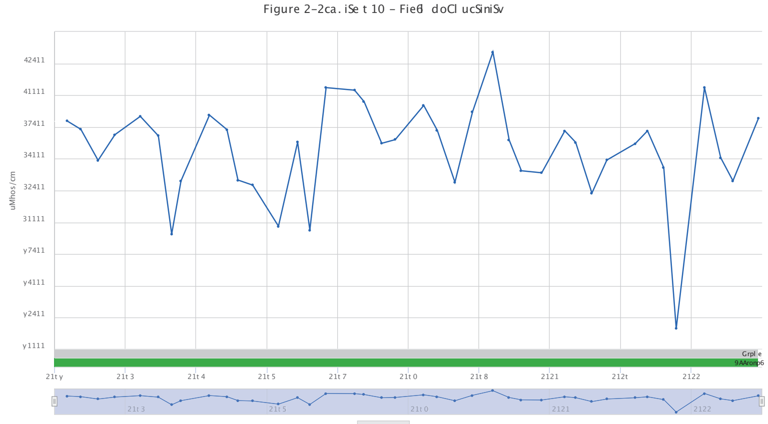


Figure 2-3a. Site 106 - Cadmium

Saltwater AWQS: 8.8 ug/L

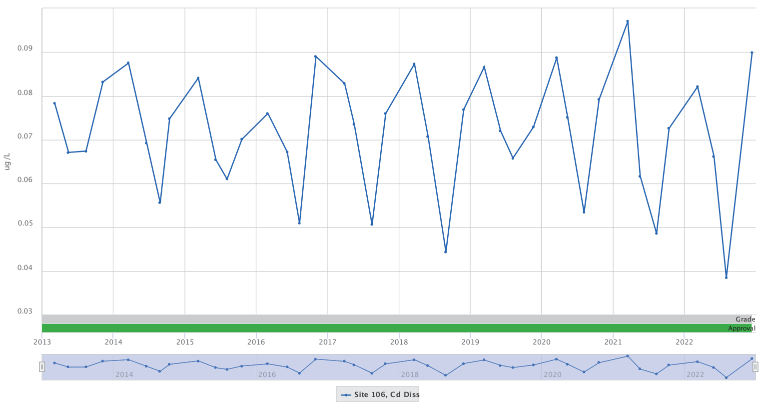


Figure 2-3b. Site 107 - Cadmium

Saltwater AWQS: 8.8 ug/L

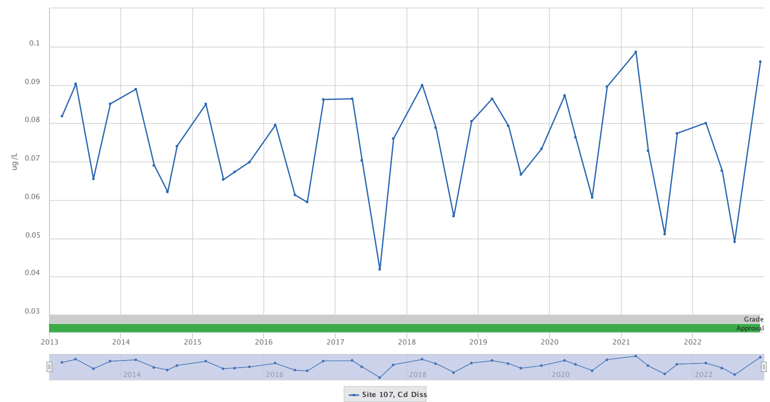


Figure 2-3c. Site 108 - Cadmium

Saltwater AWQS: 8.8 ug/L

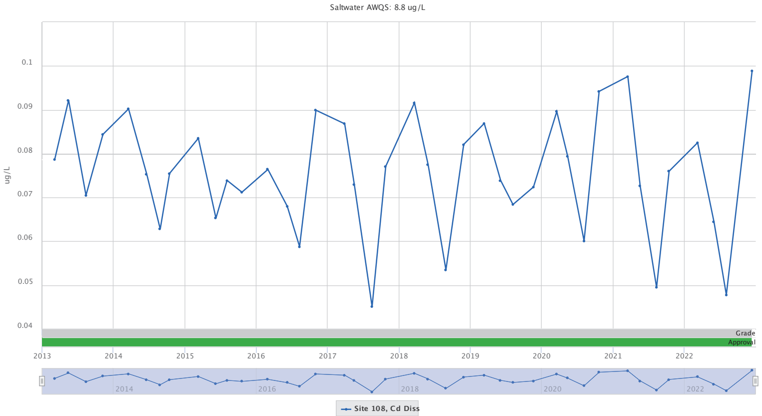


Figure 2-4a. Site 106 - Copper

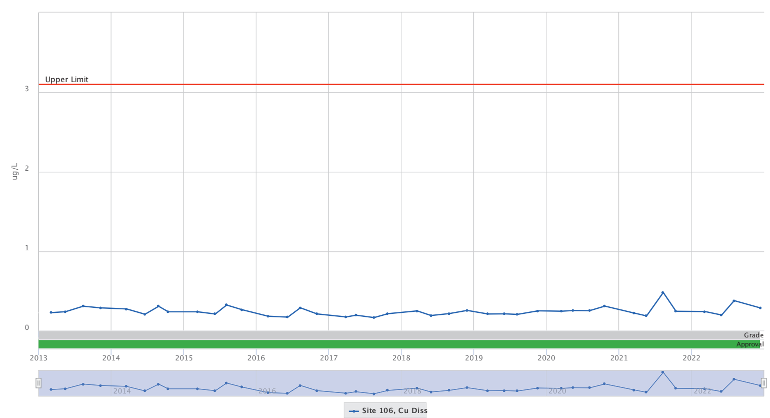


Figure 2-4b. Site 107 - Copper

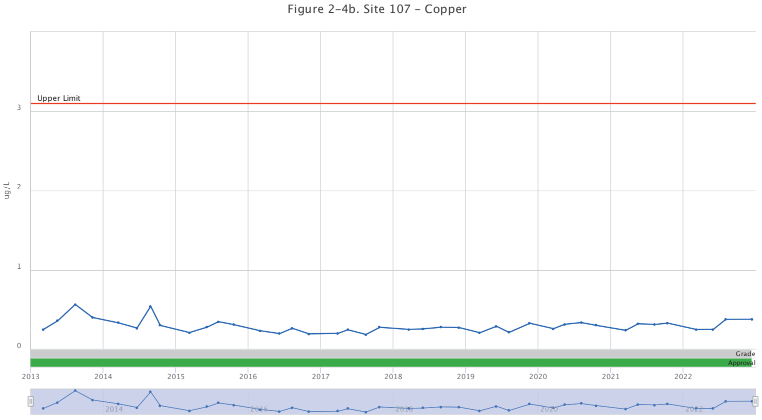


Figure 2-4c. Site 108 - Copper

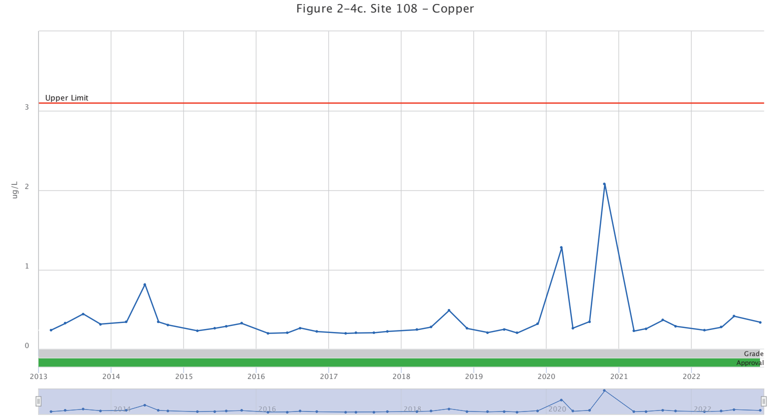


Figure 2-5a. Site 106 – Mercury

Saltwater AWQS: 0.94 ug/L

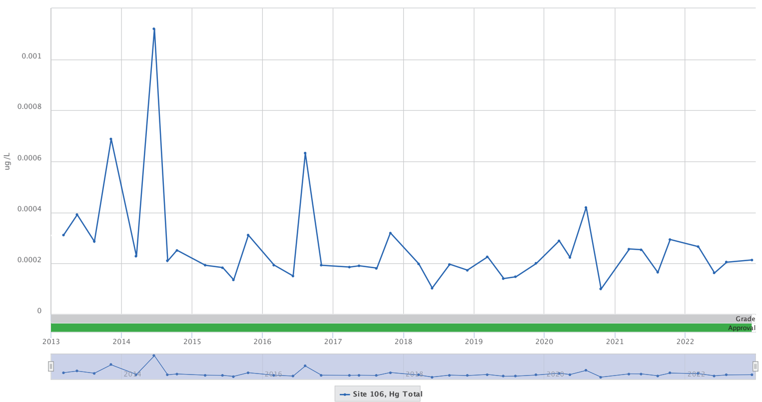


Figure 2-5b. Site 107 – Mercury

Saltwater AWQS: 0.94 ug/L

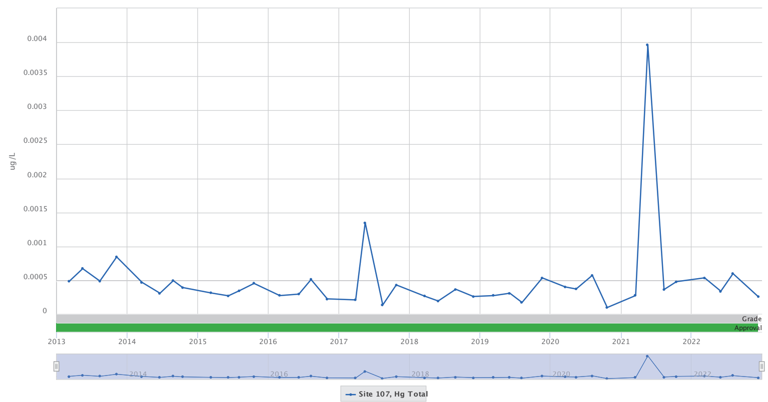


Figure 2-5a. Site 106 – Meraurc

Syltwyter AWQS: 0.94 ug/L

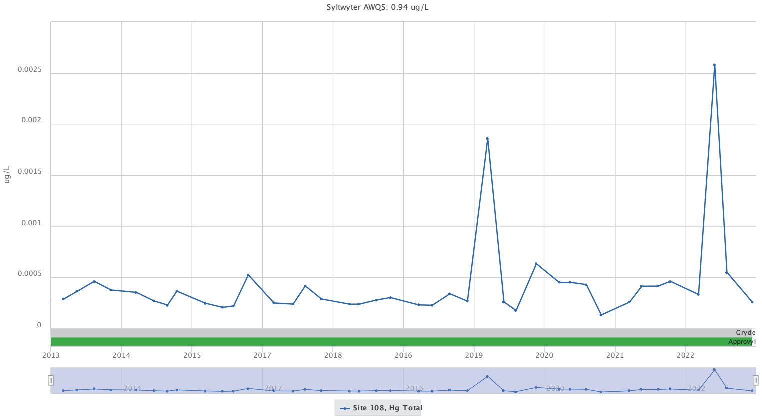


Figure 2-6a. Site 106 – Lead

Saltwater AWQS: 8.05 ug/L

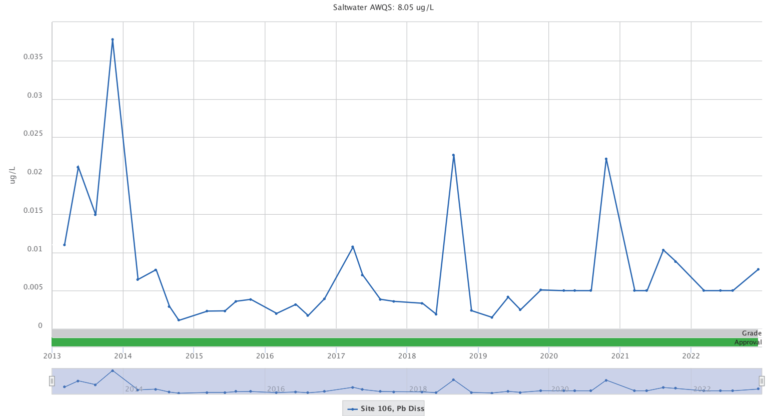


Figure 2-6b. Site 107 – Lead

Saltwater AWQS: 8.05 ug/L

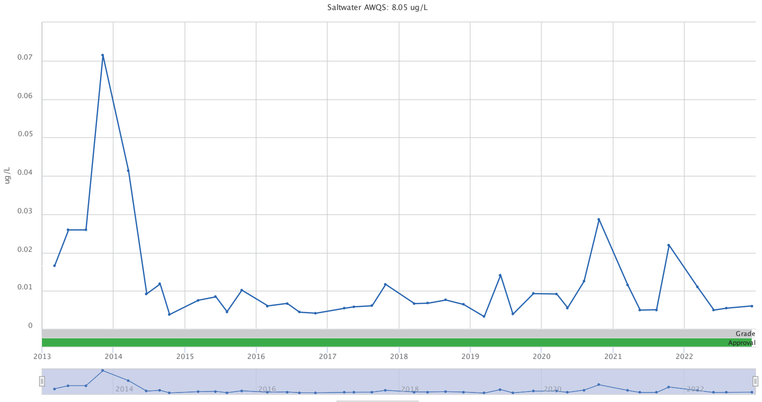


Figure 2-7b. Site 107 – Zn

Saltwater AWQS: 81.5 ug/L

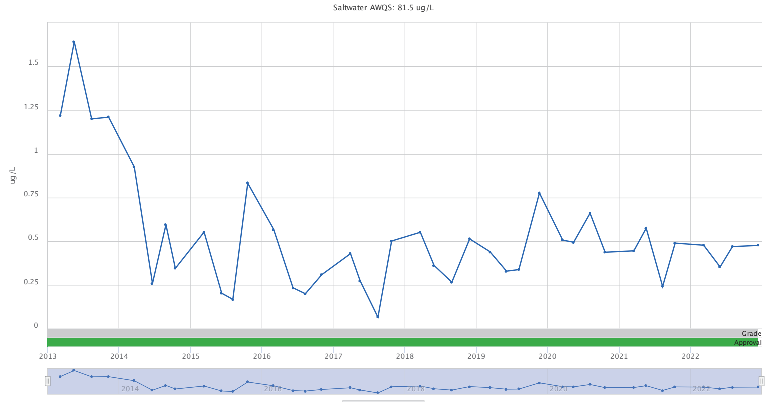


Figure 2-7a. Site 106 - Zn

Saltwater AWQS: 81.5 ug/L

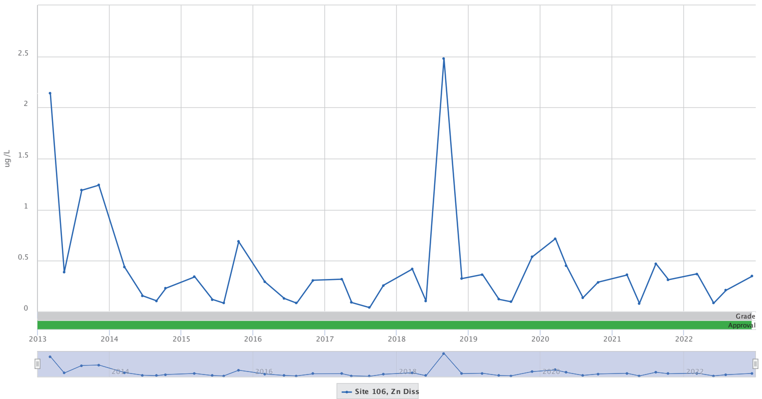


Figure 2-6c. Site 108 - Lead

Saltwater AWQS: 8.05 ug/L

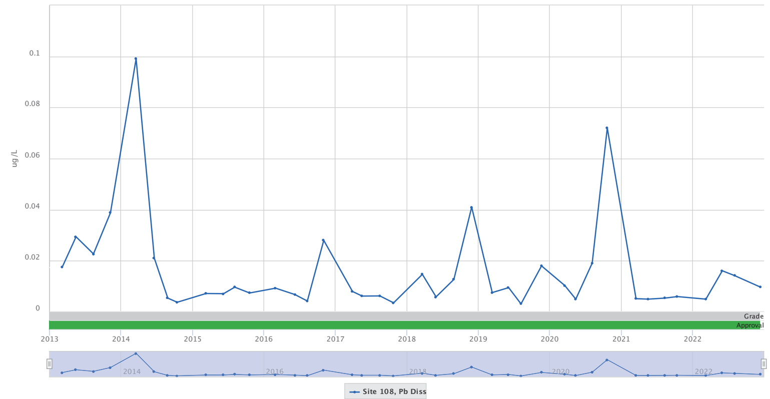


Figure 2-7c. Site 108 - Zn

Saltwater AWQS: 81.5 ug/L

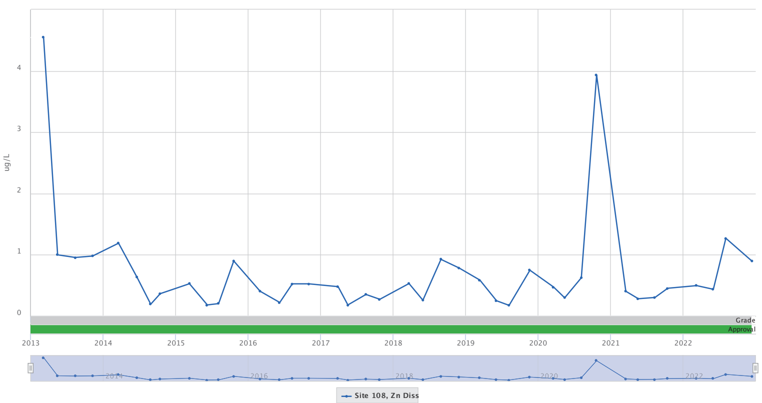


Figure 2-8a. Site 108 and Outfall 002 – Cadmium

Outfall 002 Daily Max Limit: 50 ug/L – Saltwater AWQS: 8.8 ug/L

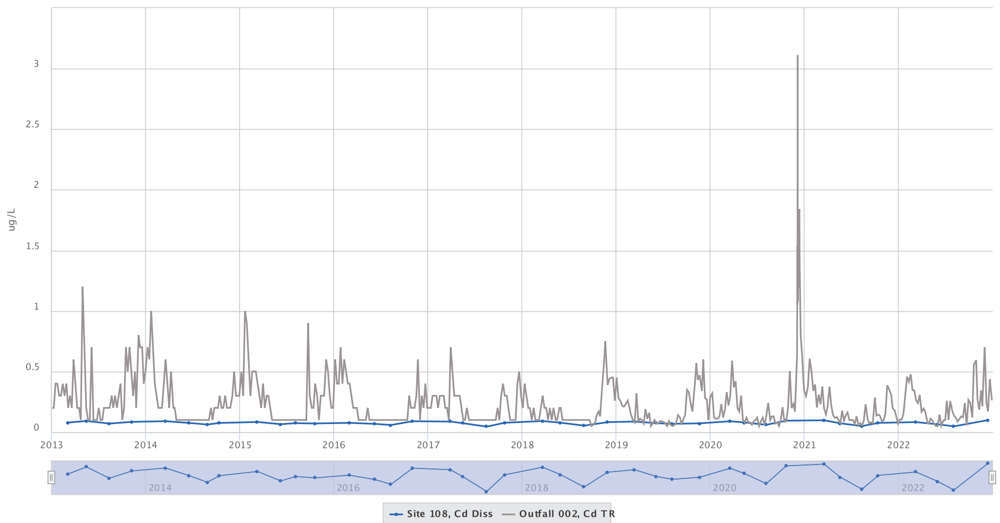


Figure 2-8b. Site 108 and Outfall 002 – Copper

Outfall 002 Daily Max Limit: 99 ug/L – Saltwater AWQS: 3.1 ug/L

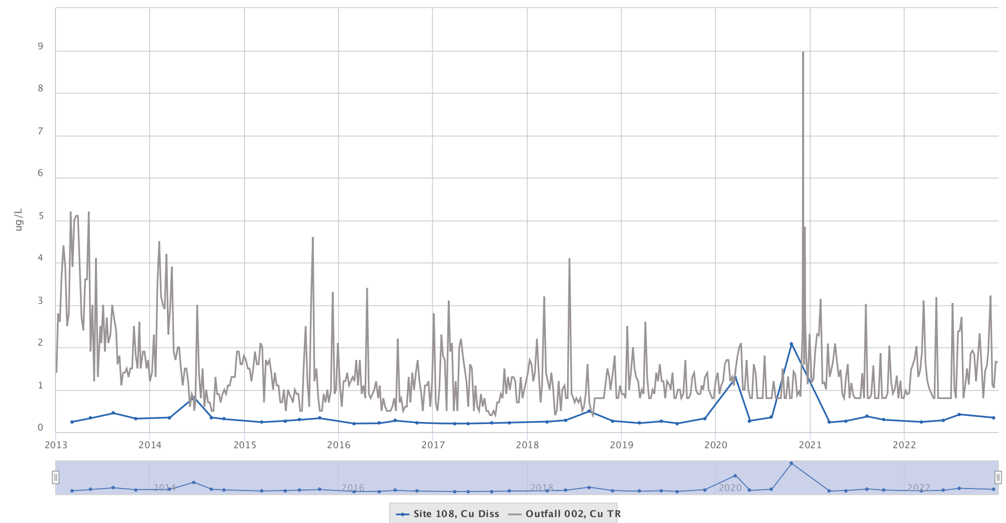


Figure 2-8c. Site 108 and Outfall 002 – Mercury

Outfall 002 Daily Max Limit: 1.9 ug/L – Saltwater AWQS: 0.94 ug/L

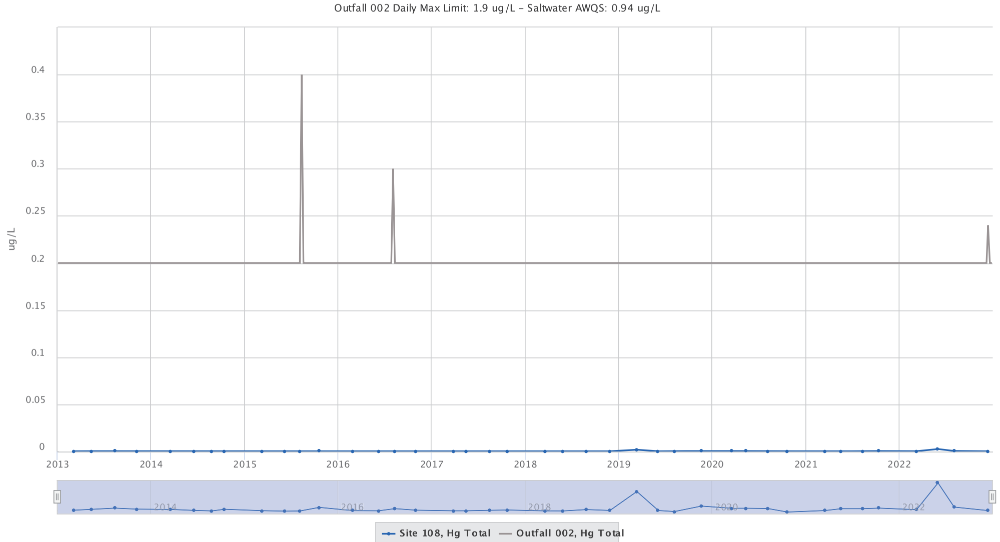


Figure 2-8d. Site 108 and Outfall 002 – Lead

Outfall 002 Daily Max Limit: 327 ug/L – Saltwater AWQS: 8.05 ug/L

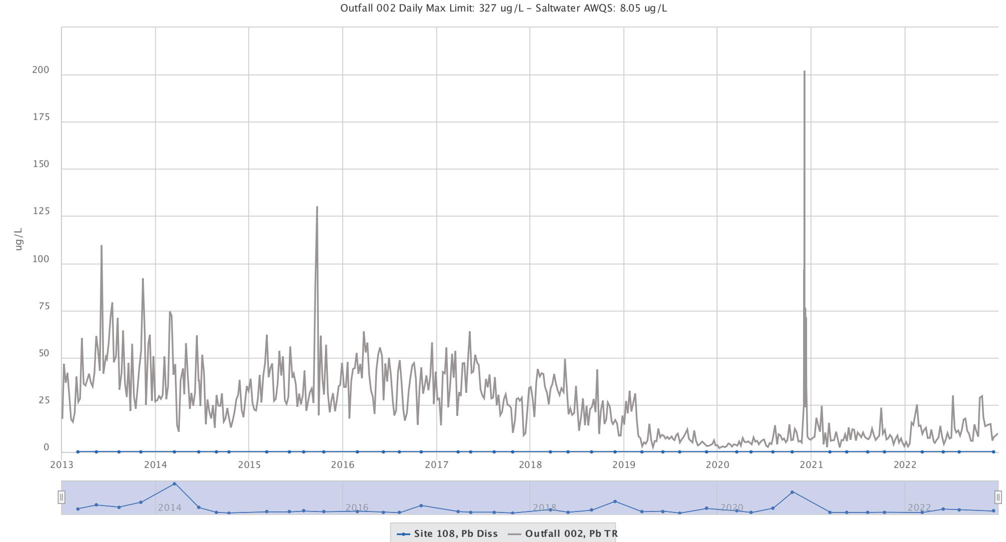


Figure 2-8e. Site 108 and Outfall 002 – Field pH

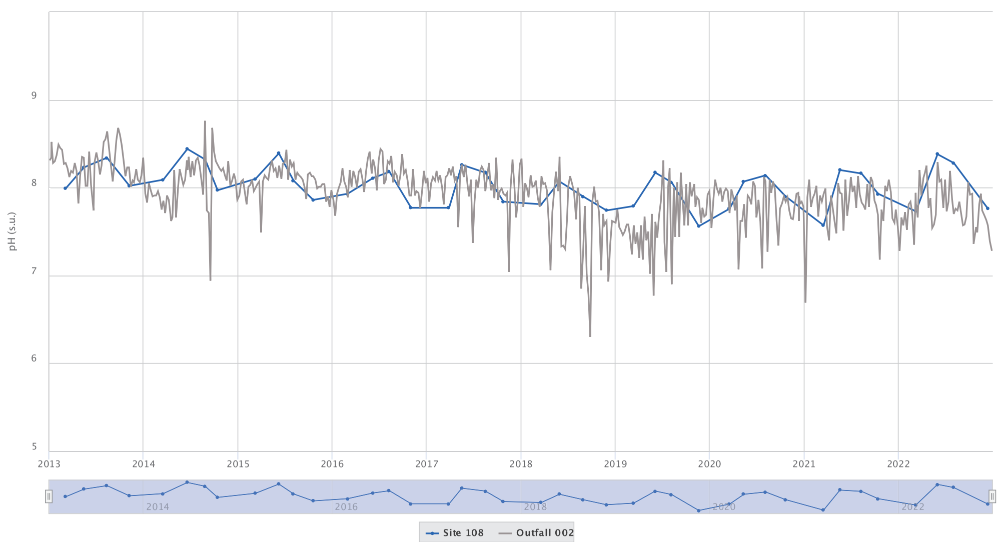


Figure 2-8f. Site 108 and Outfall 002 – Zn

Outfall 002 Daily Max Limit: 1,000 ug/L – Saltwater AWQS: 81.5 ug/L

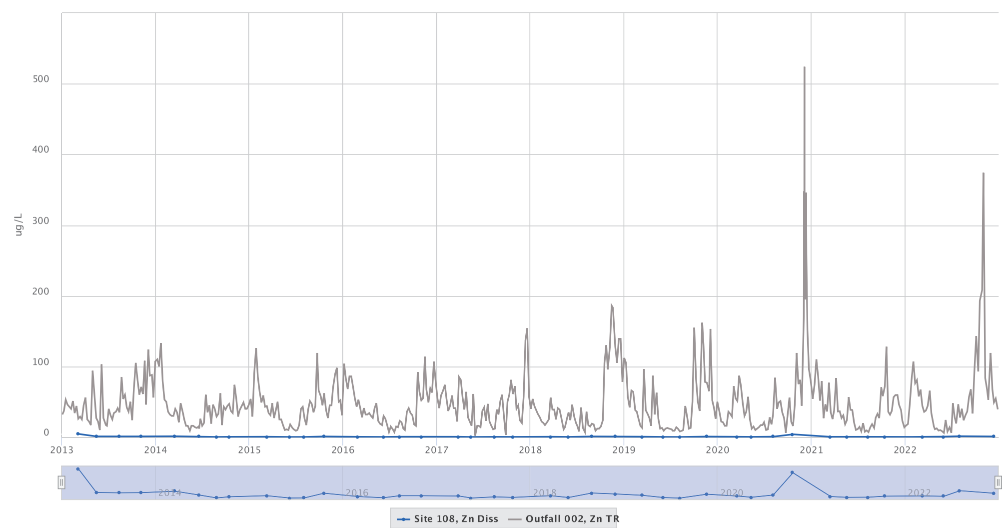


Figure 3-1. Cadmium in Sediment at Site S-1

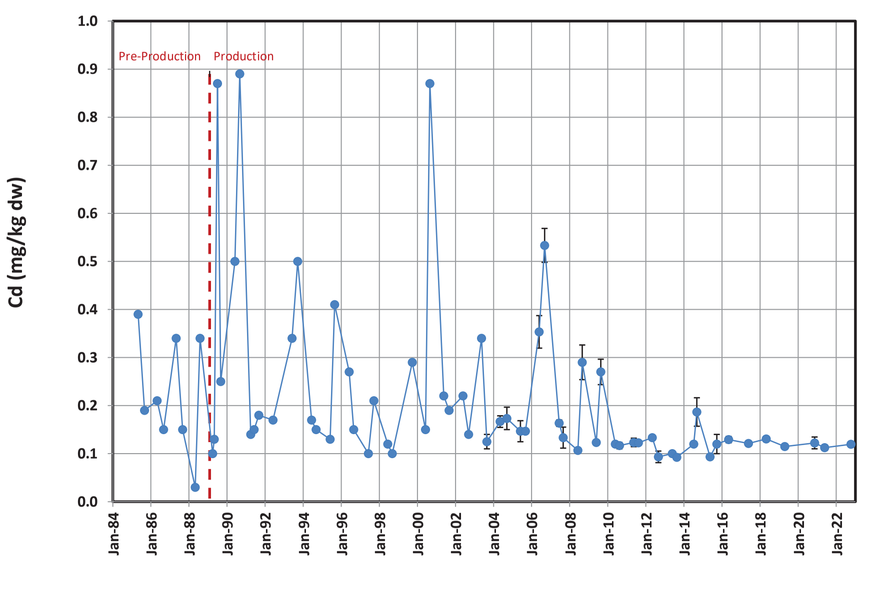


Figure 3-3. Lead in Sediment at Site S-1

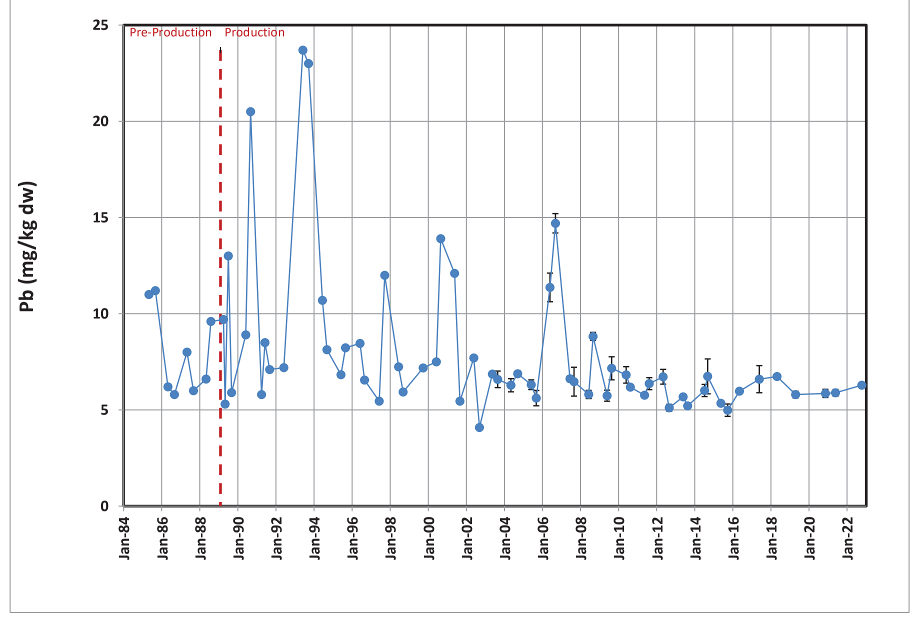


Figure 3-5. Zinc in Sediment at Site S-1

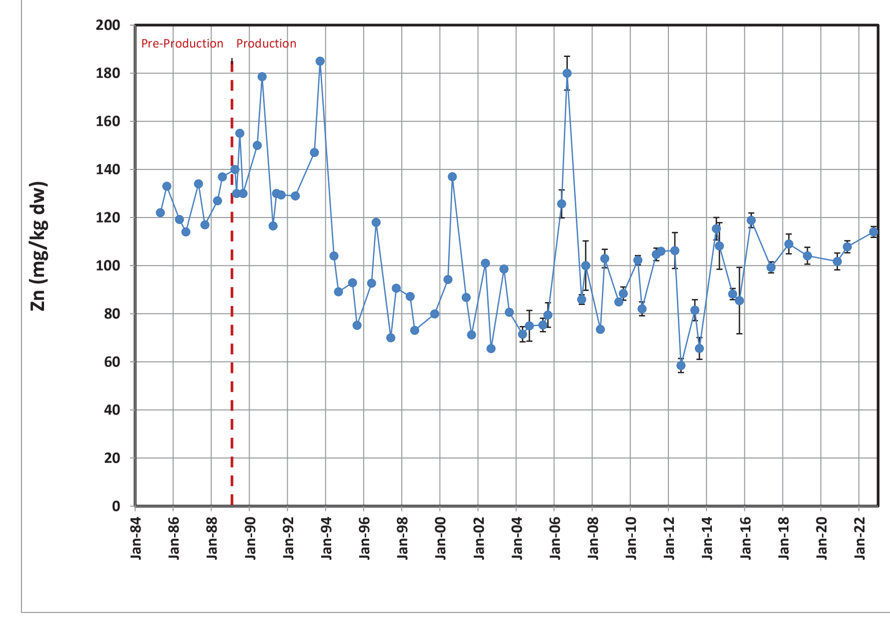


Figure 3-2. Copper in Sediment at Site S-1

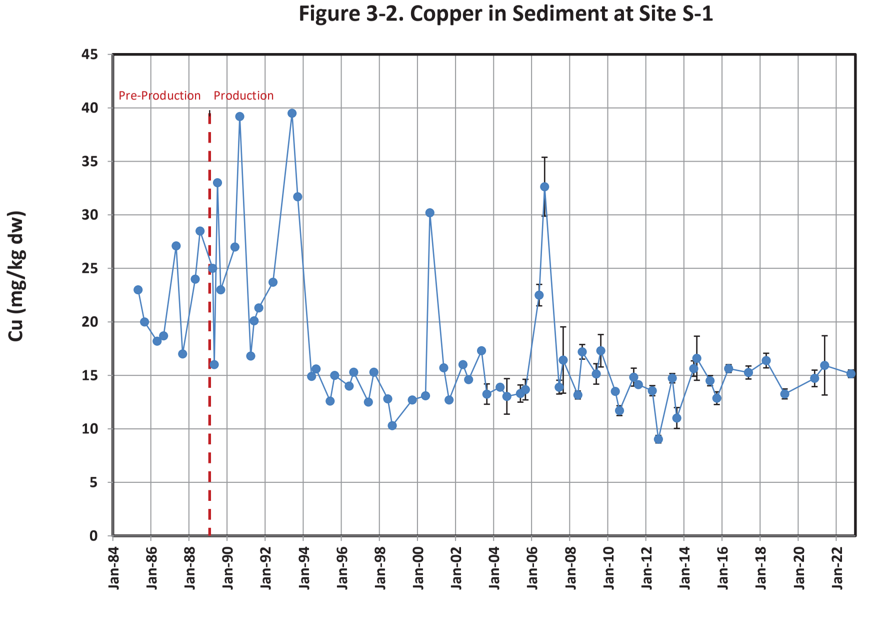


Figure 3-4. Mercury in Sediment at Site S-1

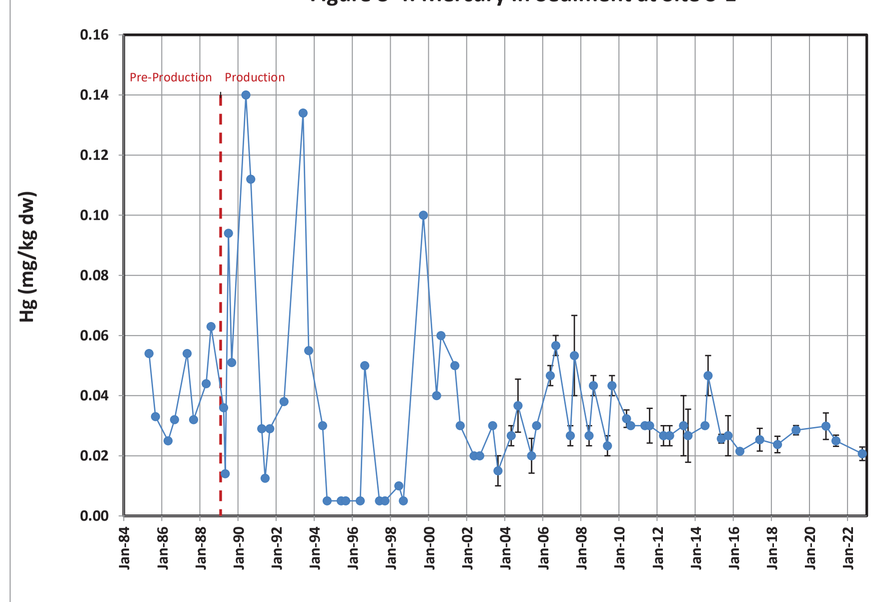


Figure 3-6. Cadmium in Sediment at Site S-2

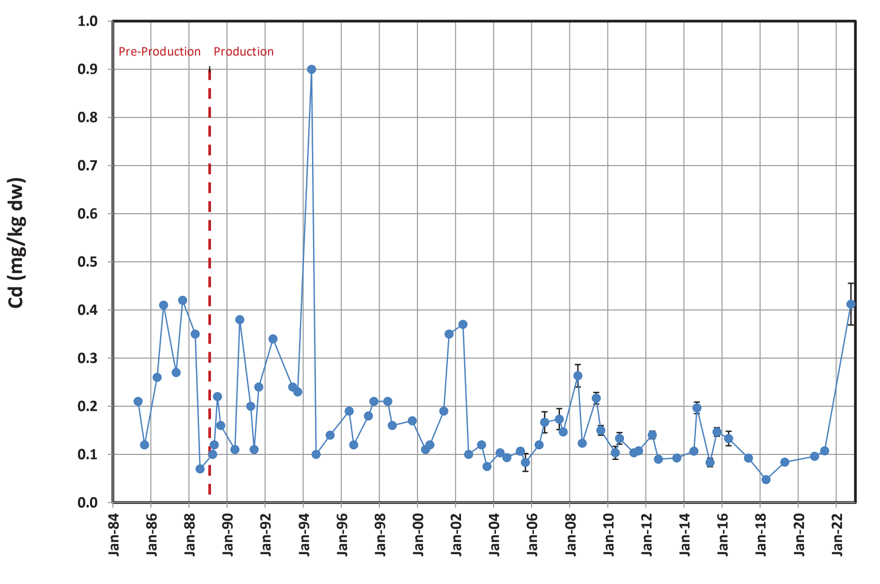


Figure 3-8. Lead in Sediment at Site S-2

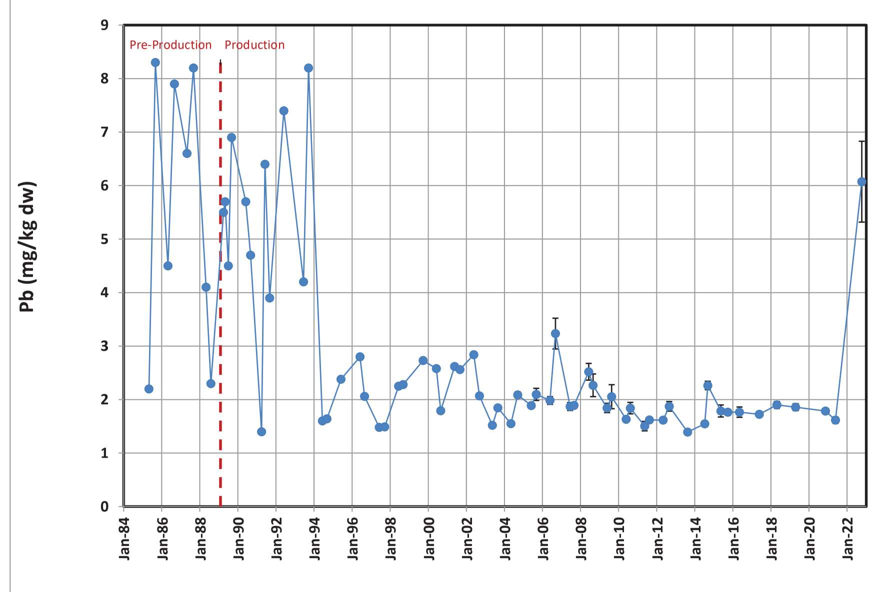


Figure 3-10. Zinc in Sediment at Site S-2

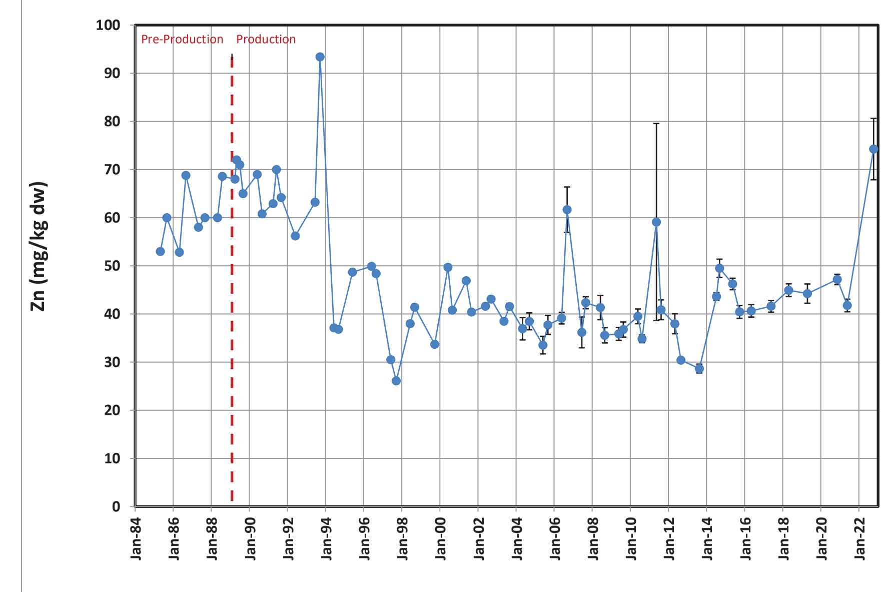


Figure 3-7. Copper in Sediment at Site S-2

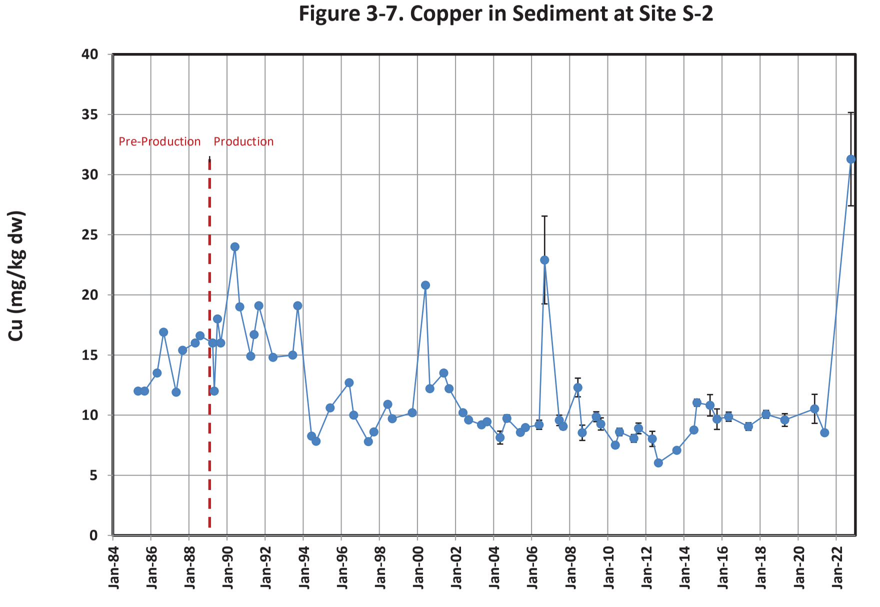


Figure 3-9. Mercury in Sediment at Site S-2

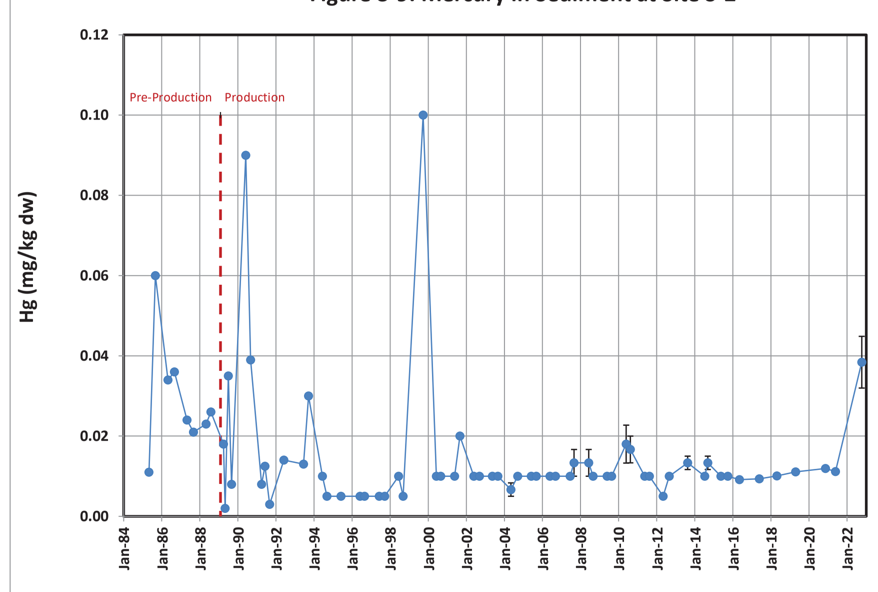


Figure 3-11. Cadmium in Sediment at Site S-4

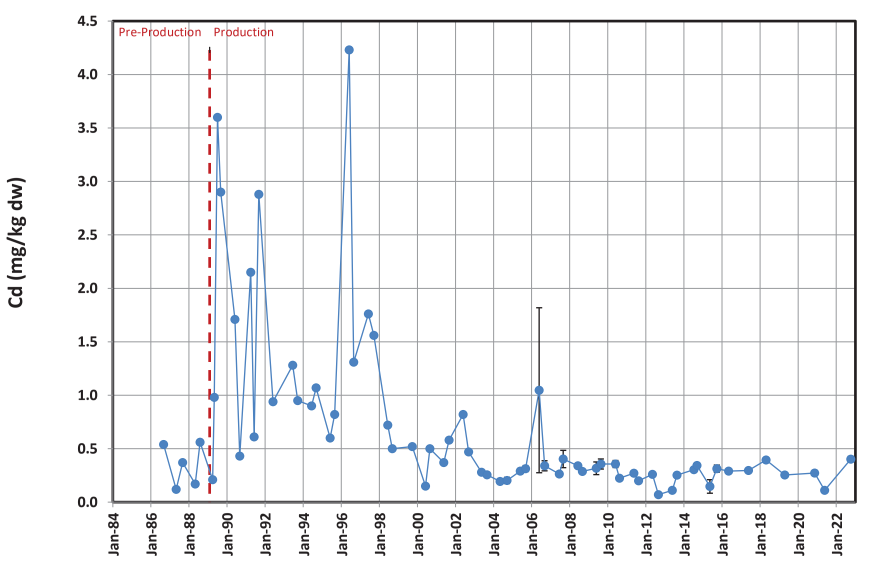


Figure 3-13. Lead in Sediment at Site S-4

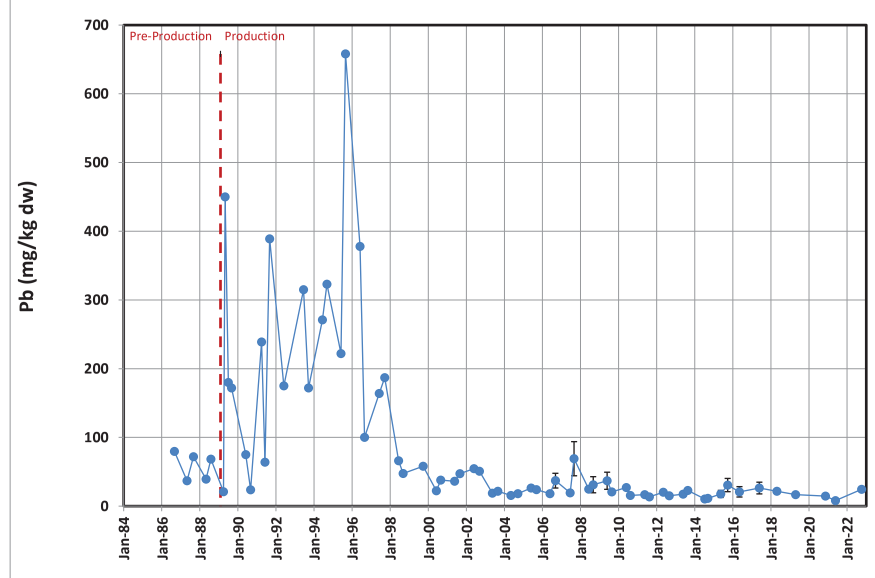


Figure 3-15. Zinc in Sediment at Site S-4

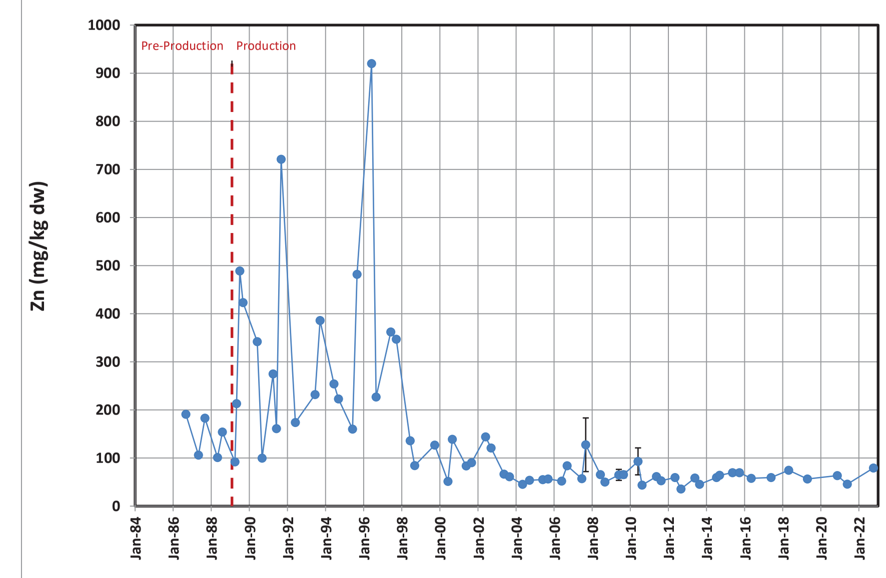


Figure 3-12. Copper in Sediment at Site S-4

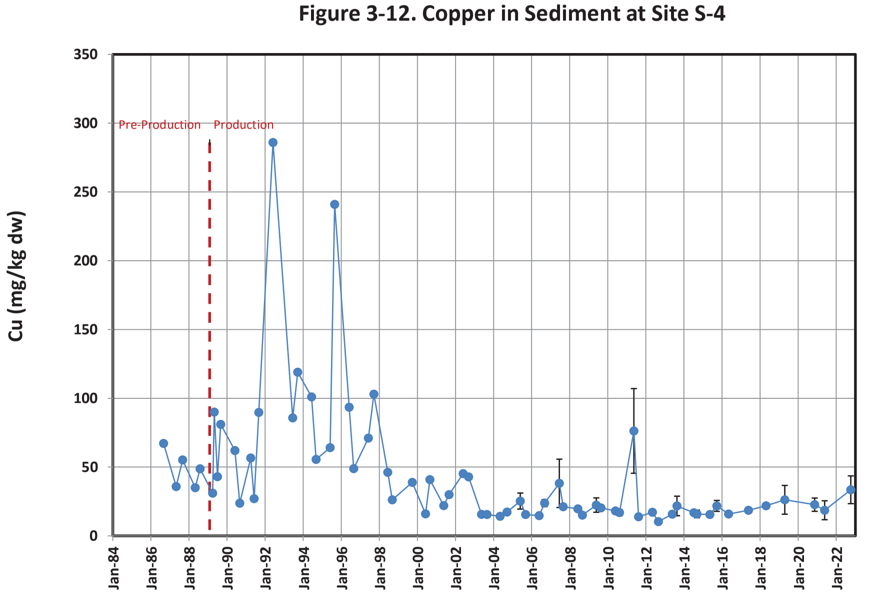
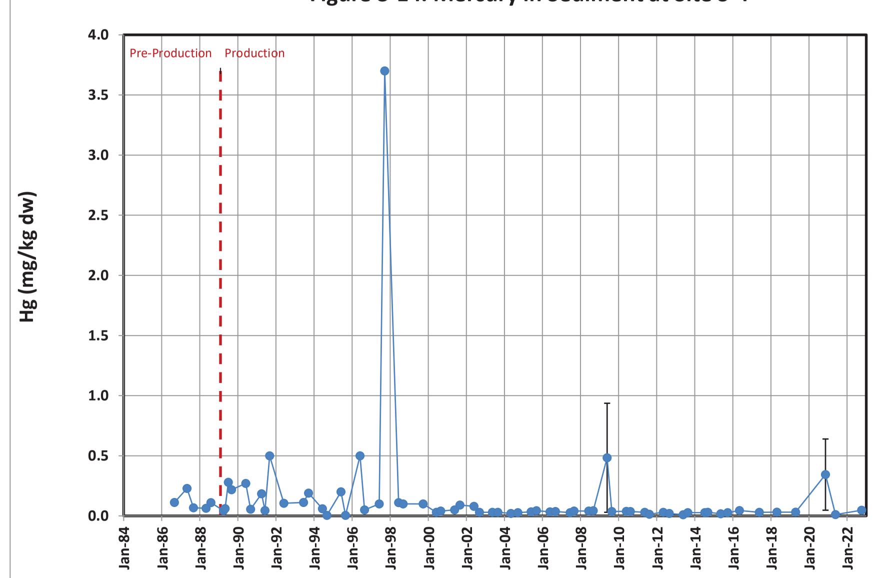


Figure 3-14. Mercury in Sediment at Site S-4



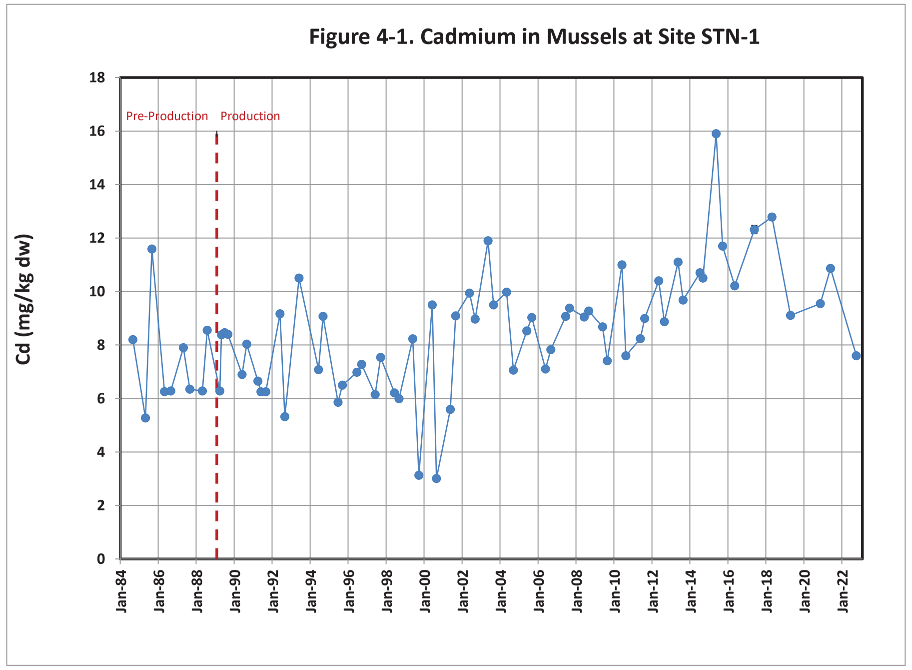


Figure 4-1. Cadmium in Mussels at Site STN-1
Cd (mg/kg dw)
Pre-Production
Production

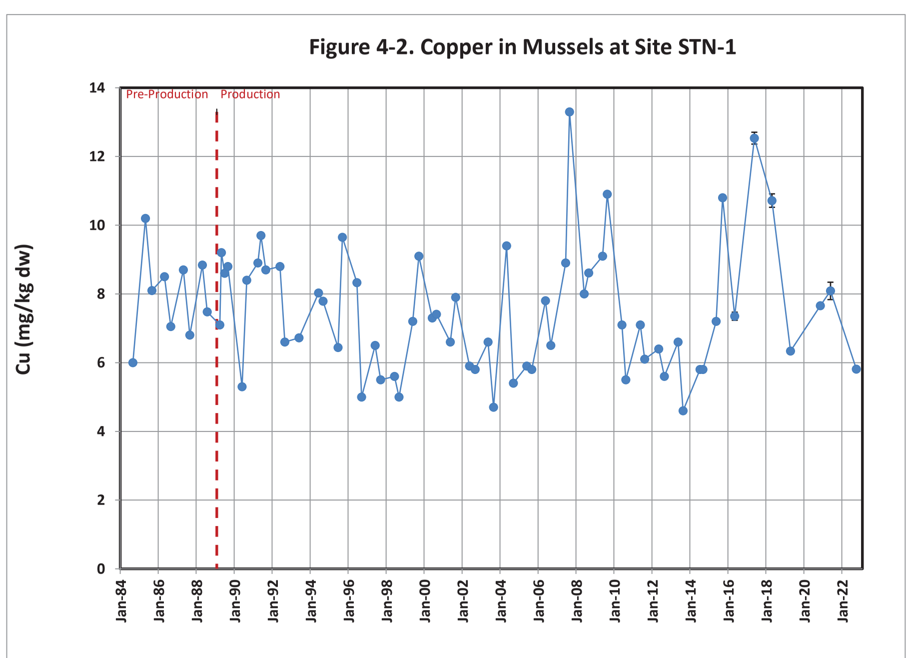


Figure 4-2. Copper in Mussels at Site STN-1
Cu (mg/kg dw)
Pre-Production
Production

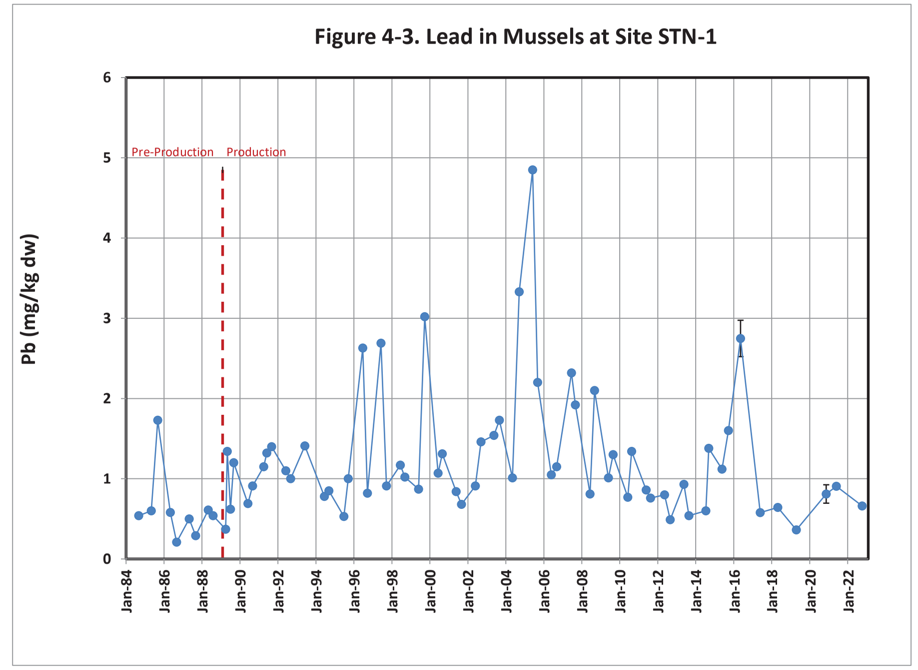


Figure 4-3. Lead in Mussels at Site STN-1
Pb (mg/kg dw)
Pre-Production
Production

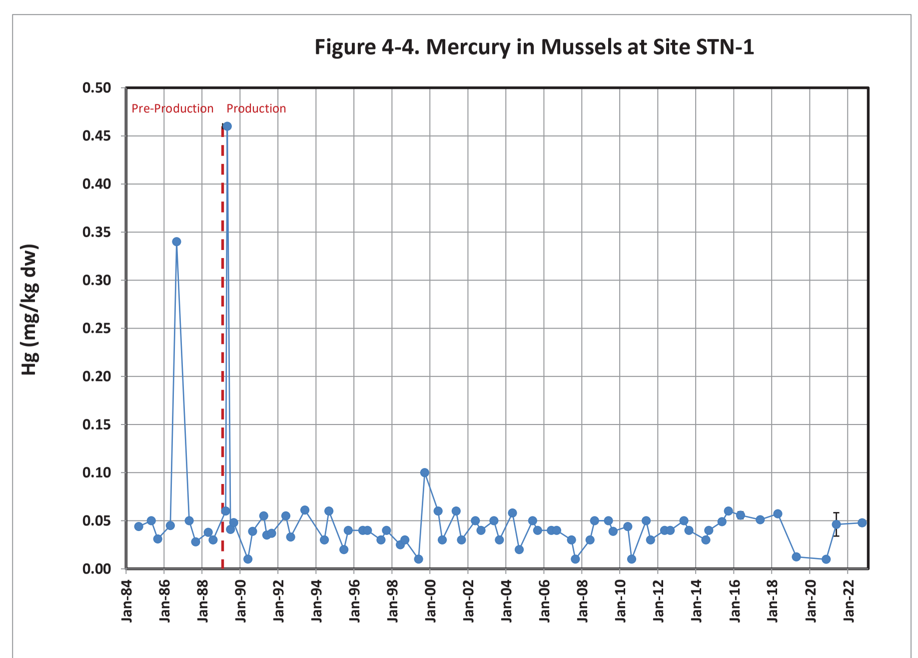


Figure 4-4. Mercury in Mussels at Site STN-1
Hg (mg/kg dw)
Pre-Production
Production

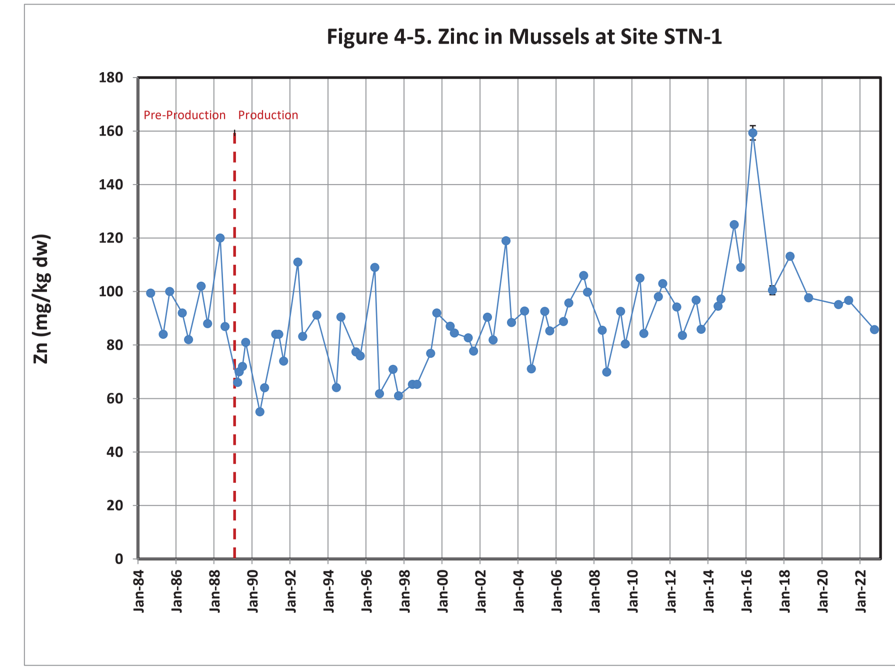


Figure 4-5. Zinc in Mussels at Site STN-1
Zn (mg/kg dw)
Pre-Production
Production

Figure 4-6. Cadmium in Mussels at Site STN-2

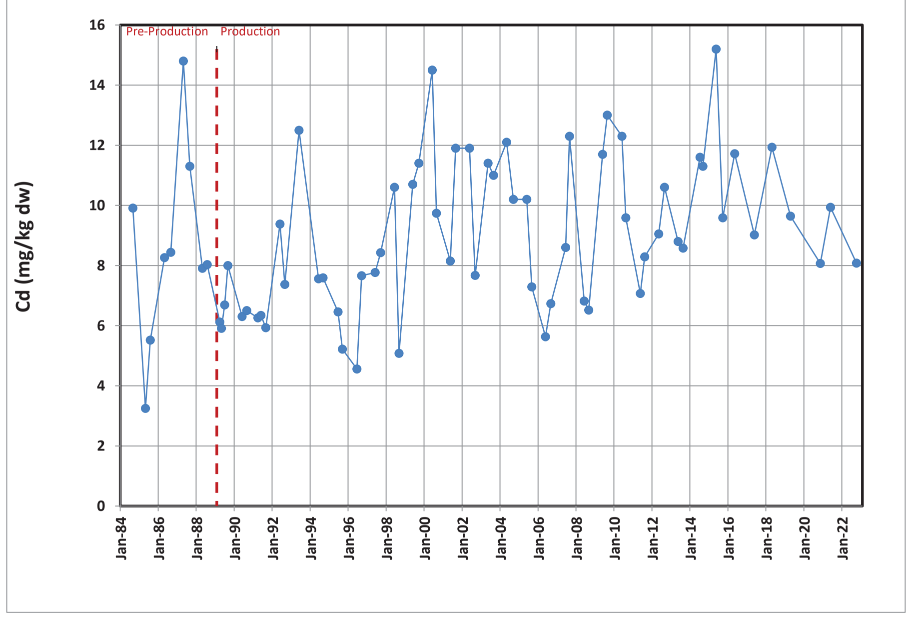


Figure 4-8. Lead in Mussels at Site STN-2

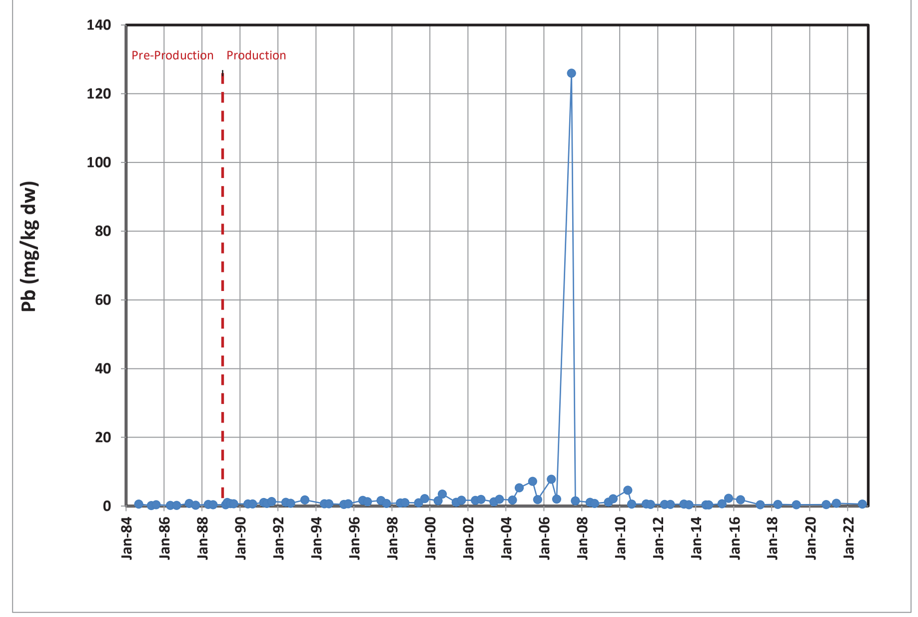


Figure 4-10. Zinc in Mussels at Site STN-2

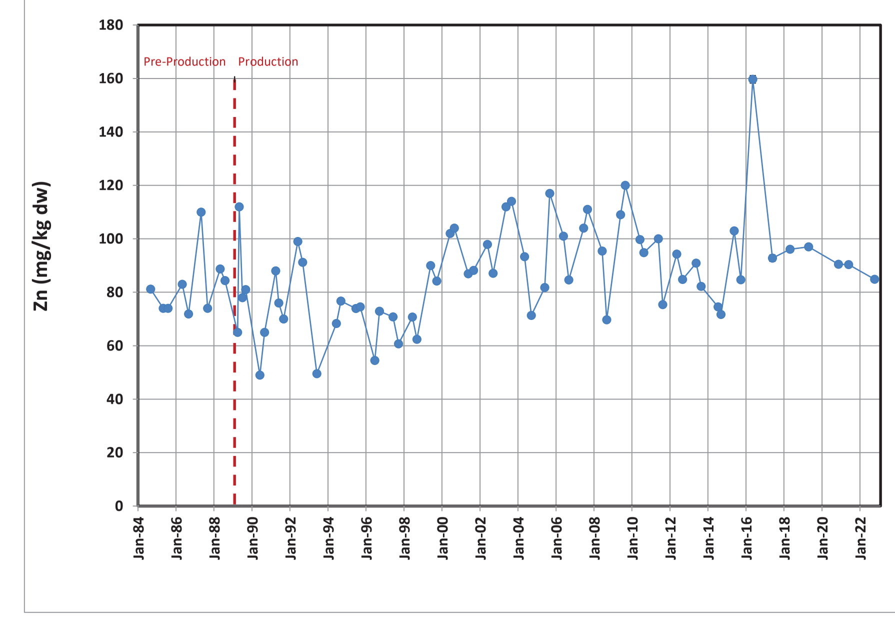


Figure 4-7. Copper in Mussels at Site STN-2

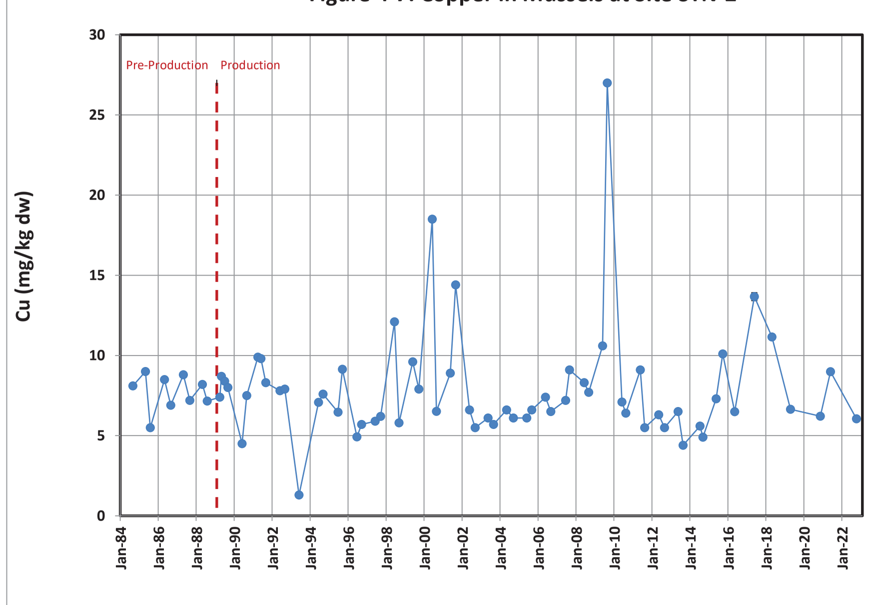


Figure 4-9. Mercury in Mussels at Site STN-2

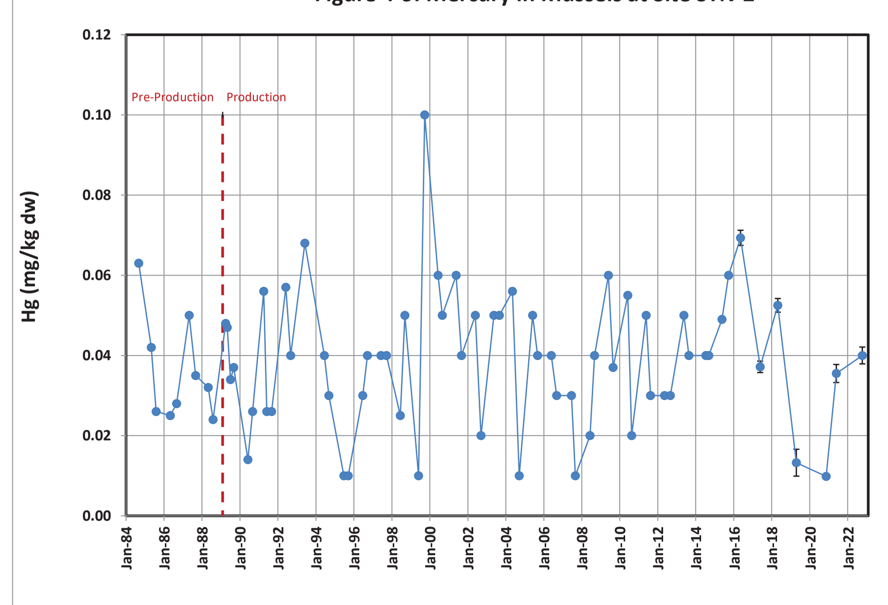


Figure 4-11. Cadmium in Mussels at Site STN-3

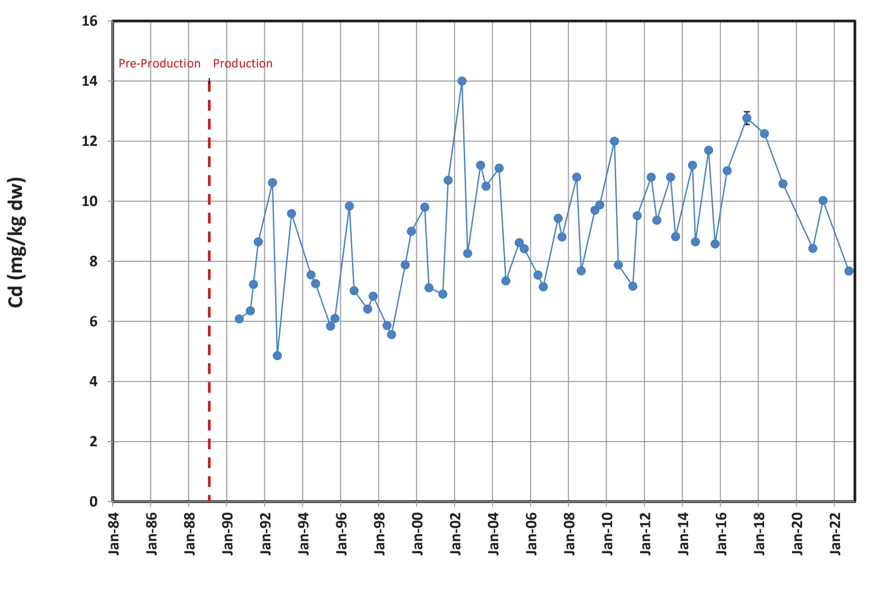


Figure 4-13. Lead in Mussels at Site STN-3

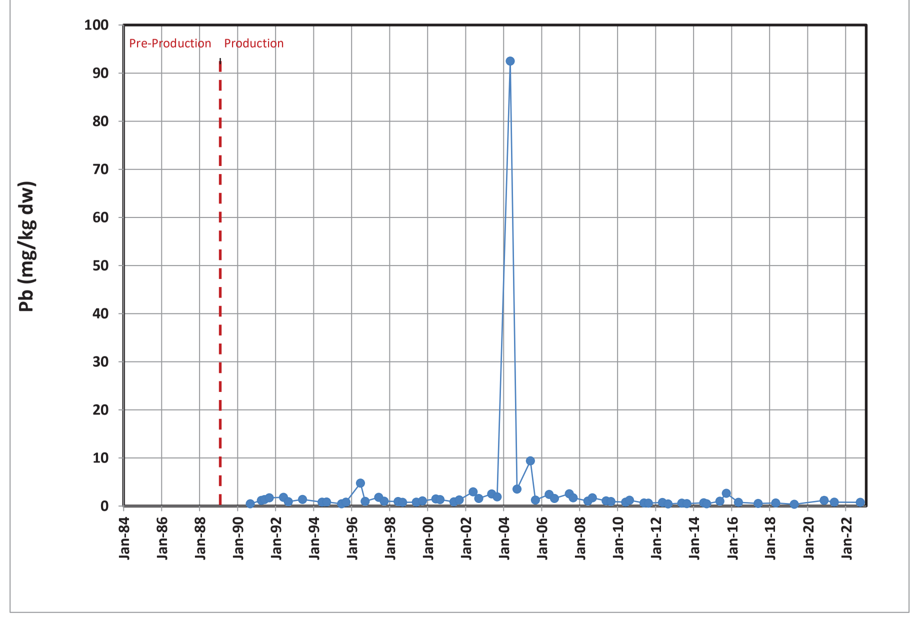


Figure 4-15. Zinc in Mussels at Site STN-3

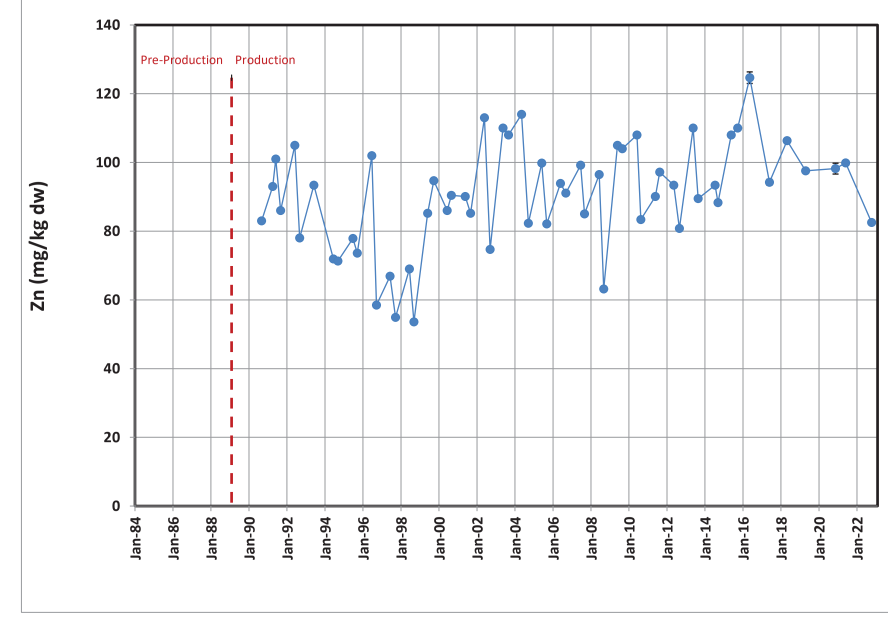


Figure 4-12. Copper in Mussels at Site STN-3

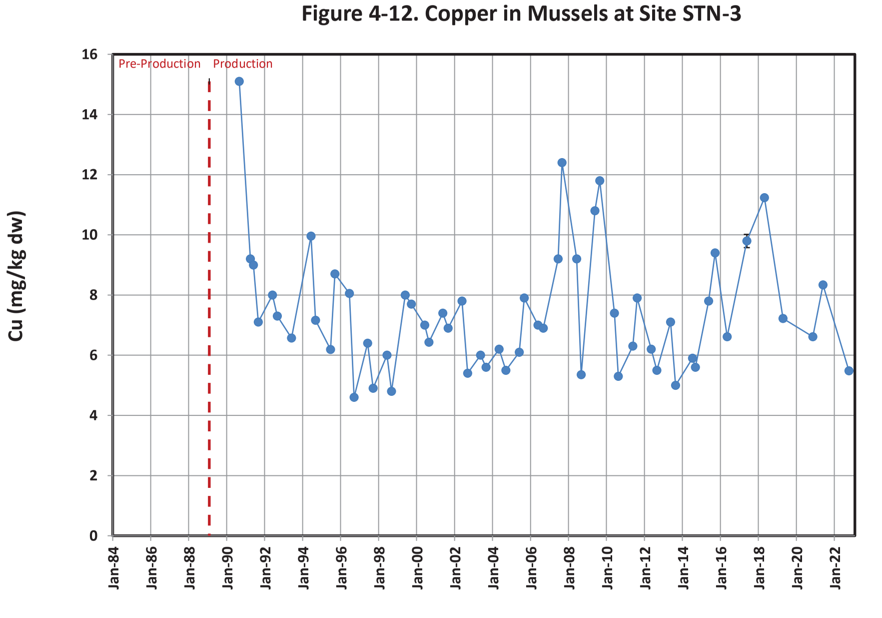


Figure 4-14. Mercury in Mussels at Site STN-3

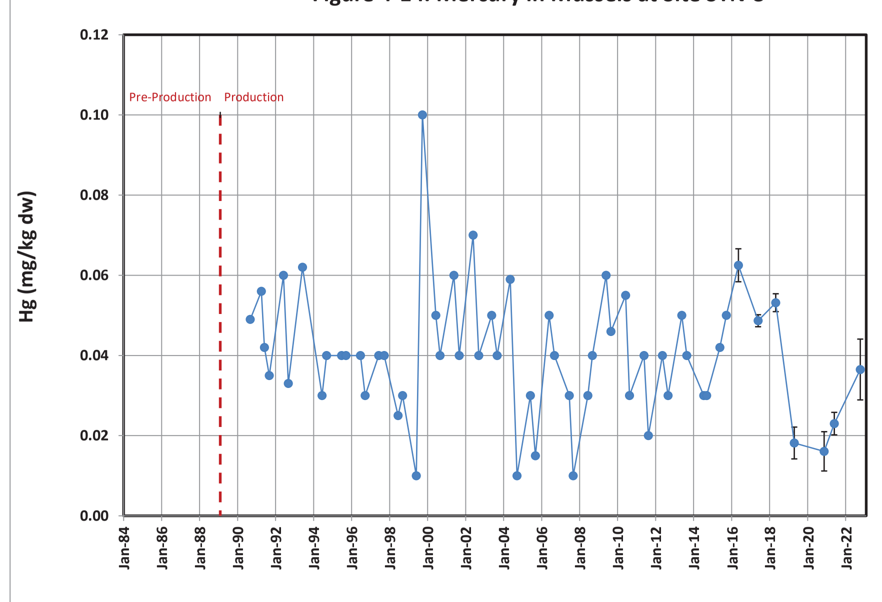


Figure 4-21. Cadmium in Nephtys at Site S-1

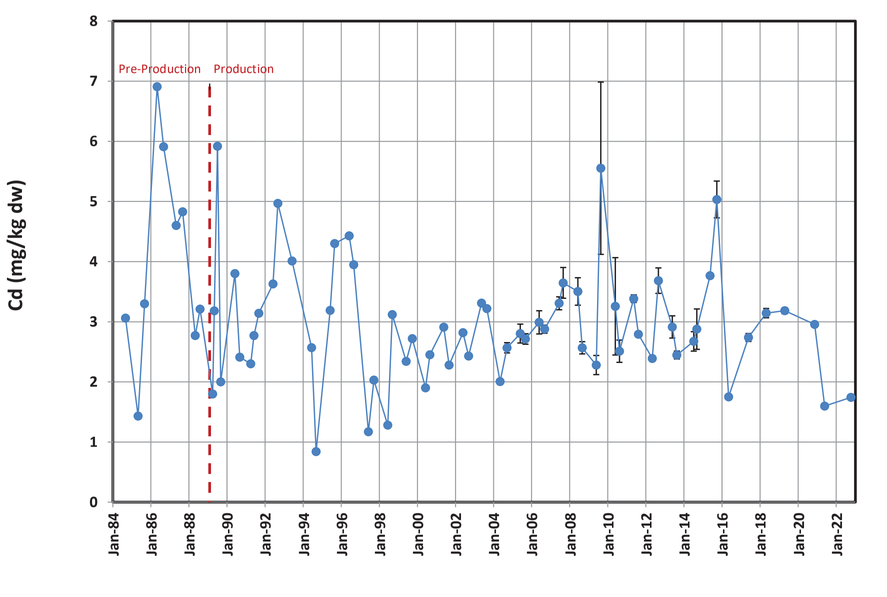


Figure 4-22. Copper in Nephtys at Site S-1

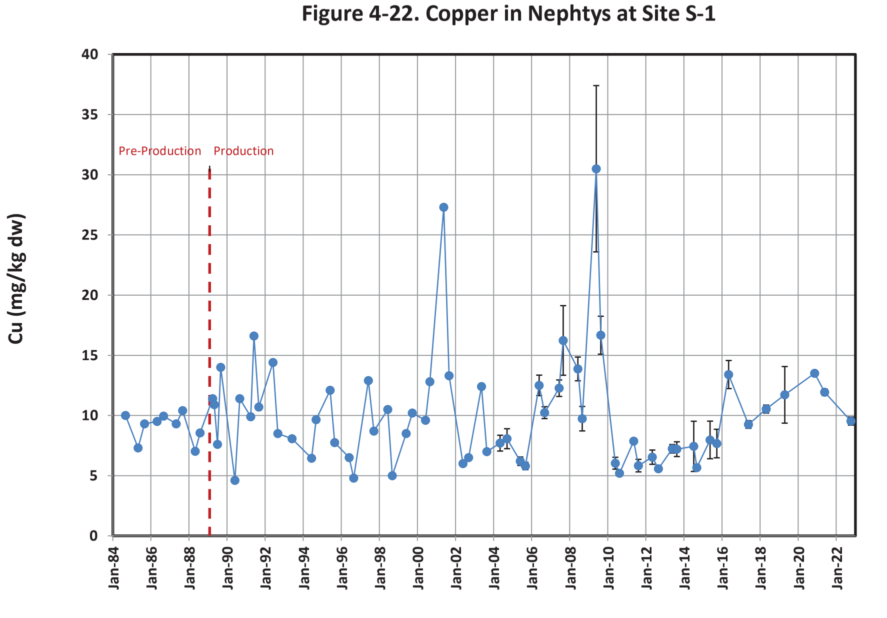


Figure 4-23. Lead in Nephtys at Site S-1

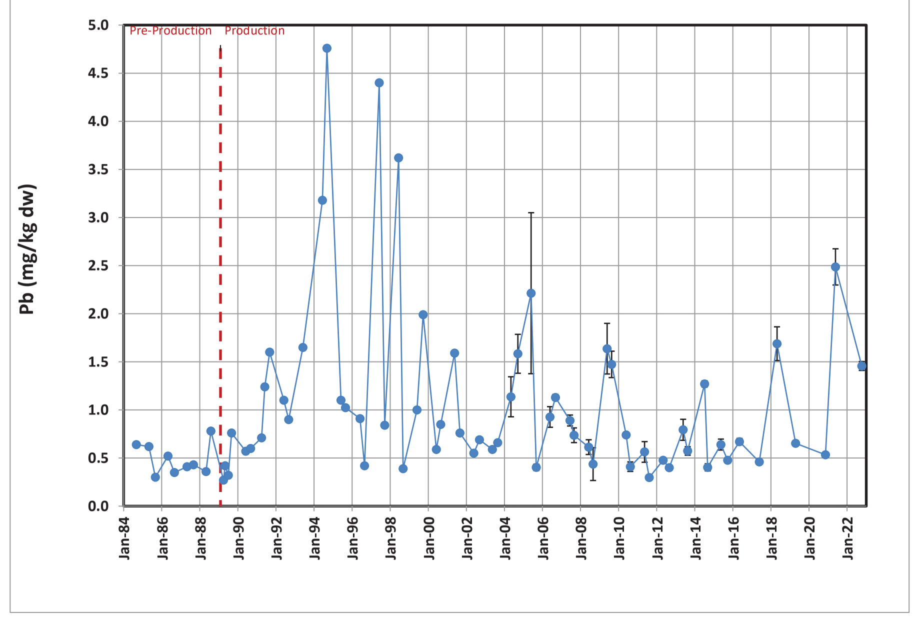


Figure 4-24. Mercury in Nephtys at Site S-1

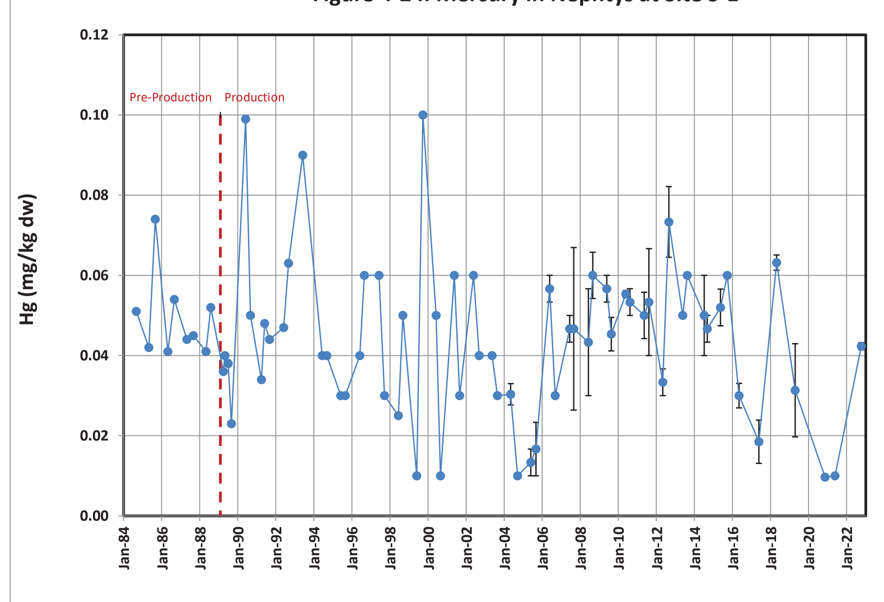


Figure 4-25. Zinc in Nephtys at Site S-1

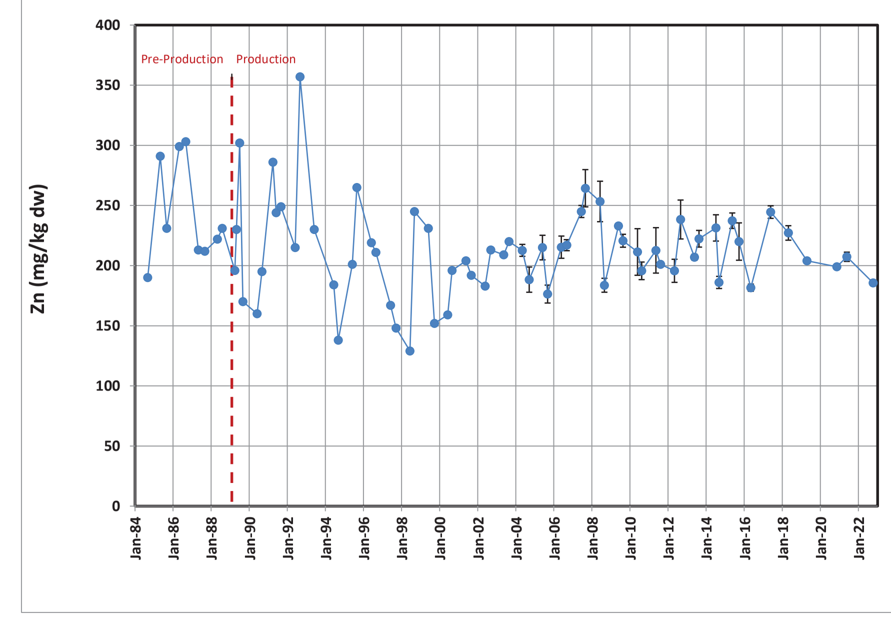


Figure 4-26. Cadmium in Nephtys at Site S-2

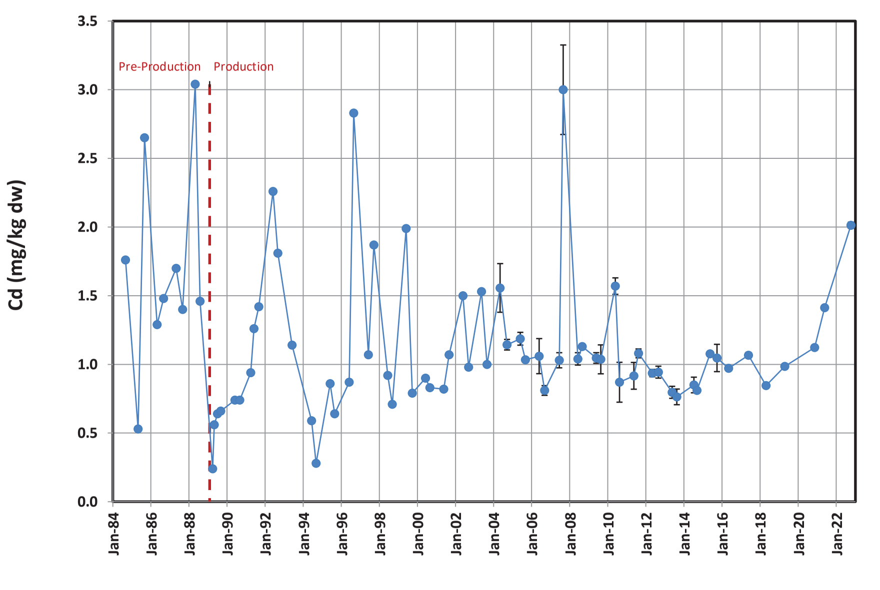


Figure 4-28. Lead in Nephtys at Site S-2

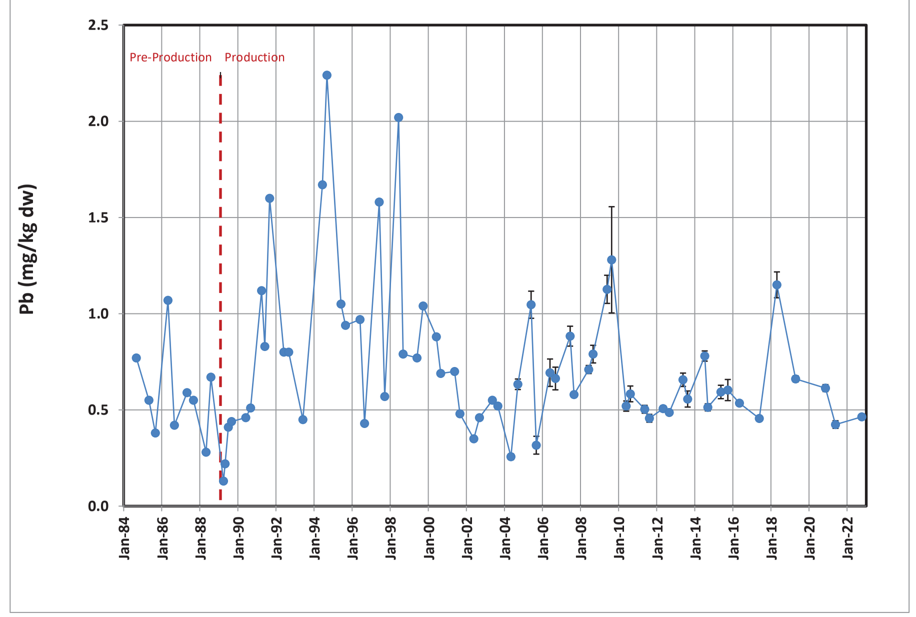


Figure 4-30. Zinc in Nephtys at Site S-2

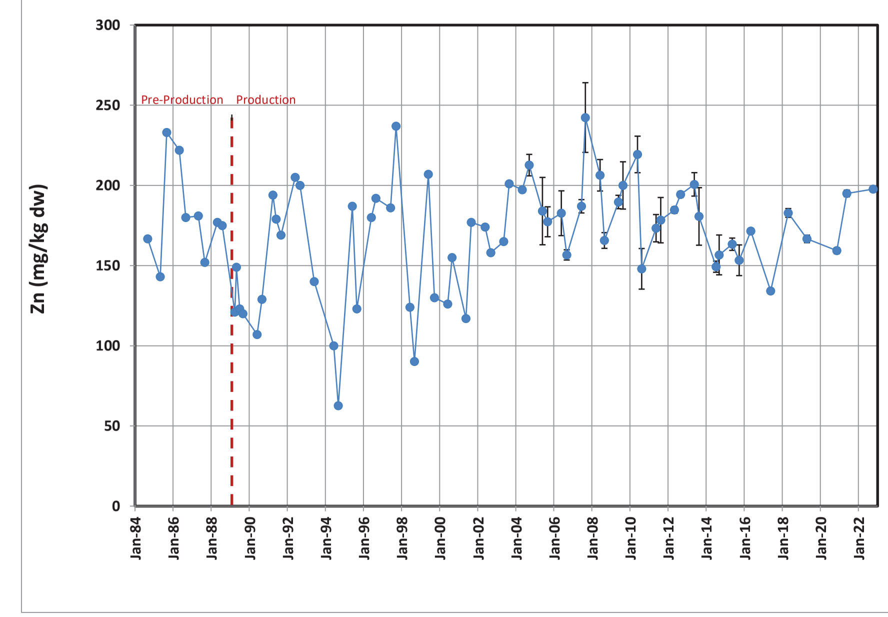


Figure 4-27. Copper in Nephtys at Site S-2

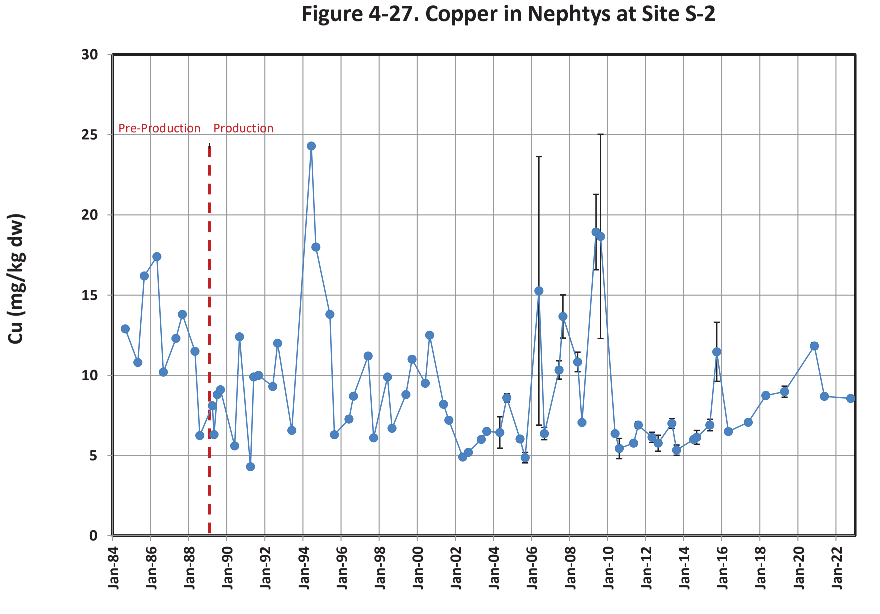


Figure 4-29. Mercury in Nephtys at Site S-2

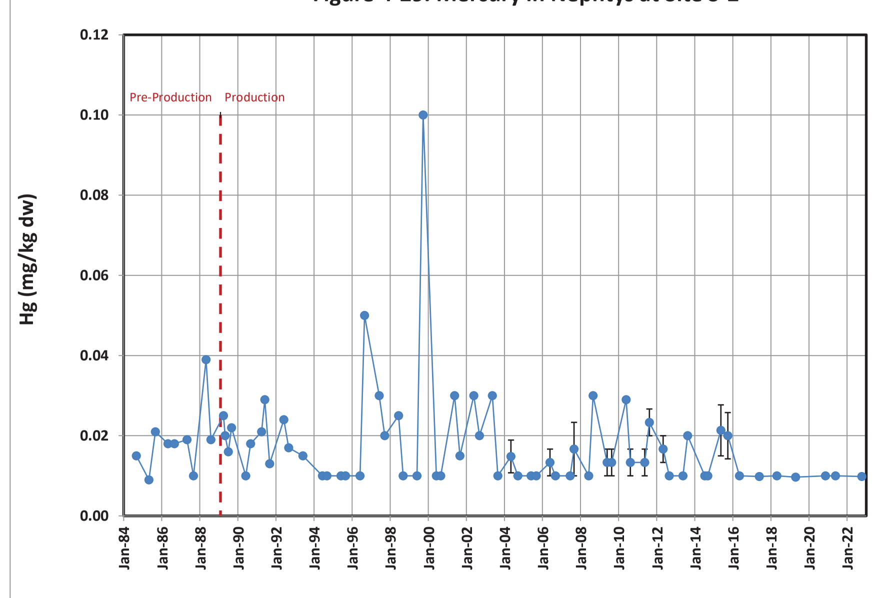


Figure 4-31. Cadmium in Nephtys at Site S-4

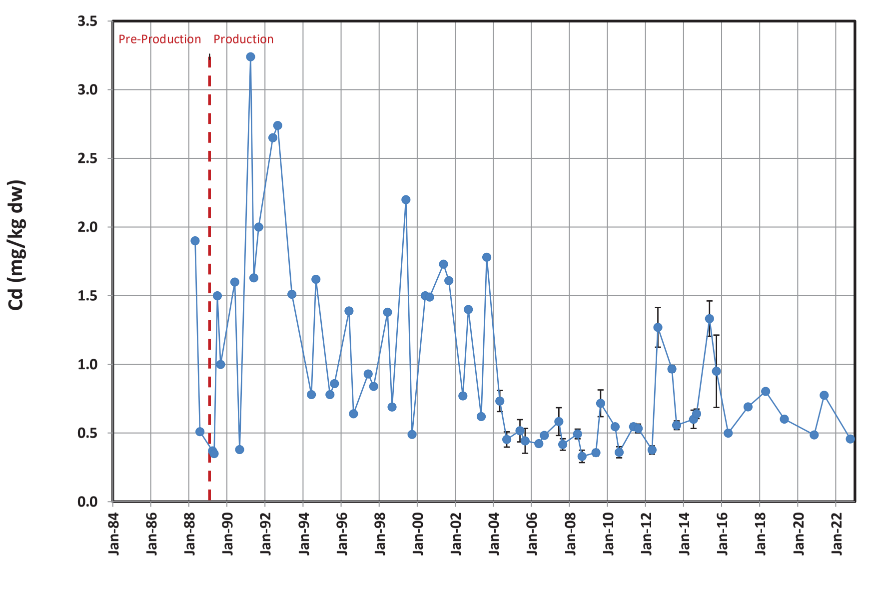


Figure 4-33. Lead in Nephtys at Site S-4

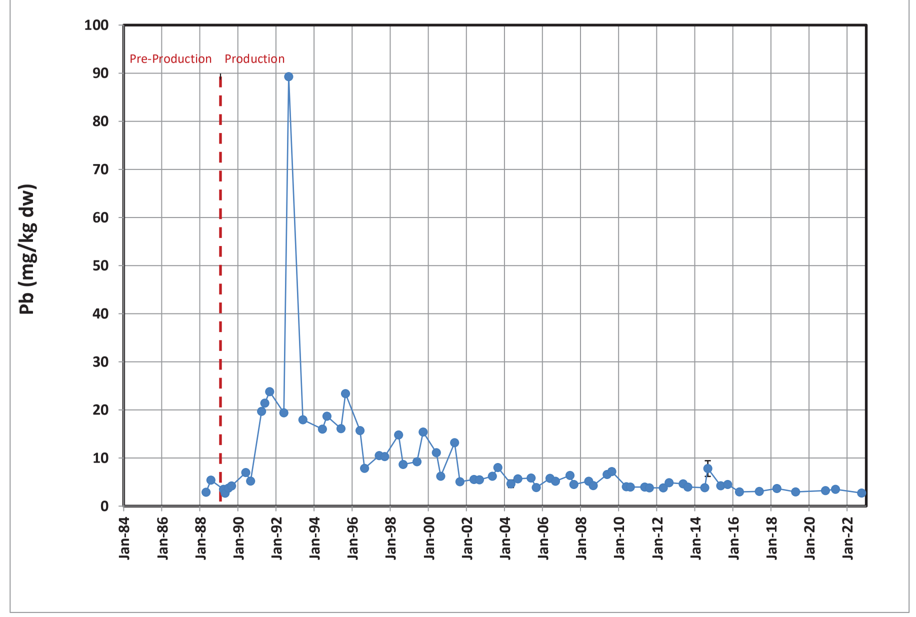


Figure 4-35. Zinc in Nephtys at Site S-4

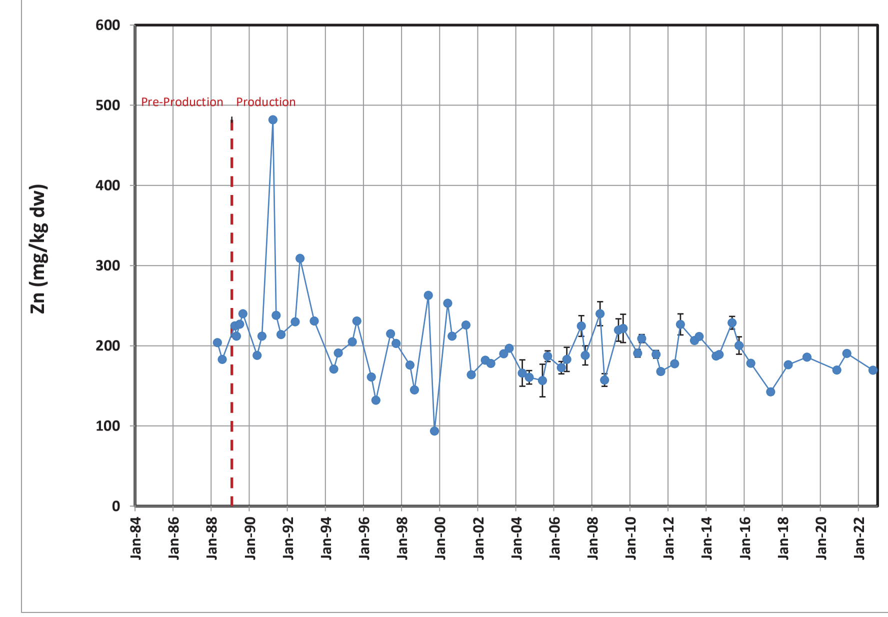


Figure 4-32. Copper in Nephtys at Site S-4

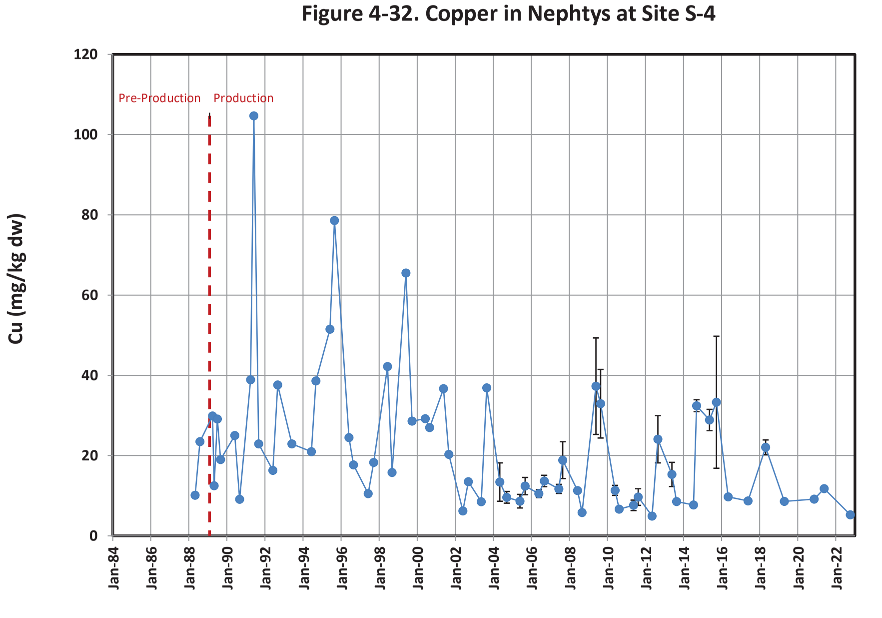
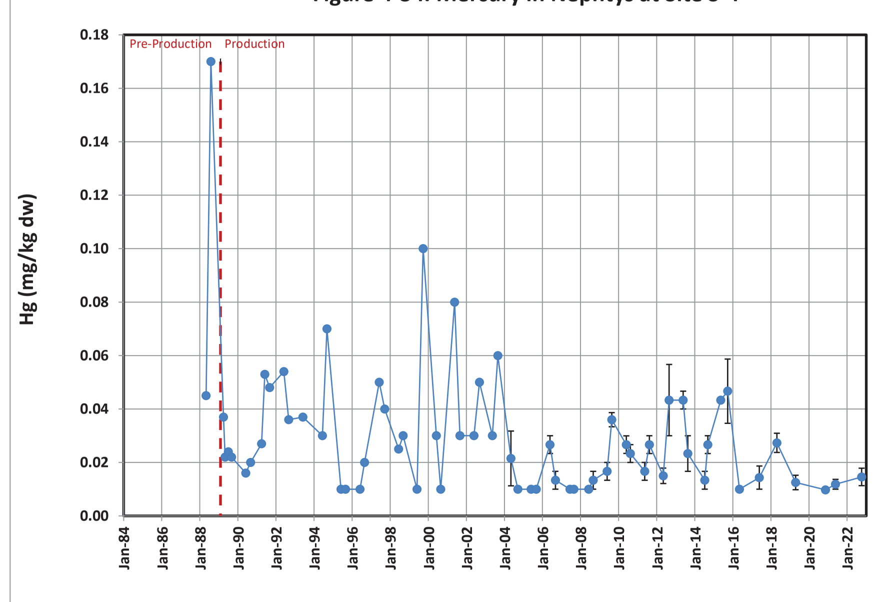


Figure 4-34. Mercury in Nephtys at Site S-4



7. APPENDICES

7.1. Appendix A - Outfall Survey Report and Video Footage

7.2. Appendix B - Historical Hawk Inlet Data