

MOUNT POLLEY MINE – REMEDIATION UPDATE

BC MEND - 2015

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an Imperial Metals company



View of the Lively Bridge over the
Quesnel River

Mount Polley Tailings Dam Breach



- dam breached early morning Aug 4, 2014
- no injuries or loss of life
- the estimated summary of materials displaced by the breach: 25M m³
- supernatant water: 10.6M m³
- tailings slurry: 13.8M m³
 - tailings solids 7.3M m³;
 - interstitial water 6.5M m³
- construction materials: 0.6M m³
- NB: Hazeltine Creek flow very low in August

Bullion Pit →

Hydraulic

Likely, BC V0K, Canada

Spanish Lake

Springer Pit →

Polley Lake →

Quesnel Lake
(West Arm)

Bootjack Lake →

TSF

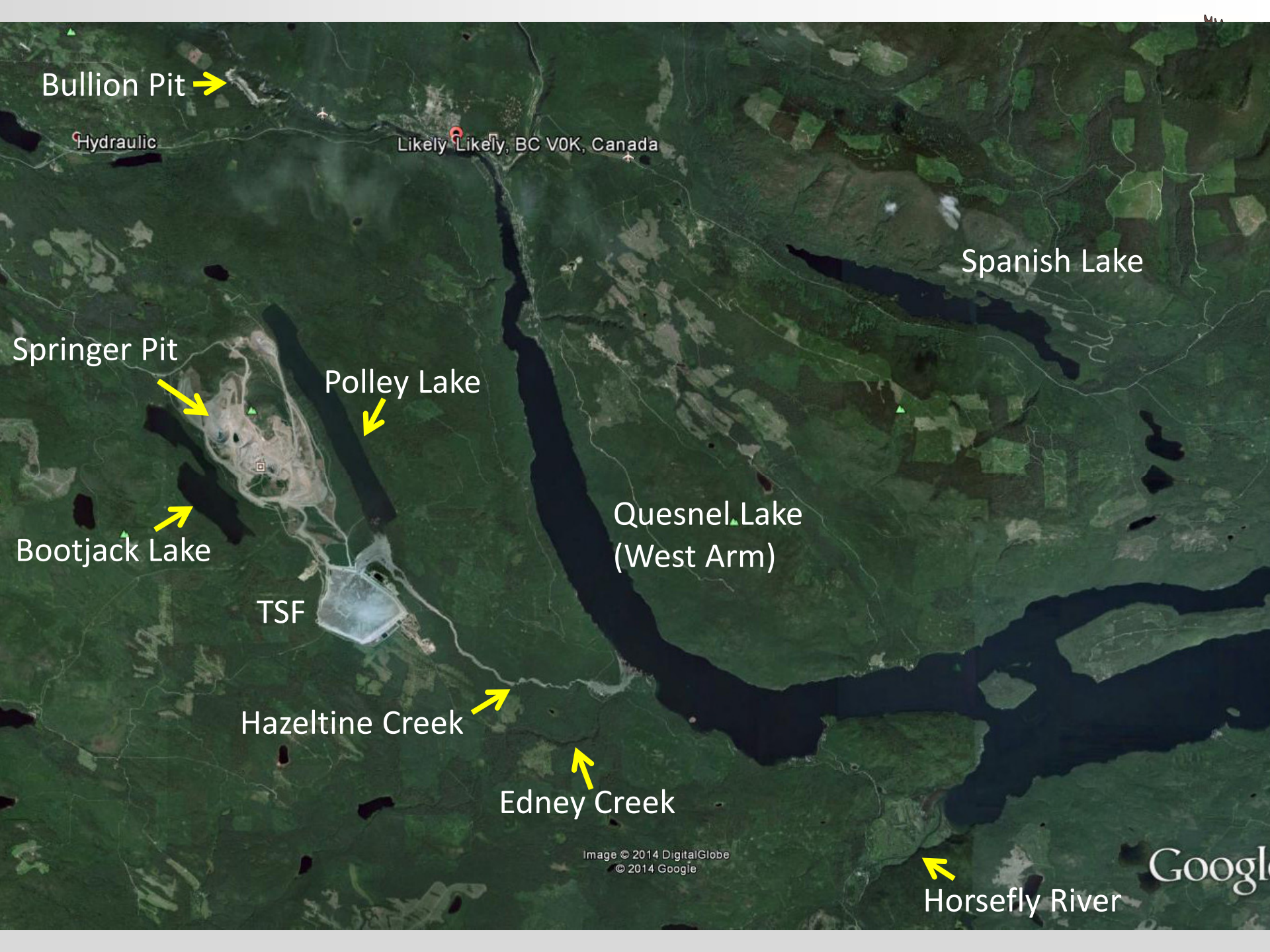
Hazeltine Creek →

Edney Creek →

→ Horsefly River

Image © 2014 DigitalGlobe
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Response Objectives



Safety



Health Protection



Environmental:

- Control impacts (short term)
- Monitoring and studies
- Restore environmental functions (long term)



Compliance:

- Pollution Abatement Order issued by Ministry of Environment



Health & Safety

- Immediate notification of MEM, MoE, Emergency Management BC, Local First Nations
- Limit public access to affected area
- Monitor Polley Lake Sediment Plug Stability
- Develop safe work plans

Communications

- Daily updates to MEM, MoE, Provincial Emergency Program, First Nations representatives
- Weekly community meetings in Likely, periodic updates in Williams Lake, First Nations

Control Tailings and Water

- Construct rockfill berm across breach
- Install sumps, pumps and pipelines

Control Debris on Lakes

- Mobilize tugs, booms and barge to manage floating debris on Quesnel Lake
- Protect Likely Bridge
- Establish West Fraser Reload to dewater floating woody debris

Control Sediment

- Construct Sediment Control Ponds near Quesnel Lake
- Construct and Armour Hazeltine Creek Channel

Ongoing Environmental Monitoring

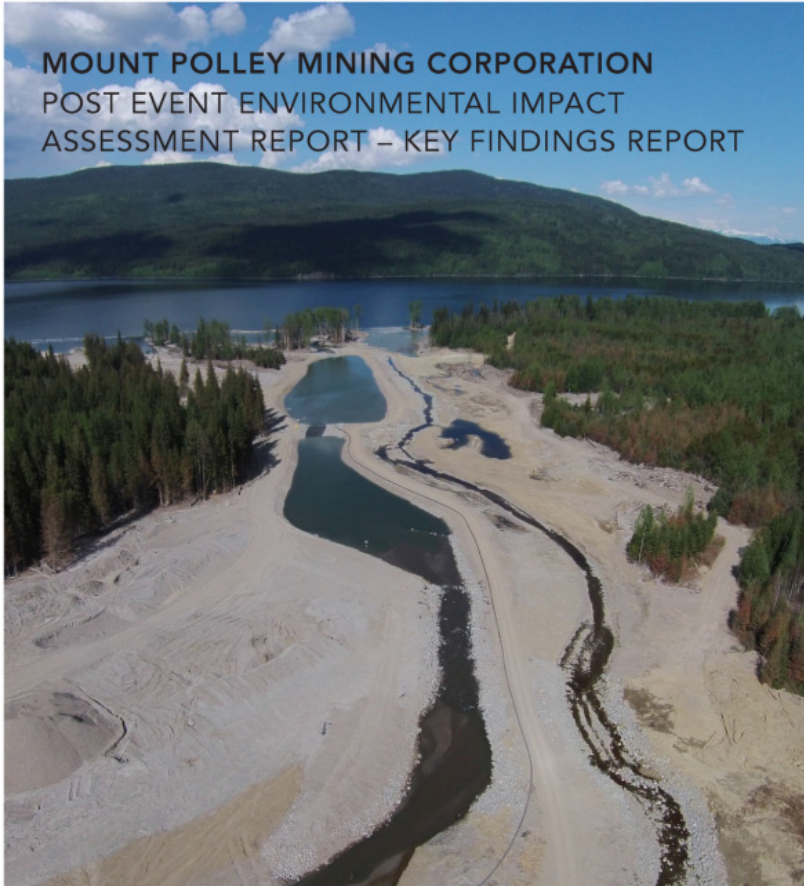


- Ongoing data collection and monitoring since the spill
- Water chemistry, geochemical and biological sampling, sediment and invertebrate toxicity testing, metal leaching studies, ...





MOUNT POLLEY MINING CORPORATION
POST EVENT ENVIRONMENTAL IMPACT
ASSESSMENT REPORT – KEY FINDINGS REPORT



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Post-Event Environmental Monitoring Program:

- Preliminary assessments (first 6-8 months) – complete, available to public online (full report ~5400 pages)
- Human Health and Ecological Risk Assessment – ongoing

Rehabilitation Approach – Operational Considerations



- Mount Polley is currently under a Pollution Abatement Order from the Ministry of Environment. **Sediment and erosion control is a key focus**, which dictates project priorities.
- Results from the Human Health and Ecological Risk Assessment and ongoing monitoring, including longer running geochemistry tests (SRK), are still outstanding. Proceeding with rehabilitation requires balancing risks and incorporating best available info at time.
- Initially, the work that is urgently required comes with challenges, particularly when working outside of typical seasonal work periods

Impact: Turbidity Plume in Quesnel Lake

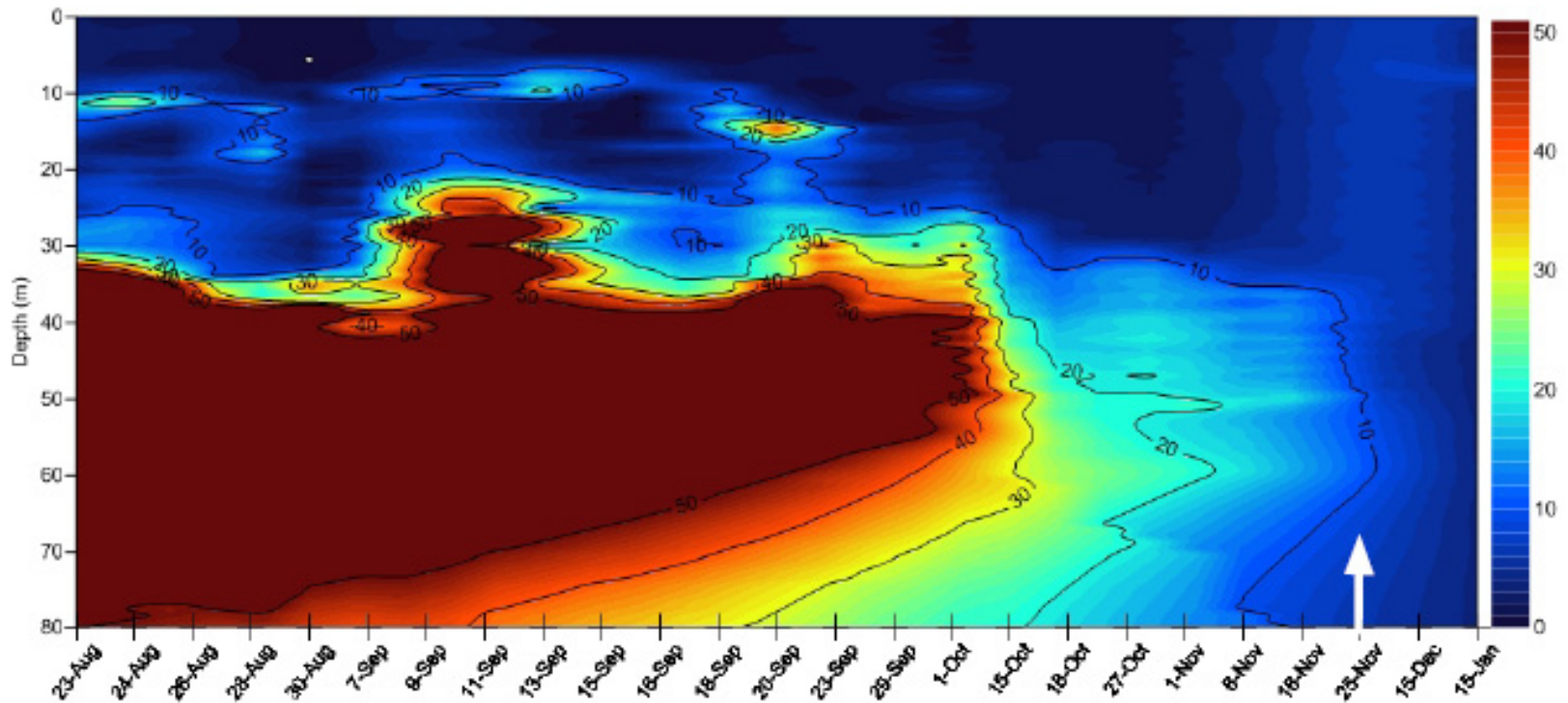


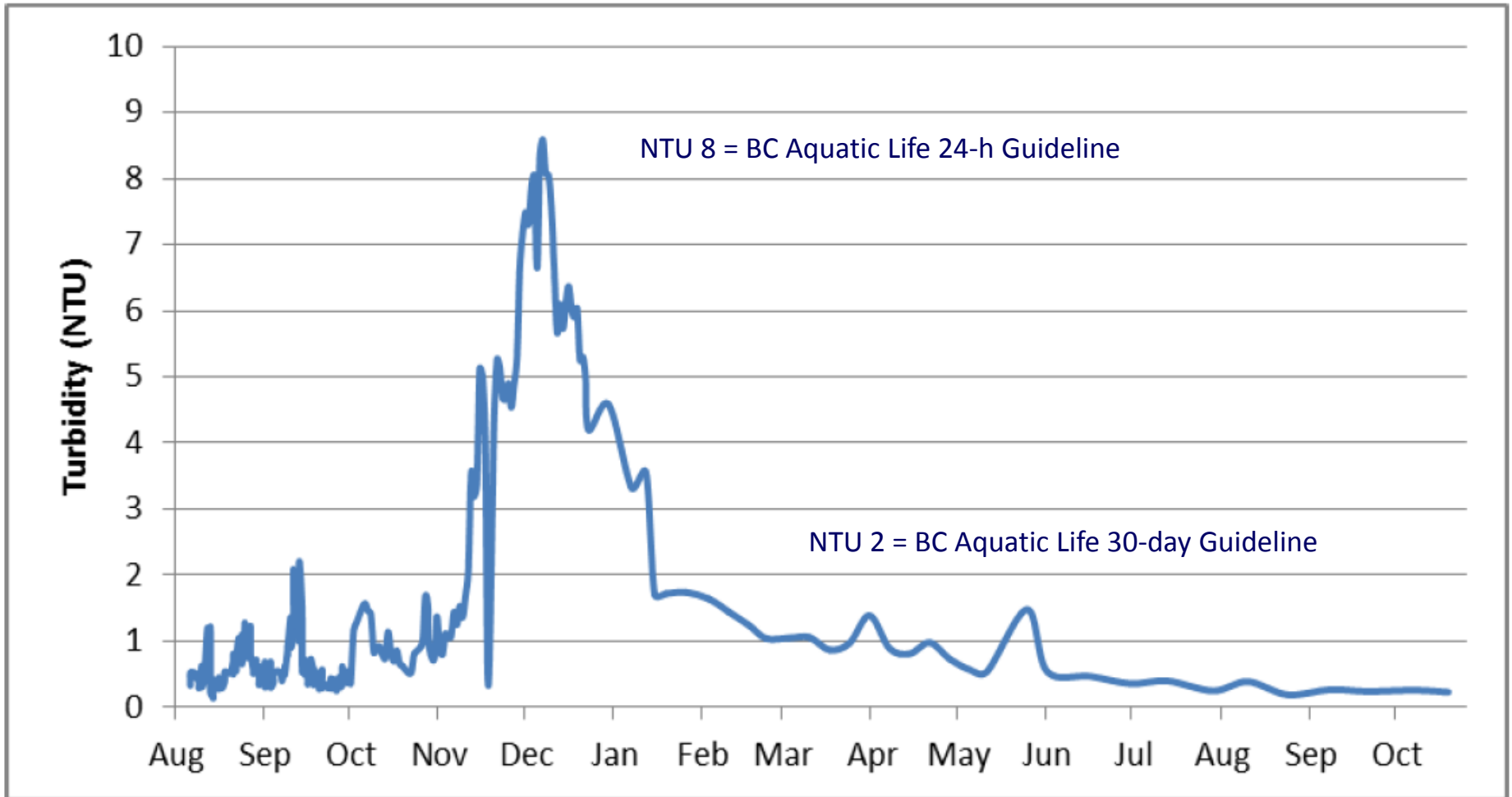
Figure 11: Turbidity measurements of Quesnel Lake water from the surface to the bottom of Quesnel Lake at a station adjacent to the Mouth of Hazeltine Creek, showing the clearing of turbid water that happened over time

Quesnel River Turbidity

August 2014 to November 2015



QUR-1 sampling station near Likely



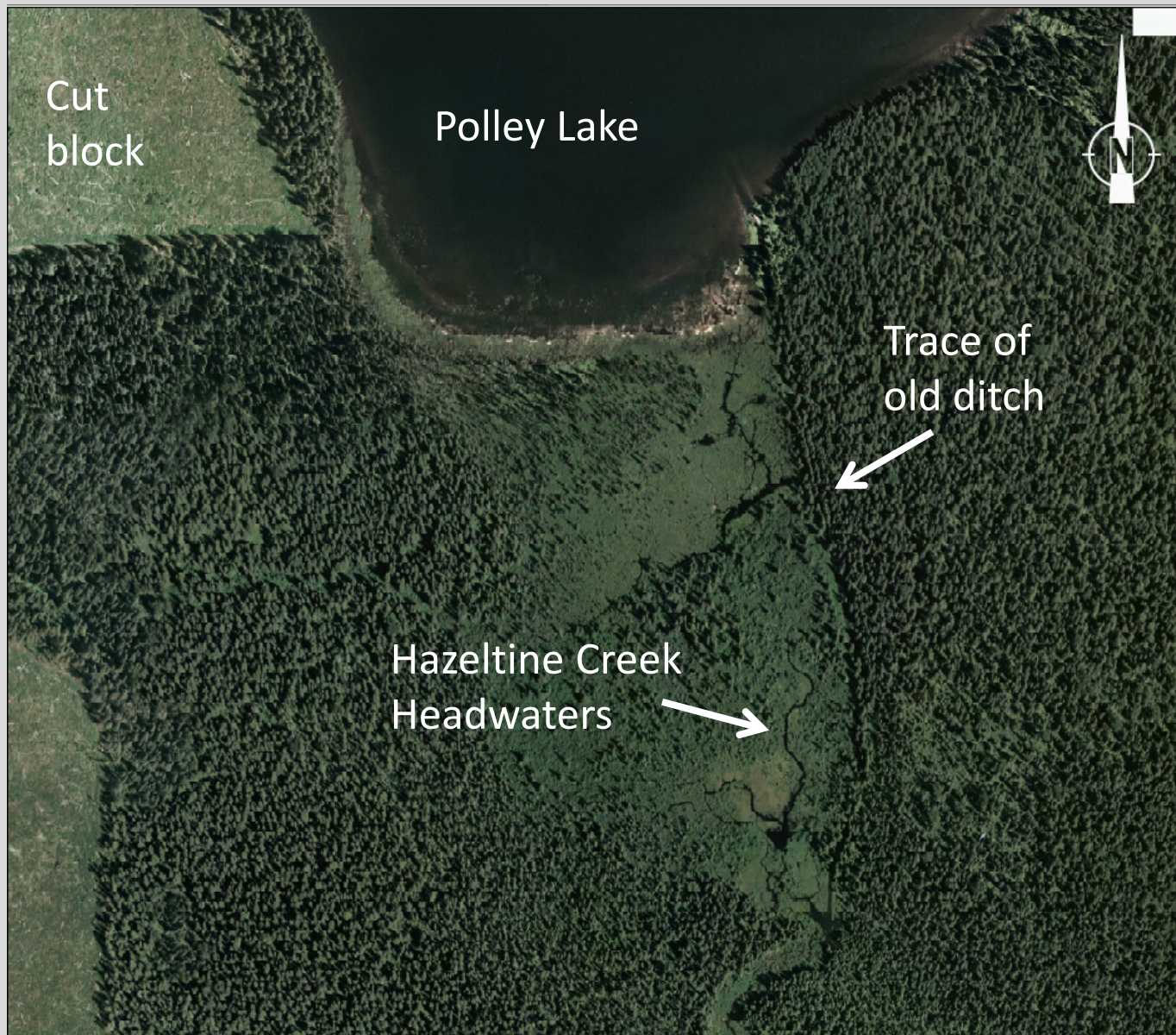
NTU 1.2 = BC Aesthetic Drinking Water Guideline

Polley Lake Weir Structure

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Polley Lake Outlet – 1980's pre-breach, pre-mining, post-forestry, image



Polley Lake Outlet Structure – early 1900's – water works for placer mining

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Placer Mining – early 1900s, water infrastructure at Polley Lake Outlet

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Polley Lake Weir Structure – May 2015

note clarity of water leaving Polley Lake

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Trout in Polley Lake, May 2015

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Lower Hazeltine Sediment Control Ponds

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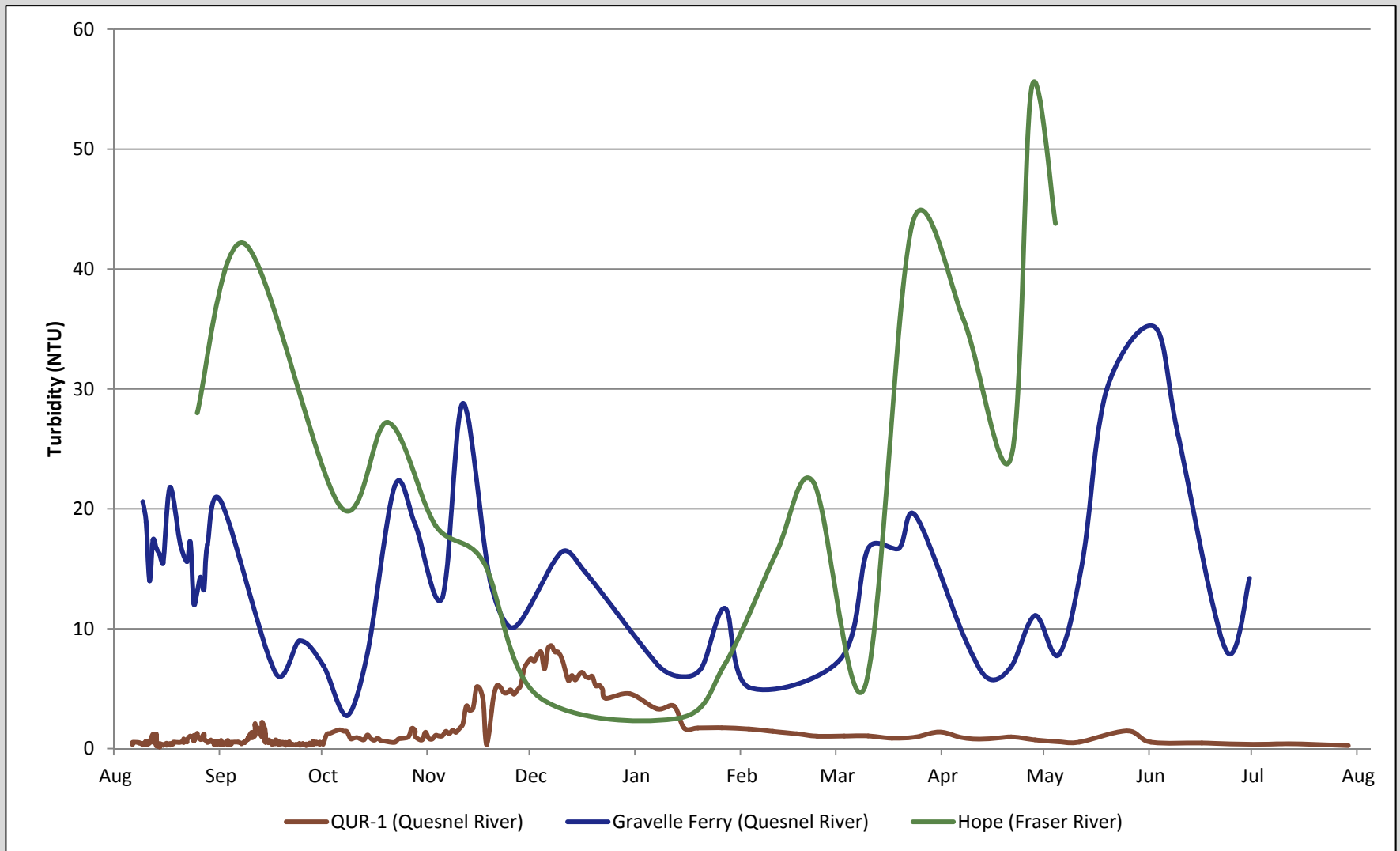


Quesnel Lake at Hazeltine Creek, May 20, 2015

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Water Quality – Turbidity Comparison



Quesnel River site QUR-1 (red), Gravelle Ferry (blue), Fraser River at Hope (green)

Rehabilitation of Hazeltine Creek – Erosion Control, Ecological Restoration

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- Field Fit Rehabilitation:
- Erosion Control + Creek Rehabilitation
- Working with FN Advisors

work began last fall,
carried on over winter,
and continues



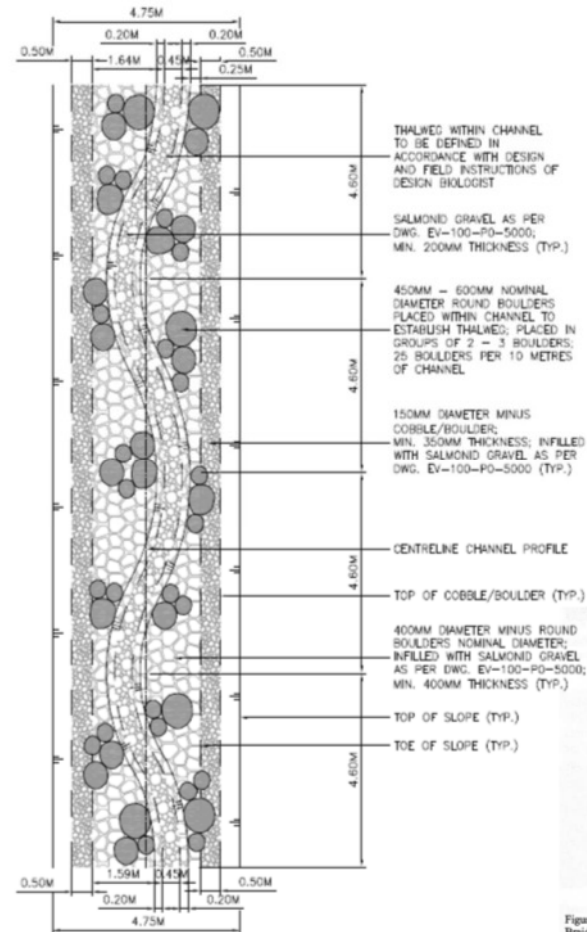
Rehabilitation of Hazeltine Creek - Design



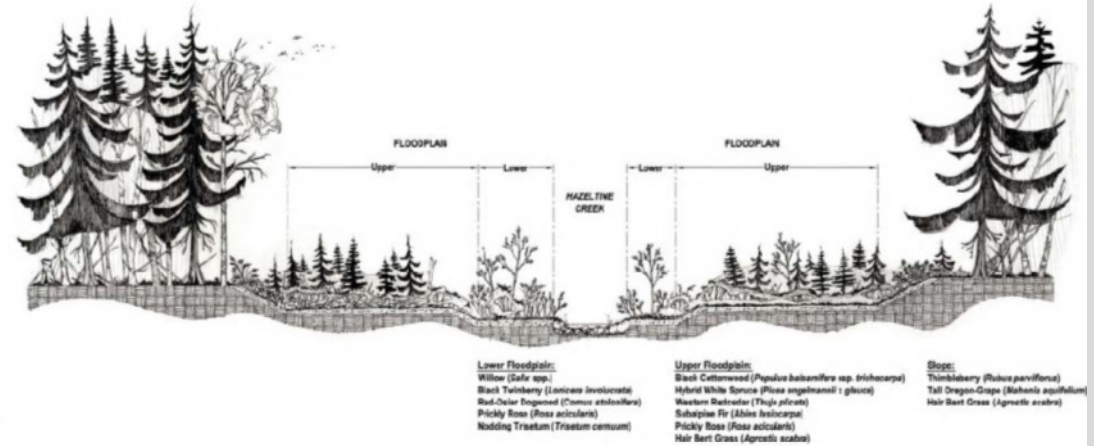
Design Concepts

DRAFT

Conceptual Channel Plan



Conceptual Channel Section (5 years after planting)



Case Study



Figure 21. Construction of a 1.2-km long Oulette Creek diversion channel from the toe of the alluvial fan to Howe Sound, BC. Braided channels on the fan surface were installed for the development and protected by the dyke shown on the left. The design discharge at the constructed floodplain level was 17 m³/s.



Figure 22. The Oulette Creek diversion channel four years after construction. The cross-vane rock sill in the foreground is buried in an infilled plunge pool. The 1.2-m diameter digger log in the background is undermined and suspended from the banks.

TYPICAL CHANNEL PLAN
WITH 450MM - 600MM NOMINAL DIAMETER
ROUND BOULDERS SHOWN AND
WOODY DEBRIS NOT SHOWN

Rehabilitation of Hazeltine Creek - Excavating Channel

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Rehabilitation of Hazeltine Creek – Rocking in of Channel, Resloping Steep Banks

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Terrestrial Rehabilitation – Recontouring

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Terrestrial Rehabilitation – Ready for Planting

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Lower Hazeltine Mulch and Woody Debris

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Hazeltine Creek Restoration – On-site Plant Collection (willow cuttings) - Winter 2014-15

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Lower Hazeltine Planting, Spring 2015

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Lower Hazeltine Planting, Spring 2015

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Lower Hazeltine - Planting



Lower Hazeltine - Planting

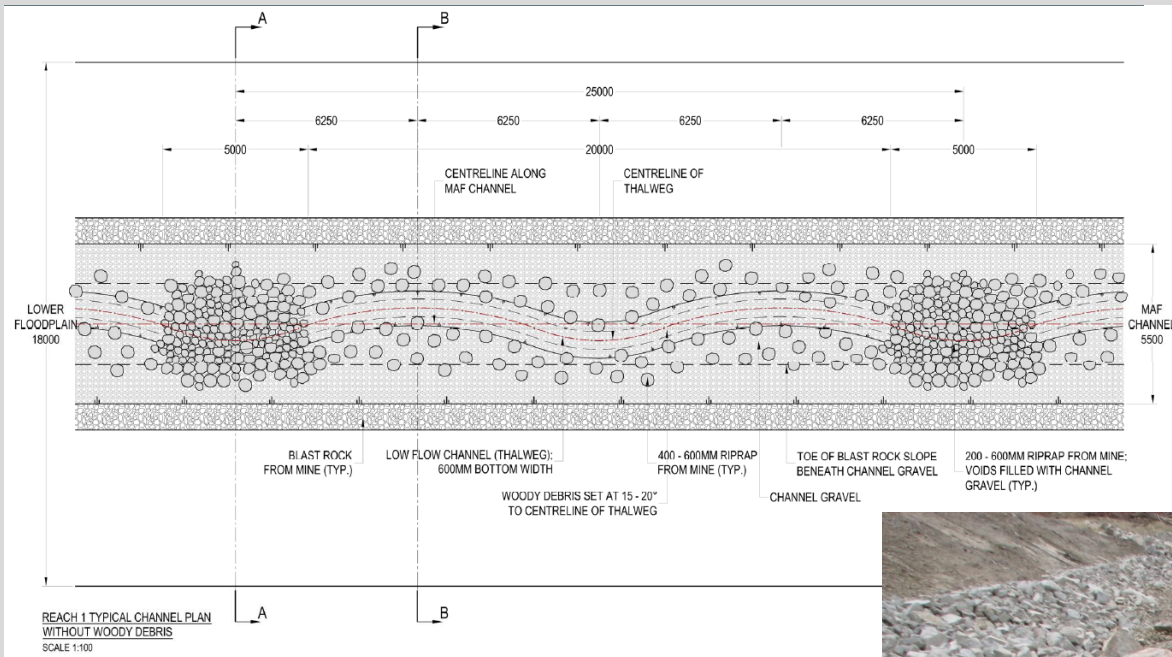


Lower Hazeltine – Native plant regrowth

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Edney Creek Fish Habitat Features



Edney Creek Fish Habitat – installed August 2015

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- Channel foundation and passage (earlier)
- Large woody debris
- Habitat complexity
- Riffles and pools
- Stream substrates (spawning gravels).

Debris Island in Polley Lake, May 2015



Wildlife Sightings

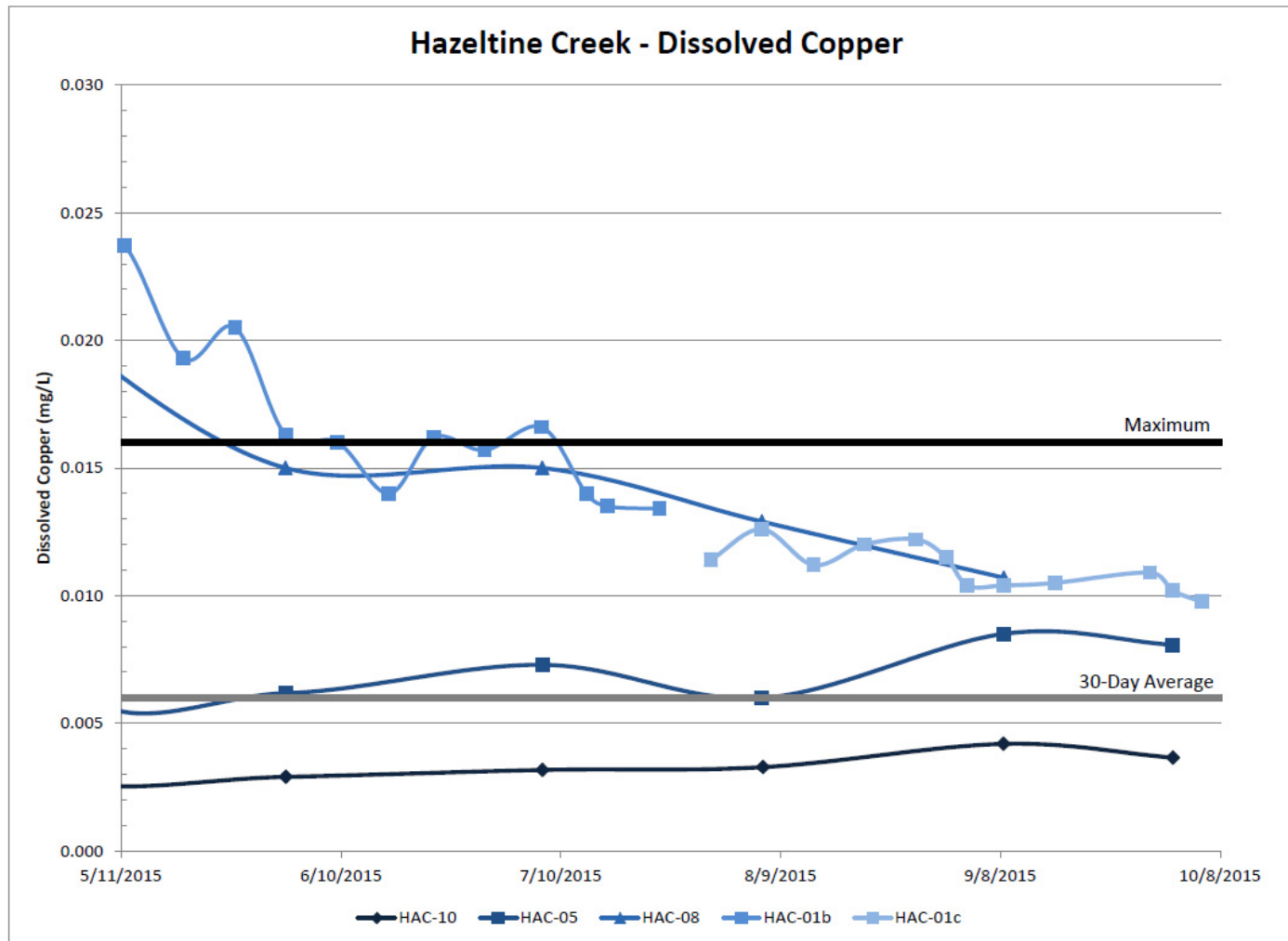
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bears, bobcats, deer, rabbits, swallows,
osprey, golden eagles, bald eagles, herons,
frogs, toads and tadpoles, moose, otters,
beavers, and cows



Geochemistry of Hazeltine Creek

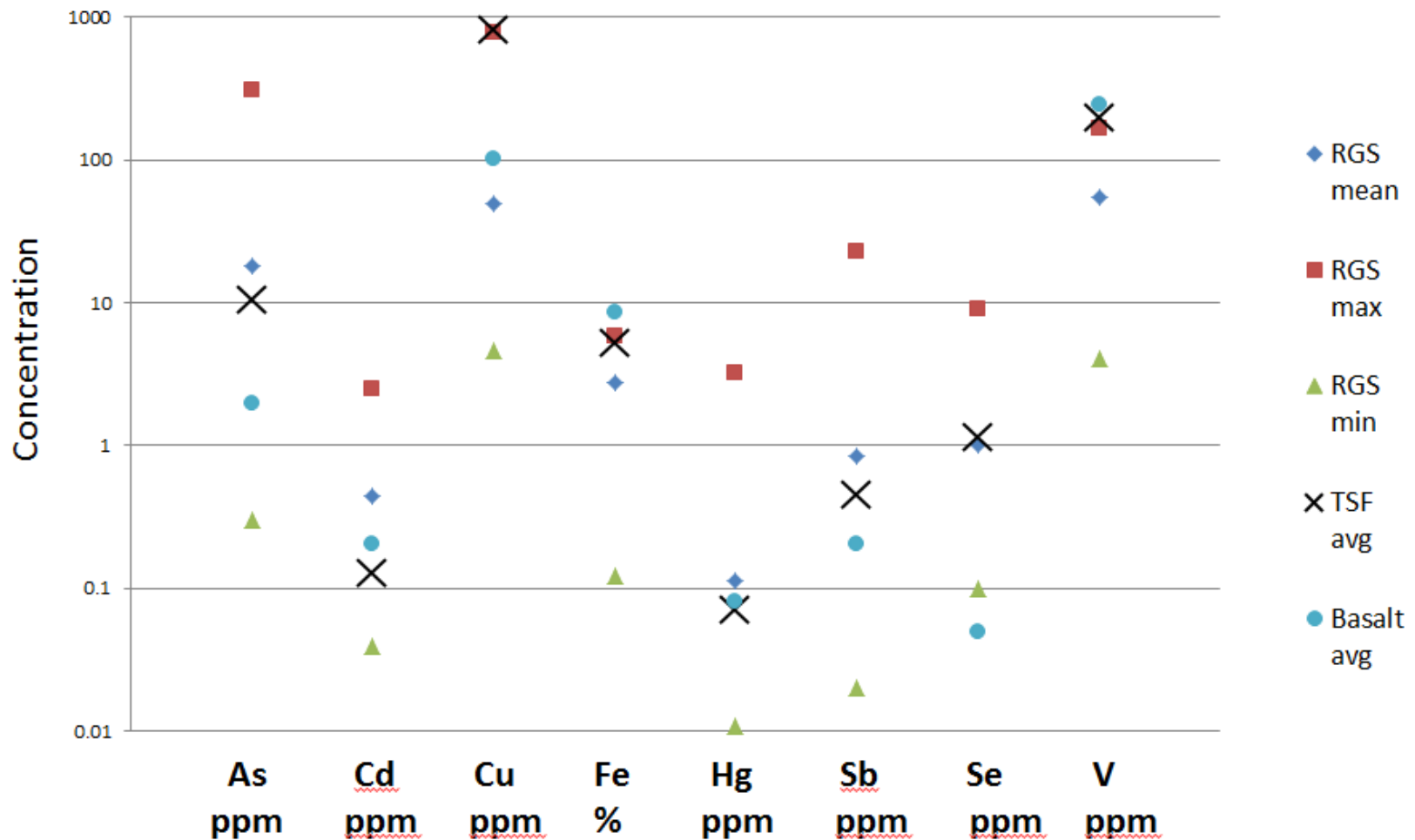


MP Tailings in Regional Geochemical Context



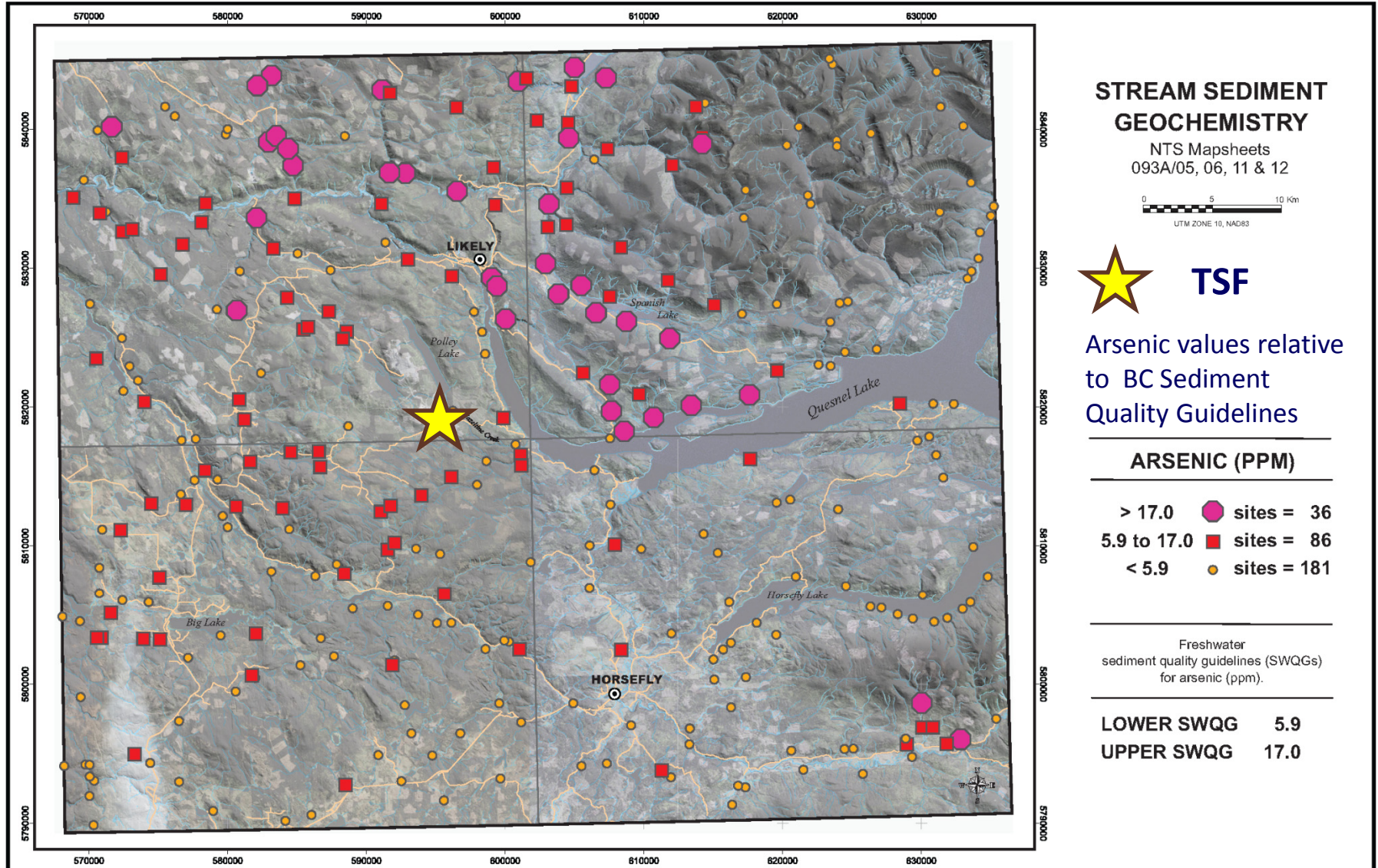
Comparison of MP tailings with regional stream sediments and average basalt

(note concentration displayed on logarithmic scale on y-axis)



Geochemical Context: Arsenic in Stream Sediments (1980). MPMC Tailings 2014 = 10.63 ppm As

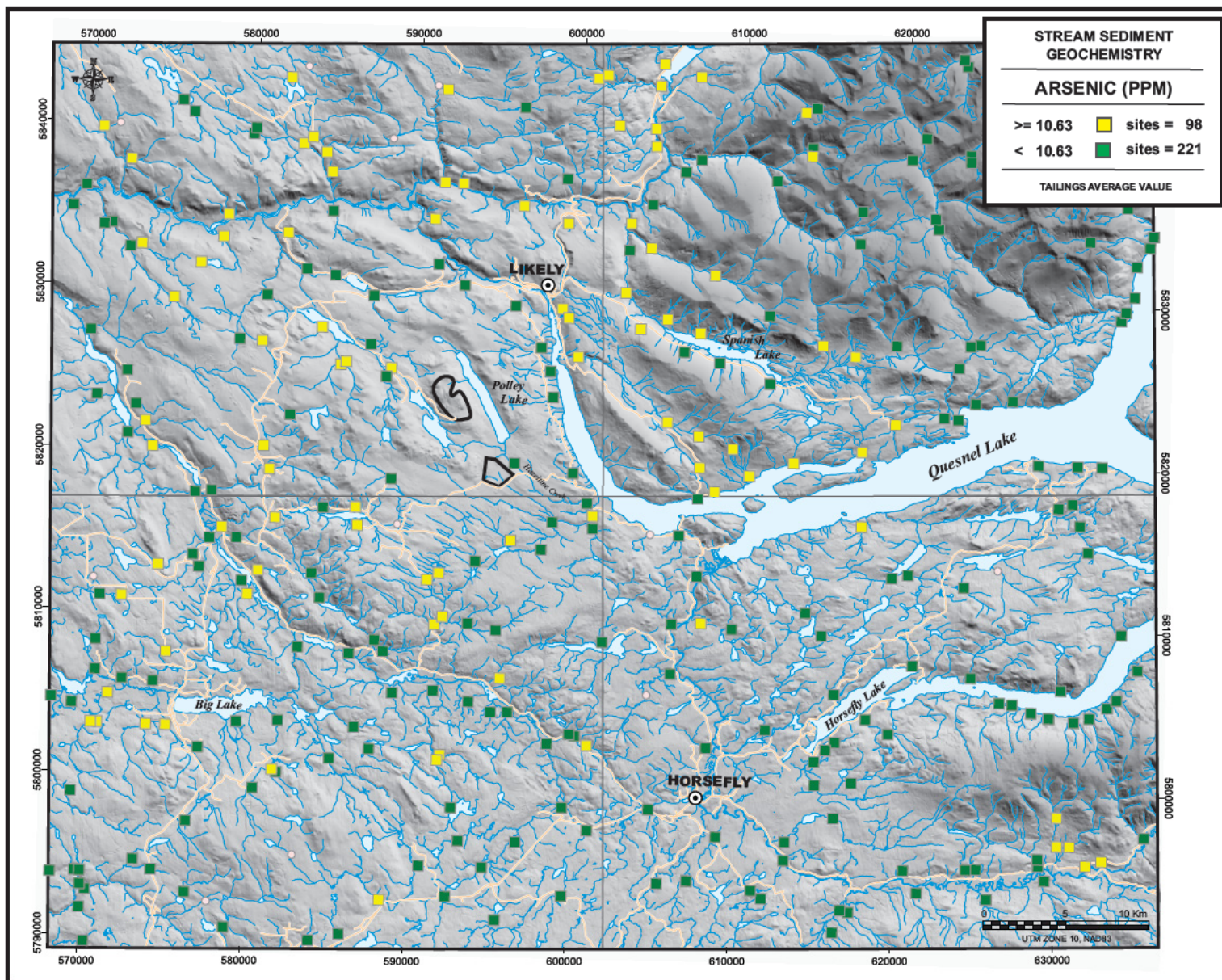
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Regional Stream Sediment – Arsenic

Note: MP Tailings average 10.63 ppm As

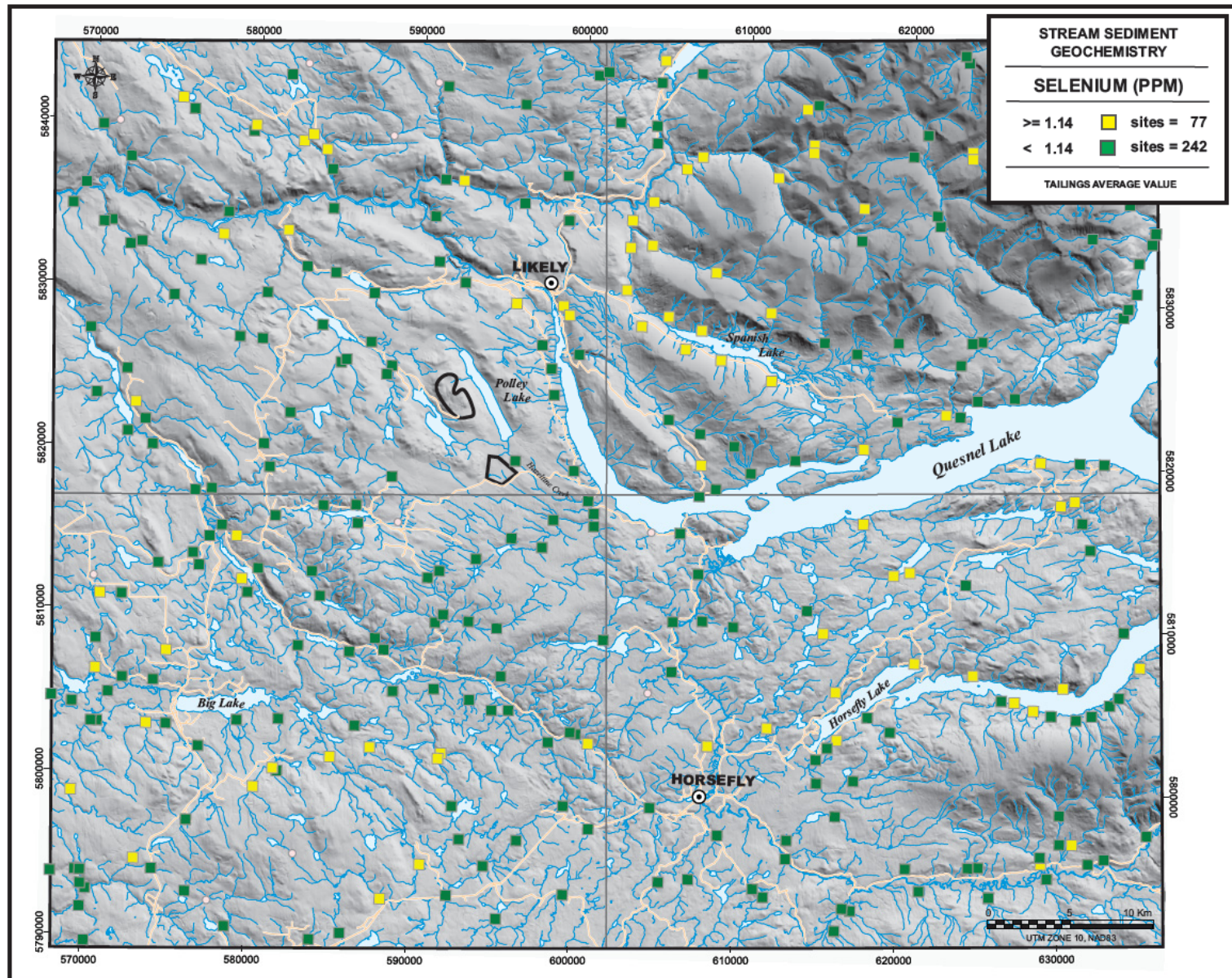
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Regional Stream Sediment – Selenium

Note: MP Tailings average 1.14 ppm Se

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MP Tailings compared to rock sample from the Likely Community Hall parking lot



Sample	As ppm	Cd ppm	Cu ppm	Fe %	Hg ppm	Sb ppm	Se ppm	V ppm	Pb ppm	Zn ppm	Ag ppb
TSF average (2013)	10.63	0.13	810.91	5.14	0.07	0.46	1.14	197.6	4.85	51.13	310
C. Hall avg	10.5	1.75	94.7	4.73	NA	2.98	1.9	194	16.7	204.2	442

- Arsenic (As), Iron (Fe), and Vanadium (V) are approximately the same.
- Copper is much higher in the tailings than in the Likely Hall parking lot outcrop.
- Cadmium (Cd), Antimony (Sb), and Selenium (Se) are lower in the tailings.
- A few other elements: Lead (Pb), Zinc (Zn), and Silver (Ag), are significantly higher concentration in the parking lot rock sample than in MP tailings.

Acknowledgements



Big thank you to all the individuals and organizations that have chosen to work with us in responding to this challenge:

Consultants: Golder Associates, SNC Lavalin, Golder Construction, SRK, BGC Engineering, Minnow Environmental, DWB Consulting, Tetrattech EBA, ...

Labs: Nautilus Environmental, ALS, SGS, ...

Contractors: Lake Excavating and Peterson Contracting (JV's with FN WLIB and SCIB); Xa'tsull FN Planting Team, Eaglecrest, Celtic Engineering, West Shore Constructors, Fraser Burrard Diving, Veolia, Norseman Structures, RL7 piping and mechanical, ...

Researchers: UBC Forestry, Thompson Rivers U, UBC Mining, UVic, UK Research Group (London University, U. of Aberysthwyth, U of Bangor), ...

and Local Community Members including the Likely Community Forest



Thank you!

Questions?

Mount Polley

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Upper Hazeltine Creek

- Creek channel established
- Ongoing habitat feature and microsite creation on recontoured slopes
- Ongoing reclamation of tailings in Plug Area
- Timber falling planned

Lower Hazeltine Creek

- Creek channel established
- Ongoing habitat feature and microsite creation on recontoured slopes
- Bridge replacement work planned (Gavin Lake Road/Ditch Road)
- Temporary access road evaluation/improvements to be completed
- Sediment pond cleaning planned, to be continued as required
- Timber falling planned



Step 1: Reduce suspended solids caused by eroding creek channel

- Installation of two sedimentation ponds in lower Hazeltine Creek
- Construction and armouring of the mean annual flood creek channel and flood plain grading
 - Required: access, removal of tailings, appropriate materials





Objective:

To reclaim the structure and function of the terrestrial habitat to a useful and productive condition.

Legacies from the previous forest can be used as much as possible to bootstrap recovery.

An adaptive management approach can be adopted, involving a structured iterative process of decision-making based on monitoring, experimentation, modelling, communication, and feedback.

Terrestrial Rehabilitation – Tailings Management



- Removing majority of tailings
 - Sedimentation risk
 - Silty material block oxygen exchange and promote a perched water table
- Management techniques will be site specific, and in some areas will depend on geochemistry results
 - Do not disturb areas where trees have survived
 - Mixing of shallow tailings / capping / excavated patches

Terrestrial Rehabilitation – Site Preparation & Coarse Woody Debris



- Re-contouring and Site preparation
 - Mix forest floor, mineral soil, and any residual tailings
 - Create raised microsites with aerated root zones
 - Scarification (dry sites)
 - Trenching/plowing/mixing (intermediate sites)
 - Mounding (wet sites)
 - Hand screening in difficult to access areas with shallow tailings
 - Mixing of woodchips to expose substrate
 - Create plant suitable areas

Terrestrial Rehabilitation – Soil Amendment



- Coarse woody debris addition
 - Create habitat diversity
 - Utilize debris disturbed by event and reclamation activities
 - Where possible, use a variety of sizes and species (range of decay rates)
 - Also used for aquatic habitat features

- Preserve organic matter in situ
- Soil transplants (adjacent floor / available stockpiled material)
- Consider: commercial microbial inoculum and/or fertilizer

Terrestrial Rehabilitation – Planting



- Erosion control, promote revegetation and development of terrestrial ecosystems
- Species selection: native species, with a focus on early successional species
 - Black cottonwood, willow, **alder**, black twinberry
 - Red-osier dogwood in riparian areas
 - Paper birch in upland areas
- Varying prescriptions and densities – site specific
- Future underplanting of native conifers (Western red cedar, hybrid spruce and subalpine fir) if ingress is not occurring at desired rates

Planting





- Establish permanent monitoring plots for ongoing assessment, feedback, and demonstration.
- Evaluate ecosystem-level responses and effects using modelling.
- Incorporate the results into continuous adaptation and improvement.



Upper Hazeltine Creek

- Creek channel established
- Tree falling has commenced
- Ongoing reclamation of tailings adjacent to creek channel and re-contouring
- Ongoing habitat feature and microsite creation on re-contoured slopes
- “Plug” area will be a next phase
- Planting of floodplain near Gavin Lake Road bridge complete
- Planting of floodplain in progress

Lower Hazeltine Creek

- Creek channel established
- Slopes recontoured
- Woodchips applied
- Ongoing habitat feature and microsite creation on re-contoured slopes
- Planting of floodplain complete
- Tree falling planned



Edney Creek

- Edney Creek channel established
- Edney Creek fish habitat complete
- Planting of floodplain complete

Quesnel Lake Beach

- Cleanup of woody debris complete
- Shoreline re-contouring and placement of gravels complete
- Planting of lakeshore in progress

Terrestrial Rehabilitation – Tree Falling



- Reduce windthrow hazard by falling dead and dying trees
- Consideration for wildlife trees, public safety, and live trees



Terrestrial Rehabilitation – Tree Falling

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- Dust Monitoring
- Fish Health
- Historical Water Works (Polley Weir, Bullion Pit Ditch)

Dust Monitoring



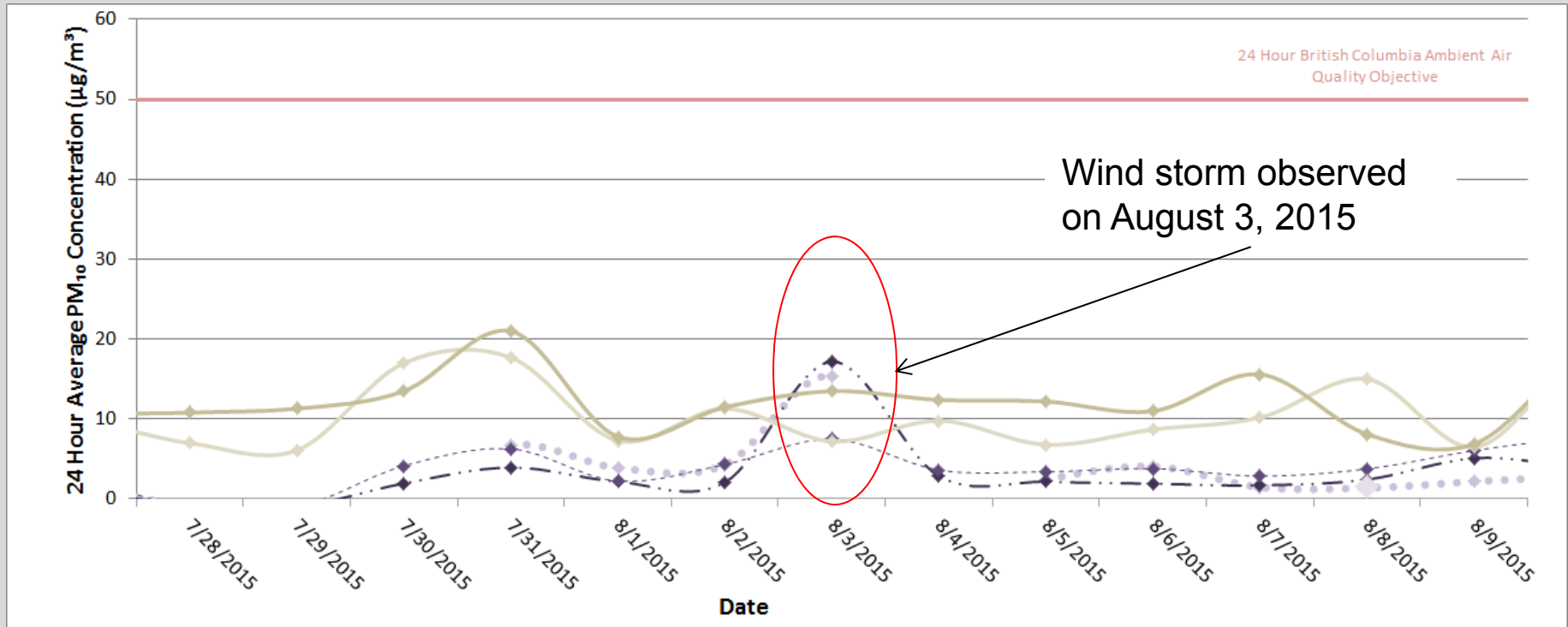
- Dust monitors at MP recorded the Aug 3 wind event
- No exceedances of the average allowable particulate exposure limits were observed (well below the BC Ambient AQ Objective)
- Dust from the MP site is not considered hazardous

24-hour PM₁₀ Concentrations



BC MOE Monitors

Quesnel Williams Lake



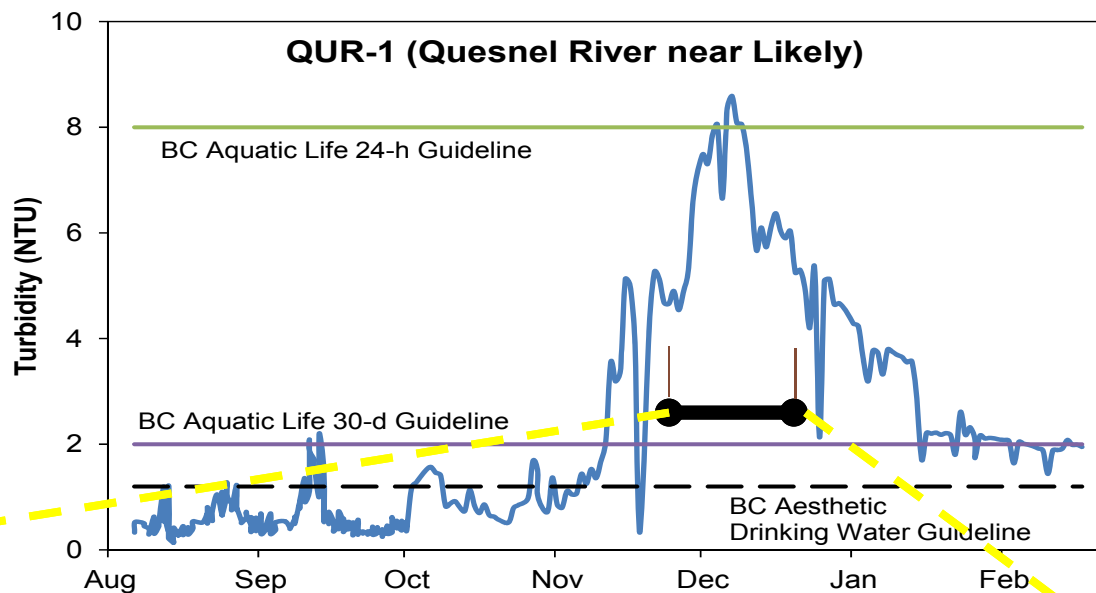
On-site Particulate Monitors

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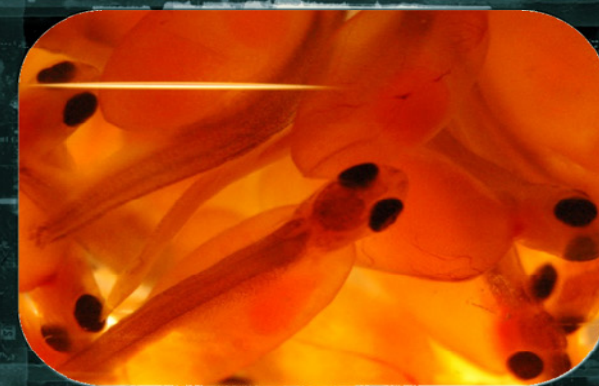
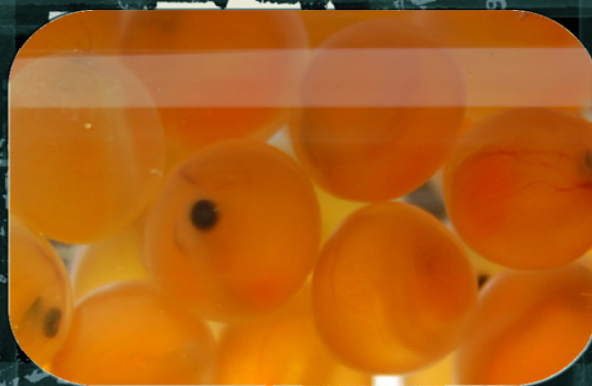
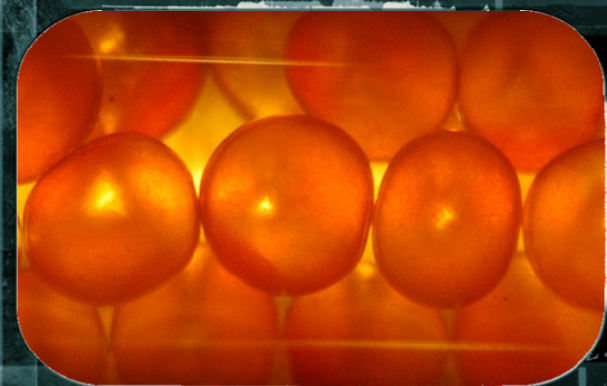
Quesnel River – Concern About Fish Health and Effects on Incubating Fish Eggs



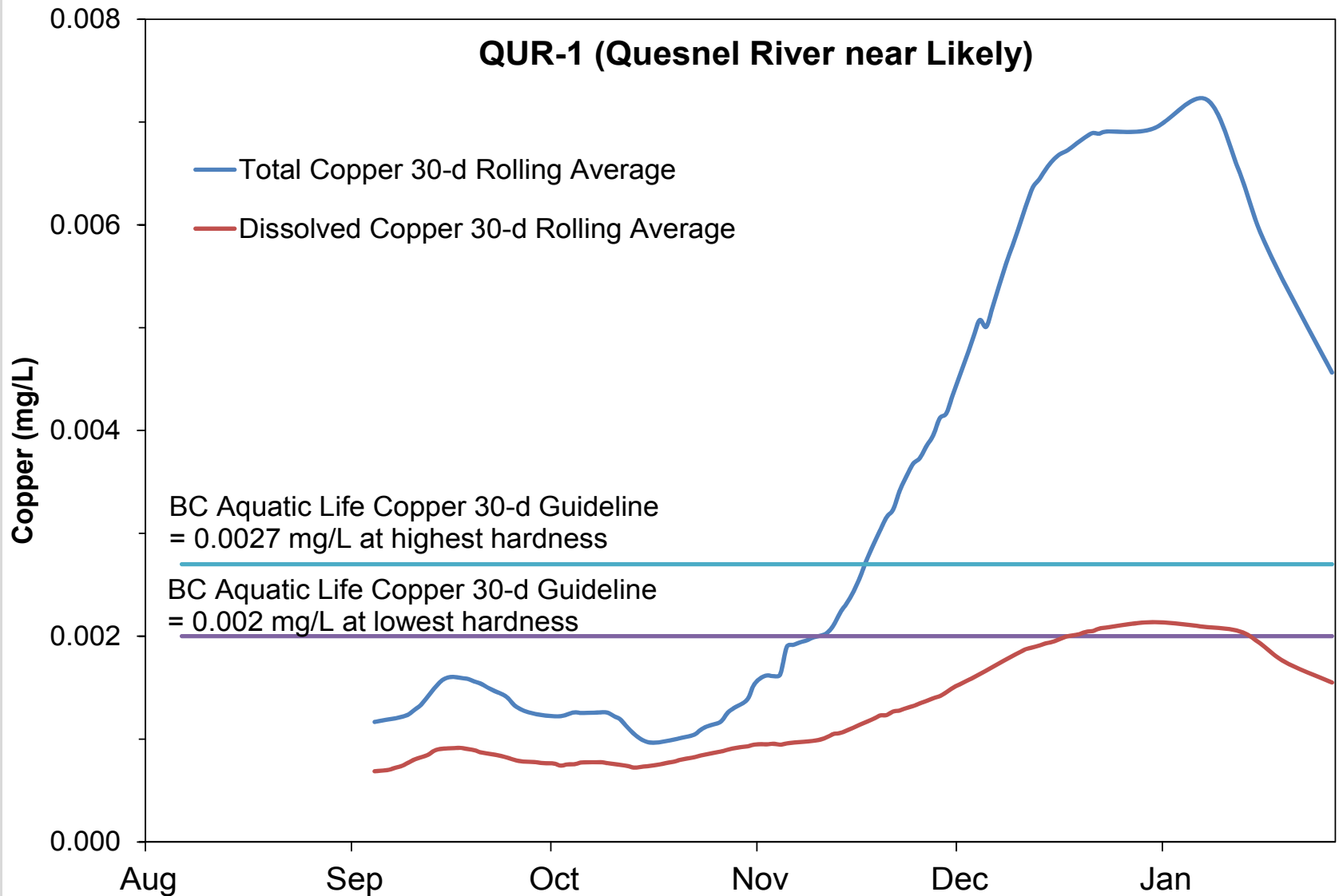
- Mount Polley carried out an **Early Life Stage toxicity test** on rainbow trout (close relative to salmon)
- Testing done using water samples at highest turbidity
- **All results normal**



Data up to February 17, 2015



Quesnel River Copper Levels



Data up to January 26, 2015



First Nations Health Authority: September 5, 2014 notice:

- “For all metals other than arsenic, **the fish muscle tissue concentrations are less than the values that would be safe assuming daily consumption** (i.e., one bowl per day for adults and one-half bowl per day for toddlers). ”
- “Although we do not have the arsenic speciation data and are awaiting further results, **the data received thus far indicates that fish muscle is safe for consumption from a metals perspective.** ”

Interior Health, MoE and MPMC results confirm this.

- Monitoring of fish health continues.
- To date, results indicate fish are safe to eat (exc. liver, gonads).