Disturbed Land Reclamation
Design and Construction Using Fluvial Geomorphic Techniques

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This project was completed by:

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Chevron Mining Inc.
McKINLEY MINE
WET Qualifications

- Professional expertise and experience in:
  - Sediment and erosion control
  - Surface water conveyance and runoff control systems
  - Regulatory permitting services
- Trained in disturbed-land reclamation models including SEDCAD, RUSLE and Natural Regrade
Project Location

The project area is located due North of Gallup NM

Overview of the McKinley Coal Mine
Reclamation challenges that are presented for a surface coal mine include:

- Areas of disturbance are very large (>100 ac.),
- An earth balance is desired to minimize haul away or import materials, and
- Haul and push distances should be minimized for economic purposes.

Disturbance is composed of overburden material cast into piles by draglines.
Area 12C

Project Area at the McKinley Mine Site
Site Specific Challenges

1. Long steep slopes (18%-35%)
2. Southwest facing aspect
3. Undisturbed rock outcropping
4. Operational need to limit bulldozer pushes
5. Balance cuts and fills
Project Area at the McKinley Mine Site

Steep Convex Slopes

Image courtesy of Google Earth
Traditional Solutions:

- Draining terraces
- Riprap downdrains

Terraces to shorten slope length
Geomorphologic Approach

- Evaluate Undisturbed Stable Landforms
- Determine Appropriate Modeling Tools
- Design Watershed Network
- Address Further Permit Stipulations
Rainfall Parameters

New NOAA Atlas 14 for New Mexico
- 2-yr, 1-hr (bankfull)
- 50-yr, 6-hr (floodprone)
- 100-yr, 24-hr (if required by permit)

Rainfall Distribution Curves
- Type II 70 distribution
- United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)
Complete Field Survey to Determine Input Parameters

A Geomorphic approach using Natural Regrade™ with GeoFluv requires input parameters including:
- Drainage density
- Ridge to head of channel
- Sinuosity
- Width to depth ratio
- A-channel reach length
Drainage Density = \frac{\text{Length Of Channel}}{\text{Watershed Area}}

Target Drainage Density = 154 \text{ ft/acre}

Length = 420 \text{ ft}
Watershed Area = 2.9 \text{ ac}
Drainage Density = 145 \text{ ft/ac}
Ridge to Head of Channel Distance
What is an “A-Channel”?

Rosgen Stream Classification System
A-Channel Reach Length
Determine the Geofluv Configuration for a Functioning Watershed System

Watershed configuration for Area 12C
Seven subwatersheds to drain to existing arroyo
Complete a Geomorphic Design for Stable Landforms using Natural Regrade™

Cut-Fill balance is achieved
Additional analysis on the geomorphic design surface was completed to show that erosion rates and specified design flows would meet the correct criteria.
Additional Analysis Completed

- A 50-yr, 6-hr peak flow analysis was completed for designed watersheds with contributing area less than 1 square mile.
- A soil loss analysis was completed on the worst case slope in each watershed. The condition needed to be better than or equal to soil loss for pre-mining conditions.
- A channel stability analysis was completed to determine if additional channel protection would be necessary.
Available Tools to Support Geomorphic Analysis

OSM = Office of Surface Mining

T.I.P.S. = Technical Innovation and Professional Services

NATURAL REGRADE™ With GeoFluv

ARC GIS

SEDCAD

HEC-RAS

RUSLE
Tools Used for Analysis

The geomorphic design was analyzed using:

SEDCAD = Sediment, Erosion, Discharge by Computer Aided Design

RUSLE = Revised Universal Soil Loss Equation
## Sensitivity Analysis

### Peak flow comparison between models:

<table>
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<th>Subwatershed</th>
<th>Peak Flow (cubic feet per second)</th>
<th>Peak Flow (cubic feet per second)</th>
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<td>Natural Regrade (50-yr, 6-hr = 2.12&quot;)</td>
<td>SEDCAD (50-yr, 6-hr = 2.12&quot;)</td>
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RUSLE Analysis
From Design to Construction

[Map with areas in cut and fill marked with red and blue colors]

- Area in Cut
- Area in Fill

Cut-Fill Color Mapping
Construction Staking

-1.0 Magnitude of Cut
+1.0 Magnitude of Fill
+0.0 On Grade
Construction

Red flagging in the field indicates the location and magnitude of channel cuts.

Channel sinuosity defined by stake locations.
Construction

Bulldozer rough grades watershed geometry by pushing horizontally from the channel bottom to the ridge tops.
Construction

Regraded hill slope draining toward existing channel
Compliance

Provisions agreed to by the Office of Surface Mining:

1. Final Post Mining Topography can deviate +/- 10 vertical feet.

2. Constructed watershed boundaries must be within 10% of designed area.

3. Drainage Density must be maintained.

4. Constructed channels designed with freeboard to meet or exceed minimum requirements.
Questions