Improving Remedy Sustainability Through Use of On-Site Construction Materials

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East Fork Ninemile Creek Waste Consolidation Area (EFNM WCA)

What is the Problem?

- Waste rock and tailings deposited in Ninemile Creek are a source of contamination (i.e., lead and zinc) to soil and surface water

Selected Remedy

- Remove the mine waste from its present location and place "high and dry"
- Place 1M cy waste in local consolidation area (EFNM WCA) to reduce transportation costs

EFNM – Tamarack Waste Rock Dumps

Identified EFNM WCA Area

Benefits of Developing On-Site Construction Material (Borrow Areas)

- Common Practice to Develop Borrow Materials from Mine Waste Repository Areas – Clean Soil/Rock Salvage
  - Efficient use of footprint; provides clean material while increasing waste consolidation volume
  - Represents Cost Savings vs. Imported Material (Up to 50%)
  - Reduces Transportation Impacts to Community, Carbon Footprint
- EPA Green Remediation Best Management Practices
  - Mining Sites (EPA 542-F-12-028): Use onsite rather than imported natural resources wherever possible
- ASTM Standard Guide for Greener Cleanups (E2893-13)
  - BMP (Materials) - Use onsite/local materials, when possible

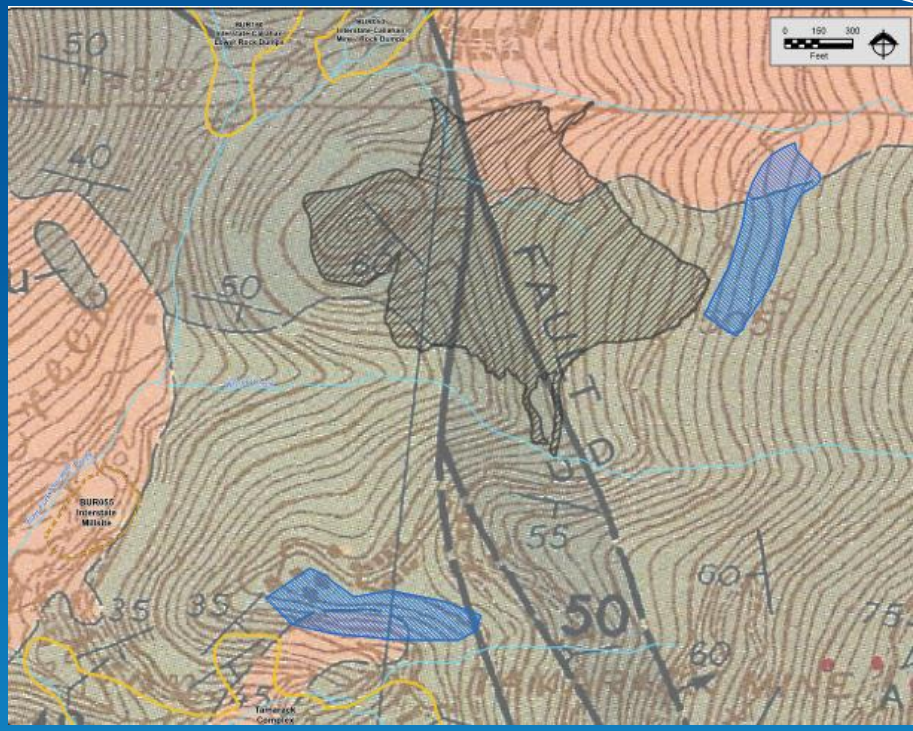
EFNM WCA Location Site Renderings

Local Construction Material Needs

- Rock Borrow Needs
  - WCA Buttress Rock
  - WCA Drainage Rock
  - Reclamation Area Riprap/Fill
  - Haul/Access Road Improvements
  - **400K CY Need Over 10 Years**
- Soil Borrow Source
  - WCA Vegetated Soil Cover
  - Reclamation Area Soil
  - **175K CY Needed Over 10 Years**

Rock Quarry Geologic Setting

- Puritan Fault Transects Site ~ Saddle/Drainage Locations
- Precambrian Pritchard Formation – metasedimentary quartzite and argillite
- Close Proximity to Mineralized Rock – nearby Tamarack Mines



Km	*Monzonite and associated rocks*
p€pu	*Upper part of the Pritchard formation*
p€r	*Revett Quartzite* ***(Hobbs et al., 1965)***

2013 Rock Quarry Planning – Quality of Material

- Lead and Zinc Primary COCs
- Existing Yards Program Borrow Sampling Program – Exposure Assumption Applicability:
  - Fine Grained vs. Coarse Grained
  - Residential vs. Worker Setting
  - Likely Exposure to Surface Water
- Conduct Quarry Drilling & Characterization Program
- Develop Quality Assurance Program Plan (QAPP)

2013 Rock Quarry Characterization & QAPP

- Collect and Analyze Rock Quarry Samples
- Evaluate Direct Contact/Ecological Risk – Total Metals Testing (EPA 6010B); Select Criteria:
  - Lead ≤ 530 mg/kg
  - Zinc ≤ 434 mg/kg
- Evaluate Leachable Metals (USGS Field Leach Testing); Select Criteria:
  - Idaho Aquatic Water Quality Criteria (AWQC)

2013 Rock Quarry Characterization & Results (Cont.)

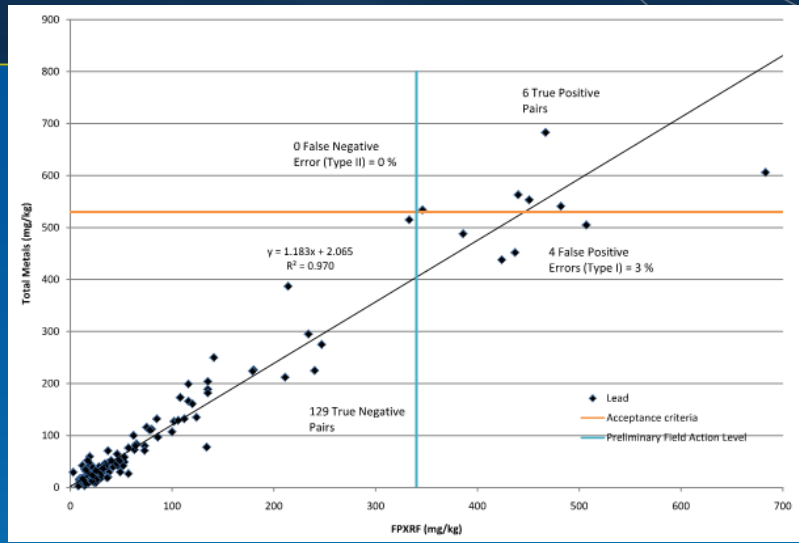
- Acid Generation Potential – Acid Base Accounting (ABA) Testing; Select Criteria:
  - Net Neutralization Potential (NNP) < 20 t/kt $CaCO_3$ eq. or Acid Potential (AP) <1 t/kt
- Flexible Rock Classification Approach to Maximize Yield / Cost-Effectiveness
  - Type A Material (Unrestricted Use)
  - Type B Material (Restricted Use – Subsurface)
  - Type C Material (Unsuitable)

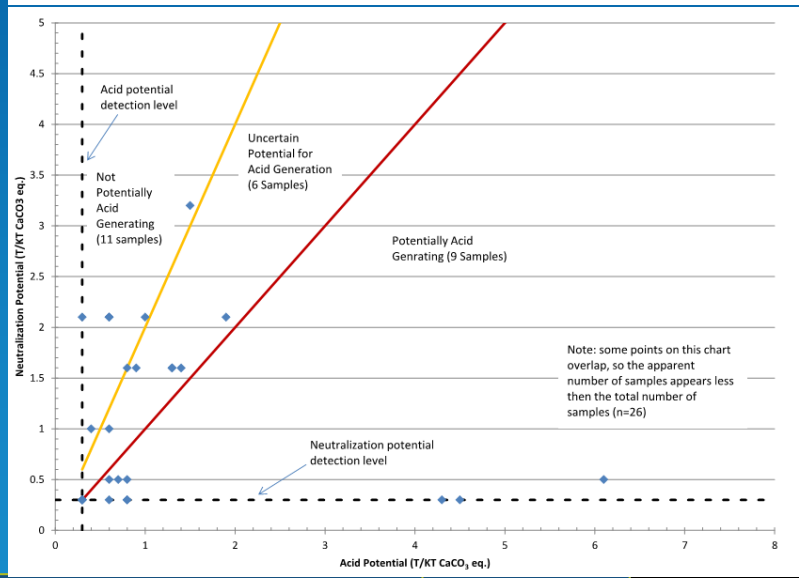
2013 Quarry Development

- Quarry Development
  - Specialty Blasting and Quarry Development Subcontractor
  - Quarry Blasting Design Executed to Correspond with Required Material Sizing
- Confirmation Sampling
  - 1 Sample per 500 CY of each material type
  - Demonstration of Methods Applicability (DMA) for X-Ray Fluorescence (XRF)

2013-2014 Confirmation Sampling Results and Program Modifications

- Total Metals Concentrations < Criteria
- Leachability Concentrations < Criteria
- XRF DMA Successful
  - Good Correlation of XRF & Lab Data
  - Establish Field Action Level for Lead of 340 mg/kg < 530 mg/kg
- Iterative/Adaptive ABA Approach
  - Low AP and NP Values
  - ABA Criterion revised to Acid Potential (AP) < 1 t/kt CaCO3 eq. in 2013 or NP:AP > 2
  - 2014 ABA Results: Uncertain/ Potentially Acid Generating
- 2014 Supplemental ABA Data Collection





2014 Geologic Reconnaissance & Select Sampling

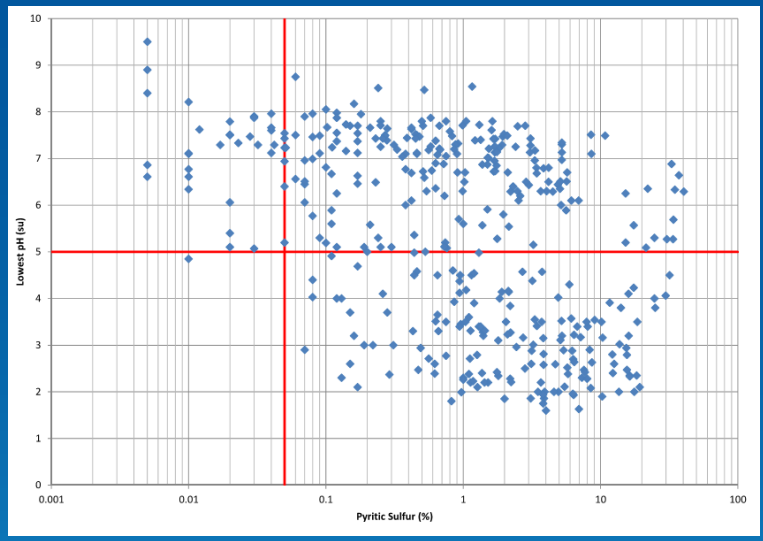
Figure 2. View of EFNM WCA quarry showing approximate location of oxide and transitional oxide-sulfide geochemical zones

2014 ABA Analyses and Mineralogical Characterization

- Selective Sampling
  - 10 Biased Rock Samples to Support SEM-EDS
  - 8 Collected Samples with Visible Sulfide Minerals
- Mineralogical Characterization of Sulfur Using SEM-EDS
  - Pyrite (FeS2) Dominant Mineralogical Form of Sulfur
- ABA Results
  - Pyritic Sulfur detected in 9 of 10 Samples; AVG 0.04% > DL 0.01%
  - NP Detected at low concentrations AVG 0.6 t/kt > DL 0.3 t/kt
  - NP:AP Ranged from 1.76 to 0.01
  - High Variability in Duplicate Data (Relative Percent Diff)
  - Evaluation of ABA using NP:AP Ratio is Tenuous

Assessment of Likelihood for Rock to Generate ARD

- Alternate ABA Approach Considered
  - International Kinetic Database (Morin & Hutt 2001); 487 kinetic tests from 63 mine sites
  - ARD unlikely for rock containing pyritic sulfur content < 0.1%; recommended value of <0.05% (Li 2000)
- EFNM WCA Rock Data Indicate
  - Sulfur content (geometric mean) = 0.024%; 2014 produced rock not acid generating (NP, AP values both low)
  - Geometric mean appropriate given lognormal data distribution; mixing of placed rock



2015 and Future Quarry Activity Recommendations

- Maximize Development of Oxidized Zone of Quarry
- Consider Additional Drilling and Characterization Activities to Focus Production in Oxide Zone
- Re-evaluate Future Quarry Volumetric Needs with Available Oxide Zone Volume – Consider Other Quarry Locations
- Modify QAPP
  - Provide Training and Use Hand Lens to Identify Transitional Oxide-Sulfide Zone Material During Rock Production
  - Revise ABA Criterion to: Pyritic Sulfur Content (Geometric Mean) < 0.05 Percent

Questions?

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