Geomorphologic Reclamation of Abandoned Coal Mines near Raton, NM

The Swastika Mine and Dutchman Canyon Reclamation Project

• Design and Construction Oversight
• Reclamation and Revegetation

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The Swastika Mine and Dutchman Canyon Reclamation Project

- Design and Construction Oversight
- Reclamation and Revegetation

Completed Geomorphic Reclamation of Dillon Canyon at the Swastika Abandoned Coal Mine Site

Sept. 18, 2012
Environmental Permitting & Reclamation Planning

- EA & FONSI
- Wetland Delineation and Jurisdictional Determination
- ACOE 404 NW-27 Permit
- ACOE Mitigation and Monitoring Plan Approval
- Archaeology Survey and SHPO Mitigation Plan Approval
- Wetlands Preservation & Reclamation Planning
Wetlands Preservation

The "Ox-bow" Wetland Preservation
Wetlands Preservation
Abandoned Coal Waste at Swastika Mine

High, ungraded “piles”

Gob Pile 3

Flat-topped “bench”

Gob Pile 2

Gob Pile 5
Site Characterization

- Gob Chemistry
- Borrow Soil Chemistry
Site Characterization

- Wetland Delineation
- Vegetation Survey
- T&E Species Survey
Reclamation Planning

- Borrow Soil Suitability
- Gob Mitigation
## Gob Mitigation

<table>
<thead>
<tr>
<th>Gob Pile</th>
<th>Depth (inches)</th>
<th>pH</th>
<th>EC (µS)</th>
<th>SAR</th>
<th>Potential Acidity (t/kt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP-5 Pre</td>
<td>0-6</td>
<td>4.4</td>
<td>0.39</td>
<td>0.73</td>
<td>2.2</td>
</tr>
<tr>
<td>GP-5 Pre</td>
<td>6-12</td>
<td>4.2</td>
<td>0.77</td>
<td>0.66</td>
<td>2.8</td>
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<tr>
<td>GP-5 Post</td>
<td>0-12</td>
<td>6.6</td>
<td>4.6</td>
<td>8.2</td>
<td>4.1</td>
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<tr>
<td>GP-3b Pre</td>
<td>0-12</td>
<td>7.4</td>
<td>2.0</td>
<td>15</td>
<td>1.4</td>
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<tr>
<td>GP-3b Post</td>
<td>0-12</td>
<td>7.8</td>
<td>2.7</td>
<td>11.5</td>
<td>6</td>
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</table>
## Borrow Soils

<table>
<thead>
<tr>
<th>Site</th>
<th>Borrow Soil Horizon</th>
<th>Depth (inches)</th>
<th>pH</th>
<th>EC µS</th>
<th>SAR</th>
<th>Texture</th>
<th>OM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swastika Borrow</td>
<td>A</td>
<td>0-35</td>
<td>7.4</td>
<td>0.44</td>
<td>0.71</td>
<td>L</td>
<td>1.87</td>
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<tr>
<td></td>
<td>Bt</td>
<td>35-54</td>
<td>7.4</td>
<td>0.77</td>
<td>0.79</td>
<td>SCL</td>
<td>1.63</td>
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<tr>
<td></td>
<td>Bk</td>
<td>54-85</td>
<td>7.5</td>
<td>.73</td>
<td>0.79</td>
<td>SCL</td>
<td>1.13</td>
</tr>
<tr>
<td>Swastika Channel</td>
<td>A</td>
<td>0-19</td>
<td>7.5</td>
<td>0.6</td>
<td>0.5</td>
<td>SCL</td>
<td>2.32</td>
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<tr>
<td></td>
<td>Bt</td>
<td>19-64</td>
<td>7.0</td>
<td>2.4</td>
<td>0.6</td>
<td>SCL</td>
<td>2.62</td>
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<tr>
<td></td>
<td>Bk</td>
<td>64-105</td>
<td>7.5</td>
<td>1.2</td>
<td>0.5</td>
<td>SCL</td>
<td>2.71</td>
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## Reclamation Planning: Seed Mixes

<table>
<thead>
<tr>
<th>Seed Mix</th>
<th>Composition (No. of species, %, PLS/SF)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Grasses</td>
</tr>
<tr>
<td>Upland</td>
<td>10, 75, 37.5</td>
</tr>
<tr>
<td>Wetland Swastika</td>
<td>10, 85, 42.5</td>
</tr>
<tr>
<td>Wetland Dutchman</td>
<td>8, 90, 45</td>
</tr>
</tbody>
</table>
Construction:

- Channel Realignment
- Soil Borrow & Gob Repository
Construction:

- Installation of BMPS
- Gob removal and reshaping
- Geomorphic grading
Reclamation: Amendments

- Lime, Gypsum and Fertilizer were amended at rates determined by the soil test results

- Lime: neutralize potential acidity and SAR
- Gypsum: neutralize SAR
- Fertilizer: Nitrogen to modify C:N ratio of compost
Reclamation: Compost

- Local source of composted sawmill waste
- C:N ration of 110:1
- Treated with N to 30:1
- Applied at 400 cy per acre
Reclamation: Compost

- Applied at 400 cy per acre over gob and poor cap soils
Reclamation: Ripping

- Ripping to incorporate amendments and alleviate compaction
- Two perpendicular passes
- Rip to 12” depth
- Final pass on the contour
Reclamation: Seeding & Mulching

- Broadcast seeding at 50 PLS/sf
- Seed size variability required hand seeding

Woodstraw™ Application Rates:

- 0-5%: 4,000 lbs/acre (40% cover)
- <33%: 7,500 lbs/acre (50% cover)
- >33%: 13,800 lbs/acre (70% cover)
Reclamation: Turf Reinforcement Mat (TRM)

EXCEL CC4
LandLok TRM 450
Duckbill anchors used to secure TRM at edges
Reclamation: TRM

- Duckbills inserted 3 feet into the ground with an impact hammer
- Friction disk hold fabric in place up to 300 psi
Reclamation: TRM

- TRM EXCEL CC-4 transitions between lower velocity point bars and straight reaches
- Landlok 450 is placed at approaches to cut banks
Reclamation: Wetland Transplant Plugs

- Wetland plugs dug from channel before backfilling
- Held in 1 gallon pots until new channel was constructed
Reclamation: Wetland Transplant Plugs

- Local provenance of wetland plugs
- Many species are not commercially available

- Wetland plugs established and spread quickly
Reclamation: Riparian Transplants

- Willows and Cottonwoods harvested with 32” tree spade from channel before backfilling
- Placed in wire baskets for storage

- Cottonwoods were fenced for protection from grazing by elk
Reclamation: Riparian Transplants

- Willows planted next to channel in wet soils
- Cottonwoods planted up gradient into mesic soils
Reclamation: Riparian Transplants

- Transplants moved from digging areas to nursery holding yard
Reclamation: Riparian Willow Staking

- Willow stakes cut in Spring 2013
- Planted by Raton area student volunteers
Reclamation: Riparian Cottonwood Pole Planting

- Cottonwood poles were cut, limbed and planted
- Hole depth to ground water table
Reclamation: Upland Transplants

- Upland species including oak, chokecherry, rabbitbrush and currant were transplanted
Reclamation: Dutchman Compensatory Wetlands

- ACOE 0.6 acre mitigation wetland
- Further finish saline/sodic historic mine adit drainage
Reclamation: Dutchman Compensatory Wetlands

- Flood irrigation onto compensatory wetland site
- Seeded with wetland mix
- Willow staking
Project Constraints:

Unidentified Cultural Resources
Project Constraints:

- Steep Slopes
- Groundwater
Project Constraints

- In-stream Construction
- Sediment Control
Project Constraints

- Wildlife
Project Constraints

Detailed Geomorphic Grading Plan
Project Constraints

• Steep and short transition from up gradient project boundary and channel

• Narrow work area due to cultural resources

• 2012-2013 drought
Geomorphologic Channel Realignment and Restoration

- Transplanting native vegetation resulted in a quick establishment
- Rapid channel stabilization

TRM will stabilize channel banks until vegetation is established
THE NEW MEXICO MINING AND MINERALS DIVISION PRESENTED A 2012 EXCELLENCE IN RECLAMATION AWARD TO THE PROJECT TEAM

Water and Earth Technologies Inc., and Habitat Management Inc., Kiewit New Mexico Company and 814 Solutions LLC, were honored for their work at the Swastika Mine and Dutchman Canyon Reclamation Project at the Vermejo Park Ranch where the focus was innovative abandoned coal mine reclamation and geomorphic landforming.
The Swastika Mine and Dutchman Canyon Reclamation Project

Habitat Management, and Water & Earth Technologies express our appreciation for the assistance and dedication of the following individuals and companies in making this award winning project a success:

Zoe Isaacson, Mike Thompson and John Kretzmann-New Mexico EMNRD AML Program; Gus Holm-Vermejo Park Ranch; Peter Kiewit New Mexico and 814 Solutions

ANY QUESTIONS?