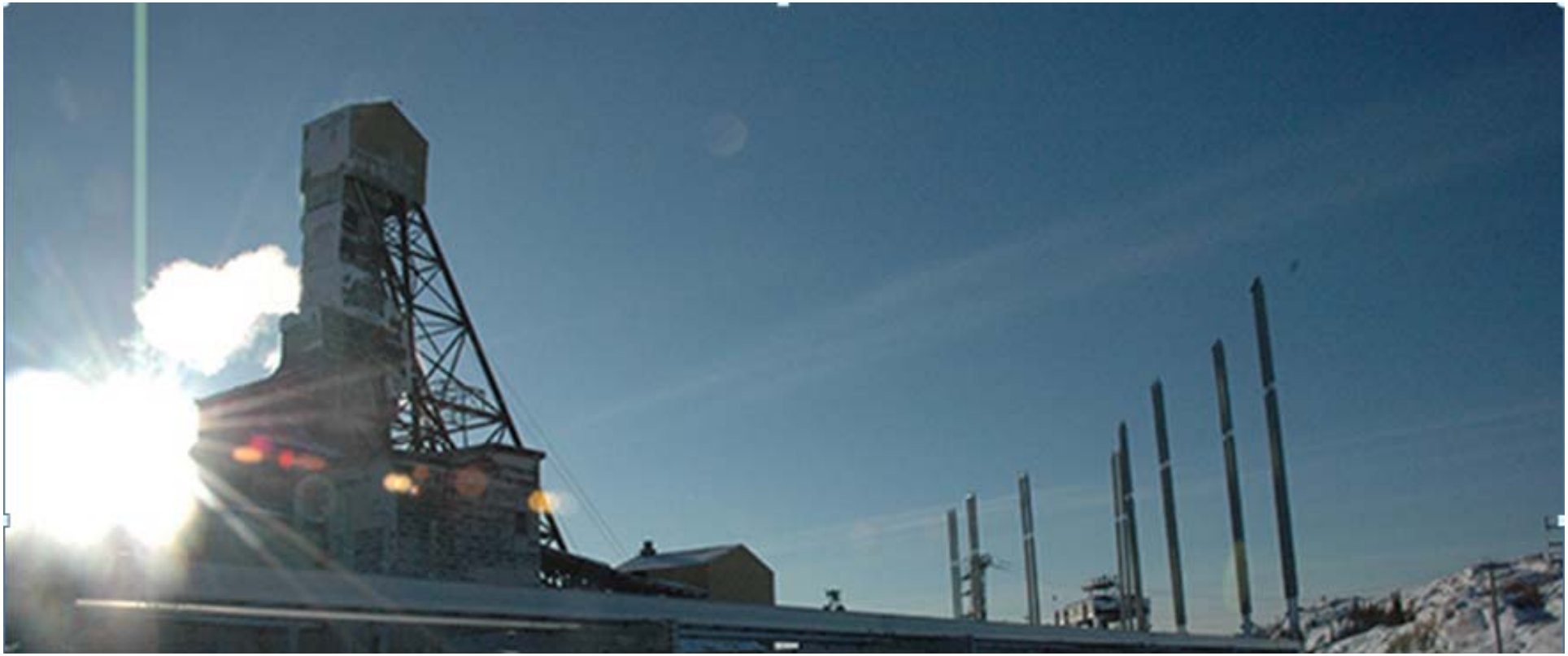


Innovative Process for Stabilizing the Subsurface at the Giant Mine Site

RemTech - October 15, 2015

Chris MacInnis, P.Eng.

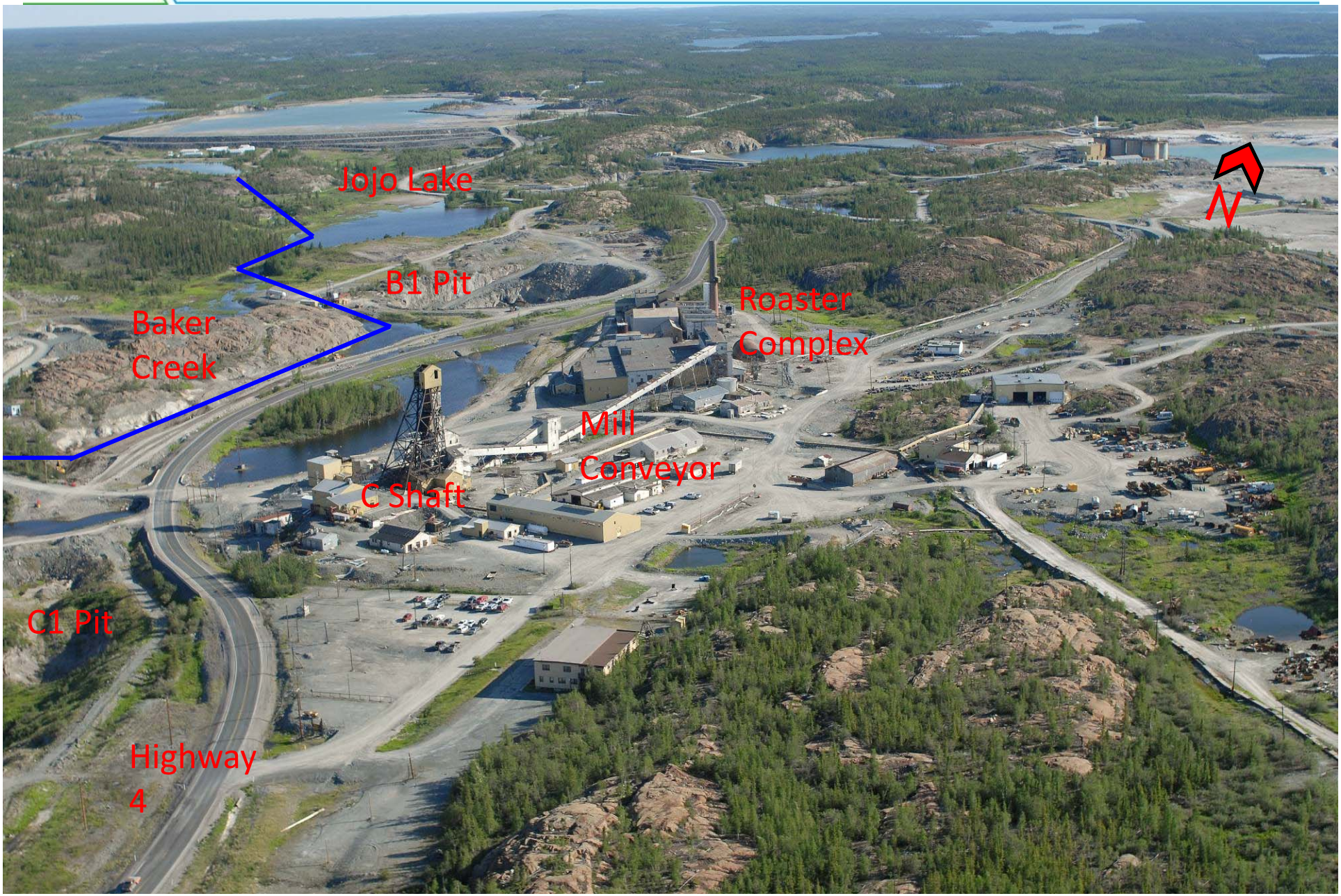
Giant Mine Remediation Project

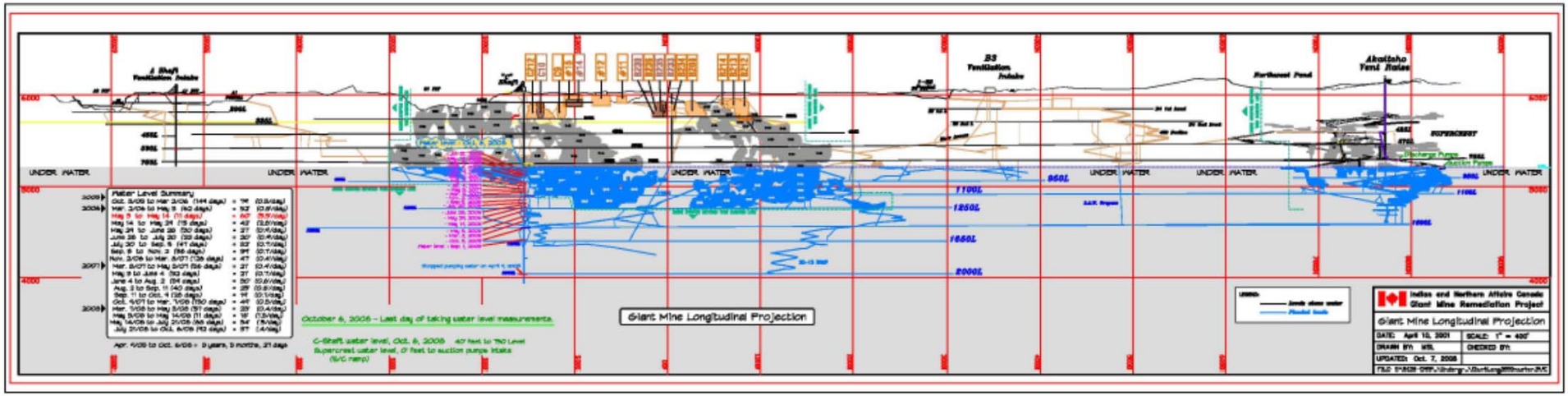
Northwest Territories

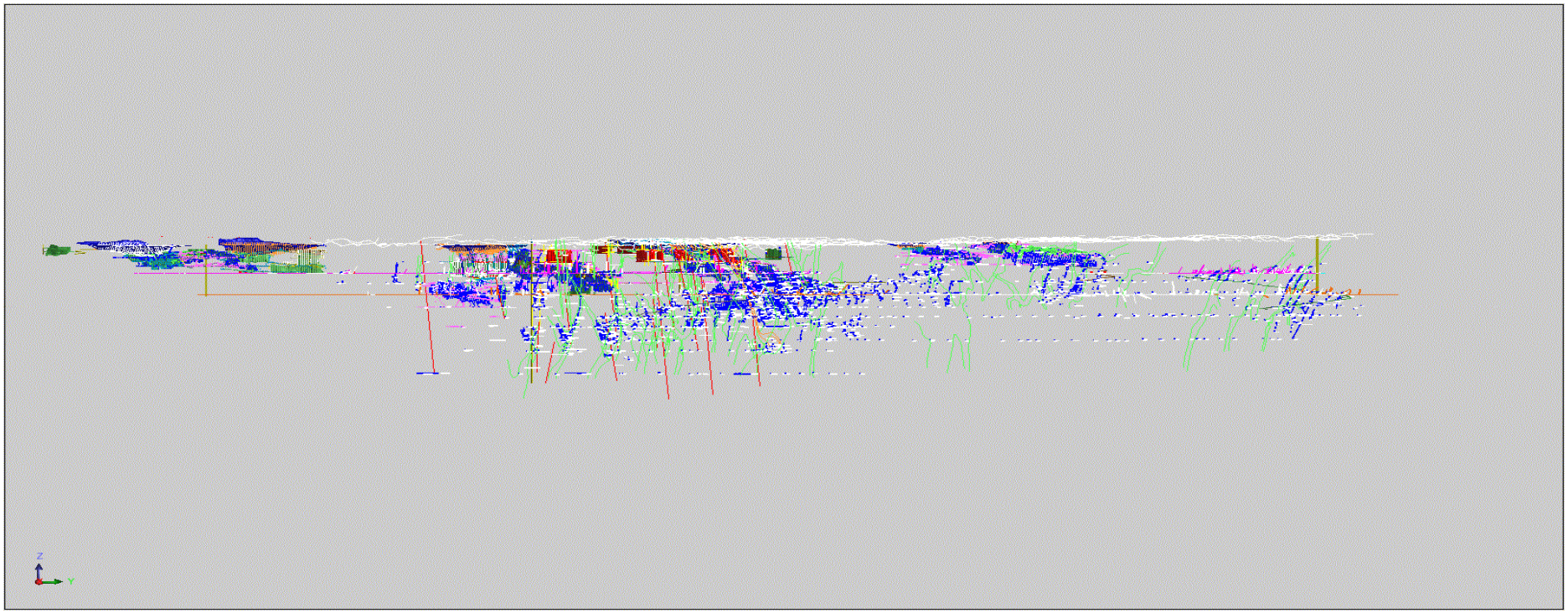
Canada

Outline of Presentation

- Brief history of the site and the Giant Mine Remediation Project (GMRP)
- Advanced Site Stabilization Plan (SSP)
- Innovative approach to stabilizing a subsurface stope (B1-18 Complex)
- Challenges and Lessons Learned
- Questions / Comments


Jojo Lake
B1 Pit
Baker Creek
Roaster Complex
Mill Conveyor
C Shaft
C1 Pit
Highway 4
N


Giant Mine Longitudinal Projection
Indian and Northern Affairs Canada
Giant Mine Remediation Project
Giant Mine Longitudinal Projection
DATE: April 10, 2001
SCALE: 1" = 400'
DRAWN BY: MS.
CHECKED BY:
UPDATED: Oct. 7, 2008
UNDER WATER
October 6, 2006 - Last day of taking water level measurements.
C-Shaft water level, Oct. 6, 2006 407 feet to 750 Level
Supercivil water level, 0 feet to suction pumps intake
(%/C ramp)
Water Level Summary
Apr. 4/05 to Oct. 6/06 = 2 years, 9 months, 21 days



Giant Mine Remediation Project

- Created in 1999 – Agreement between the Federal Government and GNWT

- Main objectives include:
  - Minimize public and worker health and safety risks
  - Minimize the release of contaminants from the site to environment
  - Remediate the site in a manner that instills public confidence
  - Implement an approach that is cost-effective and robust

- One of the main elements of the Remediation Plan includes:

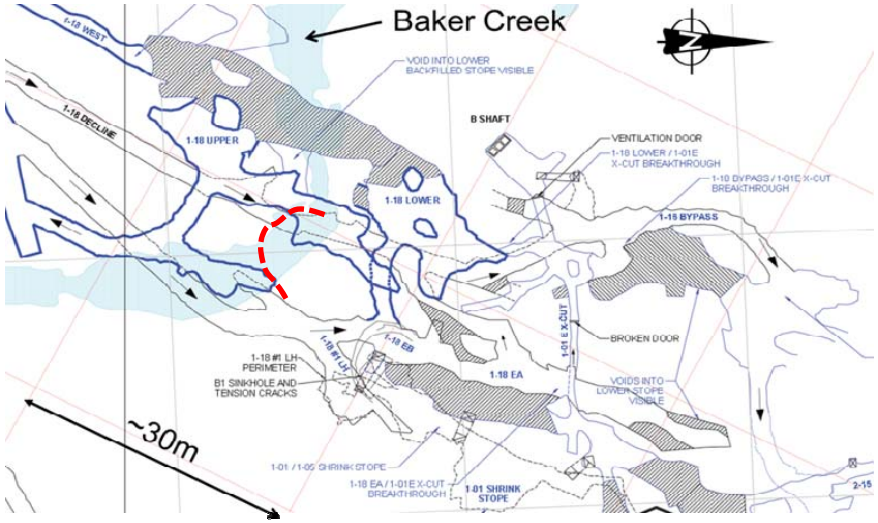
  "Stabilizing stopes and voids"

Advanced Site Stabilization Plan (SSP)

- The plan was developed to address urgent on-site risks in order to protect human health and safety as well as the environment
- Water Licence and Land Use Permit were approved by the MVLWB in March of 2013

Underground Stabilization

- Crown pillar and some bulkhead weakening and beginning to fail
- Subsidence (sinkholes) around pits and public highway
  - B1-18 Non-arsenic stope complex


Baker Creek
1-18 WEST
1-18 DECLINE
1-18 UPPER
1-18 LOWER
VOID INTO LOWER BACKFILLED STOPE VISIBLE
B SHAFT
VENTILATION DOOR
1-18 LOWER / 1-01E X-CUT BREAKTHROUGH
1-18 BYPASS / 1-01E X-CUT BREAKTHROUGH
1-15 BYPASS
1-01 E X-CUT
BROKEN DOOR
1-18 EB
1-18 #1 LH PERIMETER
B1 SINKHOLE AND TENSION CRACKS
1-18 EA
VOIDS INTO LOWER STOPE VISIBLE
~30m
1-01 / 1-02 SHRINK STOPE
1-18 EA / 1-01E X-CUT BREAKTHROUGH
1-01 SHRINK STOPE
2-15


11:36 11/MAY/2011


29/01/2014

How do we then stabilize the subsurface?

- Logical solution is to backfill these spaces with rock or aggregate

BUT.....we had many constraints to factor into the decision including:

1. **Not enough rock material to use and access to the UG is limited**
2. **Hydraulic fill is uncontrollable**
3. **Baker Creek flows in and around the major areas that require this stabilization**
4. **Tailings are far from the area requiring fill**
5. **Surface space for setup was limited**
6. **Multiple pour locations with varying volume requirements**
7. **Work needed to be done immediately due to the time of year and funding**

MOBILE PASTE BACKFILL PLANT

Stabilizing the Subsurface – General Backfill Plan

- Backfill type and approach
- Preparatory Work
- Backfill Design and Field Testing
- Backfill Production and Design for B1-18 Non-Arsenic Stope

Stabilizing the Subsurface – Backfill Type and Approach

- Tailings, which is finely crushed rock and is the main byproduct of milling gold ore, was proposed as the primary backfilling material.
- It is abundant on surface in the existing tailings ponds and is also present in large quantities in the underground as it was used during historical mining to stabilize voids.
- ***Paste*** tailings backfill was chosen to backfill the stope voids.

Definition of Paste

- ***Paste*** backfill, like hydraulic fill, contains sand to silt sized particles of aggregate, water and usually binder, if strength is required
- Sources of aggregate can be naturally occurring such as glacial till, or man-made such as tailings.
- The solids content or pulp density is generally between 70-85% but can be higher or lower.
- A true paste backfill will not segregate, is pumpable over considerable distances in a pipeline, and produces very little bleed water.

Stabilizing the Subsurface – Preparatory Work

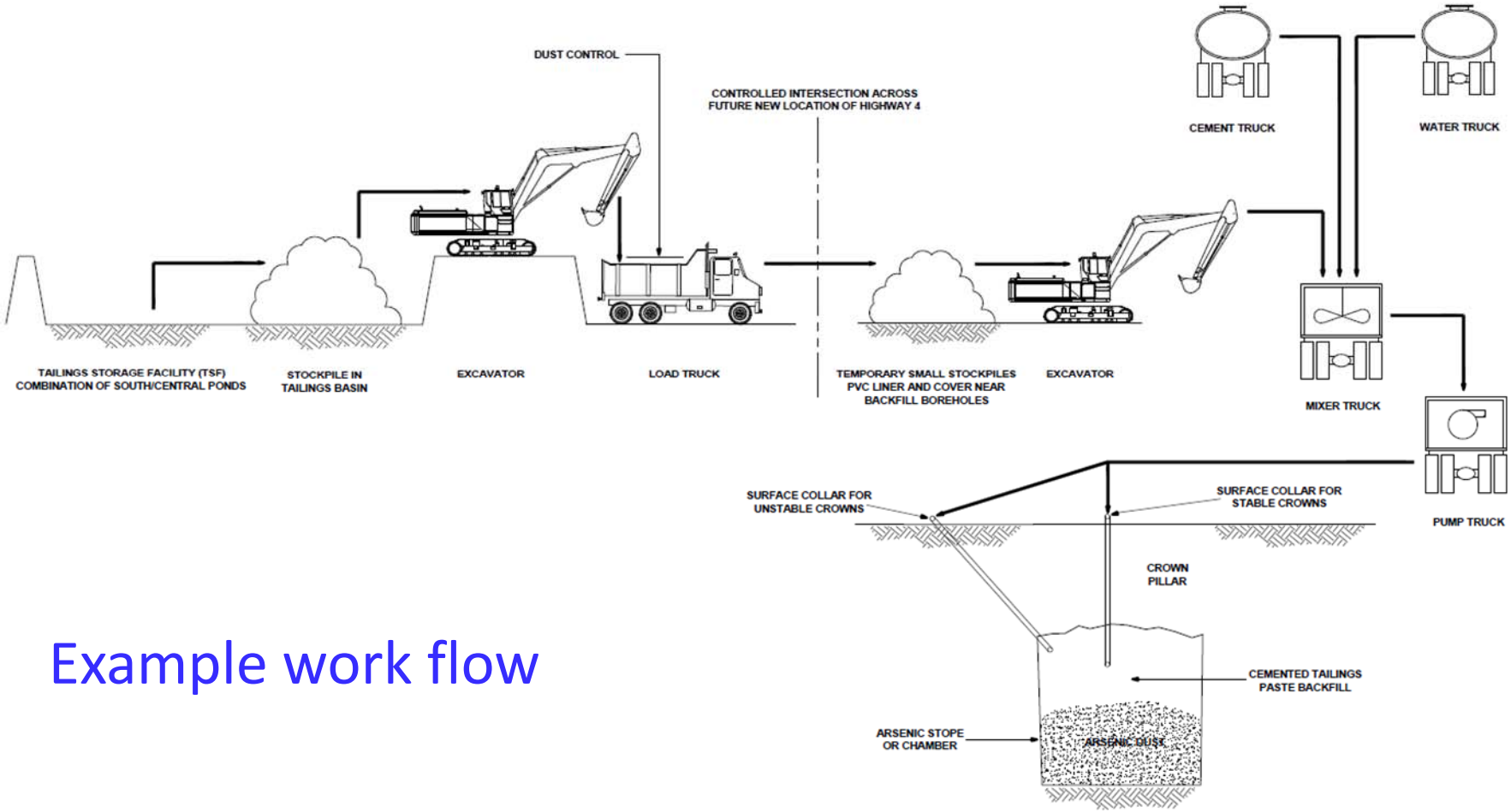
Stabilizing the Subsurface – Backfill Design

Lab and fieldwork to develop paste mix designs

Stabilizing the Subsurface – Backfill Design

Minimum Unconfined Compressive Strength of 100 kPa for bulk stope fill to prevent liquefaction and associated underground hazards to mine personnel.

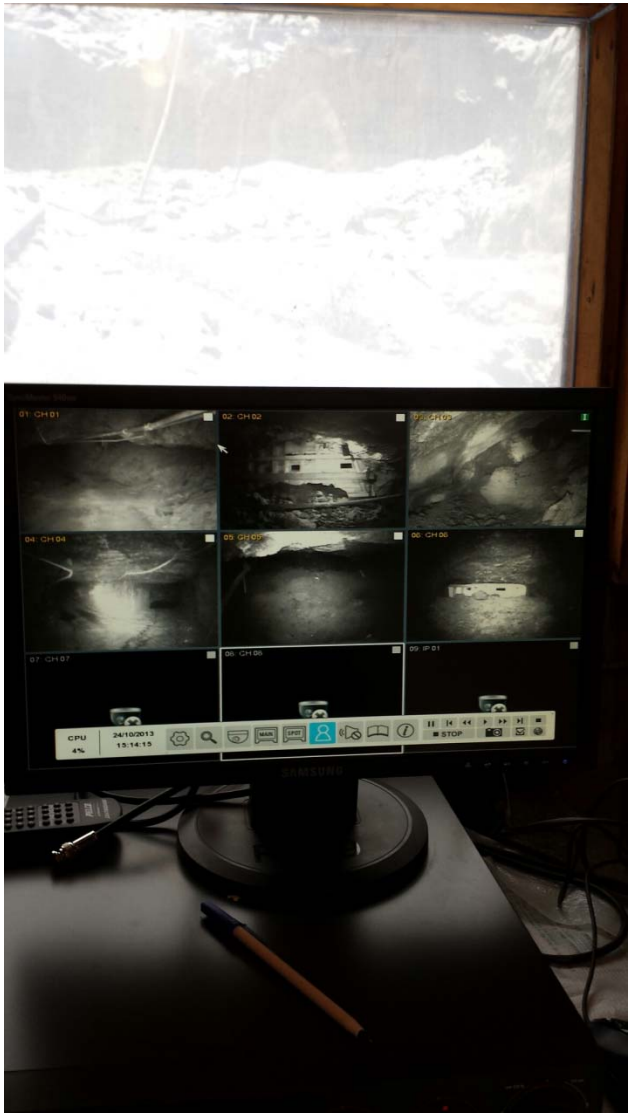
Stabilizing the Subsurface – Paste Production and Distribution



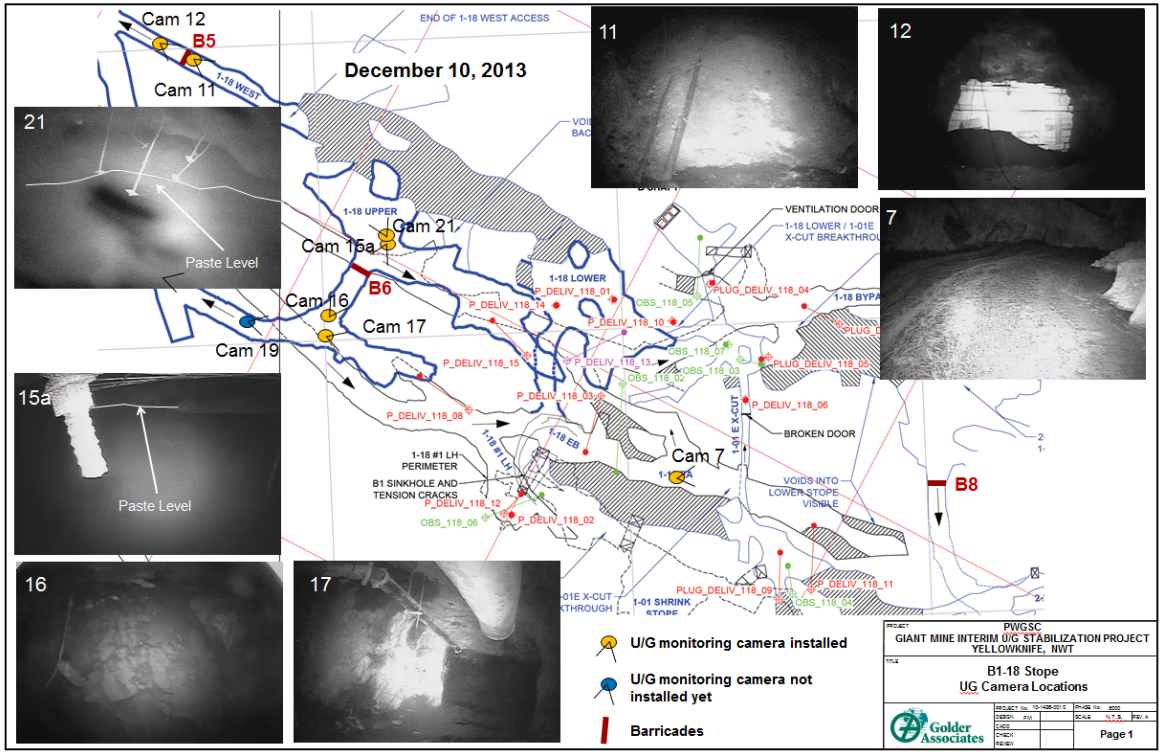
Example work flow

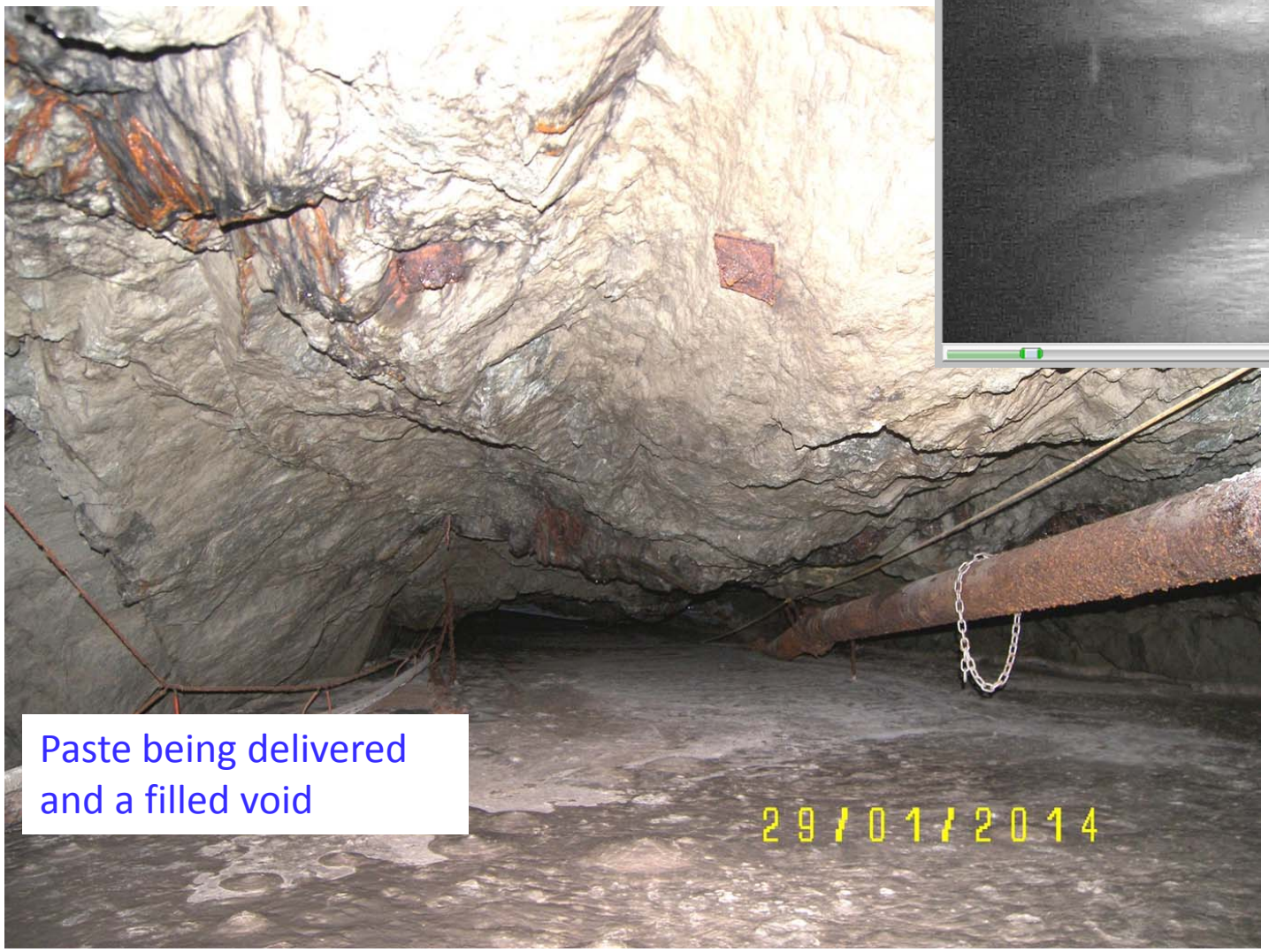
Example surface equipment distribution

A congested work site



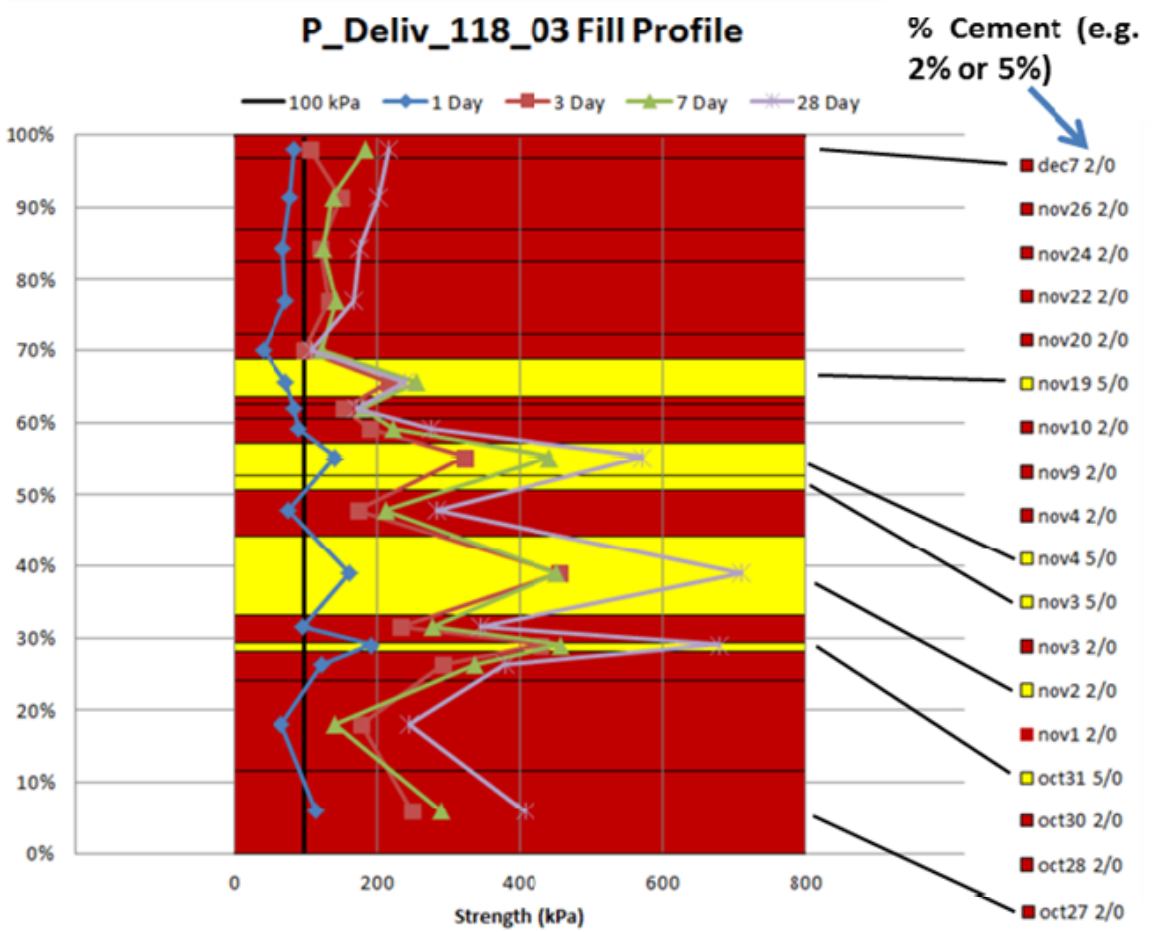
Monitoring of
paste distribution
in the underground

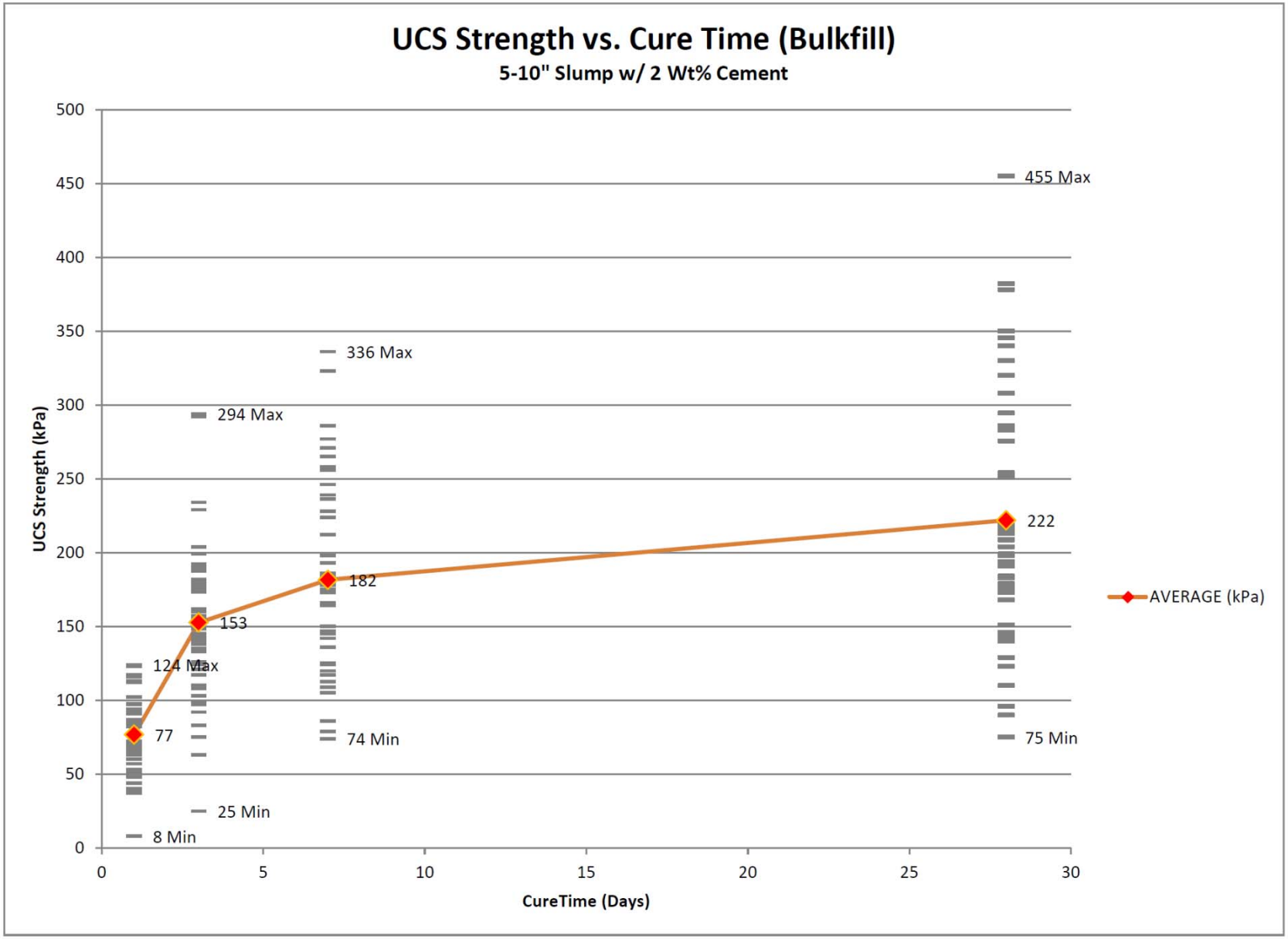


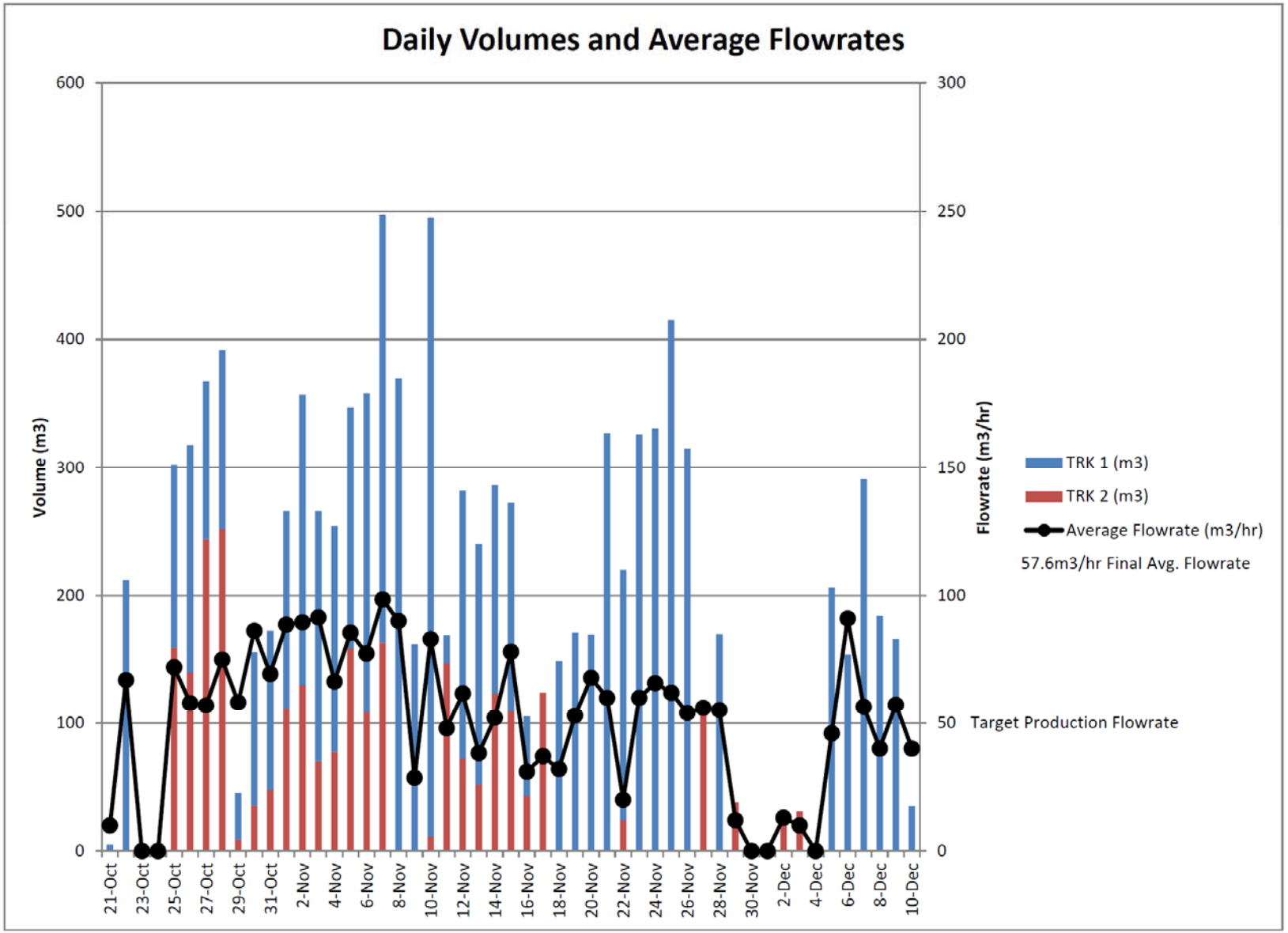


Paste being delivered and a filled void

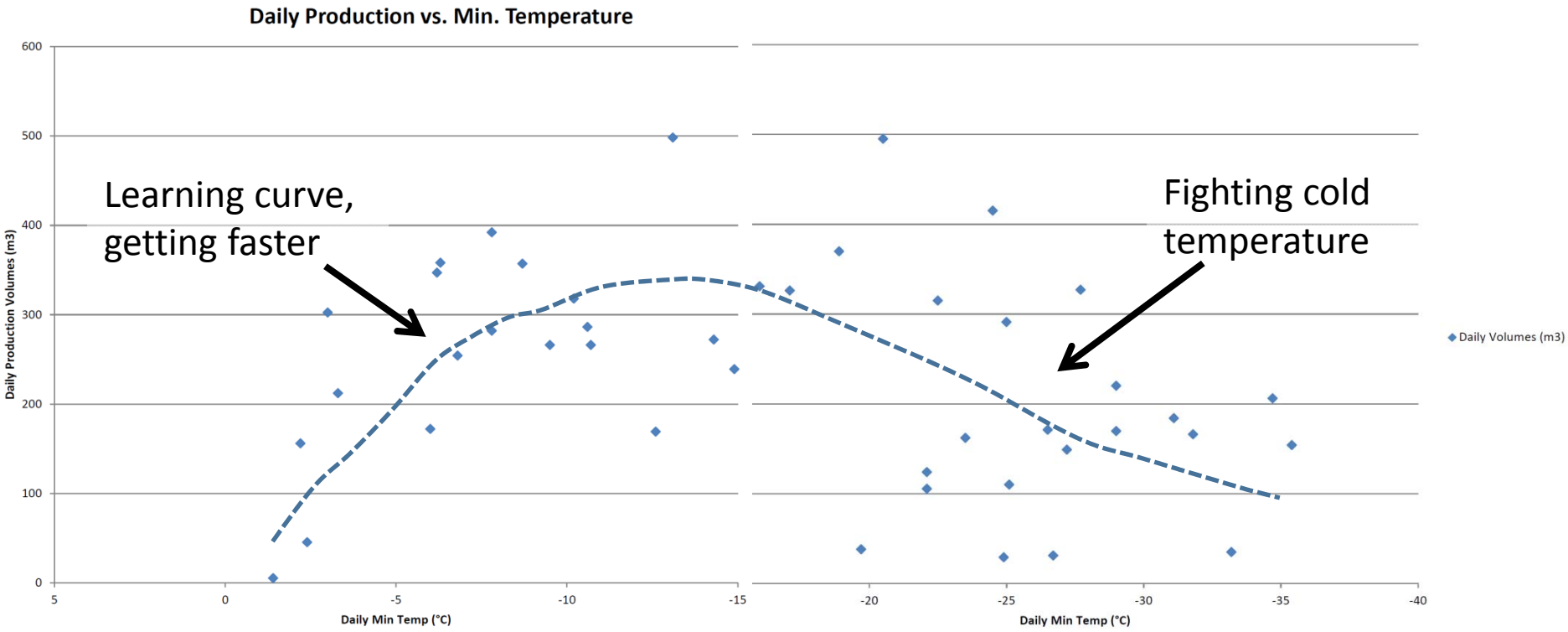
Backfill strength profiles




UCS Strength vs. Cure Time (Bulkfill)
5-10" Slump w/ 2 Wt% Cement
UCS Strength (kPa)
CureTime (Days)
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
455 Max
336 Max
294 Max
124 Max
25 Min
8 Min
74 Min
75 Min
77
153
182
222
AVERAGE (kPa)


Daily Volumes and Average Flowrates
Volume (m3)
Flowrate (m3/hr)
600
500
400
300
200
100
0
300
250
200
150
100
50
0
TRK 1 (m3)
TRK 2 (m3)
Average Flowrate (m3/hr)
57.6m3/hr Final Avg. Flowrate
Target Production Flowrate
21-Oct
23-Oct
25-Oct
27-Oct
29-Oct
31-Oct
2-Nov
4-Nov
6-Nov
8-Nov
10-Nov
12-Nov
14-Nov
16-Nov
18-Nov
20-Nov
22-Nov
24-Nov
26-Nov
28-Nov
30-Nov
2-Dec
4-Dec
6-Dec
8-Dec
10-Dec

Production vs. Temperature



Temperature is almost equivalent to timeline October - December

Challenges and Lessons Learned – Unique Operating Environment

- Backfilling targeted voids in an abandoned mine is challenging
- Limited knowledge of certain areas of the UG workings
- Fluctuating daily backfill sequencing – “If then else” strategies
- Site congestion
- Paste production in cold winter conditions

Questions /Comments