Successful Production of a Marketable Iron Product from Mine Drainage Sludge

Bob Hedin

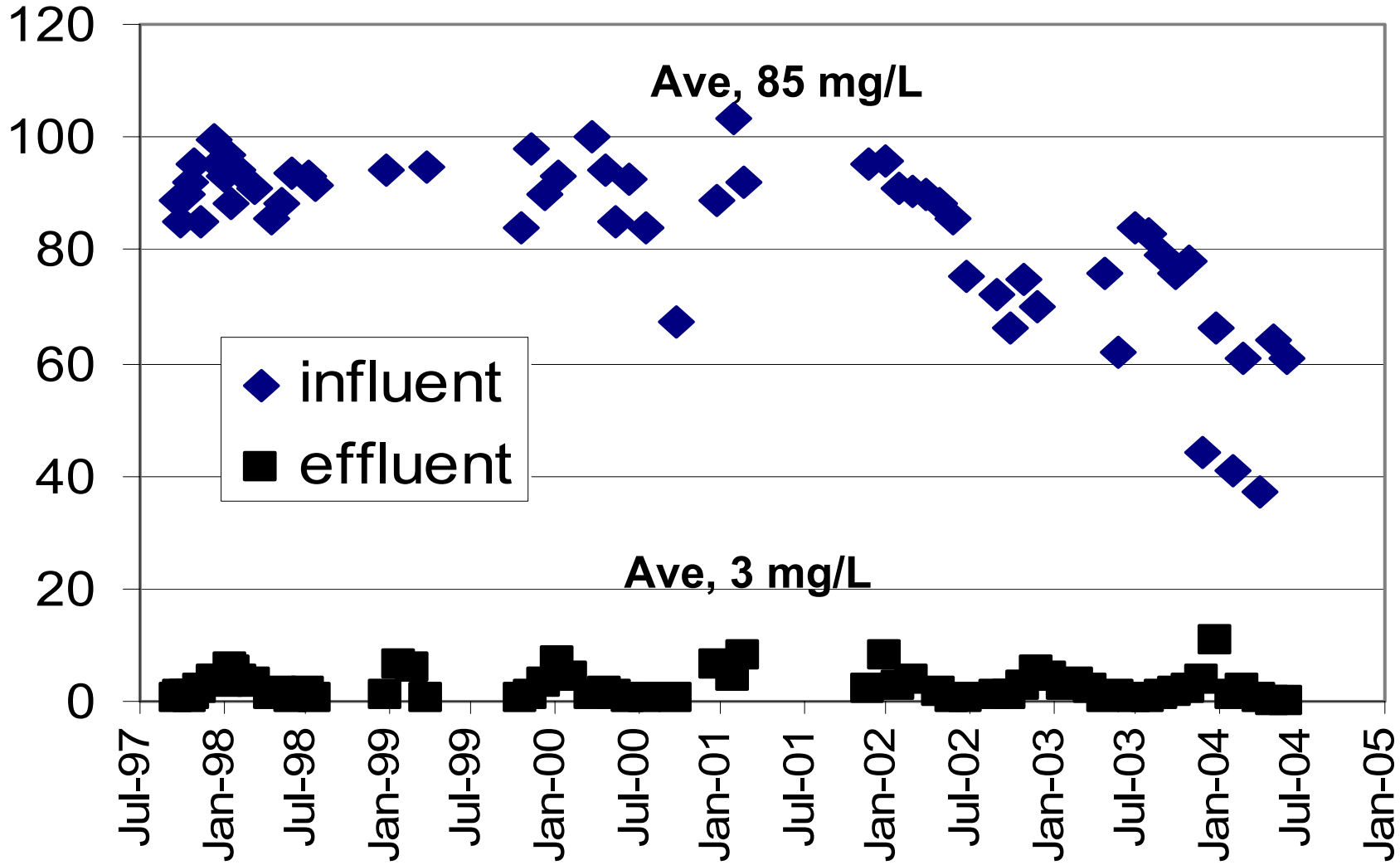
Ted Weaver

Kim Weaver

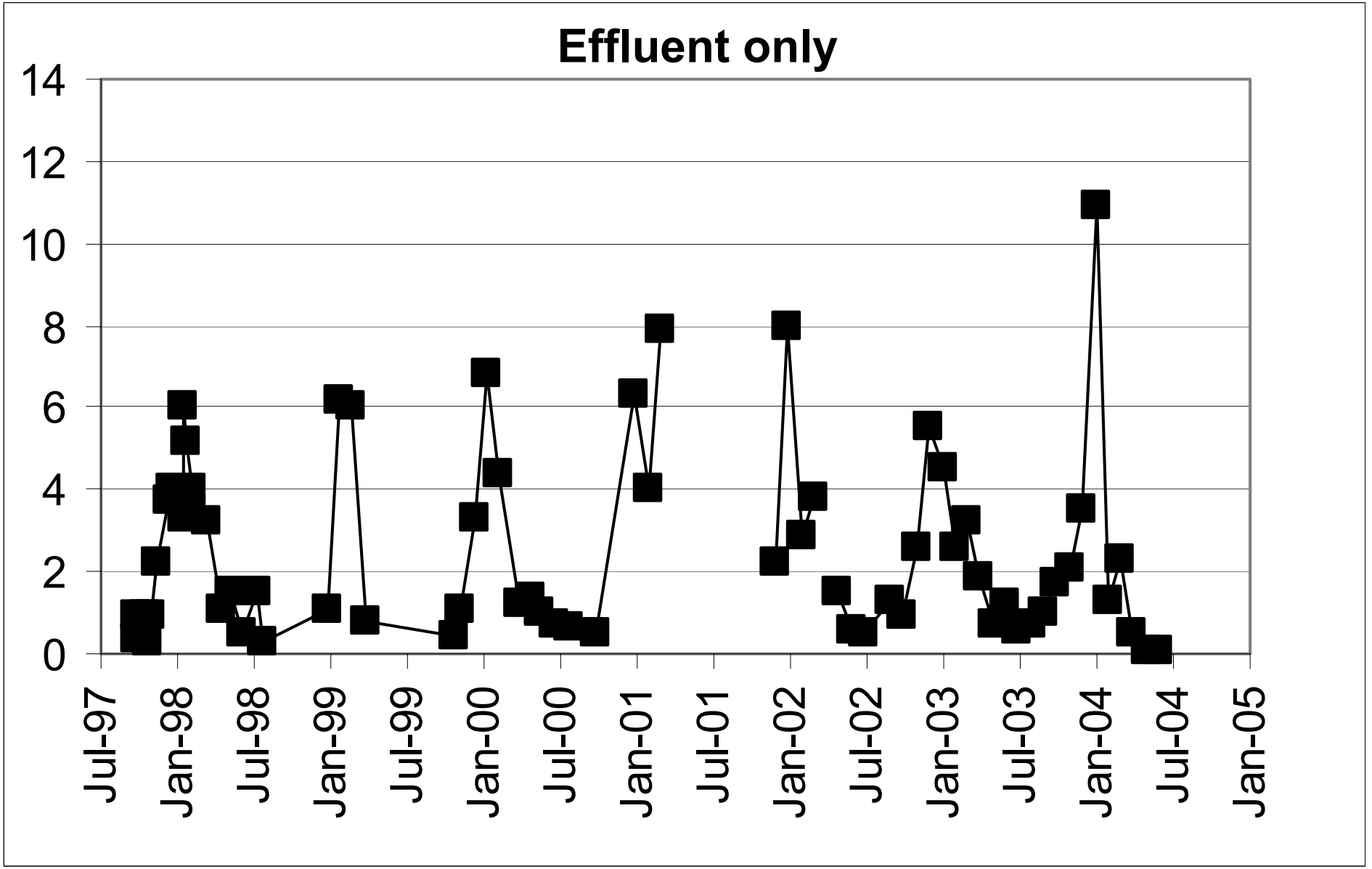
Iron Oxide Recovery, Inc

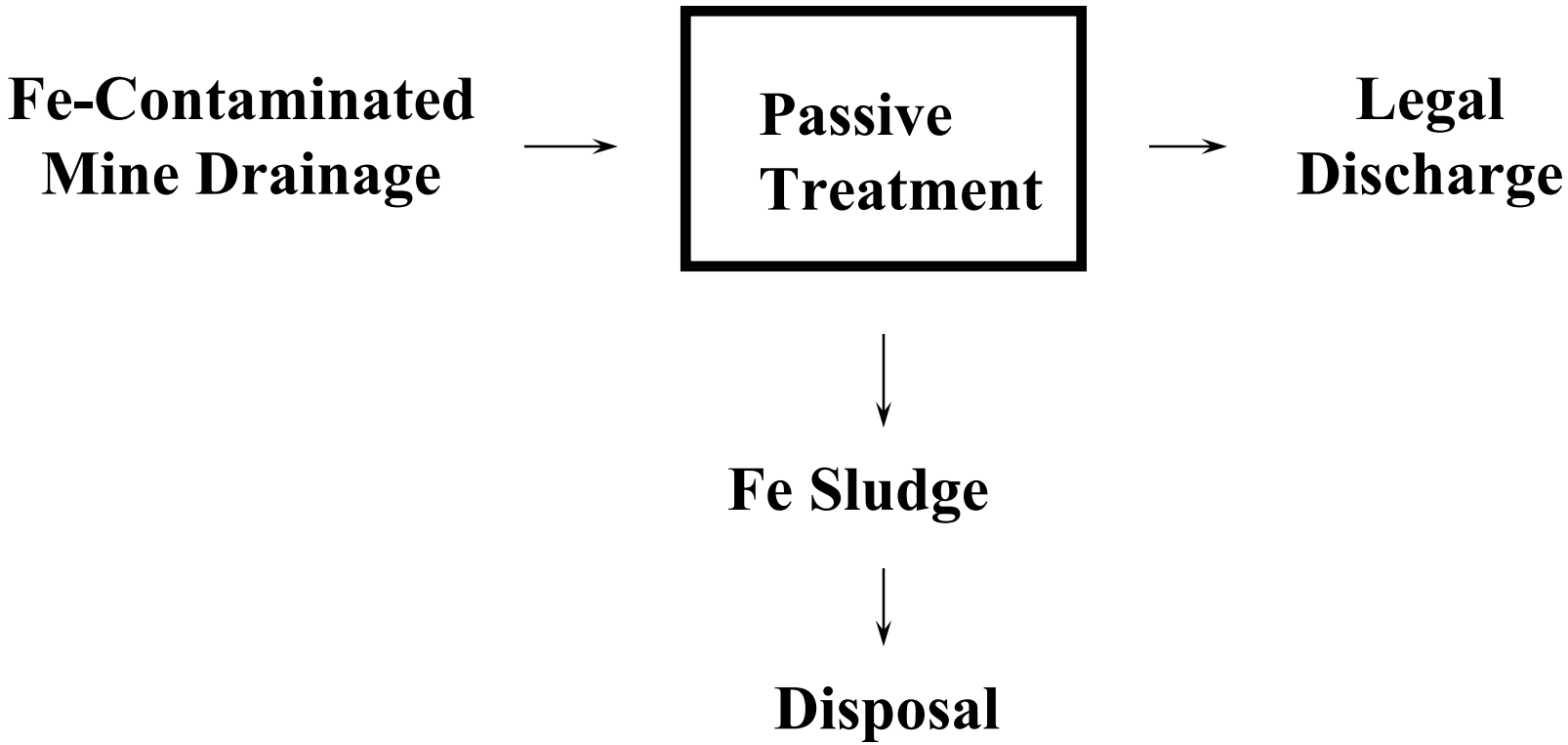
Pittsburgh, PA

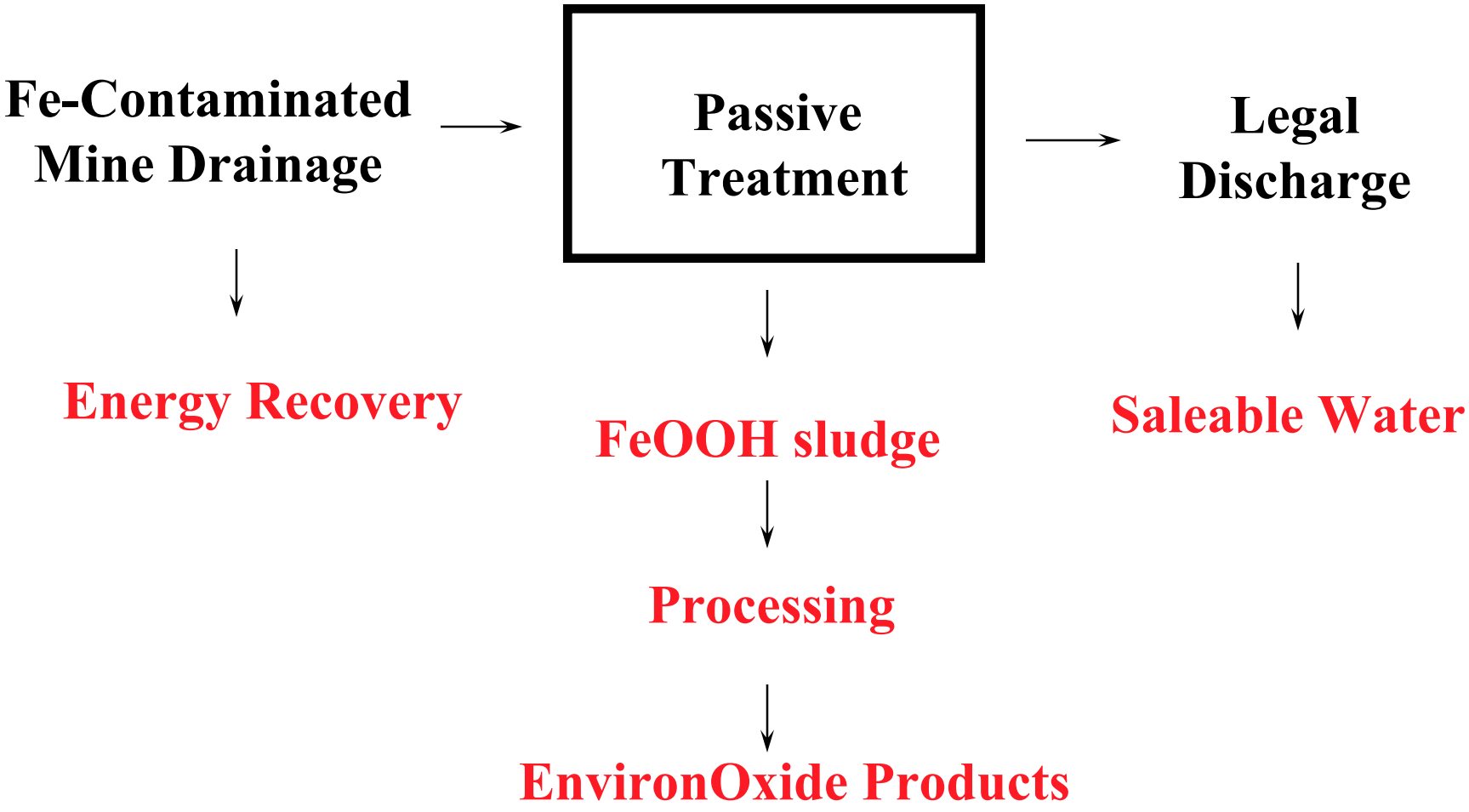
Monastery Run Improvement Project, Wetland 3



Monastery Run Improvement Project, Wetland 3




Fe-Contaminated
Mine Drainage
Passive
Treatment
Legal
Discharge
Fe Sludge
Disposal


Fe-Contaminated
Mine Drainage
Passive
Treatment
Legal
Discharge
Energy Recovery
FeOOH sludge
Saleable Water
Processing
EnvironOxide Products

Lowber Project, 2000-2003

- Can saleable product be made?
- What are economics of various recovery processes?

Objectives of Processing

- Remove sludge from channel
- Separate vegetation, litter, rocks and debris
- Dewater to at least 45% solids

Sludge Recovery with Pumps

Recovery with an Excavator

Wet Screening

Dry screening

Frame Filter Press

Belt Filter Press

Geotube

Natural Dewatering

Pressed Product

Dry Screen Product

RAVENS

Iron Oxide Production to Date

- 2002, 500 tons from Lowber
- 2003, 500 tons from Lowber
- 2004, 300 tons from Lowber
- 2004, 50 tons from Howe Bridge PTS
- 2004, 150 tons from Keystone PTS
- 2005, 50 tons from Scrubgrass PTS

environoxide™

- Registered trademark in US and EU
- The mark identifies products containing iron oxide recovered from mine drainage
- Working on scientific accreditation of the green aspects of the product

environoxide

pigments

- Hoover Color Corporation
  - new line of Yellow, Red, and Brown Pigments
  - at least 80% mine drainage iron oxide

BUILDINGGREEN
2003 TOP-10
GREENSPEC® PRODUCT

Iron Oxides from AMD

- Iron oxide database: 190 samples from 52 sites
- Impure samples due to mud (25%)
- Good purity samples that do not make good pigment (60%)
  - Natural deposits precipitated at pH < 6
  - Active treatment
- Current market only values materials similar to the original Lowber

Sites where pH is less than 6

Sample	Fe	Si	Al	Mg	Ca	LOI
Pigment	68	11	2.4	0.2	0.3	18
(95% CI)	(4)	(3)	(0.9)	(0.1)	(0.1)	(1)
Hoo	76	2	0.8	<0.1	<0.1	22
Dit	78	1	<0.1	<0.1	<0.1	22
Ke	79	1	<0.1	<0.1	<0.1	20
Hor	79	2	0.3	<0.1	<0.1	18
To	78	1	<0.1	<0.1	<0.1	20

Sites where oxidation is promoted

Sample	Fe	Si	Al	Mg	Ca
Pigment (95% CI)	68 (4)	11 (3)	2.4 (0.9)	0.2 (0.1)	0.3 (0.1)
Spray	76	5	0.9	0.2	1.4
Channel	74	6	3.1	0.2	1.3
Mixing	75	9	0.7	0.2	1.2
Aerator	81	3	0.1	0.1	1.3
H_2O_2	76	3	0.4	0.2	5.0
H_2O_2	71	3	0.4	0.2	3.6
NaOH	65	4	3.5	0.5	3.7

Chemical Treatment Sludge

Sample	Fe	Si	Al	Mn	Mg	Ca
NaOH (Fe, Al, Mn)	5.8	7.4	12.5	12.0	24.1	3.6
NaOH (Mn, Al)	1	5.5	6.6	12.8	31.6	6.9
$Ca(OH)_2$ (Fe)	4	0.6	<0.1	0.2	0.6	49.4
$Ca(OH)_2$ (Fe, Al, Mn)	27	4.8	4.0	2.8	2.9	24.3

R&D: Other EnvironOxide Values

- FeOOH → Fe^0 -- metal industries
- FeOOH → Fe_3O_4 – magnetic applications
- FeOOH – contaminant adsorption
  - Treatment of Arsenic and Selenium contaminated waters
  - Add Phosphate retention capabilities to agricultural soils
- FeOOH – soil amendment

Screening tests of anion removal

	SA, m^2/g	Se(VI) removal	As(V) removal	PO_4 removal
FeOOH – acid	156	41%	99%	99%
FeOOH – ALD	177	32%	99%	99%
FeOOH – alk	94	12%	99%	98%
Fe_2O_3	na	8%	99%	87%

Quantifying As(V) removal

	Adsorption capacity
FeOOH – acid	29 mg/g
FeOOH – ALD	23 mg/g
FeOOH – Alk	8 mg/g

Material	Adsorption Capacity mg P per gram substrate
Steel furnace slag	0.05 – 0.65
Zeolite	2.2
Lagoon fly ash	3.1
Iron oxide tailings	8.6
Precipitator fly ash	14
Treatment system ochre	26

from Heal, Dobbie, Bozika, McHaffle, Simpson and Smith. 2005. Water, Sci, Tech., 9, 275-282

Using P-saturate ochre as a fertilizer

	Control	Chem P	FeOOH-P
Available P start	4	20	18
Available P end	2	5	10
Barley seed	15	16	17
Birch growth	5	14	16
Spruce growth	4	10	12

from, Dobbie, Heal, and Smith. 2005. Soil Use and Management, 21, 231-239