Self-Sustainable Mine Water Treatment through Passive Iron Oxide Recovery

Bob Hedin

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

- Revenue from sale of iron product
- Cost control through passive technologies
- Effective treatment through good design
How did we get here?

Are we there yet?

Where are we going?
How Did We Get Here?
Milestones in Iron Recovery
<table>
<thead>
<tr>
<th>Year</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<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 II 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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<td>2000</td>
<td>Iron Oxide Recovery, Incorporated in Pennsylvania</td>
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<td>2000</td>
<td>Grants from PADEP, OSM, and WPWP to Sewickley Creek Watershed Association to support IOR’s pilot scale recovery of iron product at Lowber site (Westmoreland 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>
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<tr>
<td>2002</td>
<td>Grant support from Southern Alleghenies Conservancy to support continued iron recovery by IOR</td>
</tr>
<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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<td>2003</td>
<td>EnvironOxide™ Pigments named One of the Top Ten New Green Building Products in 2003 by GreenSpec™</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>
</tr>
<tr>
<td>2006</td>
<td>First royalties paid to landowners in exchange for iron deposits on their property (Clarion County)</td>
</tr>
<tr>
<td>2006</td>
<td>Lowber iron oxide producing passive treatment system constructed and functional</td>
</tr>
<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>
</tr>
</tbody>
</table>

- **1999** Patent
- **2001** First Sale
- **2004** First Maintenance Agreement Signed
- **2003** First Recovery from Passive System
- **2003** EnvironOxide™ is Named Top 10 New Green Building Product
- **2006** First iron royalties paid
- **2007** Clarion iPARC
2,400 tons sold from 6 sites

Howe Bridge
Jefferson County
58 tons, existing system

Lowber
Westmoreland County
1,610 tons, pond/channel

Schwabenbauer
Clarion County
89 tons, artesian deposit

Keystone
Armstrong County
239 tons, existing system

Scrubgrass
Allegheny County
48 tons, existing system

Horner
Clarion County
367 tons, artesian deposit
... recovery is occurring at two construction sites...

Farmington

...and being considered at many other sites.

Honeypot

Wilson

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

Fe, mg/L

- Influent
- Effluent

Oct-06  Nov-06  Dec-06  Jan-07  Feb-07  Mar-07  Apr-07
For the visually oriented…

Pond A

Final Discharge
Where Are We Going?

Iron Processing And Recovery Center
Clarion iPARC

- 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

Next Steps

Short-Term
- Open Clarion iPARC 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 iPARCs in PA
Questions?