ACID ROCK DRAINAGE SLUDGE MANAGEMENT ISSUES AT THE I-99 CONSTRUCTION SITE STATE COLLEGE, PA

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Introduction

- Excavation of Pyritic Material During I-99 Construction
- Formation of Acid Rock Drainage (ARD) in Late 2003
- Interim ARD Treatment Measures
- Sludge Management For the ARD Treatment Ponds
- Current Status

Excavation Of Pyritic Material During I-99 Construction

- During excavation of Skytop, approximately one million cubic yards of pyritic material were unearthed
- Some of the material was crushed and used for constructing sections of the highway, while a majority was placed in waste areas and the area referred to as the Buttress, just west of Skytop

Excavation Of Pyritic Material During I-99 Construction (cont.)

- Primary placement areas of pyritic material
  - Skytop Waste Area
  - Siebert Waste Area
  - Sellers Lane
  - 317 (area between Rts 550 and 322)
  - Buttress / Bifurcation
  - Batch Plant Area (Section C-12)

ARD Formation

Pyrite / Marcasite + Oxygen +
Water + Bacteria = ARD

ARD = Acid + Heavy Metals + Sulfates

Heavy Metals of Concern = Iron, Aluminum, Manganese, and Zinc

ARD Formation

- Wet/dry cycles associated with intermittent rainfall caused oxidation and dissolution of sulfides and their oxidation products
- During the dry phase the sulfide minerals formed soluble sulfate salts
- These salts when exposed to water form highly acidic drainage ($pH < 3$), containing high levels of dissolved Fe, Al, and SO_4 with lower levels of Zn, As, Co, Cu, and Ni

Interim ARD Treatment Measures

ARD + ALKALINITY + OXYGEN + BACTERIA = METAL PRECIPITATES

AND TREATED WATER

Interim ARD Treatment Measures (cont.)

- Utilized existing E & S basins along with ChemTreat 252 (sodium hydroxide with a coagulant aid – $KMnO_4$) addition for ARD Treatment
- ARD Characteristics
  - Extremely High Acidity and Metals Concentrations
  - Most of the ARD sources are intermittent
- Frequent monitoring of pH and chemical addition measures

Sludge Management for the ARD Treatment Ponds

- Product of the ARD Active Treatment Process
- Metal Hydroxide, Oxy-Hydroxide, and Hydroxysulfate Complexes
- Sediment
- Reddish/Orange (Iron) and White (Aluminum) Precipitates
- Capture, Settling, and Retention

Sludge Management for the ARD Treatment Ponds (cont.)

- Using Average Rainfall, Drainage Areas, and Inflow Water Chemistry Data in 2004, Average Loadings of Fe, Mn, and Al Were Computed for Each ARD Treatment Pond To Estimate Sludge Volumes Produced (Not Considering Sediment)
- Considering the Five Primary ARD Treatment Ponds, Approximately 2,500 Yd^3 of Sludge Produced Monthly

Sludge Management for the ARD Treatment Ponds (cont.)

- 2004 – Wet Year, Uncovered Pyritic Waste Areas, High Volume of Sludge Generated
- 2005 – Drier Year, Covered Pyritic Waste Areas, Less Volume of Sludge Generated

Sludge Management for the ARD Treatment Ponds (cont.)

- 2004 – Year One
  - Proposed Use of Geotubes for Sludge Dewatering
  - Contracted a Vacuum Tank Truck for Transporting of Sludge Slurry From Ponds
  - Utilized Large 18,000 Tank for Holding of Sludge Slurry From Vacuum Truck
  - Two Processing Sites: Polymer Addition and Geotubes

Sludge Management for the ARD Treatment Ponds (cont.)

- 2004 – Year One
  - Anionic Polyacrylamide Polymer: Bench Scale Tested and DEP/PFBC Approved
  - Eight Geotubes Filled to 50% Capacity or Greater
  - Operations Took Place From June Through November

Sludge Management for the ARD Treatment Ponds (cont.)

- WHY Geotubes???
  - Vacuum Tank Truck and Off-Site Disposal = High Cost, Primarily Hauling Water
  - On-Site Disposal Not an Option
  - Roll-Off Containers Lined With Impervious Material = Dewatering Issues and Small Volumes
  - Stabilize Sludge With Adsorbent Material (Portland Cement or Quicklime) and Hauled Off-Site = Labor Intensive with Safety Concerns

Sludge Management for the ARD Treatment Ponds (cont.)

- WHY Geotubes??? (cont.)

Geotubes = Economical, Safe, & Efficient

Provide for a easily handled, reduced volume (dewatered) material that can be hauled and disposed of at an approved landfill

Sludge Management for the ARD Treatment Ponds (cont.)

- 2004 – Year One
  - Via Pumping or Vacuum Truck, Sludge From the ARD Treatment Ponds was Brought to One of Two Locations On-Site and Placed into a Large Holding Tank
  - The Sludge Slurry was Then Pumped Through a Mixing Manifold After Injecting Polymer Into the Slurry and Routed Directly to the Geotubes for Dewatering
  - The Addition of Polymer was Adjusted Based on Observing the Floc Consistency at the Discharge of the Mixing Manifold

Sludge Management for the ARD Treatment Ponds (cont.)

- 2005 – Year Two
  - Based on the Construction of Pond 1A for Chemical Treatment Purposes and the Acquisition of Property Adjacent to the Pond, a Sludge Processing Area Was Constructed
  - Six 1,000 Gallon Concrete Tanks Were Modified to Form Two 3,000 Gallon Holding Cells for Sludge Before Processing
  - Geotube Area Was Excavated and Leveled with a Stone Subbase for Promoting Drainage to a Collection Channel and Collection Tank for the Geotube Filtrate


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Sludge Management for the ARD Treatment Ponds (cont.)

- 2005 – Year Two
  - Dry Prime Pumps Were Set-up and Used For Sludge and Water Management
    - Four inch pump set-up at Pond 1A for pumping sludge or water into the concrete holding tanks
    - Three inch pump set-up adjacent to the concrete tanks to pull the sludge/water mixture from the concrete tanks, through the mixing manifold where polymer was injected, and into one of several Geotubes
    - Two and/or three inch pump(s) set-up at the Geotube filtrate collection tank for directing the water to one of two ponds (Pond 1A or 1) – Useful in managing the sludge material in Pond 1A


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Polymer Tank and Electric Dosing Pump

Sludge Management for the ARD Treatment Ponds (cont.)

- 2005 – Year Two
  - First Two Months, a Vacuum Tank Truck was Used To Remove Sludge From Most of the ARD Treatment Ponds and Transport to the Concrete Holding Tanks for Processing
  - Following the First Two Months, Piping Was Put in Place for Three of the Problem ARD Treatment Ponds for Frequent Pumping of the Water and Sludge to Pond 1A for Both Treatment and Sludge Processing

ARD Treatment Basin J-2: Prior to Sludge Removal

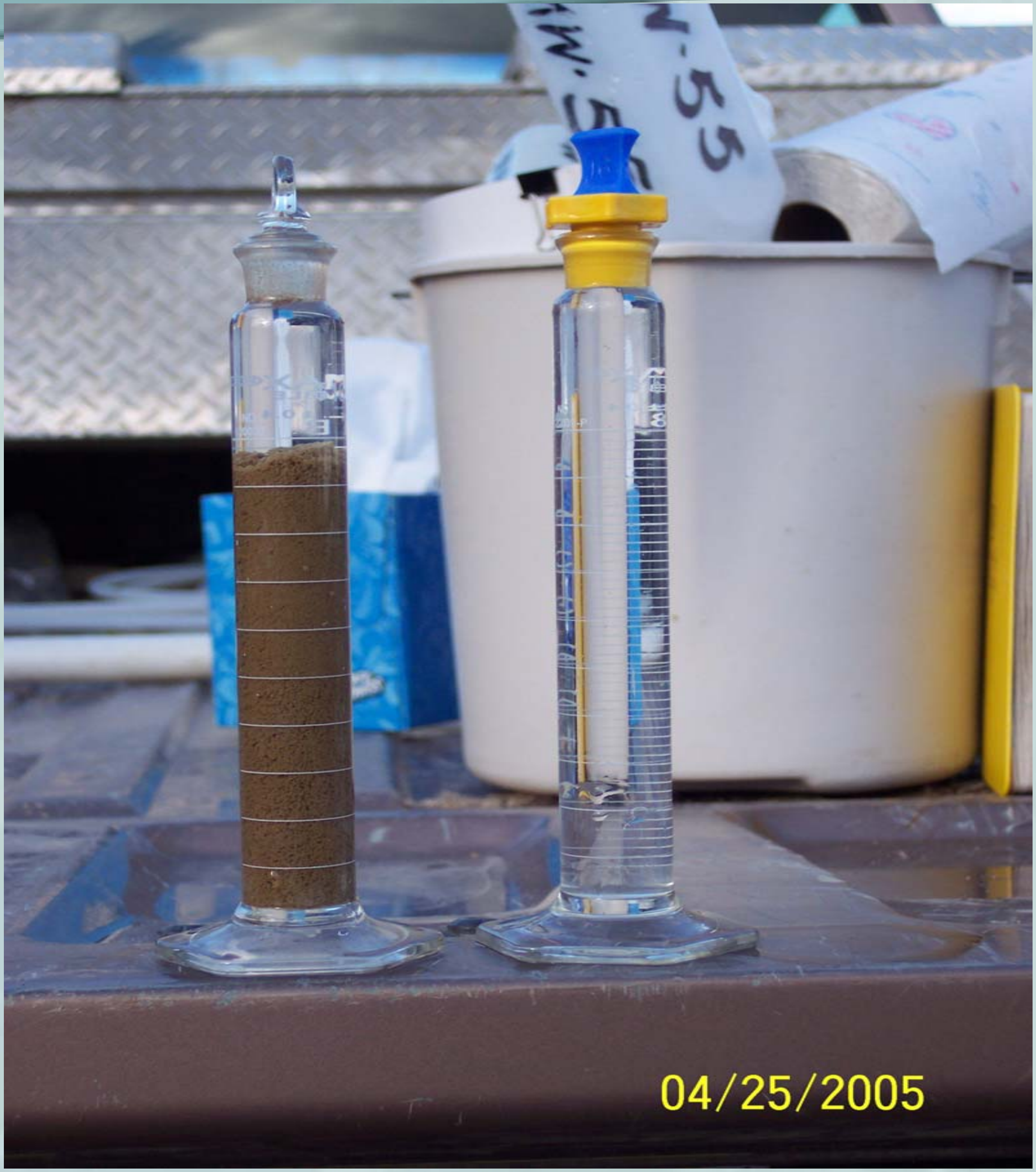
ARD Treatment Basin J-2: Following Sludge Removal

Sludge Management for the ARD Treatment Ponds (cont.)

- 2005 – Year Two
  - Lessons Learned From 2004 – Year One
    - Efficient Operation: One Processing Site Set-Up Properly
    - Pumping and Treating the ARD in One Pond, Pond 1A
    - More Efficient Use of Geotube Capacity
    - More Efficient Use of the Polymer: Recirculation
    - Water Management: Treatment, Dilution Water, and Geotube Filtrate Water

Sludge Management for the ARD Treatment Ponds (cont.)

- Water flowing from the Geotube is typically very clean and when tested for metals such as iron and manganese, both were below 1.0 mg/L
- Typically the filtrate water from the Geotube also had residual levels of polymer that were recycled back to Pond 1A, which helped create the floc particles needed for pumping to the Geotubes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Sludge Management for the ARD Treatment Ponds (cont.)

- 2005 – Year Two
  - Five Geotubes Used Since April, With Each Having Over 75% of Its Capacity Used
  - Significant Reduction in Labor Resources Utilized for Sludge Processing
  - More pumping operations employed than in 2004, using up to 5 or 6 at a time

I-99 ARD Sludge Characterization

2005 Sludge Slurry Prior to Processing:

Total Iron = 38,090 mg/kg (dry)

Total Aluminum = 17,925 mg/kg (dry)

Total Manganese = 1,525 mg/kg (dry)

Total Solids = 1.15%*

*May have been influenced by polymer recirculation in the pond sampled


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20039
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20039-P
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I-99 ARD Sludge Characterization

2004 Dried/Dewatered Sludge From Geotube:

- Total Iron = 53,562 mg/kg (dry)
- Total Aluminum = 25,505 mg/kg (dry)
- Total Manganese = 1,798 mg/kg (dry)
- Total Solids = 35.4%

Current Status of Sludge Operations at I-99

- Currently have three Geotubes each capable of holding 280 yd^3 and two Geotubes each capable of holding 144 yd^3 at 75% capacity or more
- Eight Geotubes from 2004 were recently opened up and the dewatered material, approximately 1125 yd^3, was hauled off-site to an approved landfill


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Current Status of Sludge Operations at I-99 (cont.)

- Operations are performed concurrently with ARD treatment since Pond 1A is used for treating water from 2 or 3 of the other ARD treatment ponds
- Sludge operations will continue until there is no active treatment of ARD needed


Comments Or Questions
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