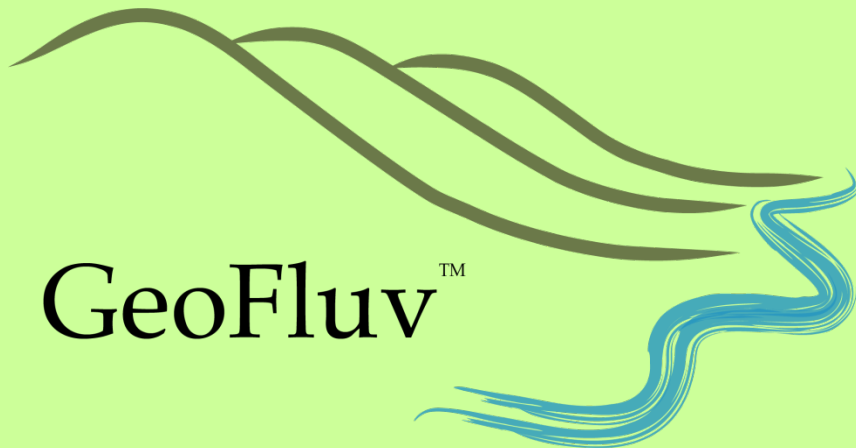# Rehabilitating Mines – using Natural Landforms

Ecological Rehabilitation of Mined Land Conference
25 September 2014

Rod Eckels, Landforma
Nicholas Bugosh, GeoFluv™

GeoFluv™

LANDFORMA
NATURAL SURFACE DESIGN

Rock Storage Facility- Waste Rock Storage

- Mine requirements
  - Move the dirt cost effectively
  - Meet regulatory requirements
  - Create "Stable" landforms remove water
- Regulators
  - Reduce the footprint
  - Protect local environment – water quality, drainage patterns, dust and noise
- Community input
  - Minimise disturbance
  - No visual affront
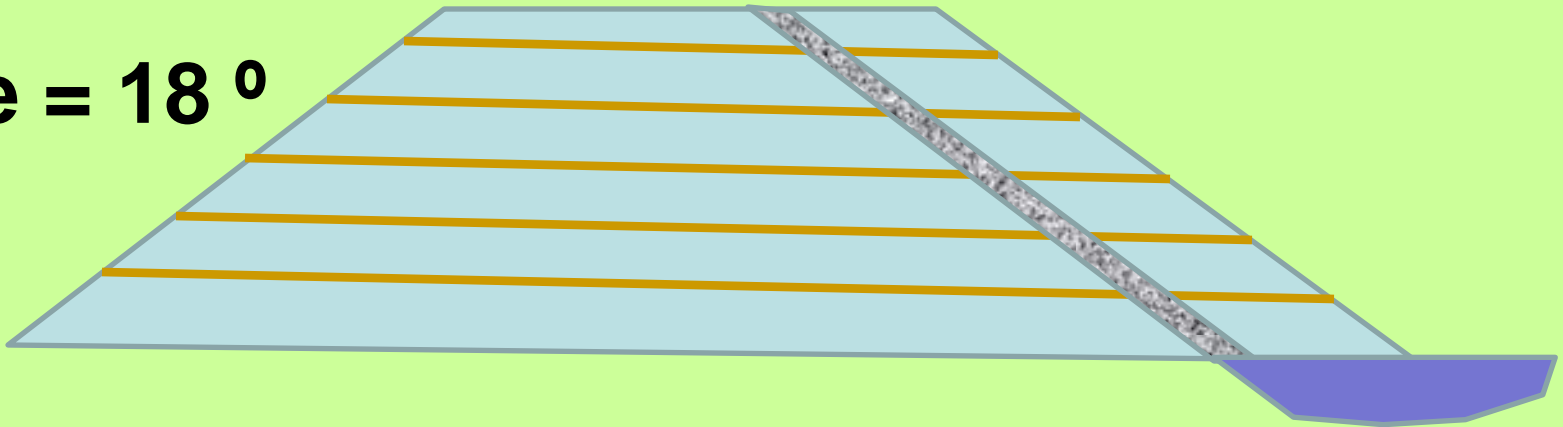 - Return land to pre-mined use

Something just tells you it isn't right . . .

Waste Rock Dump Construction

- **Mines generally build waste dumps to fit the most dirt in the smallest footprint – leads to flat-topped pyramid.**

Slope = 18 ^{0}

- **The flat gradient slopes can be up to 1:3 (=18^{0}, 33%)**
- **Water flow control structures are constructed**
  - **Contour banks and**
  - **Rock drains**
- **Retention Ponds are built to hold turbid water**

Constant Gradient Slopes subject to Erosion

- Subject to rills and gullies
- Leads to water quality issues

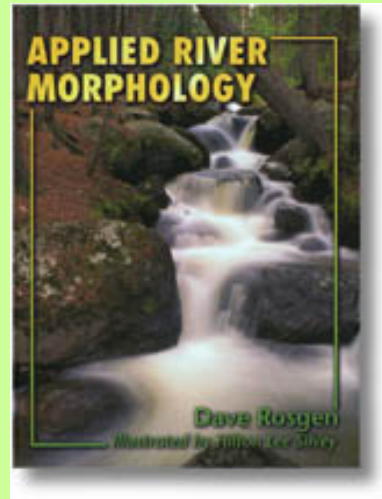# Contour Banks, Rock Drains, Retention Ponds

Issues

- Need Long term maintenance
  - Erosion and infrastructure failures

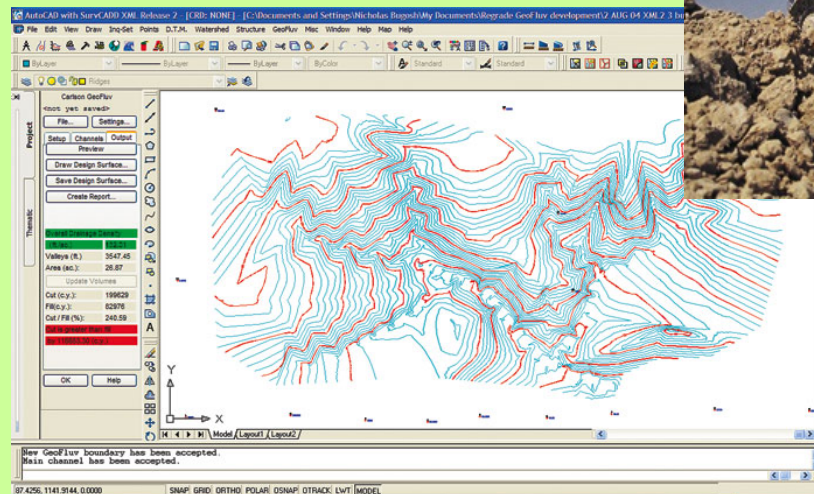# But our knowledge and access to technology has changed

We now understand more about how water flows and landscapes form. Water channel categorisation Systems

We have GPS guided earth moving machines.

We have access to fast computers with CAD capability that can calculate complex landforms

New Approach to Mined Land Rehabilitation

Combines knowledge of fluvial geomorphic principles with CAD programs and Machine Guidance to enable the construction of "natural" landforms.

- Drainage Patterns

A network of tributaries that join together to form larger channels – each characterised by gradient slope, discharge volume and sinuosity

Drainage density

– **Drainage density created to move the run-off with imperceptible erosion**

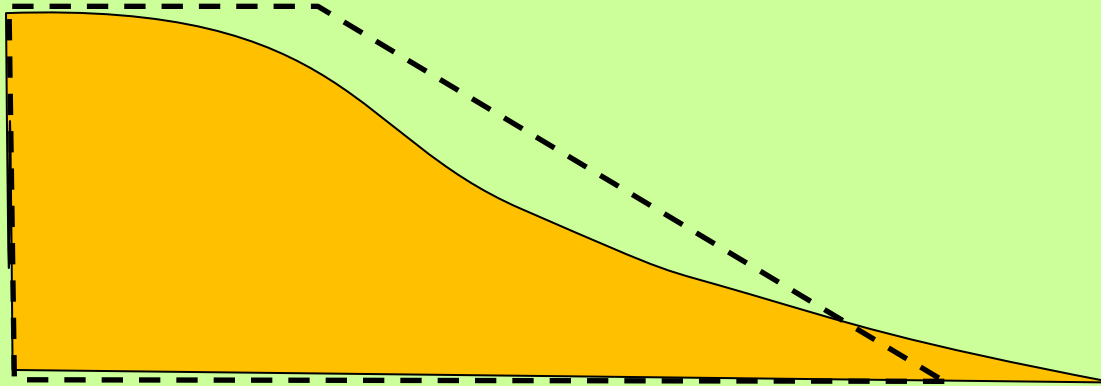# If there are not enough channels – new ones will form

Ridge line profiles – complex gradient slopes

- Natural Landforms
    - Small upper area to minimise run-off volume on the upper slopes
    - Complex slopes – steeper where there is less run-off and flatter when there is more water

What do we build ?

- Common Waste Rock Dump Landforms
  - Large flat are on the top – that concentrates water on the top of the dump
  - A series of drop structures that convey the water to the bottom of the slope.
  - But water always will find the low spot – and the path of least resistance – beside / under rock drains, piping etc.

It still does not look right

- Often do not provide habitats and biodiversity
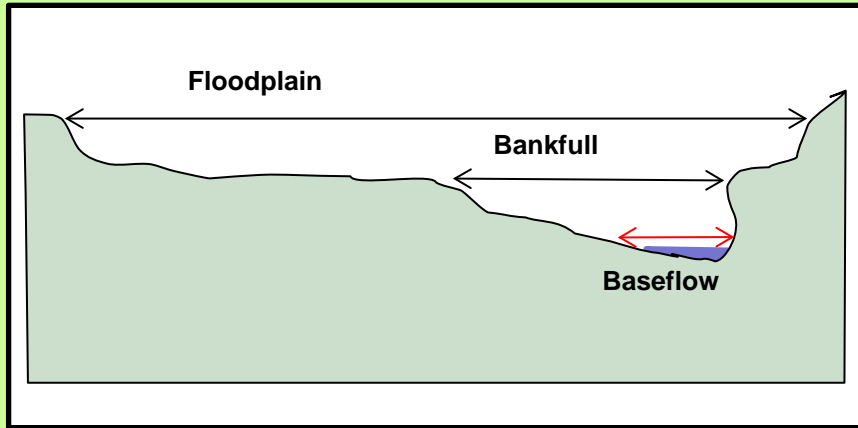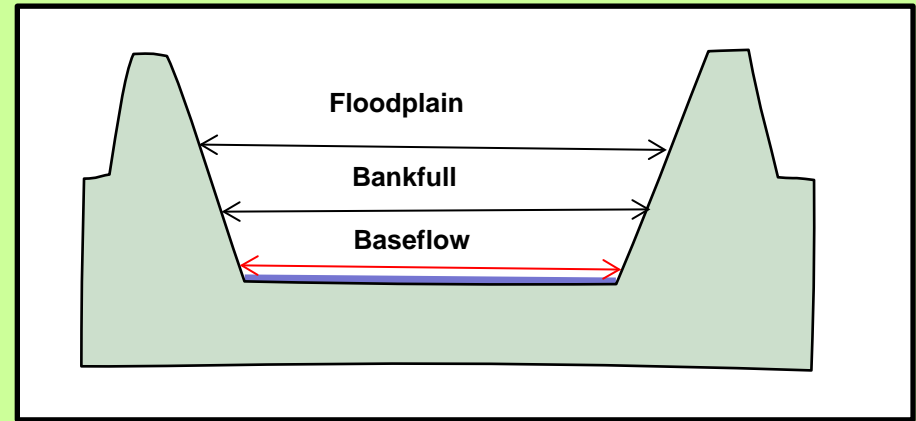 - Changing aspects, differing slopes

Waste Rock Dump

Natural Landscape

Channel Cross sections – Natural Channels

(Rosgen, 1996)

(Rosgen, 1996)

- Adjust to variable flow
- Dissipate Energy for all flows
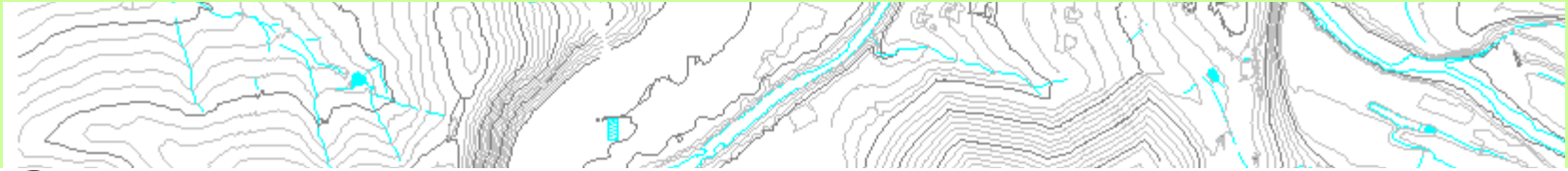- Always enough energy to keep channel from silting up.

- Do Not adjust to variable flow
- Contain Energy for all flow events
- Channel silts up in low flows – maintenance

Geomorphic Reclamation incorporates these "laws of nature" to create a functioning landscape from any disturbed land
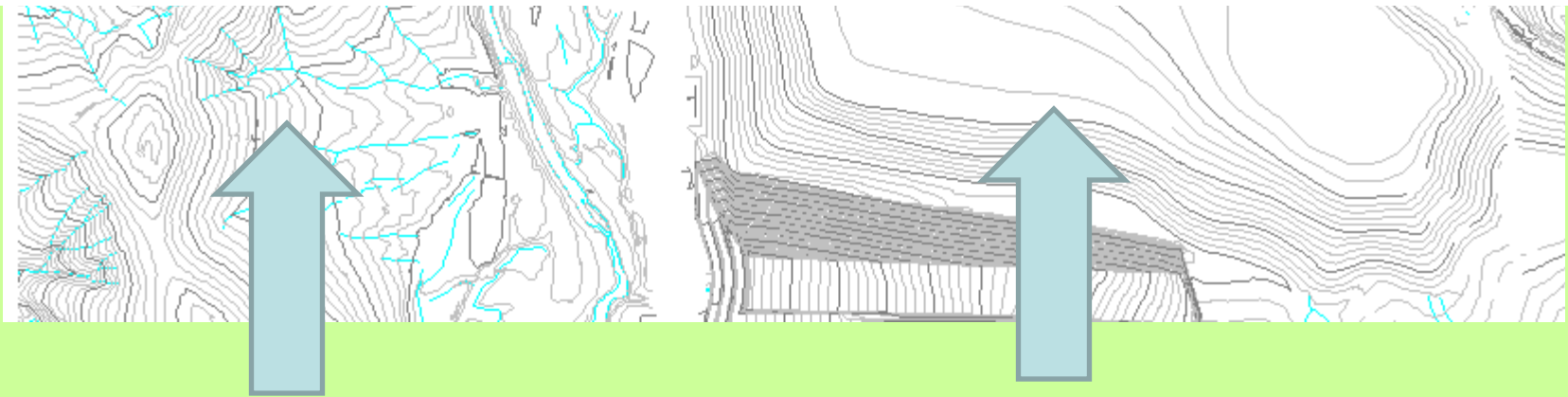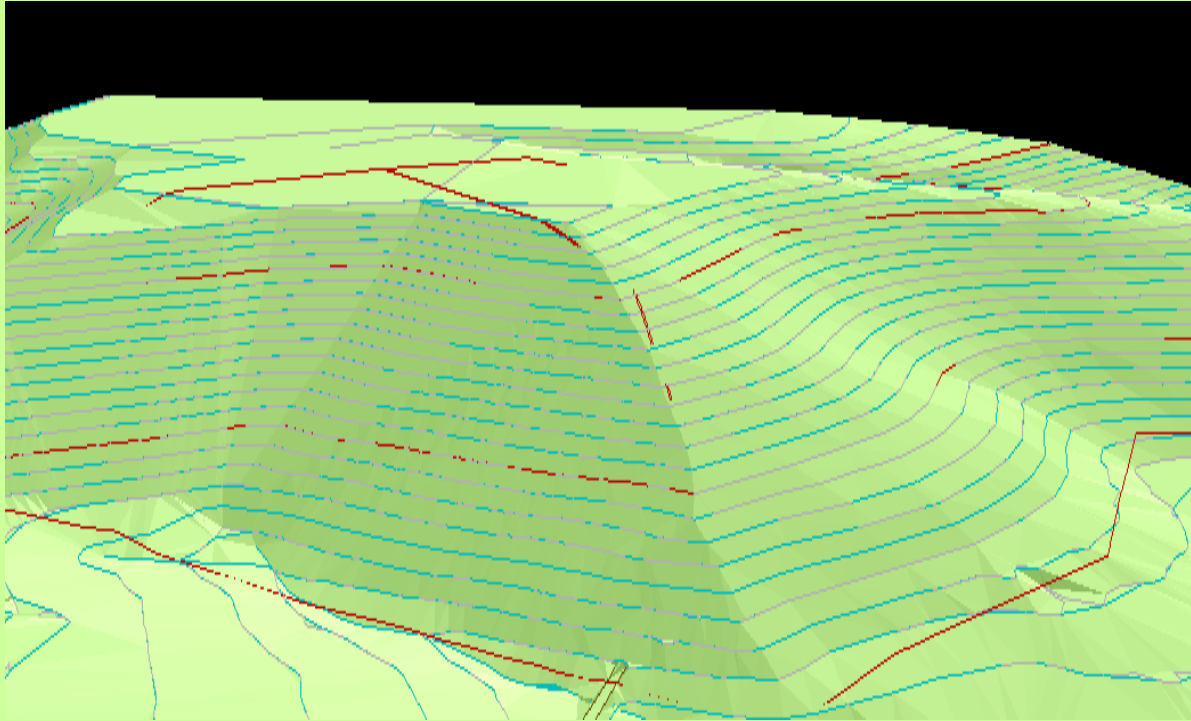
Contour Maps

Geomorphic approach to reclamation creates a landscape that would form by itself after 1000's of years of erosion.
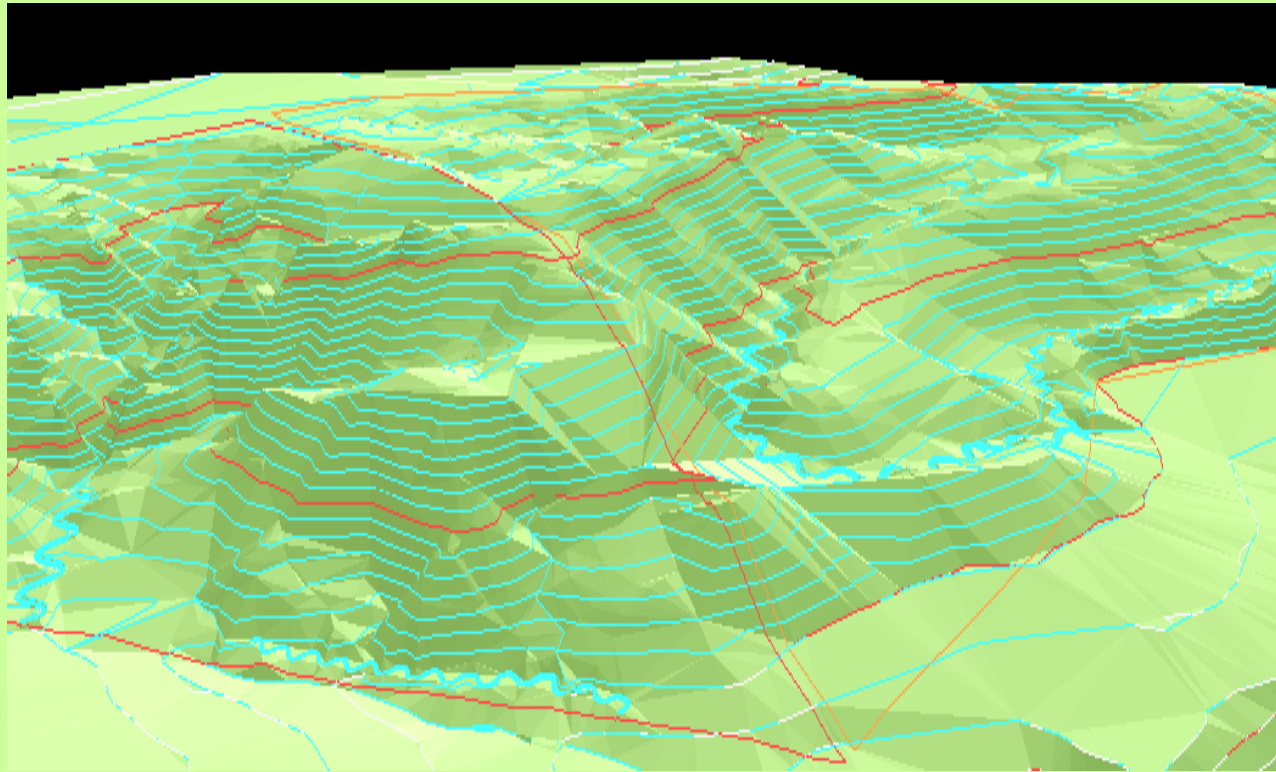
Natural Surface

Waste Dump

3D View of Traditional Design

- Long slopes without channels, promote rill and gully erosion (Needs artificial down-drains)

- Water quality – turbid run-off

- Minimal diversity for vegetation and wildlife

- Does not blend with surrounding terrain

3D View of GeoFluv Design

- Complex slopes with smaller sub-watersheds to reduce erosion
- Water run-off less turbid
- Natural slope and habitat diversity for vegetation and wildlife
- Blends with surrounding terrain

GeoFluv Process

CAD Model of Existing Site	Set the Design Boundary	Local Field Inputs

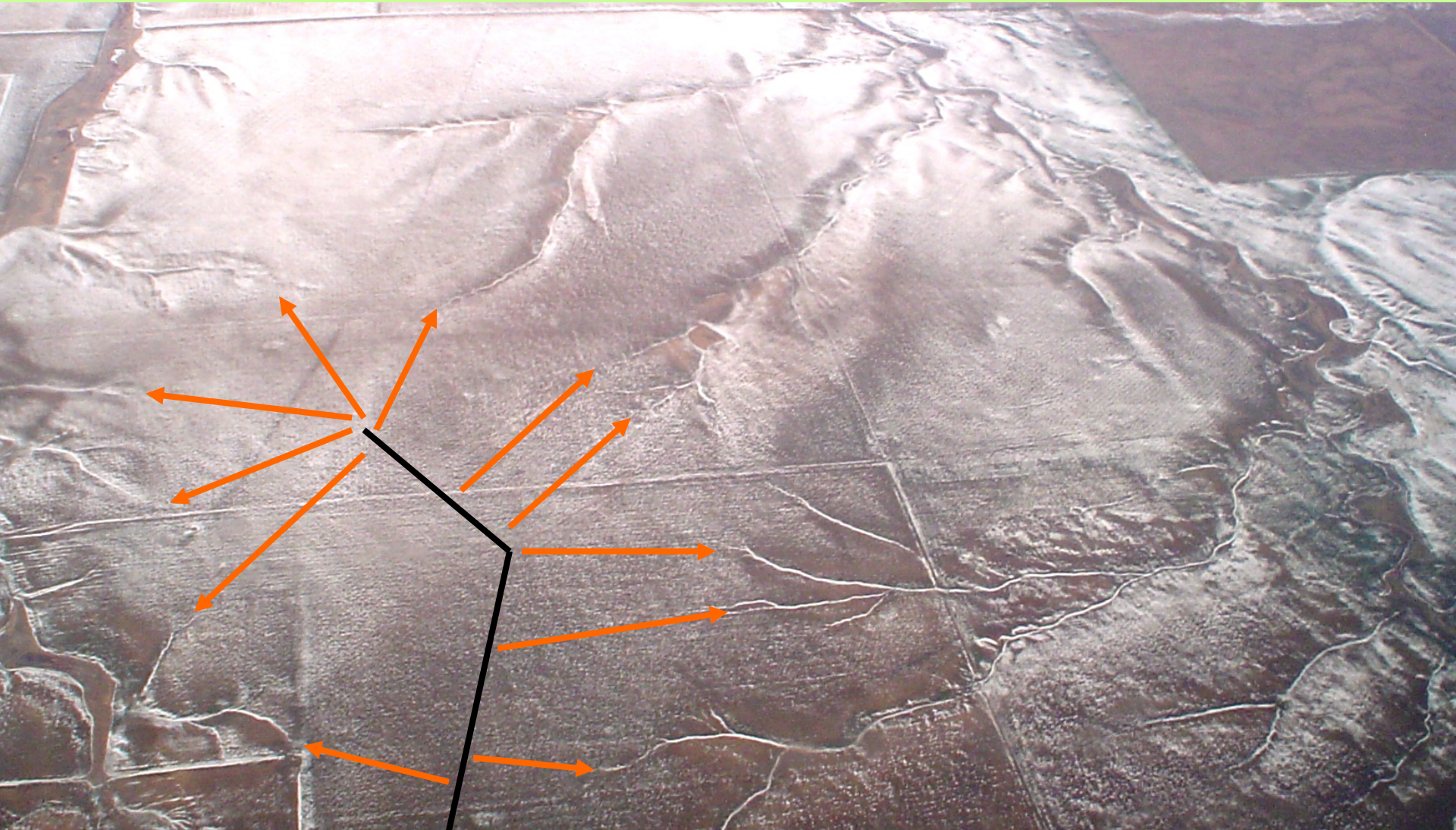| Program Design Inputs		GeoFluv Design
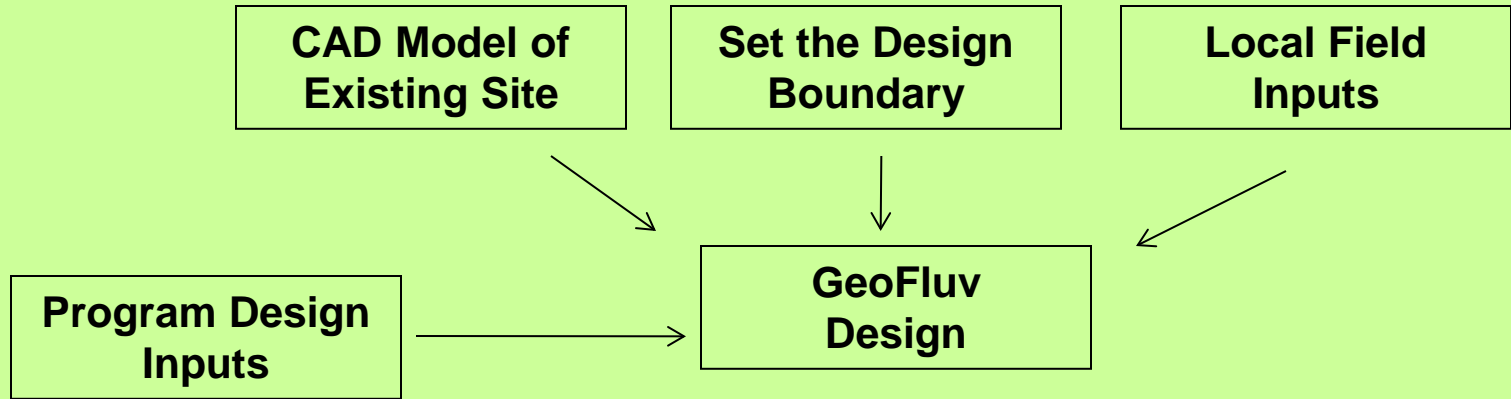
Local Reference Sites

- Local regions where unconsolidated material has been shaped by 1000's of years of water run-off

- Possible sites are the alluvial deposits on large river systems – eg. along the Hunter
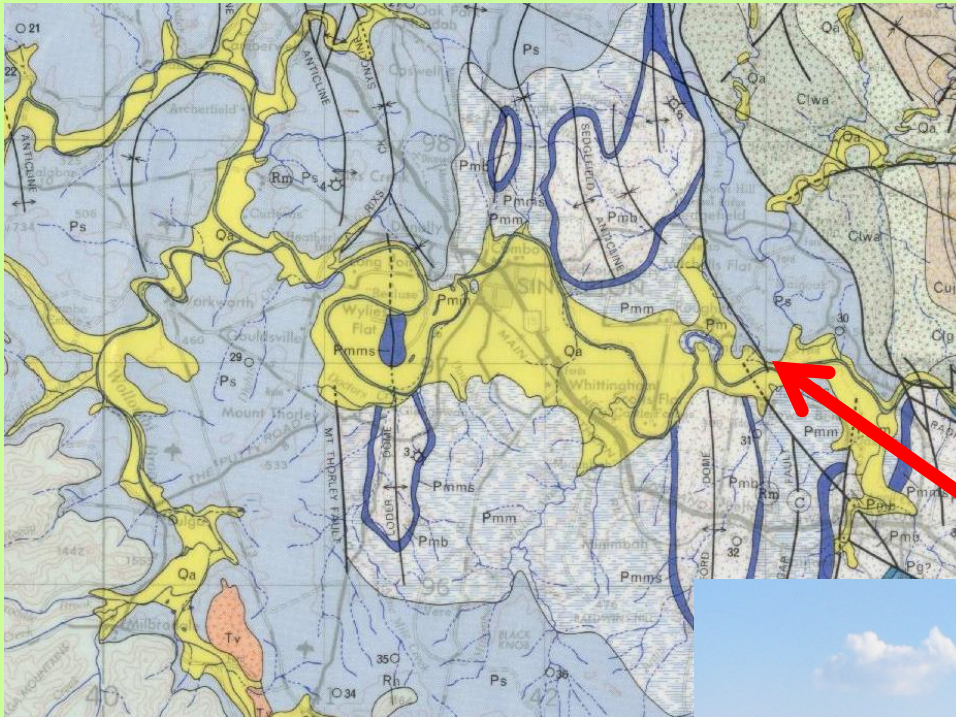
Field Inputs

- Local Base Level – the level at which the water runs off site and the gradient at that point

- Drainage Density – m / ha

- Ridge to Head of Channel Distance – distance from the ridge line where channels start to form

- A Channel Reach length – defines the areas of the sub-watersheds

Ridge to Head-of-channel (CO)

'A'-channel reach length

Determining local input values in the field

GeoFluv Process

CAD Model of Existing Site

Set the Design Boundary

Local Field Inputs

Program Design Inputs

GeoFluv Design

No

Validate Design

Yes

Output for Machine Control

Build and Monitor
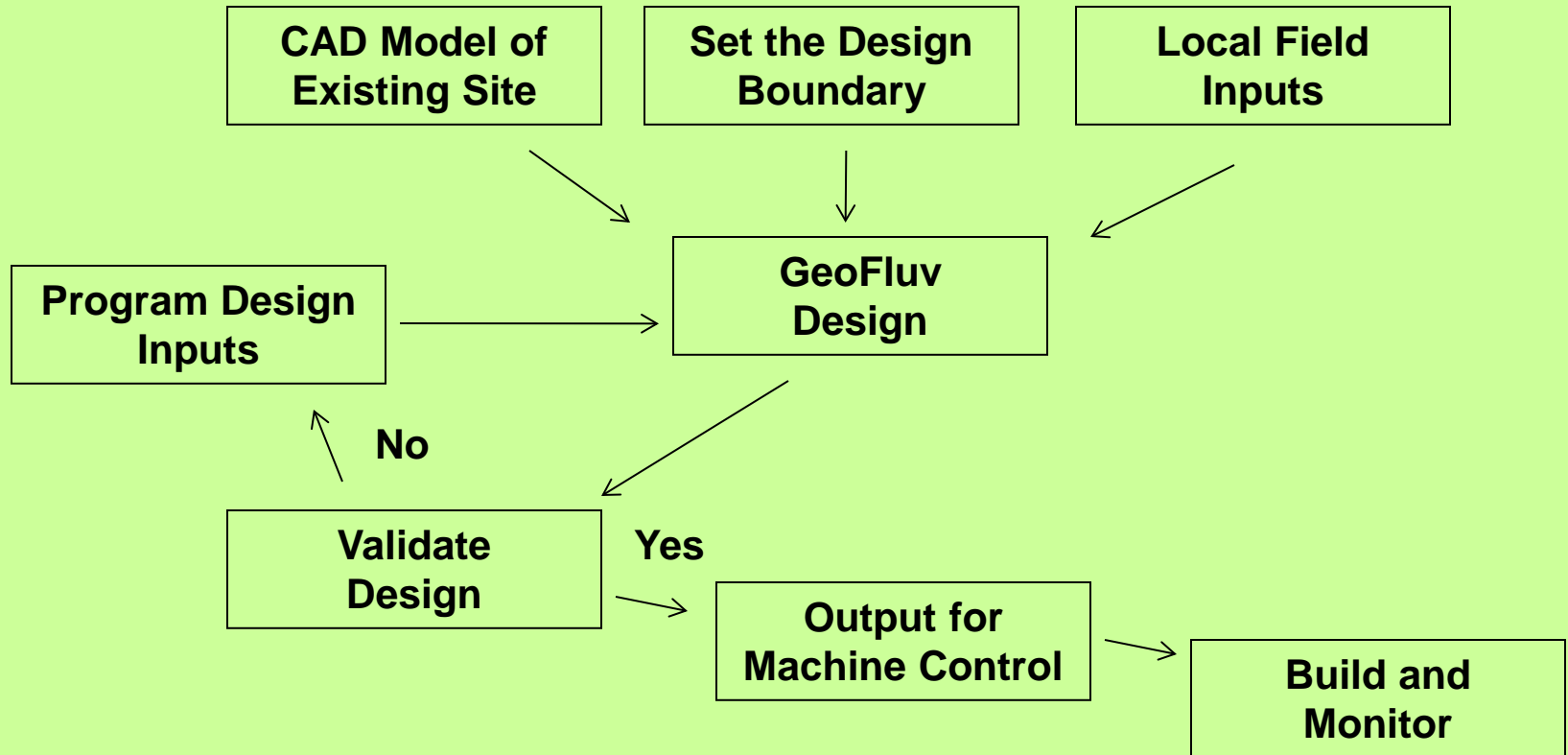
Build with Machine Guidance
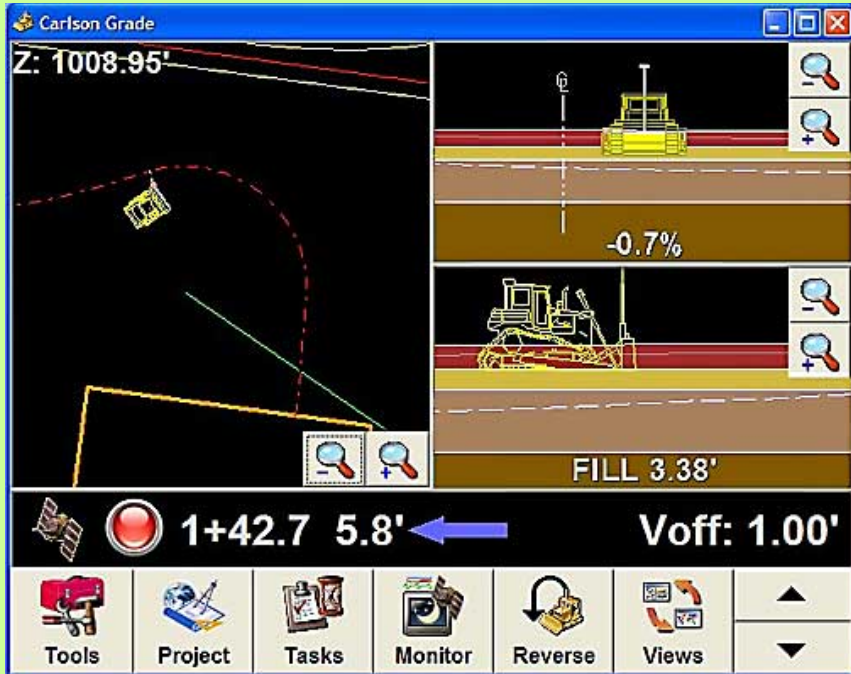
What does it look like when it is built ?

La Plata Mine,
New Mexico,
USA

Office of Surface Mining

Honors Active Mine Operations for Outstanding Reclamation
Published: November 4, 2009

San Juan Coal Company, La Plata Mine, La Plata, New Mexico
Located in northwest New Mexico, San Juan Coal Company's reclamation efforts provide for both longterm stability and topographic diversity. The regrading completed at the La Plata Mine uses the best technology currently available to control erosion and sedimentation and to achieve enhancement of wildlife habitat and related environmental resources. The geomorphic-based reclamation creates stable, maintenance-free landforms. In addition, improved topographic diversity enhances wildlife habitat by creating windbreaks and security areas

Monitoring Results

Office of Surface Mining Reclamation and Enforcement Web Page – many papers from May 2014 Meeting in Albuquerque, NM

http://www.osmre.gov/programs/tdt/geomorph.shtm

Consequences of Change

- Industry needs to be aware that there are options and alternate ways of land rehabilitation.
  - Better environmental, fiscal outcomes and community acceptance
- Training and education - Increased focus on Mine Rehabilitation - methods and validation
- Mining companies change work practices
  - Production needs to work closely with environment
  - Train staff to accept new processes
- Regulators and Community accept alternate designs
  - Eg. maybe larger footprints for better outcomes

Thank you - Any Questions??

GeoFluv™

LANDFORMA
NATURAL SURFACE DESIGN