Geomorphic Reclamation

New tools for design of heaps.

Matt Baida

Svemins miljökonferens:

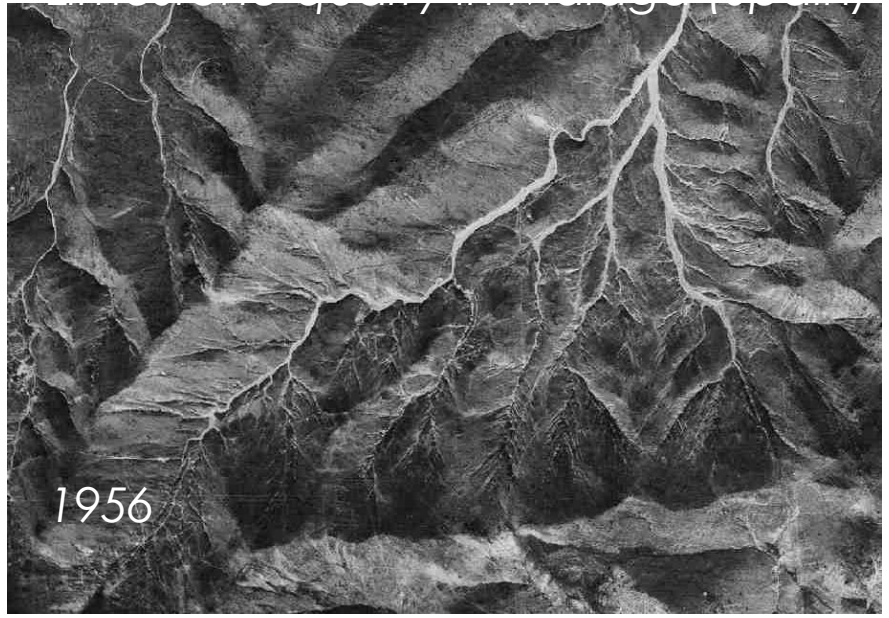
Gruvavfall – resurs och utmaning för en hållbar framtid

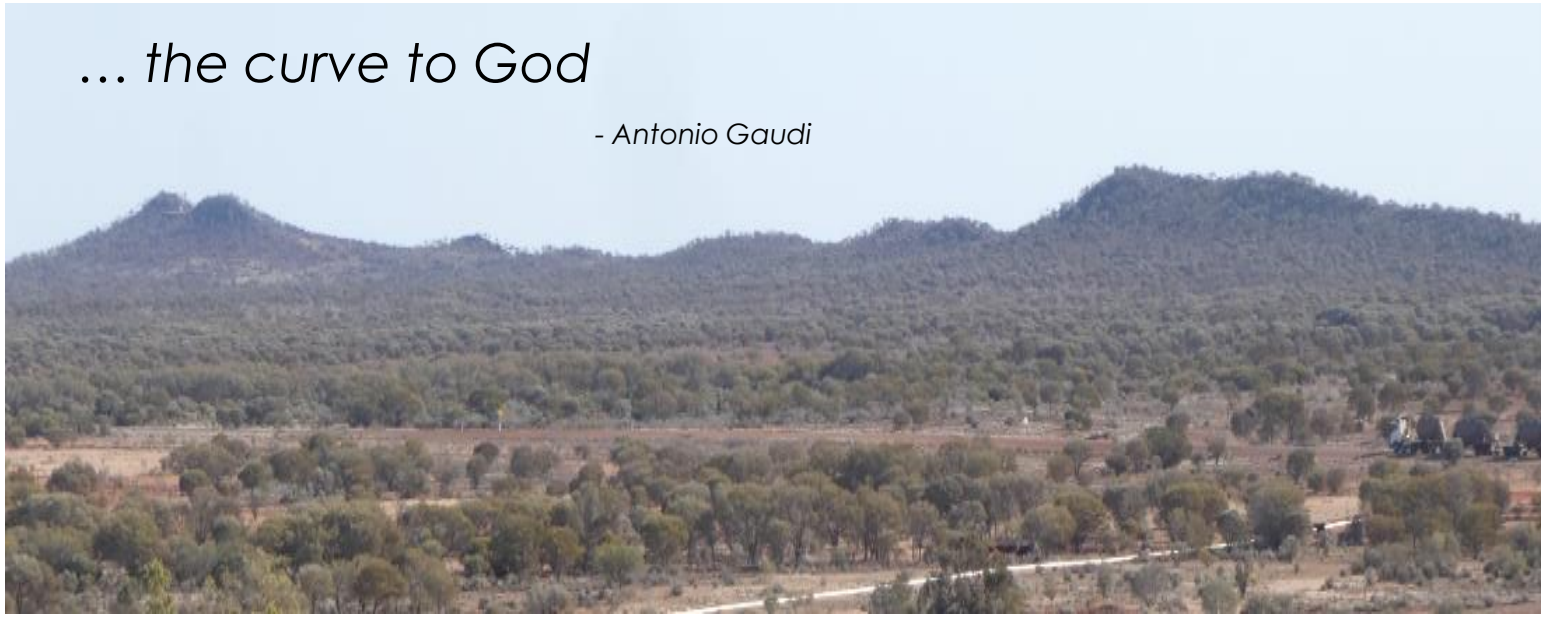
Skellefteå 2019

SveMin

Cedervall arkitekter

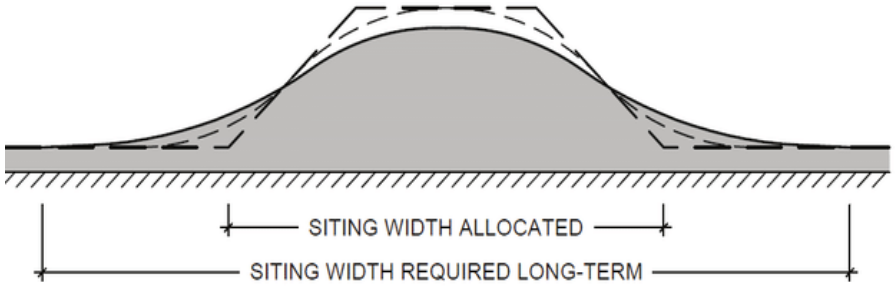
What is Geomorphic Design?





Benefits of Geomorphic Design?

- Long term stable
- Low erosion
- Blending with the surrounding terrain
- Ecological diversity
- Post-mining land-use



An obvious fact – **rivers and streams flow downhill** *(not across)*

Traditional Design Criteria…

- Minimize disturbance footprint
- Maximize fill volume
- Route water away

Also Today…

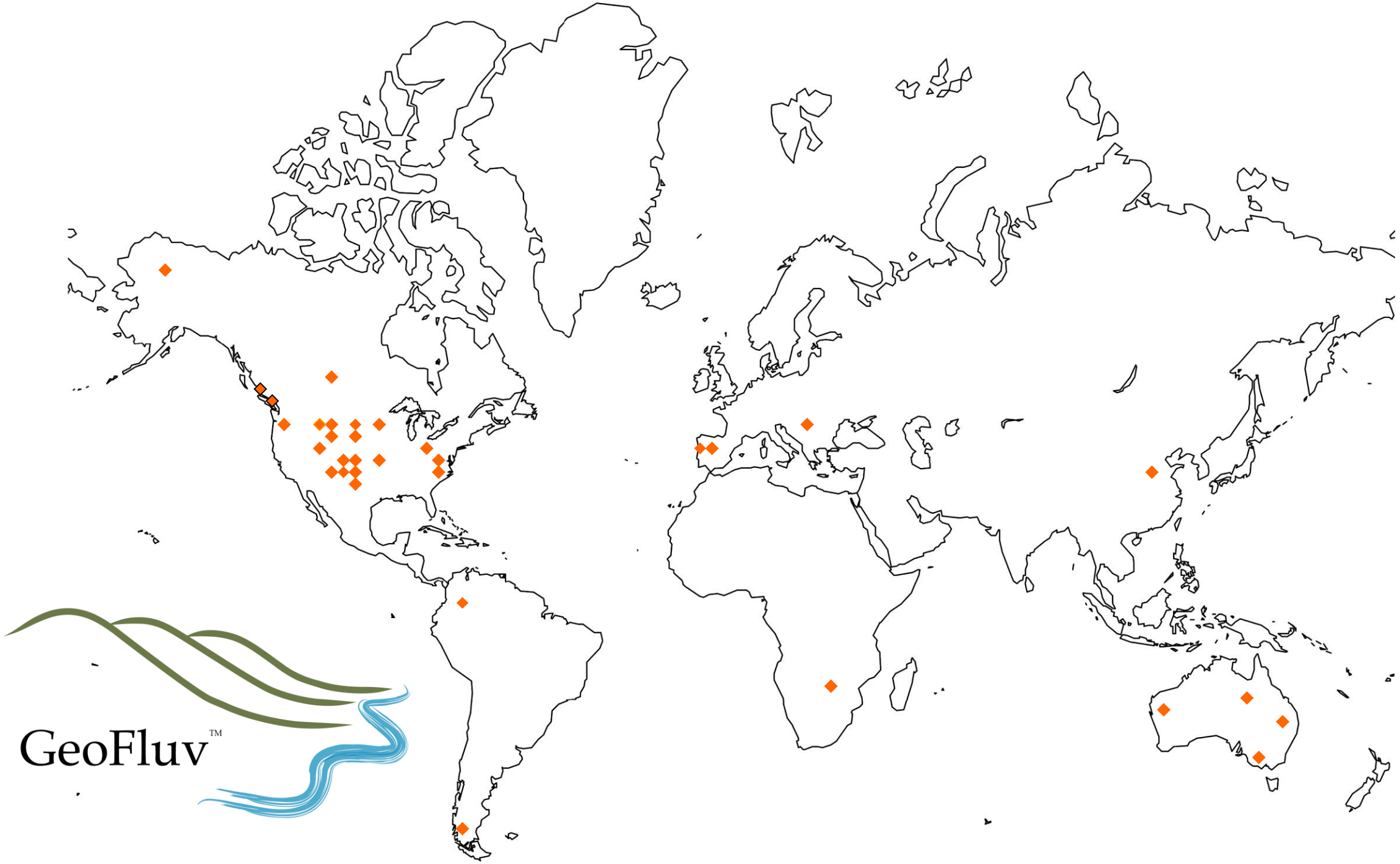
- Free from maintenance, ‘forever’
- Vegetation composition & diversity
- Prove stability against erosion, ‘forever’
- Post-mining land-use
- Low cost to achieve these criteria
- Bond release

Fluvial Geomorphic Landform Design Methods

For designing drainage systems and related topographies, at watershed scale, with non-consolidated materials

- RiverMorph (software) – Stream Restoration (D. Rosgen)
- GeoFluv (software) – Stable, non-erosive landforms
- Enhanced Geomorphic Approach (Applying stable slope characteristics found in locally stable environments)

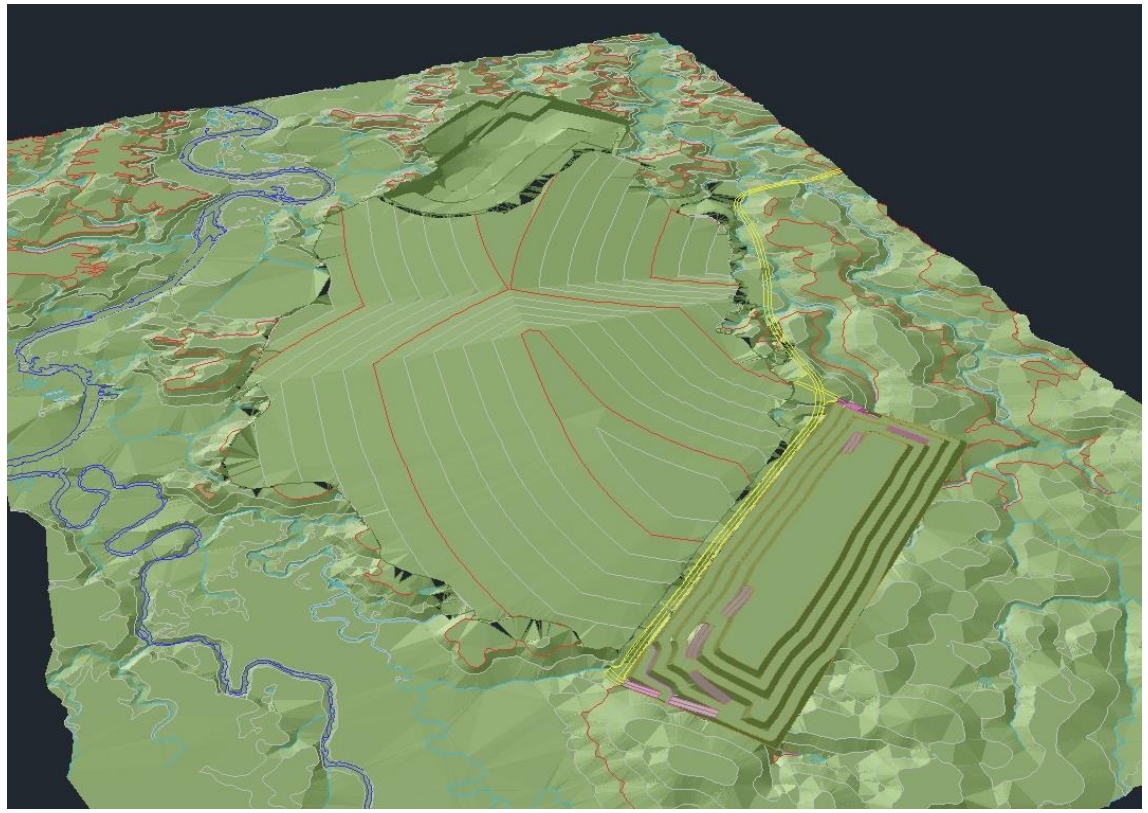
*** THE USE OF SOIL EROSION MODELS (RUSLE, WEPP) AND LANDSCAPE EVALUATION MODELLING (SIBERIA, CAESAR) SHOULD BE USED IN CONJUNCTION TO ASSESS AND TEST DESIGNS FOR LONG-TERM GEOMORPHIC STABLITY**


GeoFluv™

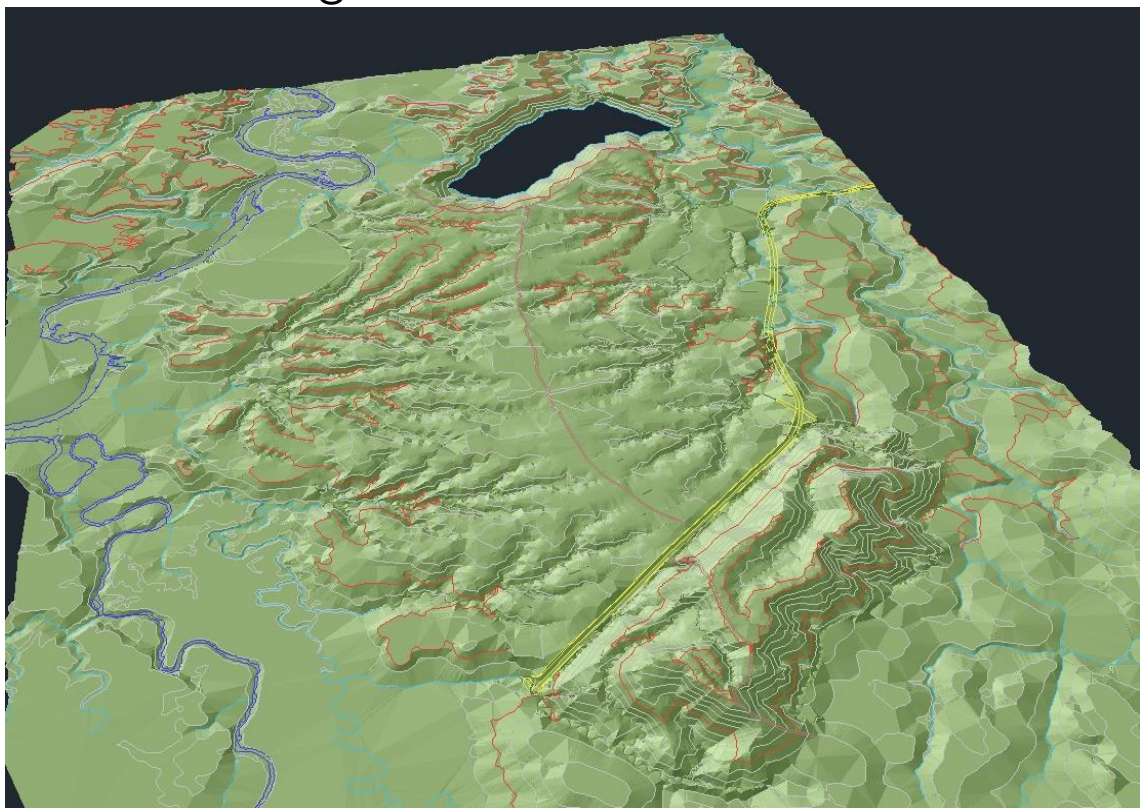
Colombia, South America

- Coal mine permit required
- High precipitation (>1,000 mm/yr)
- High visibility and sensitive area

Convential design

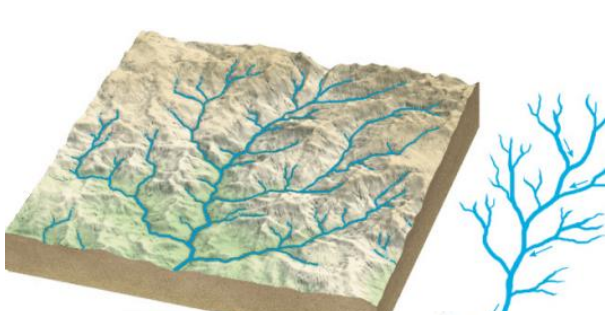


GeoFluv design

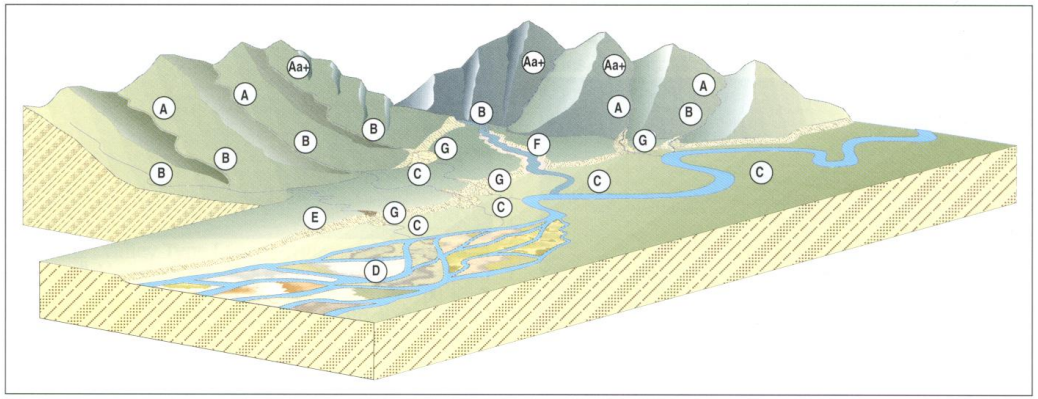


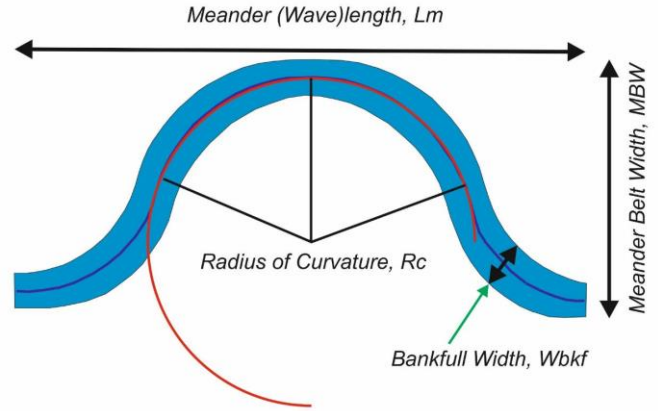
A landform has achieved geomorphic stability once the correct drainage density, channel geometry, complex slope profiles have been acheived.

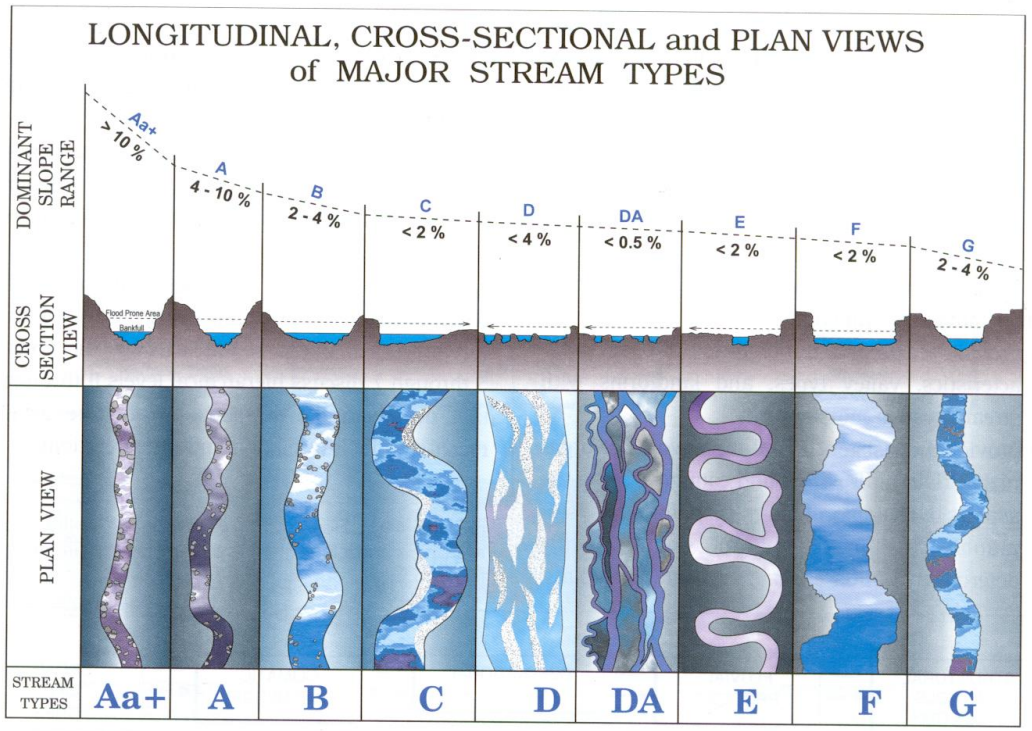
Not just guess work!

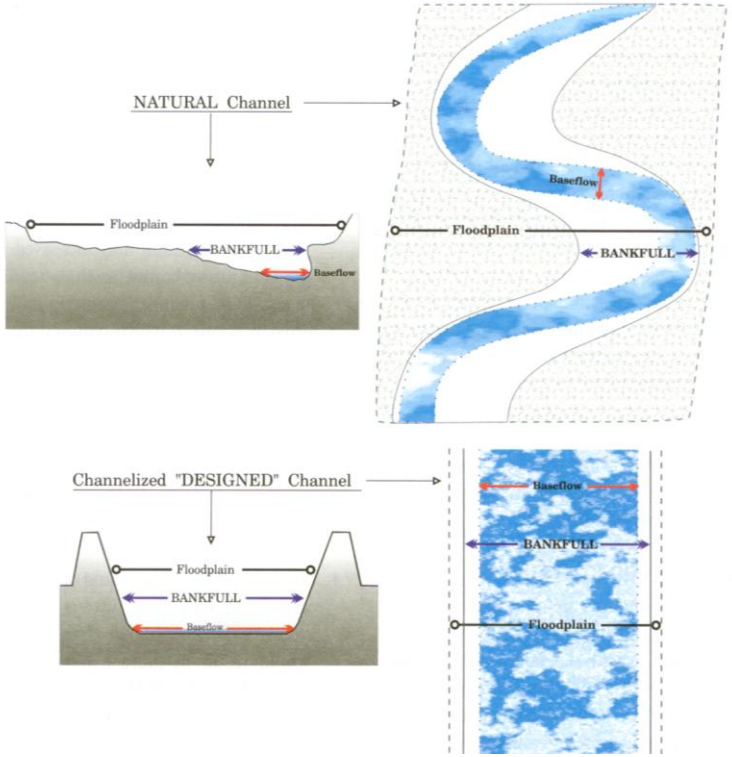


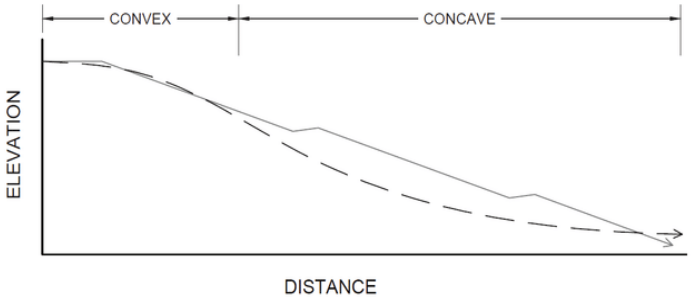
$$\text{Drainage Density } (D_d) = \frac{L_t}{A}$$









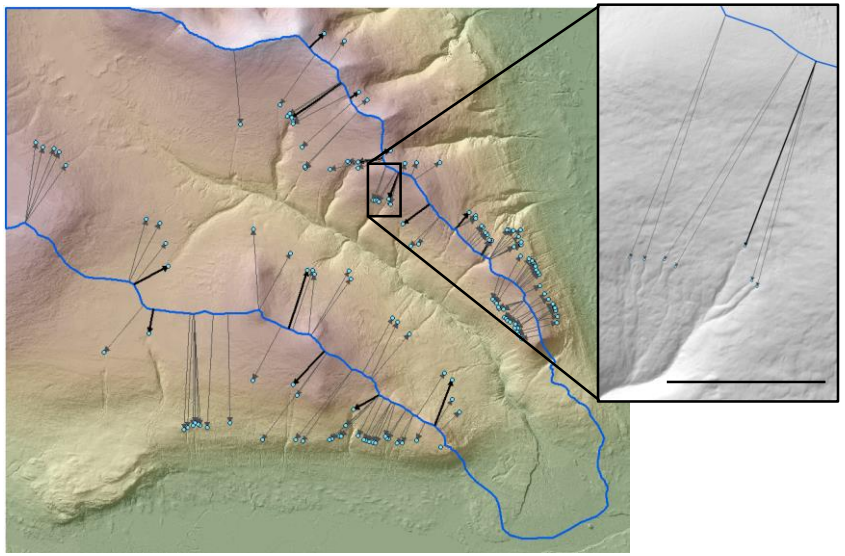


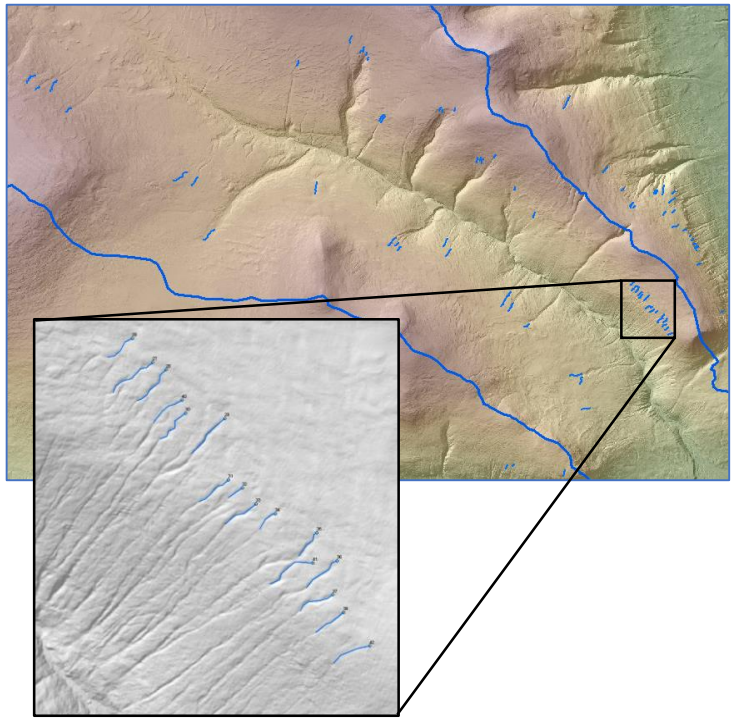
Landscape Parameters

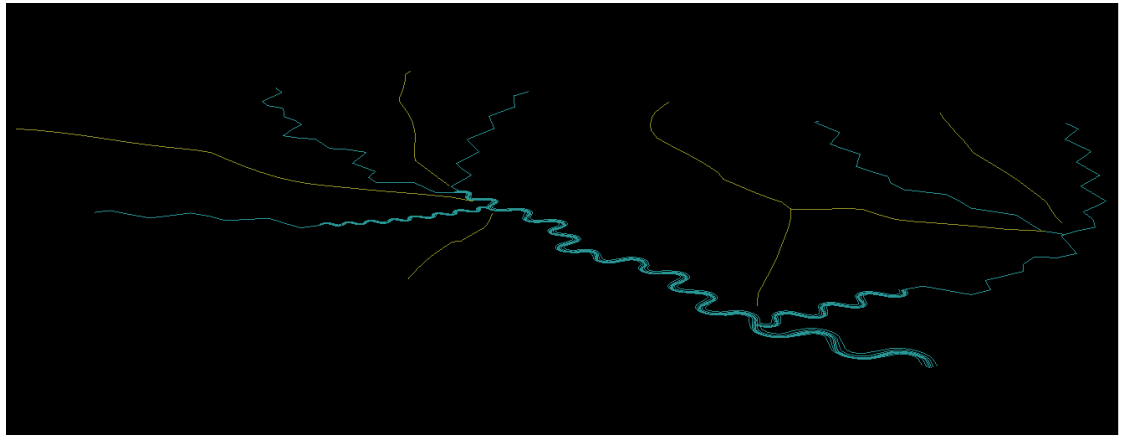
Natural Regrade Global Settings

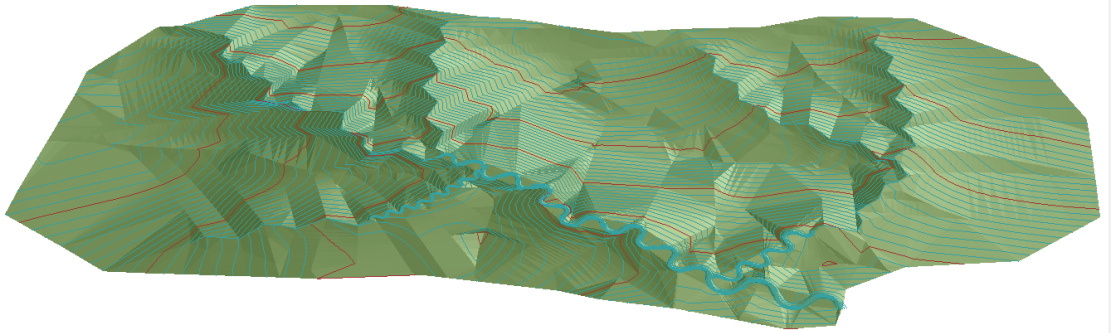
Maximum distance between connecting channels (m)		3.00
Maximum distance from ridgeline to channel's head (m)		0
Maximum convex portion of subridge:		
☑ 1.5 x 0 (m)		0
☐ Percent of overall length (%)		0
☐ Maximum convex portion of swale (m)		0
Slope at the mouth of the main valley bottom channel (%)		0.00
'A' channel reach(m)		0.00
2-yr, 1-hr(cm) (see documentation)	Rain Map	0.00
50-yr, 6-hr(cm) (see documentation)	Rain Map	0.00
Target drainage density (m/Ha)		0.00
Target drainage density variance (%)		0.00
☐ Force ridges to be lower than GeoFluv boundary		
Angle from subridge to channel's perpendicular, upstream (deg.)		0.00
North or East straight-line slopes (%)		0.00
Maximum straight-line slopes (%)		0.00
Maximum cut / fill (%)		0.00
Minimum cut / fill (%)		0.00
Cut swell factor		0.000
Fill shrink factor		0.000
Channel: head elevation tolerance (m)		0.000
Channel: head slope tolerance (%)		0.000

OK | Cancel | Load | Save As | Help





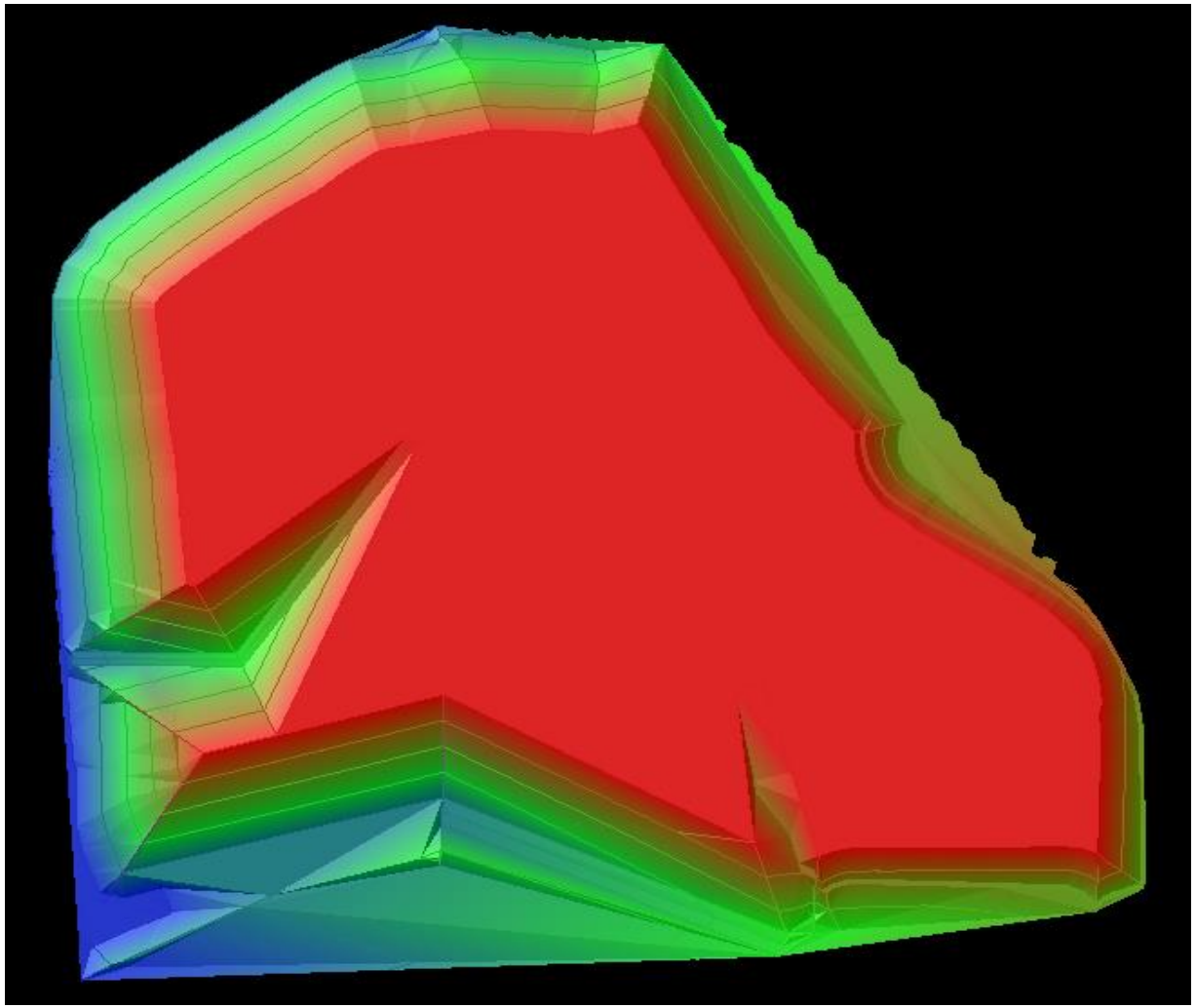


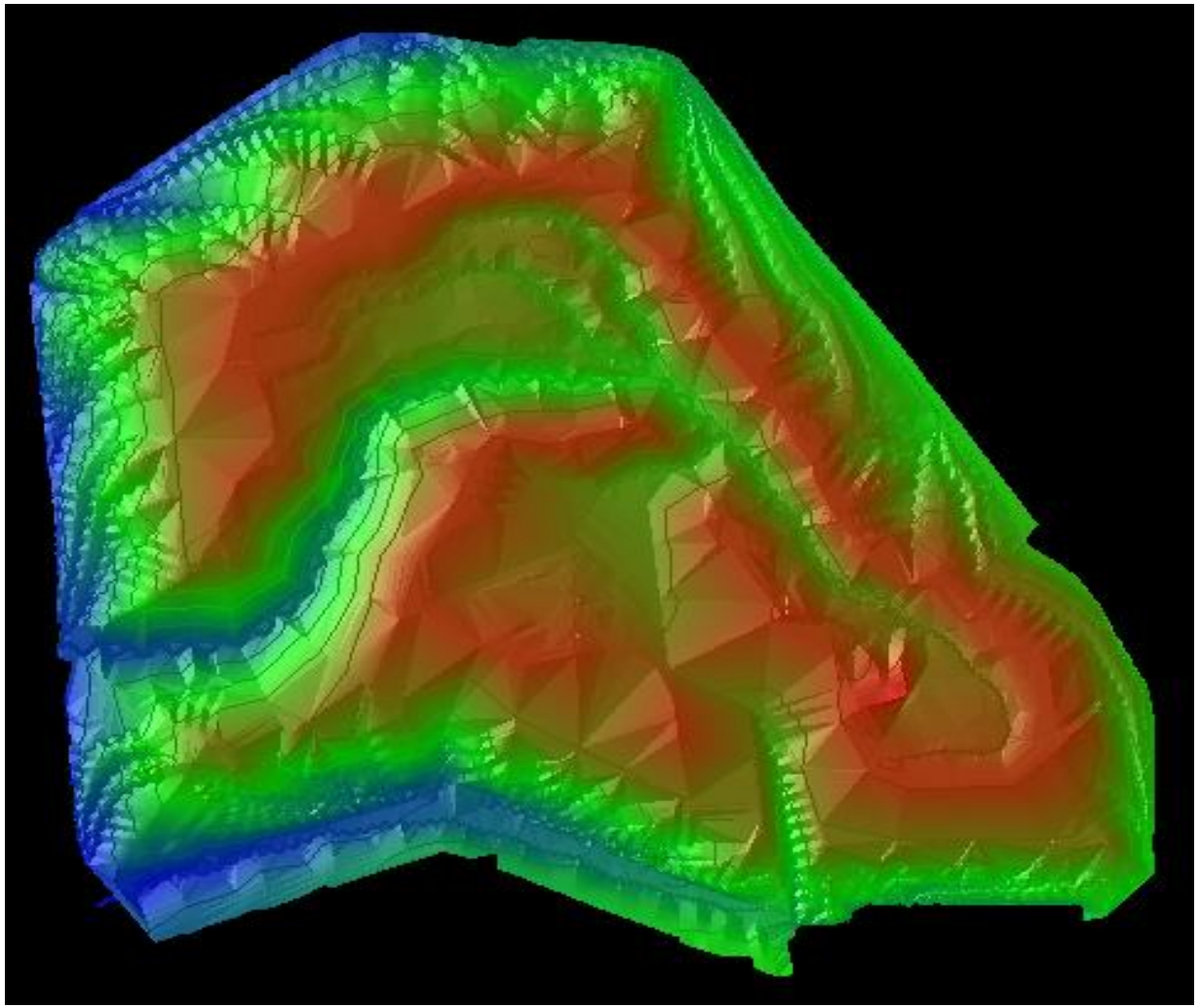


La Plata mine,
New Mexico, US

La Plata mine,
New Mexico, US

La Plata mine,
New Mexico, US





Proposed coal mine,
Hunter Valley, Aust.

EL MACHORRO KAOLIN MINE
Alto Tajo, Spain

Ecological Engineering 111 (2018) 100–116

Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

Geomorphic reclamation for reestablishment of landform stability at a watershed scale in mined sites: The Alto Tajo Natural Park, Spain

Ignacio Zapico[a,b,*], José F. Martín Duque[a,b], Nicholas Bugosh[c], Jonathan B. Laronne[d], Ana Ortega[b], Antonio Molina[e], Cristina Martín-Moreno[b], José M. Nicolau[f], Lázaro Sánchez Castillo[g]

Video at: https://www.youtube.com/watch?v=Set5shHFYS8

Playing God doesn’t always work!


San Juan mine, New Mexico, US

Demonstration project
Drayton, Aust.

'It works if you do it right and it does not work if you don't do it right'

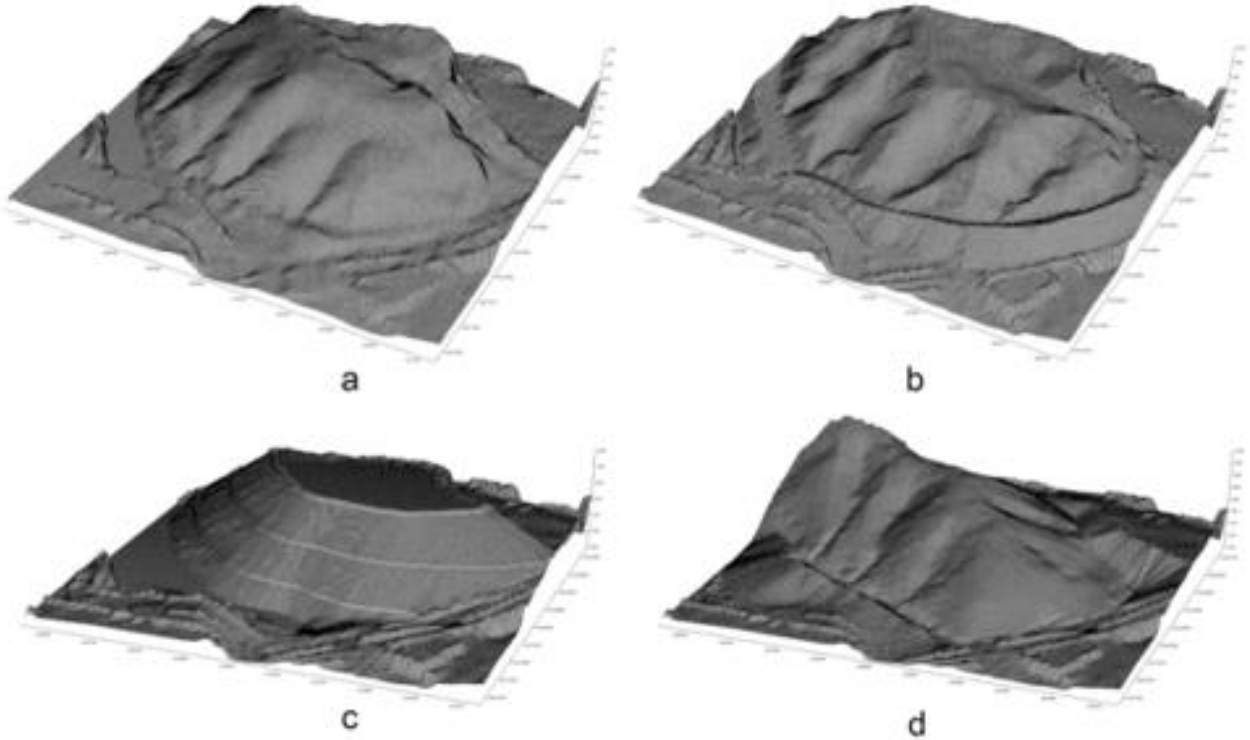
Mis-shaped convex to concave landform

Example gully, average 20cm

SIBERIA erosion modeling on four surface designs

as-built fluvial geomorphic

SIBERIA-adjusted fluvial geomorphic



Gradient terrace

'natural contour'

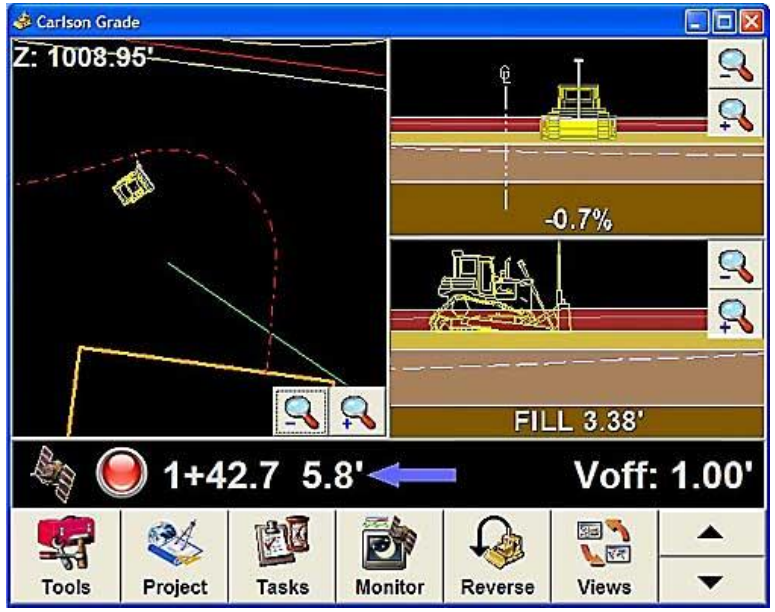
Landscape design	SIBERIA erosion rate (t-1ha-1yr)
As-built	23.4
Adjusted	13.9
Gradient terrace	25.6
'Natural contouring'	21.7

Before you ask……

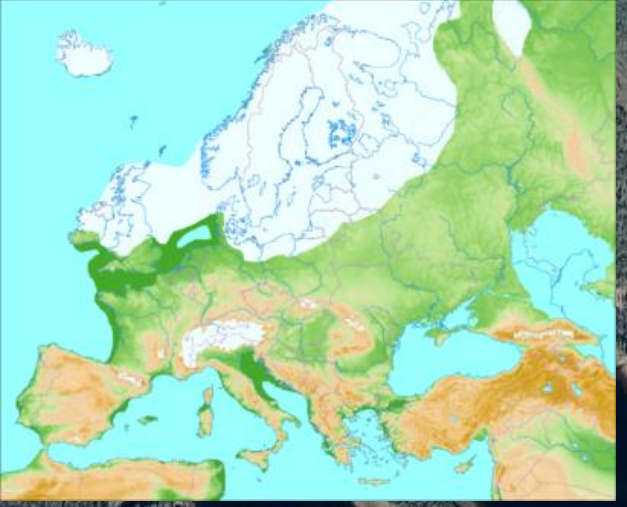
- How much extra does it cost?
- How do you construct it?
- Our site landscape is different, we are sub-arctic.

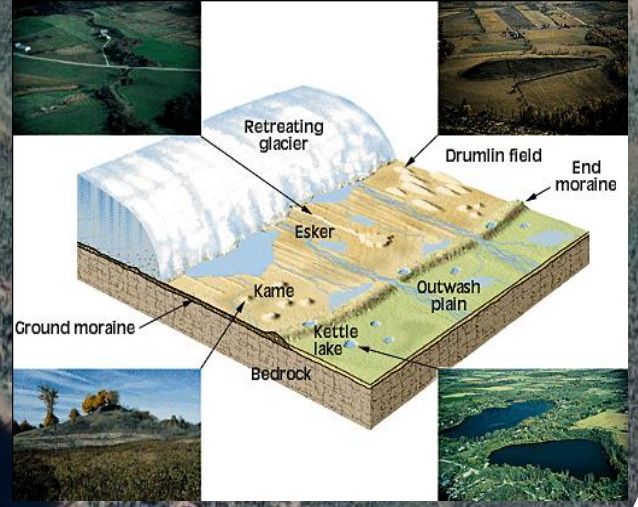
RECLAMATION COSTS
CONVENTIONAL VS NATURAL

BID	CONVENTIONAL	NATURAL	%DIFF
#1	$245,021.70	$237,822.20	-3%
#2	$269,014.00	$294,668.00	+9%
#3	$537,000.00	$417,000.00	-23%
AVG	$350,345	$316,497	-10%



How to construct





continental glaciated landforms

Not all landscapes are the same…

glaciofluvial terraces

Geomorphic Reclamation

New tools for design of heaps.

Matt Baida

Tack…

Hejdå…

Ha det bra!

SveMin

Cedervall arkitekter