Mt. Washington copper mine remediation project

Bringing salmon back to the Tsolum River

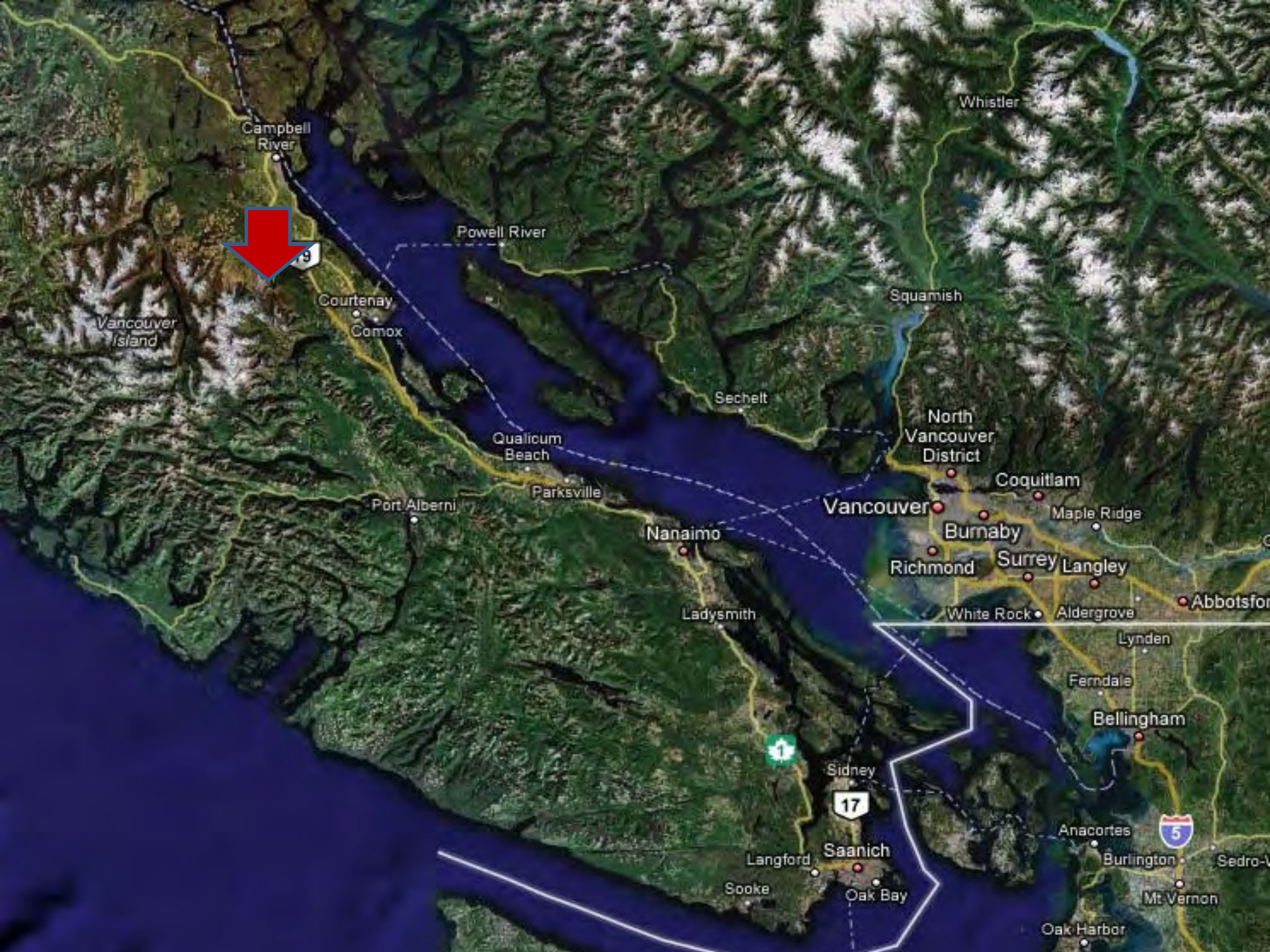
Tsolum River Partnership

"working together to bring salmon back to the Tsolum"

- Tsolum River Restoration Society
- Ministry of Environment
- Pacific Salmon Foundation
- Timber West
- Department of Fisheries and Oceans
- Environment Canada
- Ministry of Energy Mines and Petroleum Resources
- Mining Association of BC
- Natural Resources Canada
- Breakwater Resources
- SRK Consultants

OUTLINE

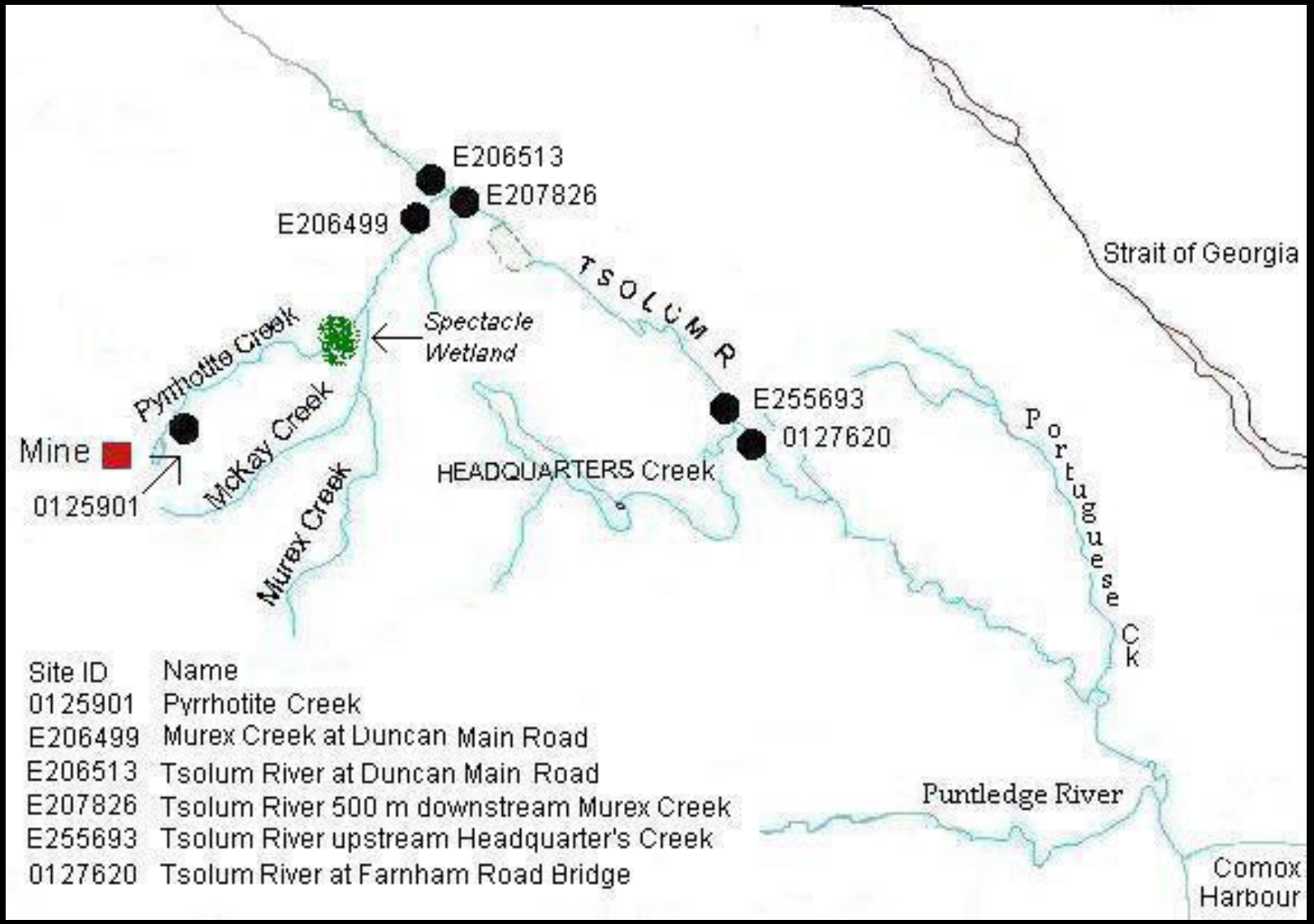
- History
- Water Quality Objectives
- Interim wetlands treatment
- Minesite Remediation
- Tsolum River water quality


Whistler
Campbell River
Powell River
Courtenay
Comox
Vancouver Island
Squamish
Sechelt
Qualicum Beach
Parksville
Port Alberni
North Vancouver District
Coquitlam
Vancouver
Maple Ridge
Burnaby
Nanaimo
Richmond
Surrey
Langley
Abbotsfor
White Rock
Aldergrove
Ladysmith
Lynden
Ferndale
Bellingham
Sidney
17
Anacortes
5
Saanich
Langford
Burlington
Sooke
Oak Bay
Mt Vernon
Oak Harbor

A Little Background

- Tsolum has been listed as the most endangered river in BC
- Originates on Mt Washington, flows 30 km to Courtenay and Comox Estuary
- Fisheries >$2.7 million to local economy

Tsolum River Watershed



What Happened?

- A small, open pit copper mine operated from 1964 to 1967 at 1310 m elevation on Mt Washington - went bankrupt in 1967
- Mine site = lots of snow most of the year
- early 80's – fish returns in Tsolum in severe decline
- 1986 - EIA work found the river to be acutely toxic to fish during the spring snow melt – linked to ARD/copper leaching from mine site
    - Water chemistry, in-situ bioassays (coho, steelhead and RT eggs)

1987-91

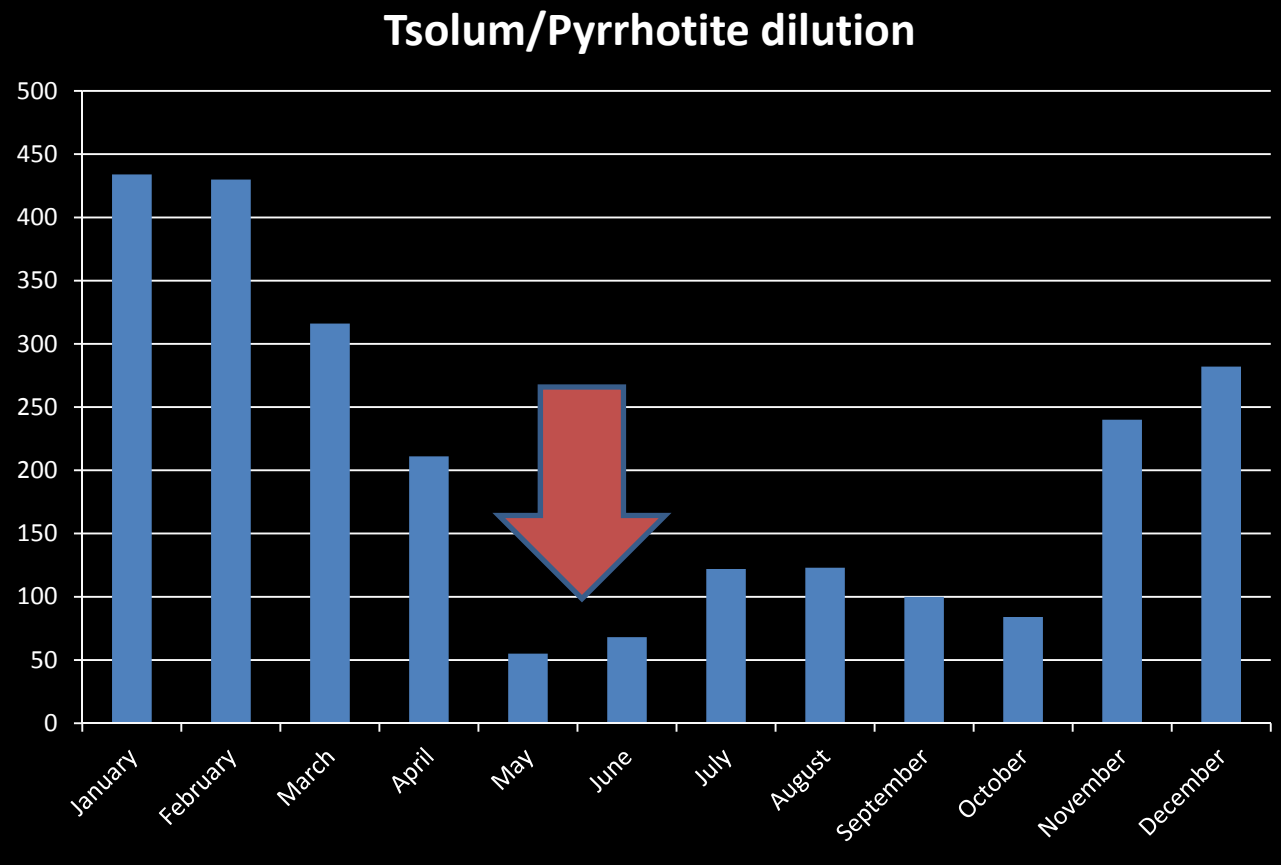
- province put $1.5 to $2 million into minesite remediation
- Significant amount of disturbance of site, high expectation for immediate benefits
- No immediate pay back on investment
- Project ended =>> perceived as a failure

Water Quality Objectives

- Provincial copper guidelines for soft water:
  2 ug/L avg, 4 ug/L max
- Tsolum background 2 ug/L
- Areas of 6 ug/L with no impacts
- Highest copper levels in May/June

Hydrology

- Tsolum is driven by rain
- Pyrrhotite Ck is driven by snowmelt



Copper complexing

- Sent Pyrrhotite Creek 96hr RT LC50's – PESC lab
  - Using lab water (Capilano R.)
  - Using Tsolum River water

	Lab Water	Tsolum River
96 hr LC50	1.1%	4%
Copper concentration	83 ug/L	300 ug/L

Copper Complexing

- Dissolved Organic carbon and copper complexing – modelling (biotic ligand model)
- Biological perspective
  - Pinks, coho, chum, rainbow, cutthroat
    - Pinks, chum migrate in March
    - Coho and steelhead hatch in late April to early May
      - Remain in river for up 12 – 14 months
      - **Most critical period** - yolk sac absorbance to swim up stage
    - Worst case scenario =>> May

Water Quality Objectives

- Average 7 ug Cu /L, max of 11 ug Cu/L
- Added ecosystem/biological objectives
- requires a **95%** reduction in copper loading from minesite

Meanwhile....

- By the late 90's the copper loadings from minesite had been reduced by 50%
  - PARTIALLY SUCCESSFUL

- Needed to find a way to move forward

Spectacle Wetlands Project

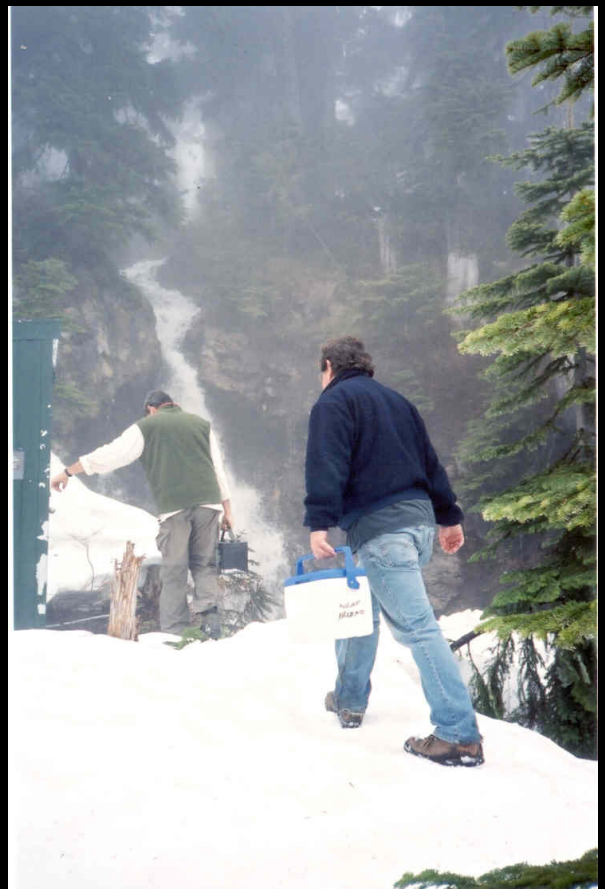
- **A unique partnership evolved from 2001 to 2003**
  - Timber West – LAND OWNER
  - Pacific Salmon Foundation
  - Tsolum River Restoration Society
  - MOE
  - Environment Canada
  - DFO
- Objective: to change the perception of this watershed - by working together

Spectacle Wetlands

- Use an existing wetland to protect the Tsolum until the minesite reclamation could be completed
- An 850 meters section of Pyrrhotite Creek was re-routed into the Spectacle Wetlands

Monitoring Data

- Spring and fall 5/30 sampling
- Automated samplers
- Continuous flow at Pyrrhotite



- In-situ fish bioassays
- Fed/prov site
- Partnerships

Copper

- Late 80's spring peak – ranged 70 to 90 ug/L
- Late 90's to 2003 – ranged 35 to 45 ug/L
- Since completion of wetland project in Oct 2003 – short term spring peak 20 to 25 ug/L – usually 15 to 18 ug/L
  - Copper concentrations in the Tsolum dropped by 40%

What does this mean to the Tsolum River? i.e. biological objectives

- Used to measure success of reclamation and state of water quality and confirmation of site specific copper objectives
- More meaningful to decision makers and stakeholders than simple numerical copper objectives

In-situ bioassays

In-situ bioassays

1986	Mortality
Control	0%
Murex Creek	100%
Tsolum R. d/s Murex	73%
Tsolum R. at Farnham	40%

2004	Mortality
Control	0%
Murex Creek	0%
Tsolum R. d/s Murex	0%
Tsolum R. at Farnham	0%

- Obviously a good sign, but we know that fish need to be able to survive year round

What did this mean for the fisheries resource in the Tsolum?

- Copper levels needed to decrease further to bring back the entire resource
- Pinks and chum migrate out early– no feeding
- Coho/steelhead – reside in river up to 14 months – subject to spring peak
  - Need a food supply – benthic invertebrates
- Wetlands effectiveness projected to decline after 5 to 10 years

Momentum Builds....

- Perception – viewed as a positive success story
- Partnership grew – MEMPR, MABC, NRCanada, Breakwater Resources
- 2006 – determine best remediation option for site
- 2007 – detailed cost estimates and detailed design work
- February 2008 – Treasury Board submission

April 2008

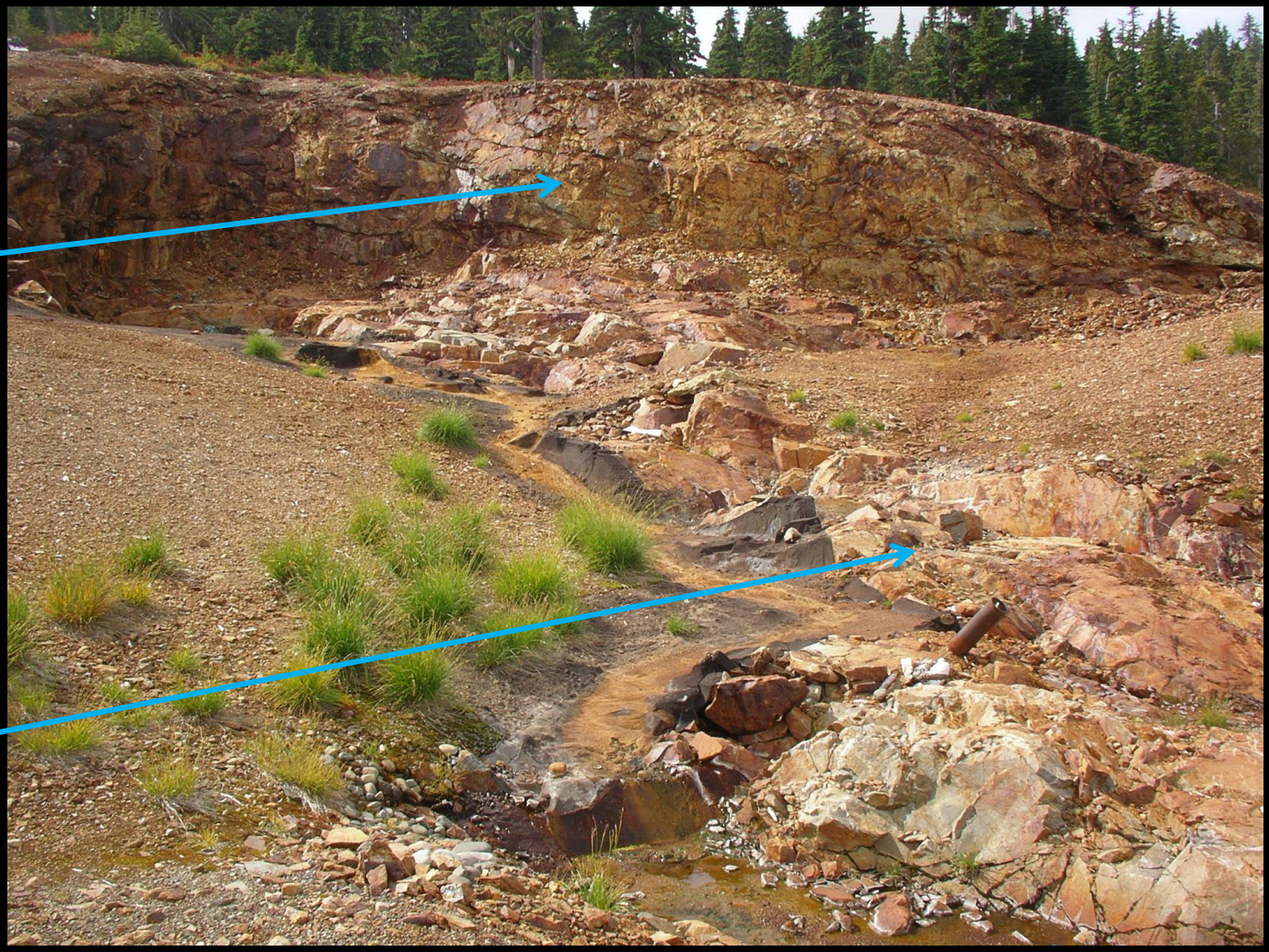
Minister Penner announces $4.5 million in provincial funding to remediate the mine site and restore the Tsolum River fisheries resource


Summer - 2009
Quantum Murray, SRK
Consultants, Stantech
Road upgrades to allow heavy equipment
access to the site

ARD Sources in Pit Highwall and floor

Rubble fines in highwall

Typical Pyrite/Chalcopyrite Veinlets in Pit floor



Underdrain Construction

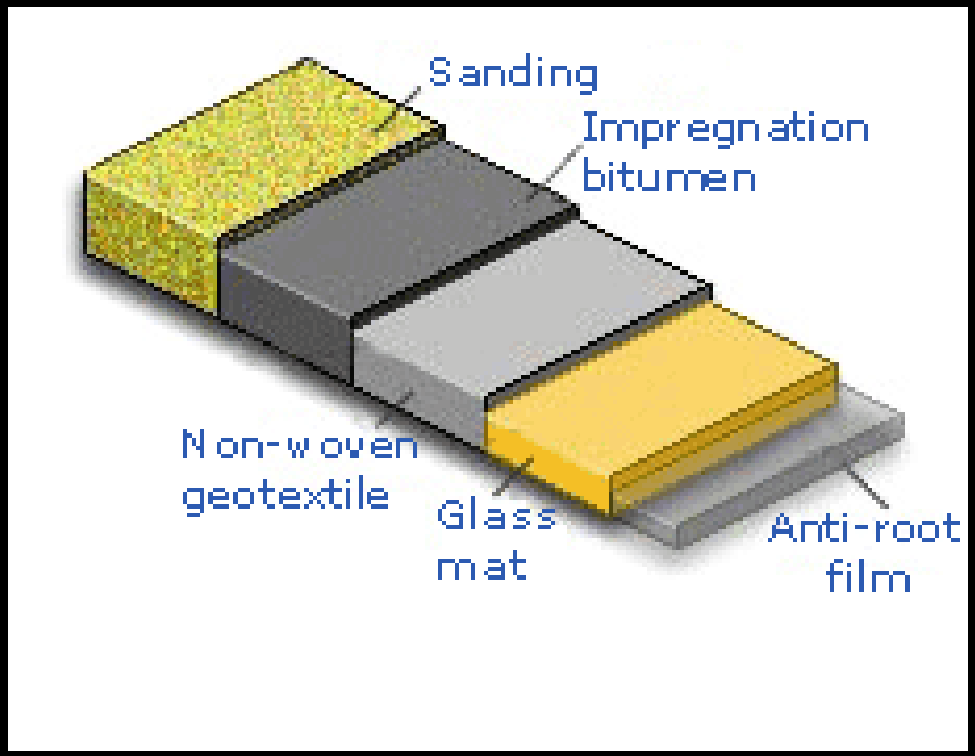
A layer of soil and clay is placed to prepare the site for a permanent impermeable cover

More than 4100 truck loads or 128,000 tonnes of material are moved to the mine site

Large rolls of a bituminous geomembrane are brought to the site

Bituminous Liner Installation

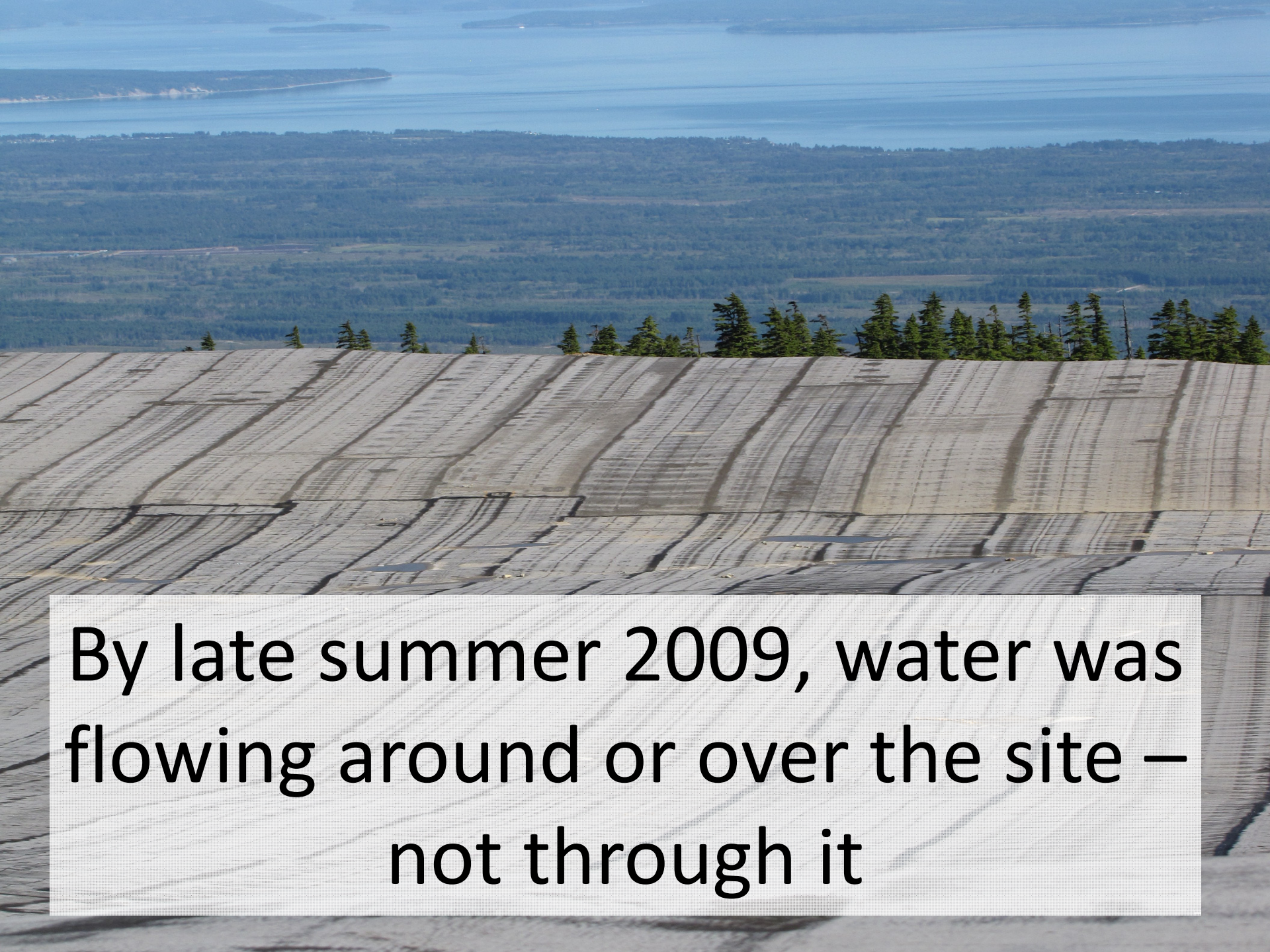
Bituminous Geomembrane composition




Placing more than 12 km of material begins...

The seams were sealed by hand

A ditch was added to divert clean water around the mine site



By late summer 2009, water was flowing around or over the site – not through it

Next Step: cover the membrane with glacial till to protect it from the elements

Soil Cover Placement

Fall 2010/11

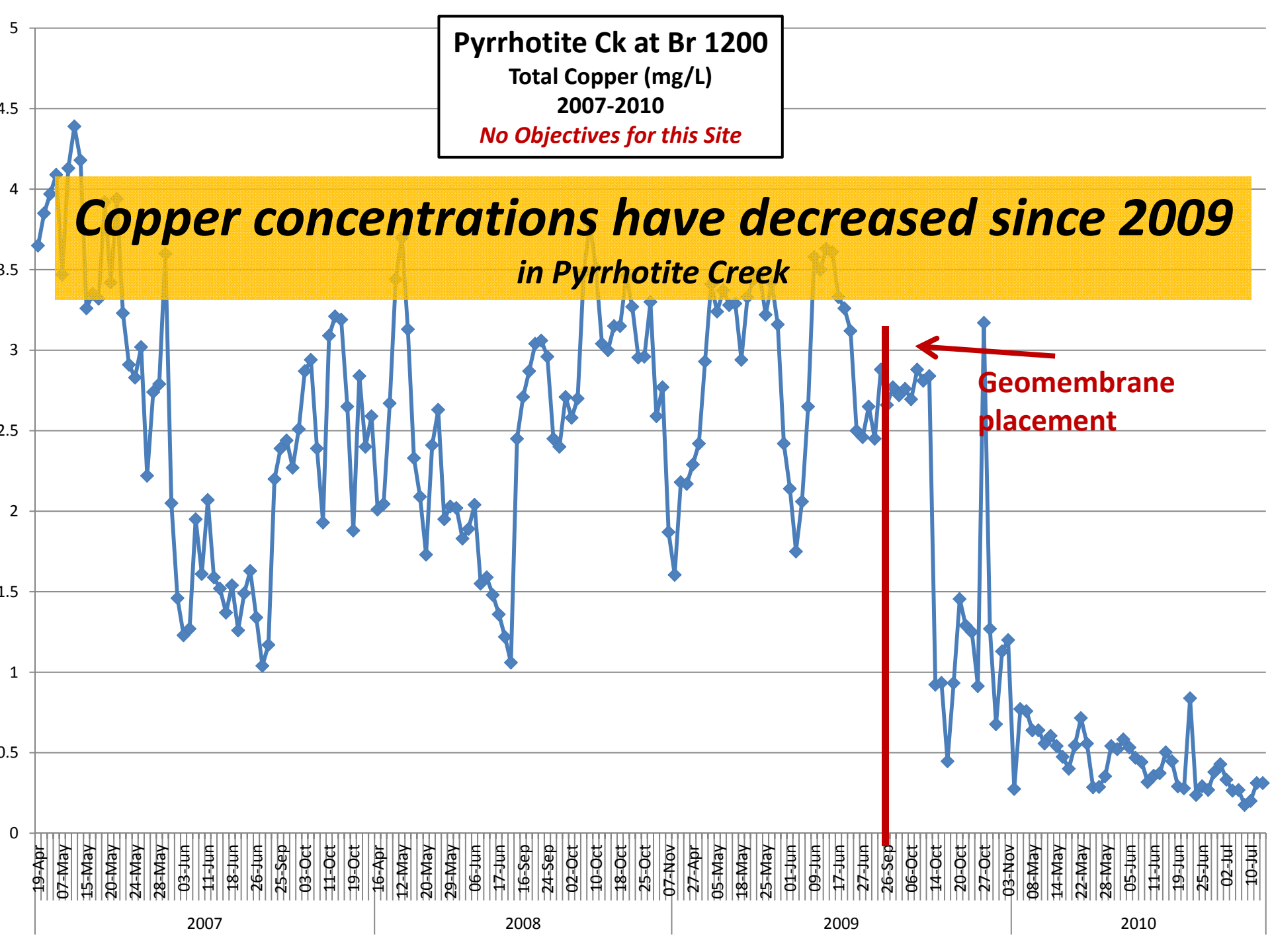
-woody debris for stability

-channels to divert clean water away from the site

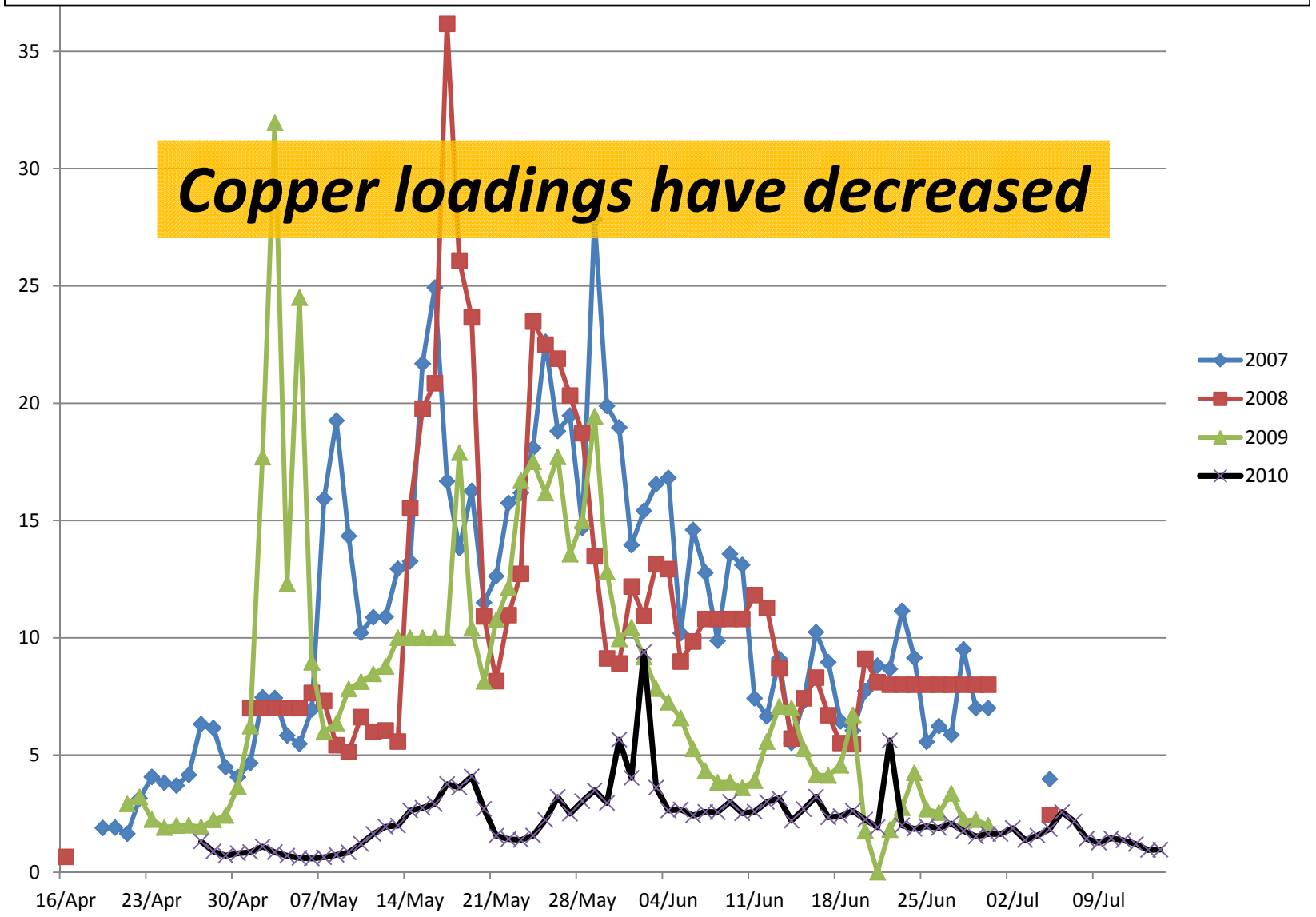
Success Indicators

- Water quality objectives
  - Copper 5 samples in 30 days on spring and fall
- mine site drainage
  - Copper trends and loadings
- Biological objectives
    - Benthic invertebrates
- Fish escapement
- Funding – MOE, MEMPR, PSF, TRRS, Env. Canada, Timber West

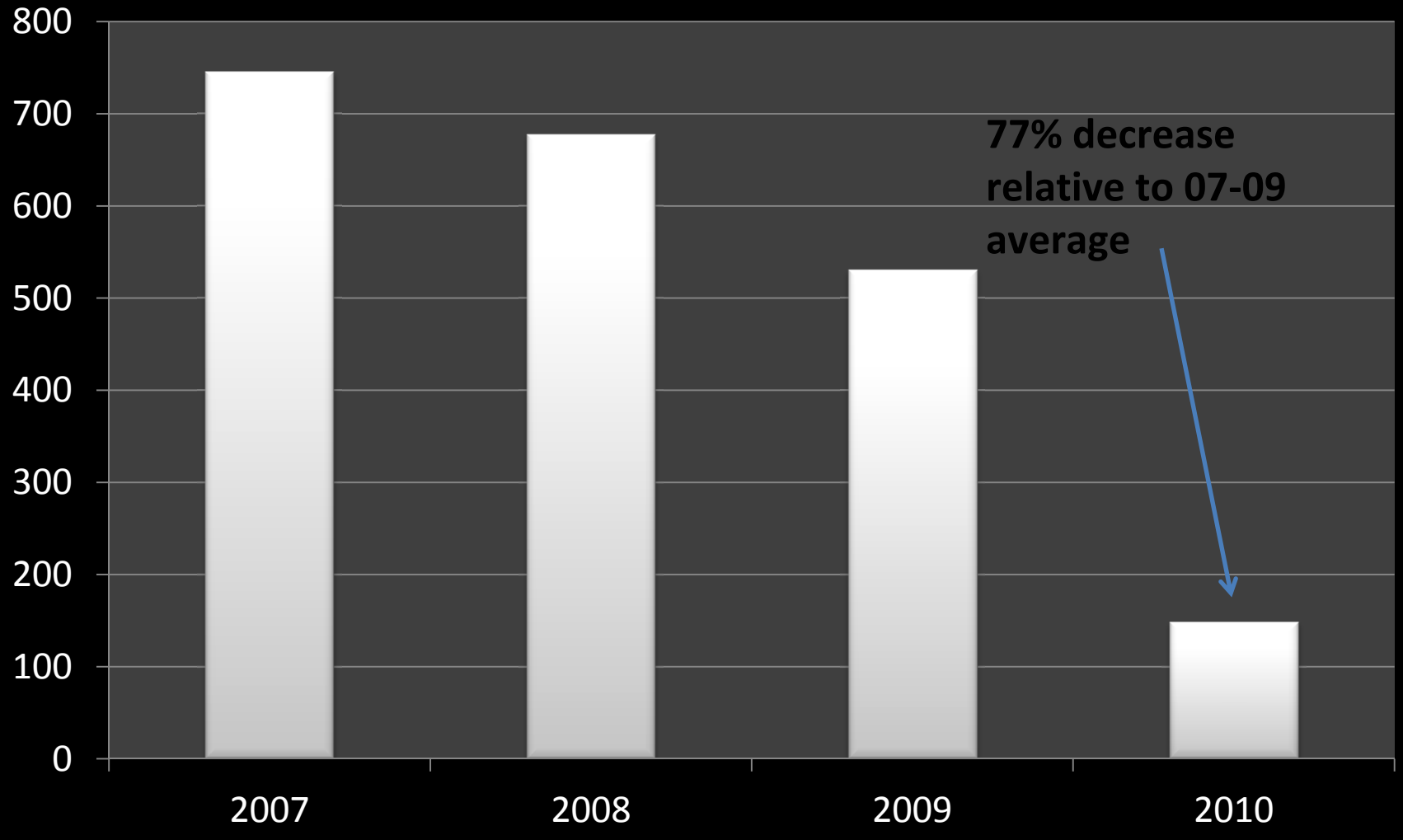
The Team goes to work!

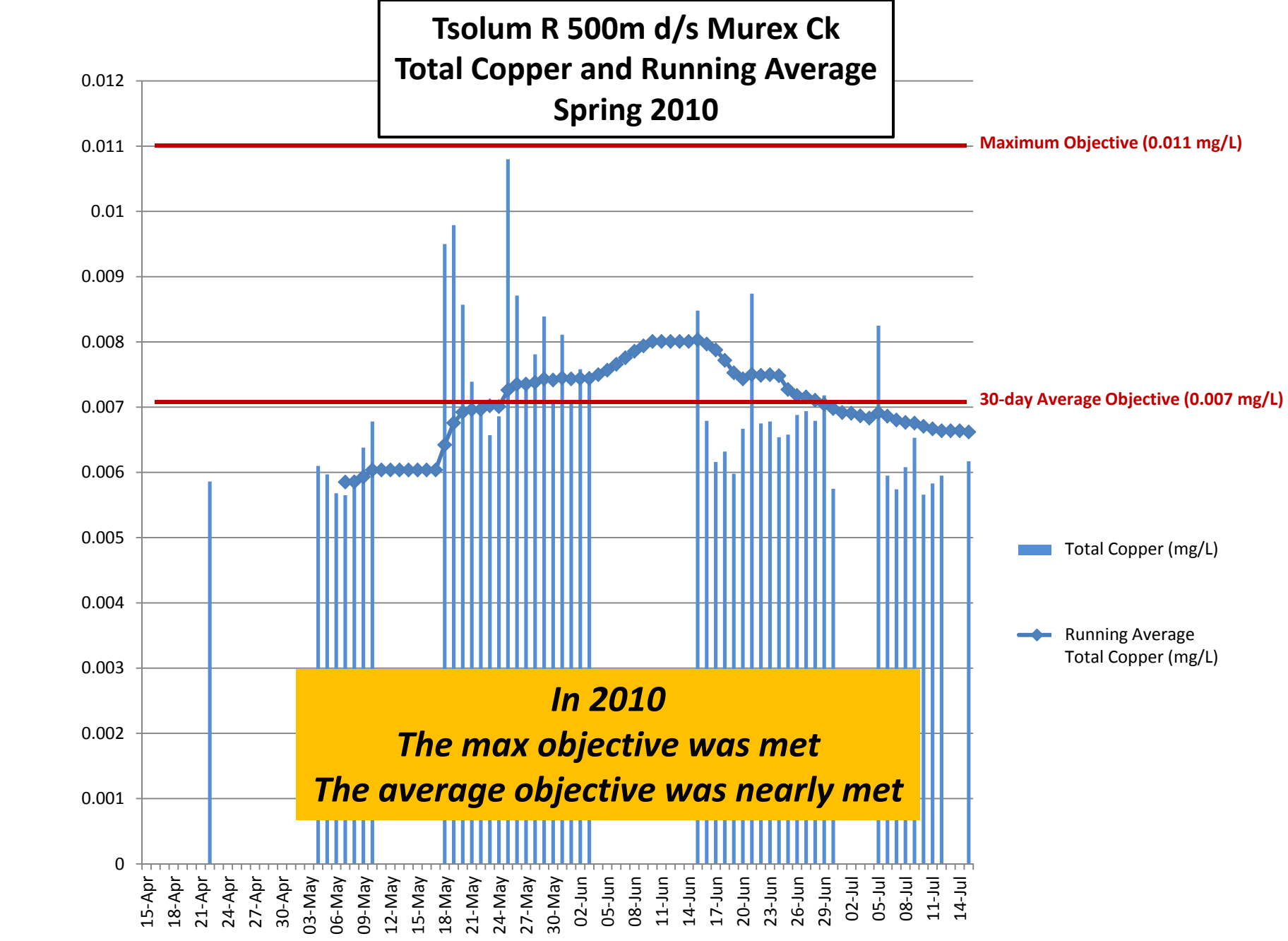

Pyrrhotite Ck at Br 1200
Total Copper (mg/L)
2007-2010
No Objectives for this Site
Copper concentrations have decreased since 2009
in Pyrrhotite Creek
Geomembrane placement
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
19-Apr
07-May
15-May
20-May
24-May
28-May
03-Jun
11-Jun
18-Jun
26-Jun
25-Sep
03-Oct
11-Oct
19-Oct
16-Apr
12-May
20-May
29-May
06-Jun
17-Jun
16-Sep
24-Sep
02-Oct
10-Oct
18-Oct
25-Oct
07-Nov
27-Apr
05-May
18-May
25-May
01-Jun
09-Jun
17-Jun
27-Jun
26-Sep
06-Oct
14-Oct
20-Oct
27-Oct
03-Nov
08-May
14-May
22-May
28-May
05-Jun
11-Jun
19-Jun
25-Jun
02-Jul
10-Jul
2007
2008
2009
2010

Pyrrhotite Creek at Branch 1200 kg copper/day



Pyrrhotite Creek at Br 1200 (kg Cu/month) – May/June




Tsolum R 500m d/s Murex Ck
Total Copper and Running Average
Spring 2010
Maximum Objective (0.011 mg/L)
30-day Average Objective (0.007 mg/L)
Total Copper (mg/L)
Running Average Total Copper (mg/L)
In 2010
The max objective was met
The average objective was nearly met
0.012
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
15-Apr
18-Apr
21-Apr
24-Apr
27-Apr
30-Apr
03-May
06-May
09-May
12-May
15-May
18-May
21-May
24-May
27-May
30-May
02-Jun
05-Jun
08-Jun
11-Jun
14-Jun
17-Jun
20-Jun
23-Jun
26-Jun
29-Jun
02-Jul
05-Jul
08-Jul
11-Jul
14-Jul

Biological Objectives

"restore a healthy, diverse and abundant benthic invertebrate population to the Tsolum River" - abundance and diversity assessment

- Preliminary 2010 data => significant improvement in diversity, species richness and overall abundance =>fish now have an abundant food supply

Salmon are Coming Back

Encouraging signs for coho, steelhead, cutthroat – kids are fishing again....

Future of the Tsolum

- Thru 2012– confirmation that it's working
- Develop O & M plan for minesite - MEMPR
- Study ecological recovery of Tsolum River – apply lessons learned to other watersheds
  - Water chemistry, sediment chemistry, wetlands, benthic invertebrates, salmonid recovery and enhancement....

Future of the Tsolum

- Just another east coast Vancouver Island watershed
- No longer dominated by copper
  - Move forward on other issues
  - Mixed land use – forestry, legacy impacts, lower watershed urbanization and agriculture, summer low flows, winter storm events
  - Develop water quality objectives for other key variables

Future of the Tsolum

- Tsolum River trust fund – private $
- Signage, trails
- Habitat restoration, salmonid enhancement
- Recreational and economic opportunity for the community
- The Tsolum River as a research watershed for ecological recovery

Thank you!!

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