Self-Sustainable Mine Water Treatment through Passive Iron Oxide Recovery

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Iron Oxide Recovery, Inc.
Hedin Environmental
Current Mine Water Treatment

**COSTS**
- Design and Construction ($$$)
- Purchase and Install Substrate ($$$)
- Removal from System ($$$)
- Disposal ($$$)

**PHASE**
- System Construction
- Alkaline Substrate Replacement
- Sludge Management

**BENEFITS**
- Clean Water
- Continued Neutralization
- Continued Removal of Metals
Items in bold and inside the dashed line represent new costs and benefits associated with iron recovery.

Green $$$ indicates monetary costs and benefits; others are non-monetary.
Self-Sustaining Mine Water Treatment

Value (income) produced from treatment system offsets operation and maintenance costs
Self-Sustaining Mine Water Treatment: IOR Approach

• Revenue from sale of iron product
• Cost control through passive technologies
• Effective treatment through good design
How Did We Get Here?
Milestones in Iron Recovery
<table>
<thead>
<tr>
<th>Year</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>Iron Oxide Recovery, Incorporated in Pennsylvania</td>
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<tr>
<td>2000</td>
<td>Grants from PADEP, OSM, and WPWP to Scrubgrass Creek Watershed Association to support IOR’s pilot scale recovery of iron product at Lowber site (Washington County)</td>
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<tr>
<td>2001</td>
<td>First sale of iron oxide as unrefined pigment</td>
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<tr>
<td>2002</td>
<td>EnvironOxide™ registered as trademark in US and EU</td>
</tr>
<tr>
<td>2002</td>
<td>Grants from PADEP, OSM, and WPWP to Southern Alleghenies Conservancy to support IOR’s pilot scale recovery of iron product at Lowber site (Washington County)</td>
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<tr>
<td>2003</td>
<td>First recovery of saleable product from passive mine water treatment system (Howe Bridge, Jefferson County)</td>
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<tr>
<td>2003</td>
<td>EnvironOxide™ Pigments named One of the Top Ten New Green Products in 2003 by GreenSpec™</td>
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<td>EnvironOxide™ registered as trademark in US and EU</td>
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<td>2004</td>
<td>First signed maintenance agreement, Scrubgrass Creek Watershed Association and IOR, maintenance in exchange for rights to future iron (Allegheny County)</td>
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<tr>
<td>2004</td>
<td>Recovery of saleable product from Keystone passive treatment system (Armstrong County)</td>
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<tr>
<td>2005</td>
<td>First recovery of saleable product from artesian AMD discharge site (Clarion County)</td>
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<tr>
<td>2005</td>
<td>EnvironOxide® registered as trademark by US Patent and Trademark Office</td>
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<tr>
<td>2006</td>
<td>First royalties paid to landowners in exchange for iron deposits on their property (Clarion County)</td>
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<tr>
<td>2006</td>
<td>Lowber iron oxide producing passive treatment system constructed and functional</td>
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<tr>
<td>2006</td>
<td>Record year for iron oxide production (664 tons)</td>
</tr>
<tr>
<td>2007</td>
<td>Iron oxide processing center scheduled to open in Clarion County</td>
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<tr>
<td>1995</td>
<td>SBIR Phase I Award from USDA to Hedin Environmental to investigate the feasibility of recovering a valuable solid from coal mine drainage.</td>
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<tr>
<td>1996</td>
<td>SBIR Phase I Award to Hedin Environmental to continue research</td>
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<tr>
<td>1999</td>
<td>Patent No. 5,954,969 for the recovery of iron oxides from mine drainage awarded to Robert Hedin by U.S. Patent and Trademark Office</td>
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<tr>
<td>2000</td>
<td>First Maintenance Agreement Signed</td>
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<tr>
<td>2003</td>
<td>EnvironOxide™ is Named Top 10 New Green Building Product</td>
</tr>
<tr>
<td>2004</td>
<td>2001 First Sale</td>
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<td>2004</td>
<td>2004 First Maintenance Agreement Signed</td>
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<tr>
<td>2006</td>
<td>2006 First iron royalties paid</td>
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<tr>
<td>2007</td>
<td>Clarion iPARC</td>
</tr>
<tr>
<td>Site</td>
<td>County</td>
</tr>
<tr>
<td>------------------</td>
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</tr>
<tr>
<td>Howe Bridge</td>
<td>Jefferson County</td>
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<tr>
<td>Lowber</td>
<td>Westmoreland County</td>
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<tr>
<td>Schwabenbauer</td>
<td>Clarion County</td>
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<tr>
<td>Keystone</td>
<td>Armstrong County</td>
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<tr>
<td>Scrubgrass</td>
<td>Allegheny County</td>
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<tr>
<td>Horner</td>
<td>Clarion County</td>
</tr>
</tbody>
</table>

2,400 tons sold from 6 sites
... recovery is occurring at two construction sites...

Farmington

Wilson

...and being considered at many other sites.

Honeypot

Hoyman

Hall
Are We There Yet?
The Present State of Iron Recovery
Effective Treatment

• Marchand Discharge
  – Sewickley Creek
  – Flow, 1400 – 2250 gpm
  – Fe, 65 – 90 mg/L
  – Fe, 1500 lb/day
  – FeO(OH), 800,000 lb/yr

• Passive Iron Oxide Producing System
  – series of settling ponds and constructed wetlands
  – $1.3 million
Fe removal by the Marchand System
For the visually oriented…

Pond A

Final Discharge
Anticipated Long-term Costs and Values

• Routine O&M: $4,000 per year

• Sludge recovery
  – years 0-6, no recovery
  – years 7 forward, 400 tons/yr
  – $75-100/ton (delivered to PC)

• Sludge value (delivered to PC)
  – $100/ton
Where Are We Going?
IOR Processing Center

- Located near I-80 in Clarion County
- Iron sludge will be dried, screened, and blended
- Highest quality product will be sold to existing customer
- Lower quality products will be marketed for lower-value uses
- 2007: accepting Fe sludge from 3rd parties
  - Sludge must be pre-approved
  - Paying royalties, recovery costs, and trucking in some cases
  - Avoid landfilling, restore treatment system effectiveness, reclaim degraded AML
iPARC Network (3 sites) and Areas of Influence

Clarion iPARC
Irwin iPARC
Anthracite iPARC

EXPLANATION

BITUMINOUS FIELDS
- High-volatile bituminous coal
- Medium-volatile bituminous coal
- Low-volatile bituminous coal

ANTHRACITE FIELDS
- Anthracite
- Semi-anthracite

Prepared by Bureau of Topographic and Geologic Survey

LDNR
Next Steps

Short-Term
• Open PC and develop processing procedures
• Establish new markets for bulk unfinished products
• Develop market for iron sludge

Mid-Term
• Establish sludge recovery feasibility across PA
• Increase iron sludge production

Long-term
• Advance processing capabilities: produce finished products
• Develop other PCs in PA
Questions?