Mine Tailings Water Treatment

September 11st, 2018

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BluMetric Environmental Inc.

Overview

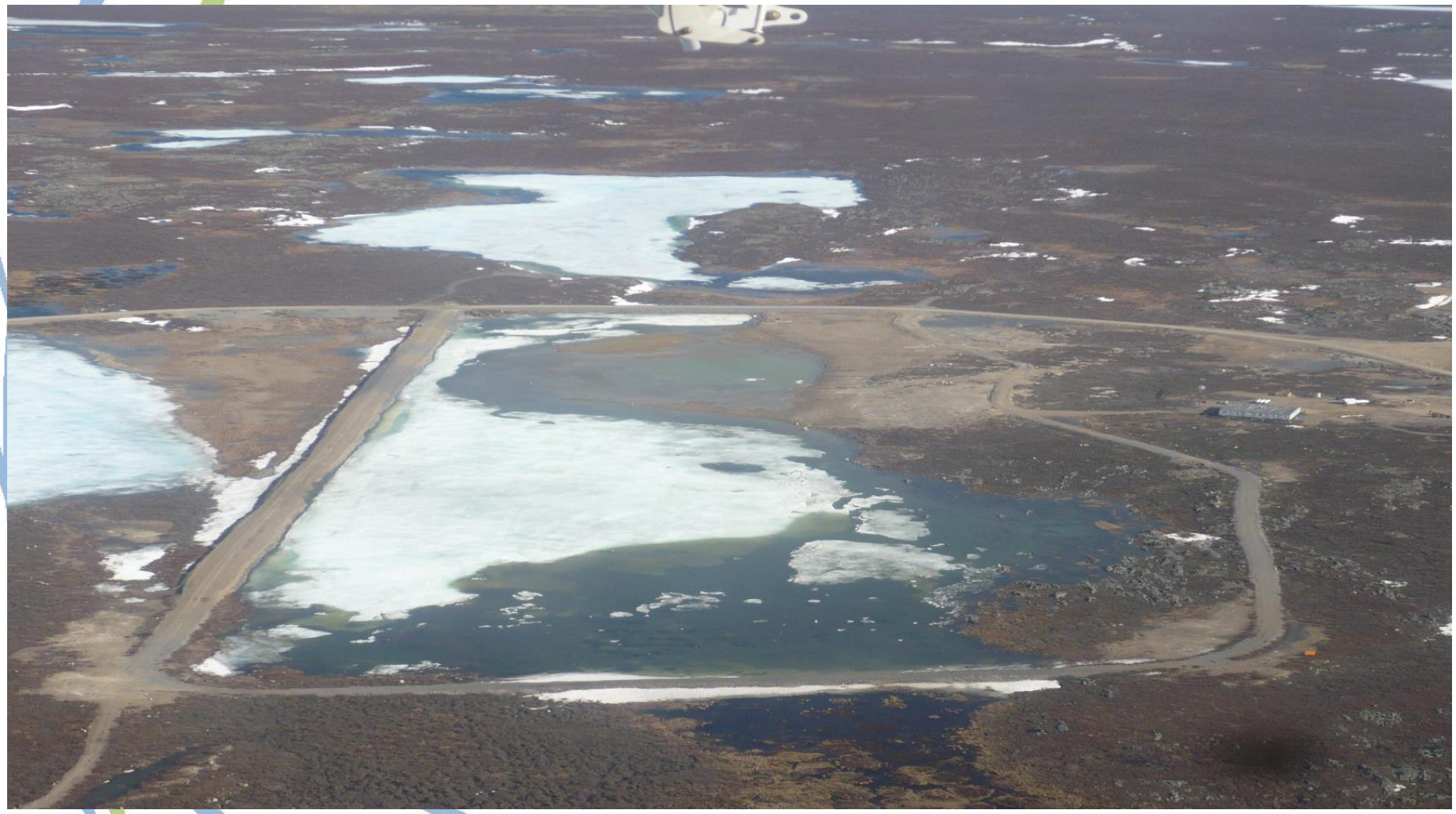
TUNDRA MINE CHALLENGE

- Logistics and Schedule

DESIGN REQUIREMENTS

- Logistical Constraints
- Treatment Requirements
- Construction Requirements
- Analytical Requirements

Tundra Mine
Tailings Water Treatment



Tundra Mine
Tailings Water Treatment

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Tundra Mine Challenge

- Very short timeframe
- Remote location
- No roads
- High quality of treatment required
- Large volume to be treated
- Need to train for staffing
- Must disassemble and remove

2009 Pilot - Timeframe

- Bid in mid-May
- Award on June 15th
- Equipment to Yellowknife on July 6th
- Onsite by July12th
- Construction complete and ready to discharge July 19th
- First discharge on July 29th
- Reached design volume of 120,000 m^3 Sept 7th
- Ceased treating Sept 24th at 180,000 m^3

Traditional Set-up

Transport Constraints

The Design Needs

- Air access
- Small components
- Rapid delivery
- Ease of construction
- Building block design
- Treat 24/7
- Direct discharge

Variables

- Flow Volumes
- Concentrations
- New Contaminants of Concern
- Extremely High TSS
  - Low tailings pond
  - Weather

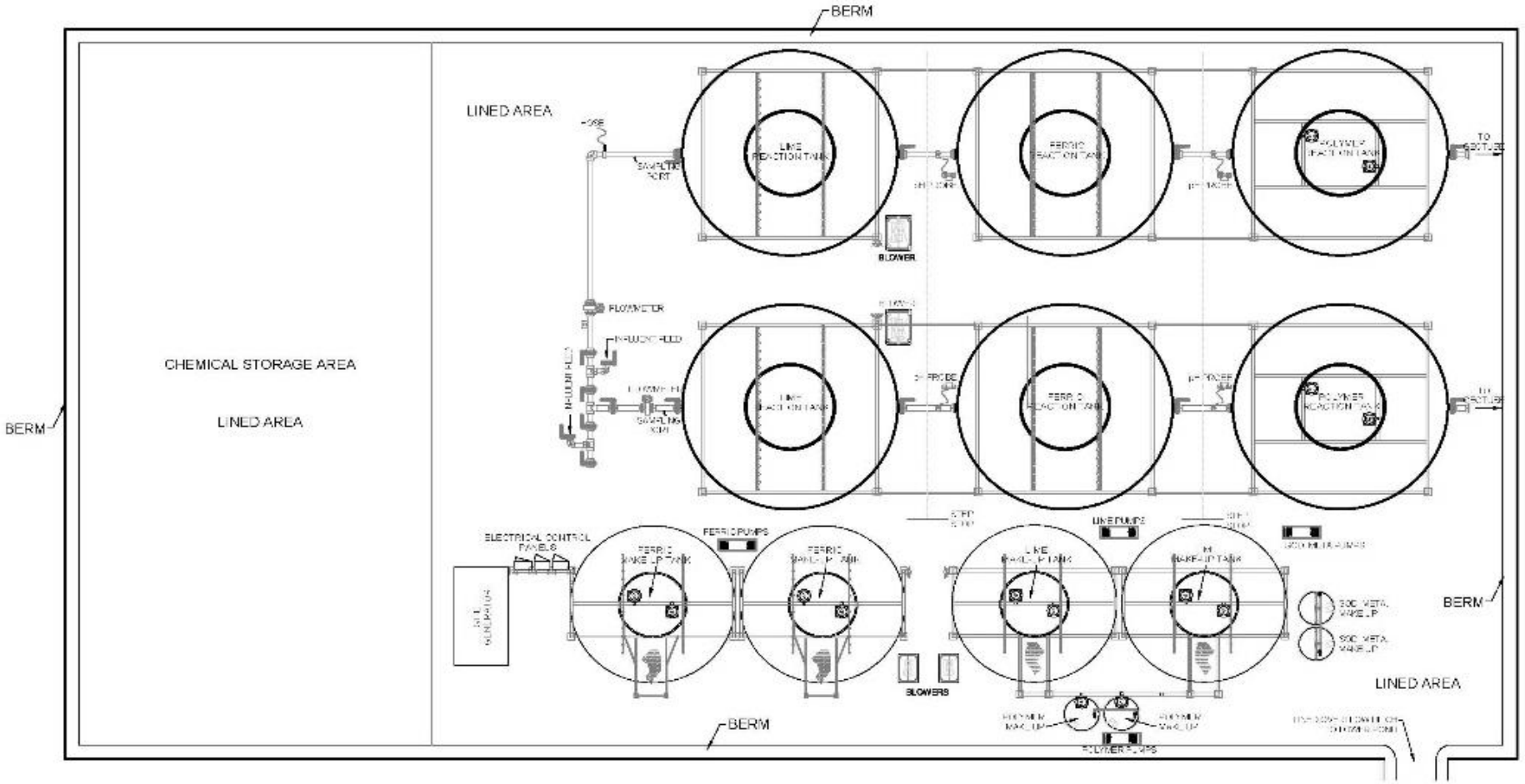
Configurable Treatment Trains

- Flexibility in treatment train configuration
- Series for double pass and pH manipulation
- Parallel when appropriate and able to achieve higher flows

Chemical Treatment Process

- Precipitating arsenic from solution
- Chemical reaction with ferric sulphate (ferric) and lime
- Minimum ratio of iron to arsenic (by weight) of 5:1
- Arsenic, zinc and other heavy metals are precipitated as metal hydroxide and adsorb to create flocs.
- Polishing treatment of zinc and lead
- Degraded influent quality
- Injection of a SMB to precipitate metal sulphides
- Solids separated by dewatering using Geotubes®
- Discharge to the environment

Plant Design and Layout



Treatment Quality

ARSENIC LEVELS

- Influent levels around 3 ppm
- Required a maximum of .5 ppm
- Finite chemicals on site
- Positive capture of the contaminant
- Require immediate and direct discharge

Discharge & Contract Criteria

Parameter	Unit	Effluent Criteria		
		Contract Specifications: Maximum Daily Average Concentration	Water License Criteria: Monthly Average Concentration	Water Licence Criteria: Maximum Concentration of Any Grab Sample
Metals				
Total arsenic	mg/L	0.20	0.50	1.00
Total copper	mg/L	0.01	0.01	0.02
Total lead	mg/L	0.01	0.01	0.02
Total nickel	mg/L	0.05	0.05	0.10
Total zinc	mg/L	0.02	0.02	0.04
Anions				
Nitrate (as N)	mg/L	5.00	5.00	10.0
Nitrite (as N)	mg/L	0.40	0.40	0.80
Conventional Parameters				
Total ammonia nitrogen	mg/L	5.00	5.00	10.0
Total suspended solids	mg/L	15.0	15.0	30.0
pH	-	6 - 9	6 - 9	6 - 9

Structural Components

Assembled Plant

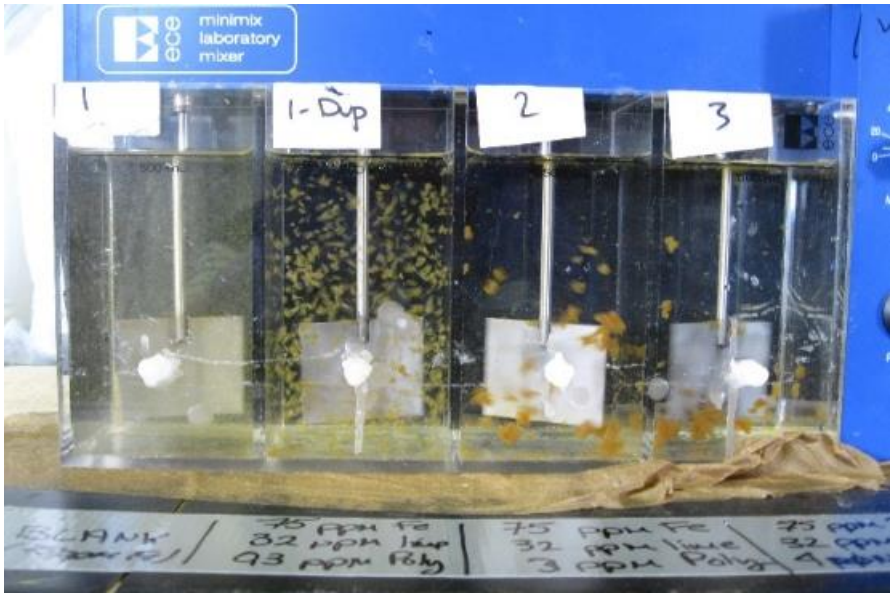
Solids

- Hyroxide precipitation design to trap arsenic in a metal flock
- Must capture the flock for treatment to be effective
- Had to do that in positive and immediate way
- Must be able to handle new design flows of 150 m^3/hr from 60 m^3/hr
- Had to operate 24/7 with minimum attention

Inflated Geotube

Onsite Laboratory

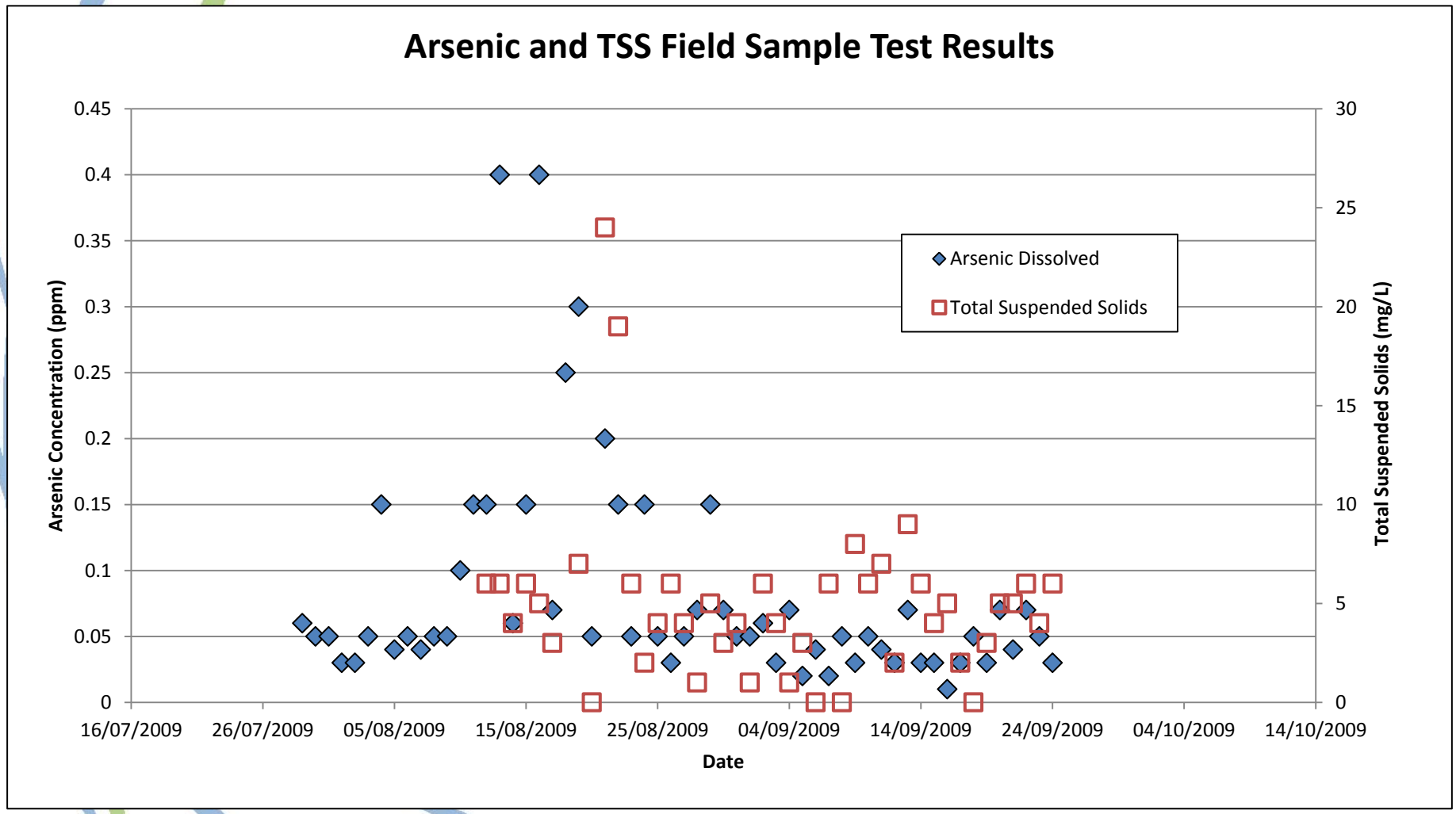
- AA – allowing for low level zinc and arsenic detection
- Allowed much greater control of the treatment process and real time adaptation to changes to influent chemistry
- Ensured plant maintained discharge compliance at all times



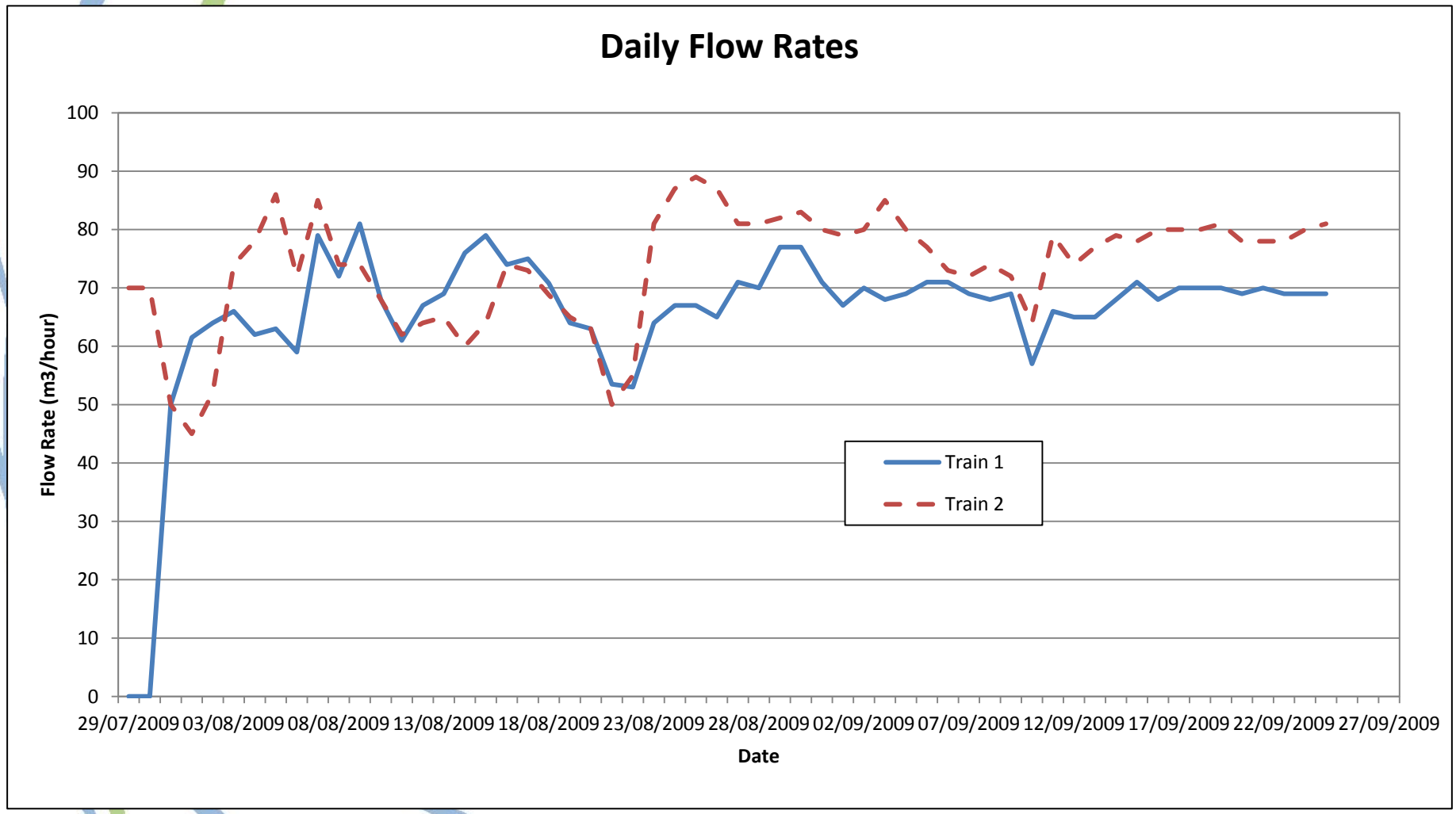
Onsite Laboratory

Onsite Laboratory

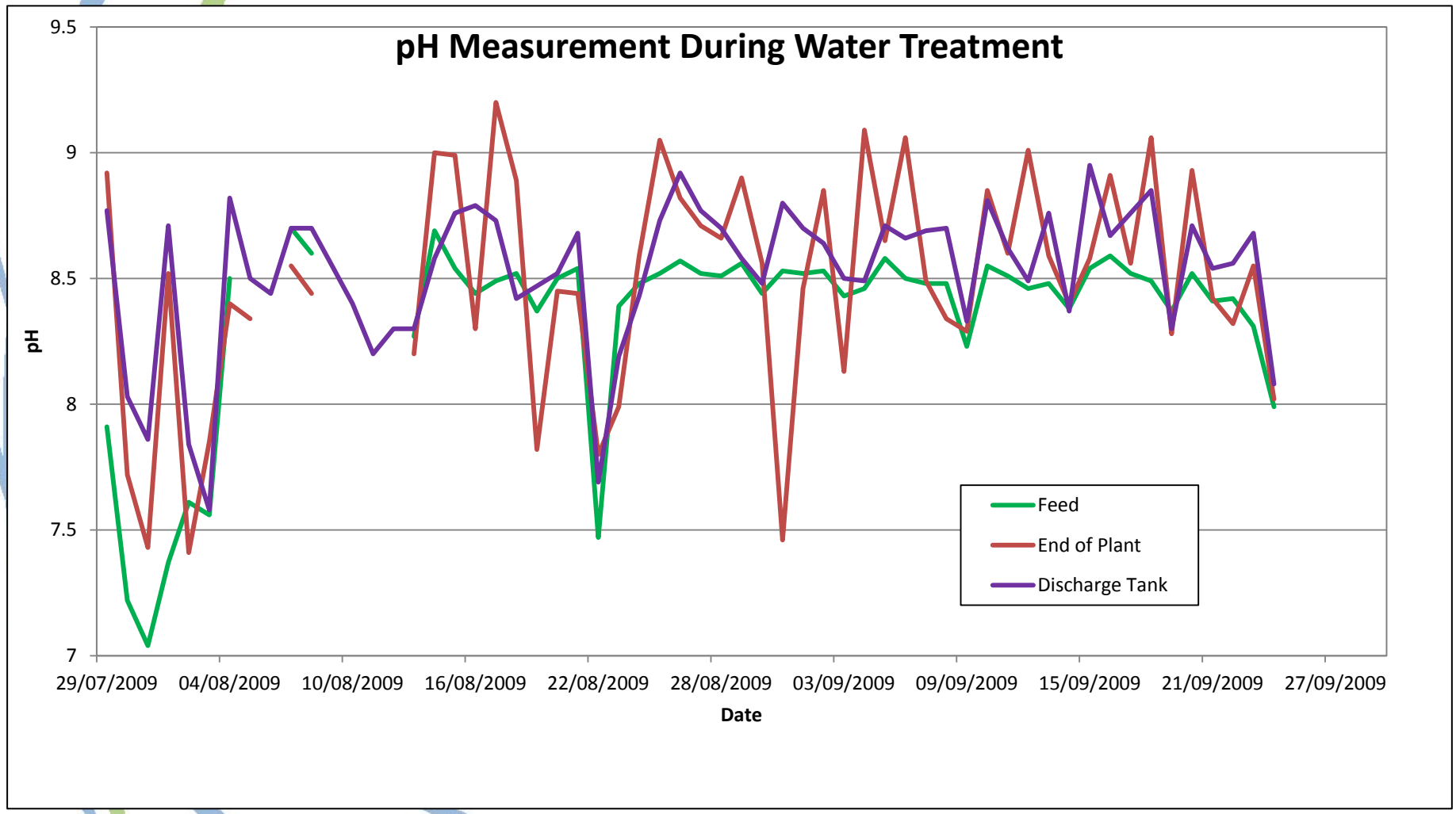
Results

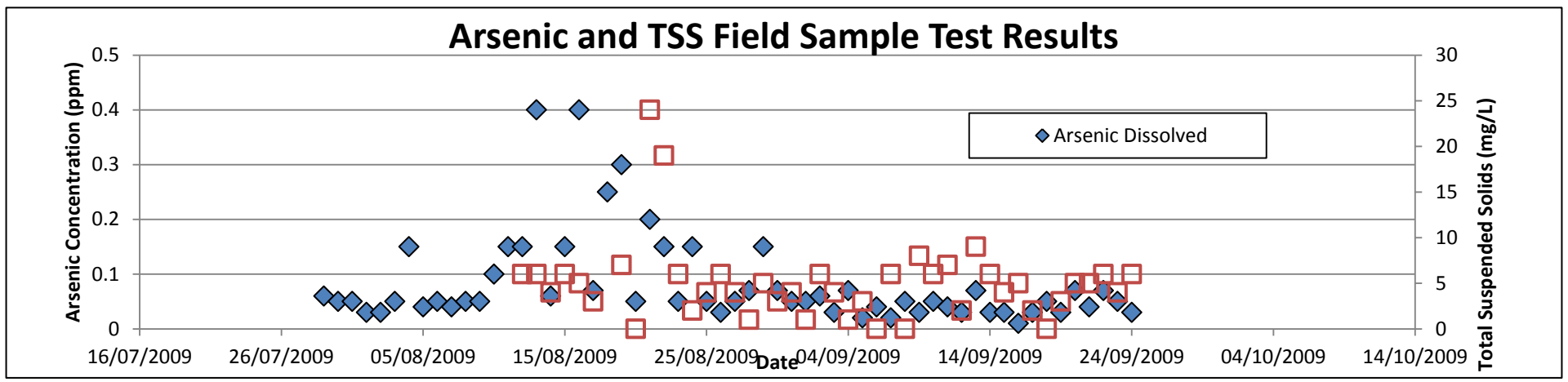

Arsenic and TSS Field Sample Test Results
Arsenic Concentration (ppm)
Total Suspended Solids (mg/L)
Date
Arsenic Dissolved
Total Suspended Solids
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
30
25
20
15
10
5
0
16/07/2009
26/07/2009
05/08/2009
15/08/2009
25/08/2009
04/09/2009
14/09/2009
24/09/2009
04/10/2009
14/10/2009

Results


Daily Flow Rates
Flow Rate (m3/hour)
100
90
80
70
60
50
40
30
20
10
0
29/07/2009
03/08/2009
08/08/2009
13/08/2009
18/08/2009
23/08/2009
28/08/2009
02/09/2009
07/09/2009
12/09/2009
17/09/2009
22/09/2009
27/09/2009
Date
Train 1
Train 2

Results


pH Measurement During Water Treatment
9.5
9
8.5
8
7.5
7
pH
29/07/2009
04/08/2009
10/08/2009
16/08/2009
22/08/2009
28/08/2009
03/09/2009
09/09/2009
15/09/2009
21/09/2009
27/09/2009
Date
Feed
End of Plant
Discharge Tank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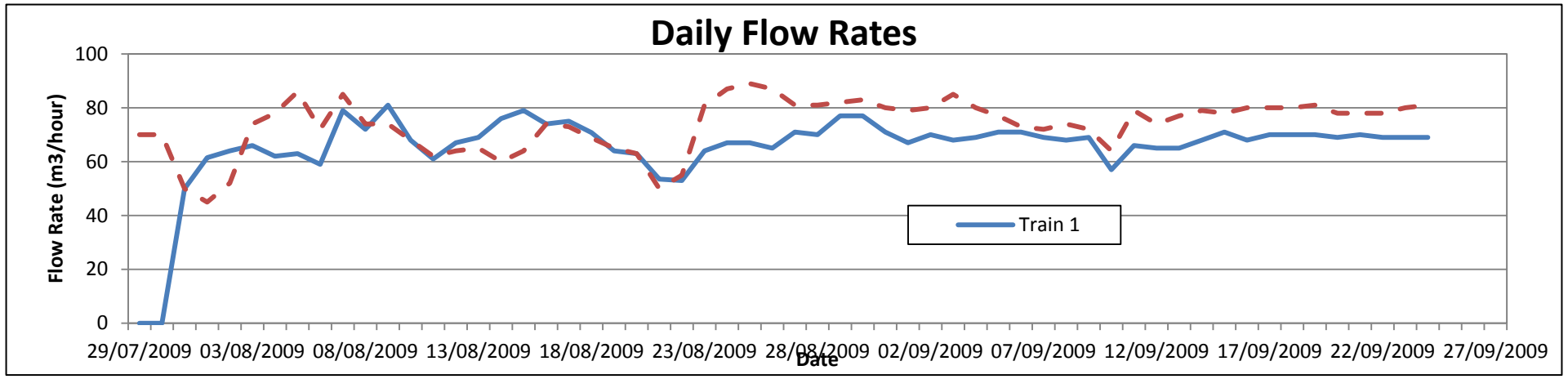
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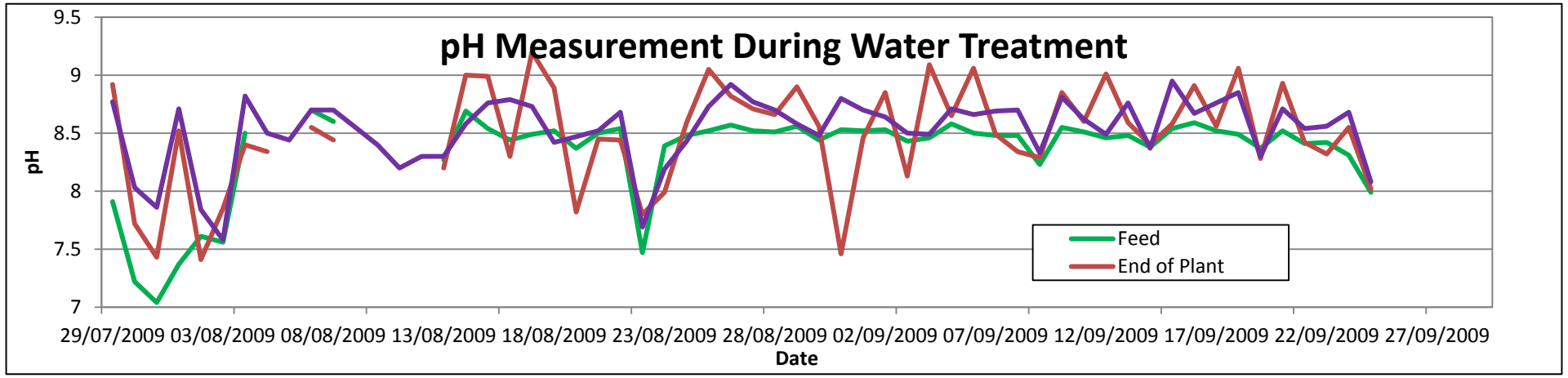
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Date

Final Benefits

- 180,000 m^3 of tailings water treated to an average of .08 ppm arsenic
- Over 58 days w/ average operation time 23 hr/d
- Average solids in discharge of 5 ppm
- Water levels reduced by 0.4 meters below requirement
- Lower pond final level 7.65
- Local community members trained as operators
- Over 80% of project was aboriginal labour
- Completed on time spec and on budget

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Treatment Progress

- 2009 Dual Train Pilot: 180,000 m^3
- 2010 Dual Train: 250,000 m^3
- 2011 Triple Train: 300,000 m^3
- 2012 Dual Train (Not onsite): 350,000 m^3
- 2013-2016 Dual Train: 100,000 m^3–200,000 m^3
- 2017 Dual Train (New): 60,000 m^3
- 2018 (No Treatment Required)
- Total: ~1.8 million m^3

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Overview

Operating Challenges

Site Closure

https://www.cbc.ca/news/canada/north/tundra-mine-site-remediation-1.4791893

Long Term Monitoring

Remote Monitoring

Thank You

Thank You

Thank You

Thank You