



Report Series G: Naturally Occurring Constituents (Vegetation, Fish, Mammal and Mussel Tissue)

Since 2004, the Pebble Partnership has retained independent environmental consultants and laboratories to conduct trace element or naturally occurring constituent (NOC) studies focusing on vegetation, fish, mussel and mammal tissues. The consultants and laboratories that were involved include:

- CH2M Hill
- SLR Alaska
- BEESC
- Shaw Alaska
- HDR Alaska
- Test America
- Columbia Analytical
- ABR

The objectives of trace elements studies are:

- to provide accurate documentation and characterization of the natural levels of trace elements occurring in terrestrial and aquatic vegetation, as well as mussel, fish (whole fish and muscle) and mammal tissue prior to mining operations;
- to establish background levels for the purpose of long-term monitoring of project operations;
- to evaluate variability in baseline levels of NOCs across different geochemistries, habitats, fish, mussel and vegetation species; and
- to evaluate both spatial and temporal variability of trace elements in vegetation, mammals, fish and mussels.

NOCs analyzed include metals in fish, mussels, mammals and vegetation and also anions and cyanide in vegetation.

Studies were conducted in the deposit area and the proposed port and road corridor, as well as nearby streams and lakes. A systematic random sampling program was employed to establish the best representation of study area conditions and to collect statistically representative and technically valid data sets.

Vegetation:

Vegetation sampling began in 2004, with program updates in 2005 to add sampling locations and density proportionate to habitat abundance. Aquatic vegetation, which is often consumed by moose, was added in 2005 and collected from lakes and ponds where available. Aquatic plant/pond sampling was expanded in 2006 to include groundwater fed and precipitation fed ponds, as well as those created by beaver dams. The Pebble East area was added during this time as well.

Summary of Vegetation Samples Collected Between 2004 – 2007

Medium	2004	2005	2006	2007	Totals
Plant Tissues	66	180	169	203	618
Berries	11	25	17	25	78
Aquatic Plants	0	15	44	32	91
Totals	77	220	230	260	787

Specific species of vegetation were selected for the study based on:

- need for adequate characterization of multiple habitats and species groups;
- overall abundance;
- biological uptake potential;
- medicinal, traditional, food and subsistence uses by humans; and
- food sources and forage for wildlife.

The proposed mine development will likely include features that cut across several landforms containing characteristic types of vegetation common to the region and study area. Therefore, the approach to adequately characterize vegetation media was based on first identifying landforms in the mine site study area, identifying sample types from each environmental medium common to these landforms, and ensuring that enough samples were collected to be statistically valid.

The settling of dust on vegetation and associated uptake of trace elements are also pathways of interest in the vegetation program. As such, non-woody material was collected from plants with clippers and placed into sealed plastic bags to ensure edible portions of plant species were analyzed.

Each vegetation sampling location was visited twice per season to collect both early season browse and late season browse and berries. In the deposit study area, sampling was based on preliminary identification of seven upland habitats, including over 50 different plant species. A total of 39 plant locations and 17 ponds containing aquatic plants were sampled.

Fish & Mussel Tissue:

Fish tissue samples were collected from 17 stream locations and four ponds. Samples collected for analysis consisted of either whole fish or of dissected muscle or liver tissue, depending on fish species and age. One or more key fish species was selected for each drainage/monitoring site and sampled. Juvenile salmonids, primarily coho salmon, were selected as key species when present. Freshwater mussels were also collected from four locations within Lake Iliamna as part of the Lake Iliamna study.

The study program for fish tissue extends 160 square miles to include the full length of the North and South Forks of the Kottuli River and all of Upper Talarik Creek.

Qualified independent commercial analytical laboratories utilized Environmental Protection Agency (EPA) analytical methods modified to quantify NOCs in fish and mussel tissue. Fish and mussel tissues were analyzed for antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium and zinc.

Mammal Tissue:

In 2007, the mammal study program included analysis of caribou liver and kidney samples collected from two caribou harvested near the village of Portage Creek, approximately 100 miles southwest of the deposit. The samples were collected by Alaska Department of Fish and Game (ADF&G) as part of their ongoing studies and subsamples of the tissues were provided by ADF&G to Pebble Project consultants for analysis. This sampling of mammal tissue was a preliminary, opportunistic effort that was made at the time due to availability of the samples and does not necessarily constitute a statistically valid data set. Collection and analysis of additional mammal tissue samples are being planned for later studies.

Qualified independent commercial analytical laboratories utilized Environmental Protection Agency (EPA) analytical methods modified to quantify NOCs in mammal tissues. Mammal tissues were analyzed for antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium and zinc.

Plants that have been sampled:

- Trees – 3 species, 13 samples
- Shrubs – 16 species, 188 vegetative samples, 5 species, 78 berry samples
- Forbs – 19 species, 103 samples
- Grasses and sedges – 5 species, 60 samples
- Mosses – 5 species, 60 samples
- Lichens – 3 species, 46 samples

Naturally Occurring Constituents (Vegetation, Fish, Mammal and Mussel Tissue) data reports, released as part of the Pebble Partnership's Pre-Permitting Environmental & Socio-Economic Data Report Series, are available online at www.pebblepartnership.com.

****Preliminary data only. Do not cite or quote.***

Summary of Fish Tissue Samples Collected Between 2004 – 2007

Common Name	Species-Tissue Type-Lifestage	Location	2004	2005	2006	2007	All Years
Northern Pike	Esox lucius linnaeus-LIVER-ADULT	Black Lake		10	10		20
Northern Pike	Esox lucius linnaeus-LIVER-ADULT	Big Wiggly Lake	10	10			20
Northern Pike	Esox lucius linnaeus-LIVER-ADULT	Frying Pan Lake	10	10			20
Northern Pike	Esox lucius linnaeus-LIVER-ADULT	Lake #2	12	10			22
Northern Pike	Esox lucius linnaeus-MUSCLE-ADULT	Black Lake		10	10	10	30
Northern Pike	Esox lucius linnaeus-MUSCLE-ADULT	Big Wiggly Lake	10	10		10	30
Northern Pike	Esox lucius linnaeus-MUSCLE-ADULT	Frying Pan Lake	10	10		10	30
Northern Pike	Esox lucius linnaeus-MUSCLE-ADULT	Lake #2	12	10		10	32
Northern Pike	Esox lucius linnaeus-WHOLE-JUV	Southfork Koktuli	12	10			22
		annual summary	76	90	20	40	226
Salmon, mixed Coho and Chinook	Oncorhynchus kisutch & tshawytscha-WHOLE-Age JUV	Northfork Koktuli	12	10			22
Salmon, mixed Coho and Chinook	Oncorhynchus kisutch & tshawytscha-WHOLE-Age JUV	Southfork Koktuli	12				12
		annual summary	24	10	0	0	34
Coho	Oncorhynchus kisutch-WHOLE-Age JUV	Kaskanak Creek	12	10			22
Coho	Oncorhynchus kisutch-WHOLE-Age JUV	Northfork Koktuli		10			10
Coho	Oncorhynchus kisutch-WHOLE-Age JUV	Southfork Koktuli	24	40			64
Coho	Oncorhynchus kisutch-WHOLE-Age JUV	Bearden Creek	12	10			22
Coho	Oncorhynchus kisutch-WHOLE-Age JUV	Chum Creek	12				12
Coho	Oncorhynchus kisutch-WHOLE-Age JUV	Ursa Creek	13	10			23
Coho	Oncorhynchus kisutch-WHOLE-Age JUV	Upper Talarik	36	30			66
		annual summary	109	110	0	0	219
Chinook	Oncorhynchus tshawytscha-WHOLE-Age JUV	Upper Talarik		10			10
		annual summary	0	10	0	0	10
Dolly Varden	Salvelinus malma Walbaum-WHOLE-Age MIXED AGES	Upper Talarik		10			10
Dolly Varden	Salvelinus malma Walbaum-WHOLE-Age NOT SPEC	Northfork Koktuli	23	20			43
Dolly Varden	Salvelinus malma Walbaum-WHOLE-Age NOT SPEC	Chum Creek		10			10
Dolly Varden	Salvelinus malma Walbaum-WHOLE-Age NOT SPEC	Red Creek	12	10			22
Dolly Varden	Salvelinus malma Walbaum-WHOLE-Age NOT SPEC	Y-Valley Creek	12				12
Dolly Varden	Salvelinus malma Walbaum-WHOLE-Age NOT SPEC	Upper Talarik	36	10			46
		annual summary	83	60	0	0	143
Arctic Grayling	T. arcticus arcticus-Liver-Adult	Big Wiggly Lake			11		11
Arctic Grayling	T. arcticus arcticus-MUSCLE-Adult	Southfork Koktuli				10	10
Arctic Grayling	T. arcticus arcticus-MUSCLE-ADULT	Northfork Koktuli				9	9
Arctic Grayling	T. arcticus arcticus-MUSCLE-ADULT	Upper Talarik				12	12
Arctic Grayling	T. arcticus arcticus-MUSCLE-Adult	Big Wiggly Lake			9		9
Arctic Grayling	T. arcticus arcticus-WHOLE-Age JUV	Southfork Koktuli	24	20			44
Arctic Grayling	T. arcticus arcticus-WHOLE-Age MIXED AGES	Northfork Koktuli	12				12
		annual summary	36	20	20	31	107
Whitefish	various Whitefish genera-MUSCLE-ADULT	Big Wiggly Lake				10	10
		annual summary	0	0	0	10	10
		all fish samples	328	300	40	81	749