MINE DEWATERING IMPACTS ON LOCAL HYDROLOGY IN FRACTURED CRYSTALLINE ROCKS

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Objectives

- The importance of understanding the hydrogeology
- Conceptualizing the approach to analysis
- Impacts as a function of mining method
- Impacts as a function of geology and hydrology

Why hydrology is important

- Planning the mining method and sequence
  - Amount and quality of water to manage
- Regulatory requirements
  - Projecting impacts on wetlands
  - Projecting impacts on streamflow (quality/quantity)
  - Projecting impacts on groundwater (quality/quantity)

Conceptualizing bedrock hydrogeology as porous media flow

- The ability to model most Maine bedrock problems with porous media approaches has been demonstrated many times:
  - Pumping tests show porous media behavior
  - Relatively uniform contaminant plumes and flow fields
  - Moderately good ability to predict hydraulic and contaminant transport behavior
  - Fracture planes in foliated rock typically 0.1' to 1' spacing whereas porous media model elements typically 10 to 100' : makes the porous media approach a good approximation of flow in discrete blocks
  - High yield bedrock zones can be treated as heterogeneities with elevated transmissivity
  - See: "The Applicability of Porous Media Theory to Fractured rock Flow in Maine" by Gerber, Bither & Muff (1991) NWWA Northeastern Regional Conference, Portland, ME

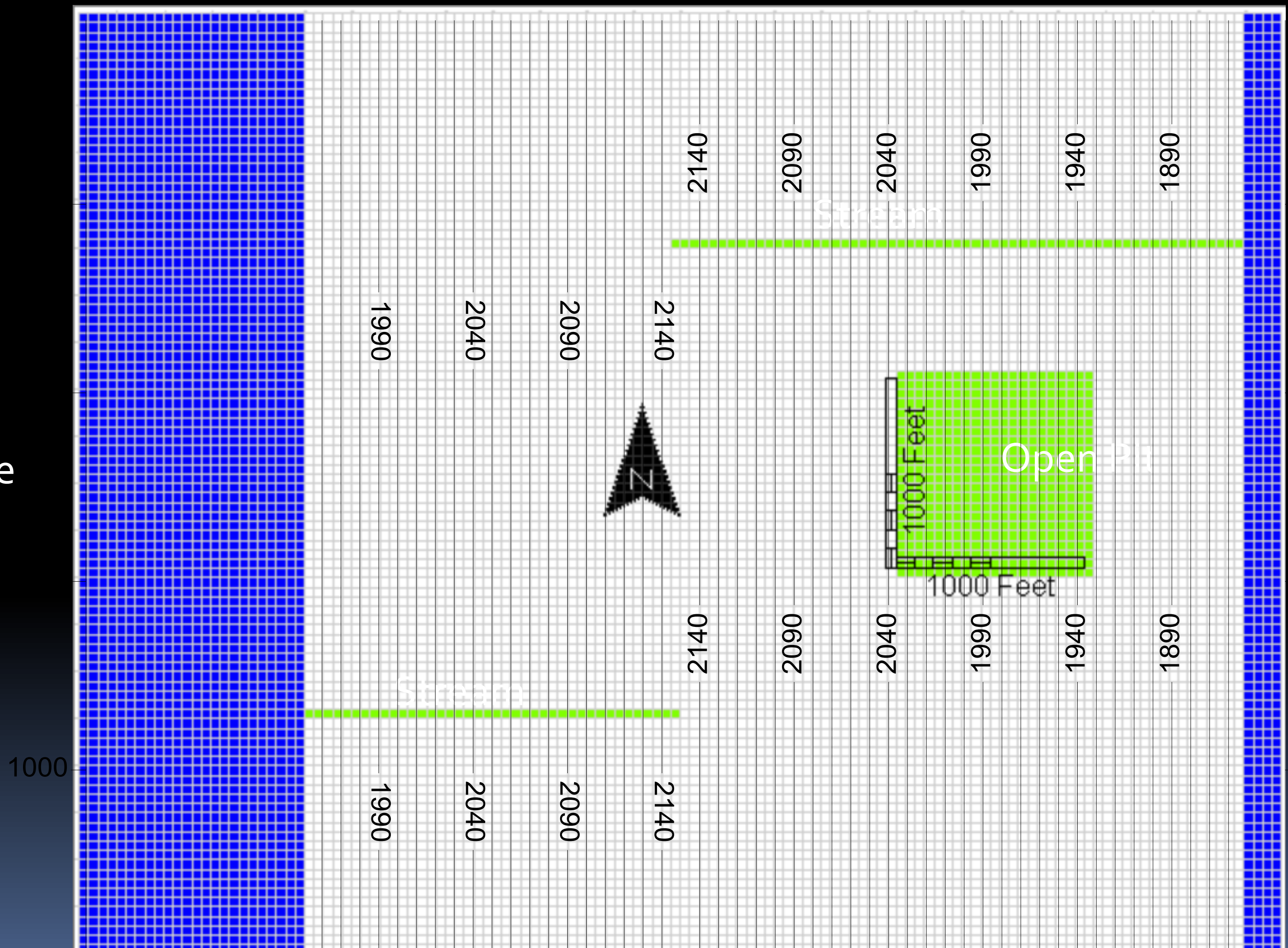
Mining methods dictate impacts

- The smaller the hole that has to be dewatered, the smaller the extent of impact
  - The rate of water flowing out of a dewatered hole is proportional to the $1/(\log t)$, where t is the amount of time the hole has been dewatered
  - The rate of water flowing out is proportional to $C_1/[\log(C_2/r)]$, where r is the hole radius. Doubling the hole diameter will increase the yield between 7% to 11%
- Therefore, mine drifts and shafts that target very specific enriched zones should produce less impact than large diameter open pit mines, other things being equal

Basic Conceptual Model

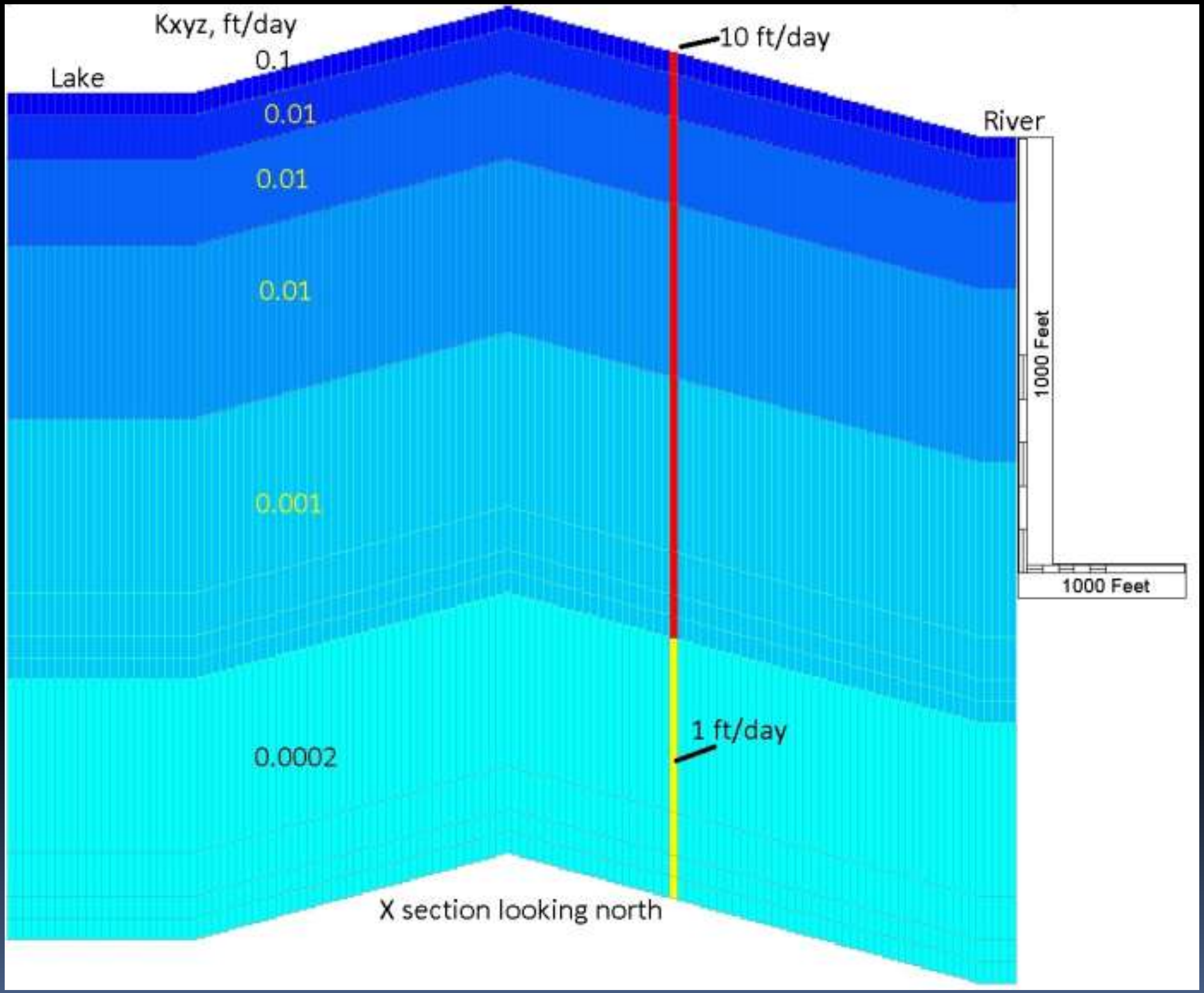
10’
drop
from
south

Lake

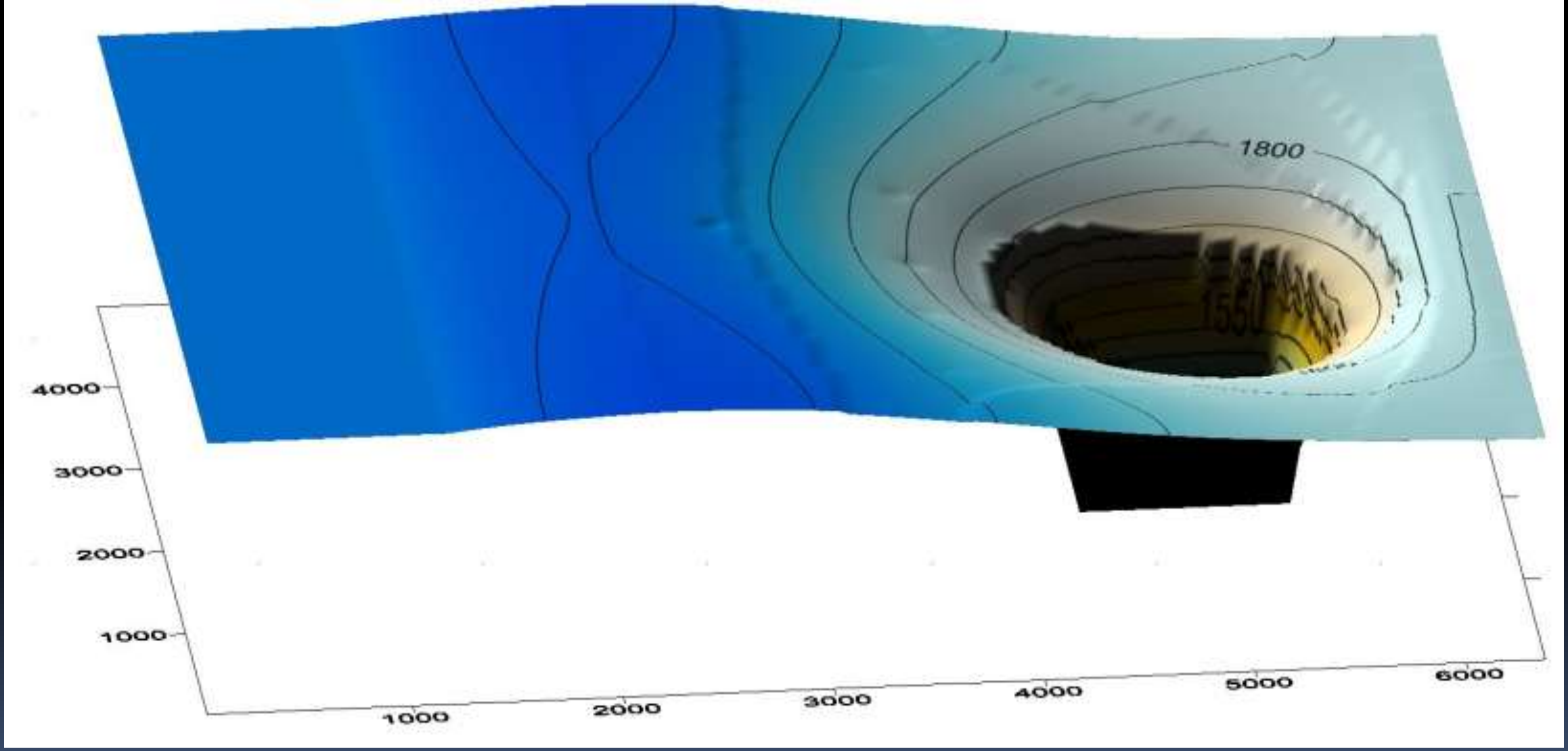


River

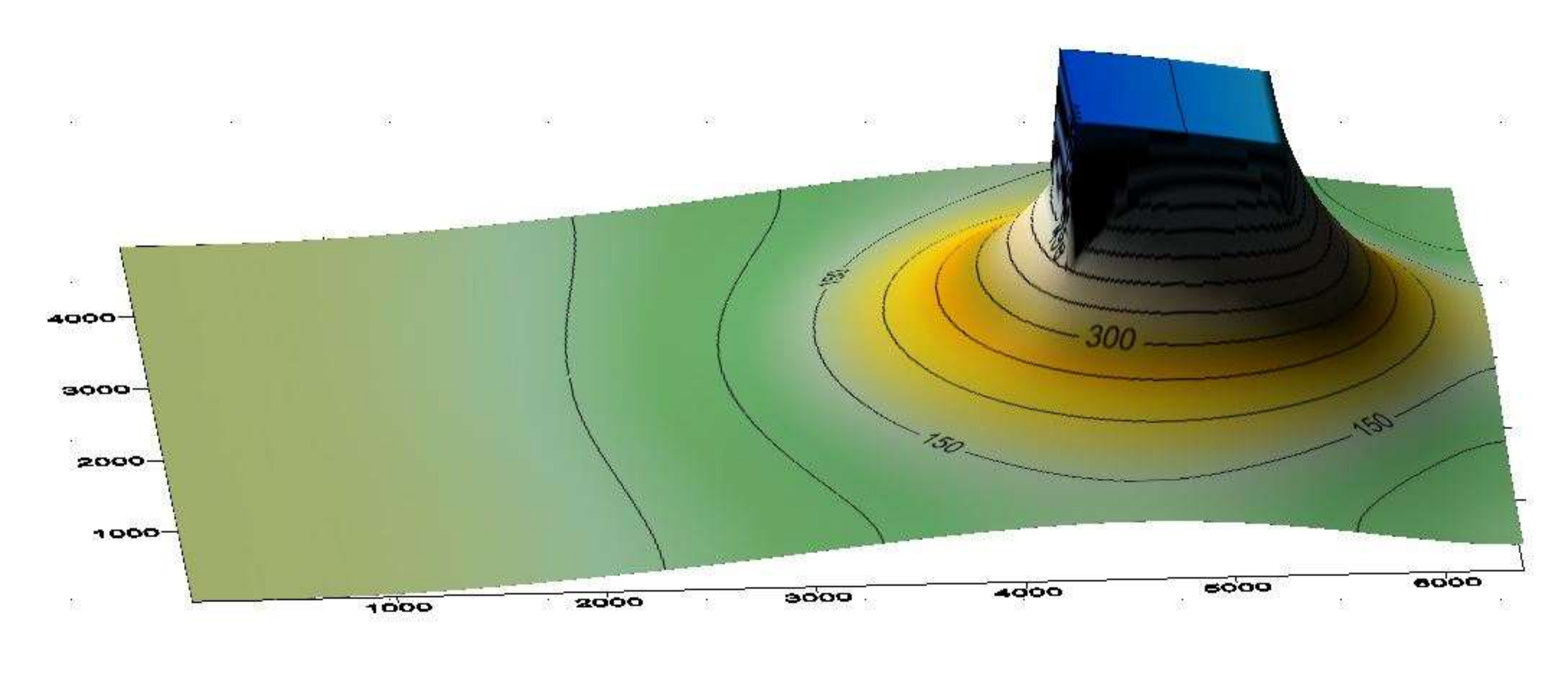
Steady-state model Cross Section with Hydraulic Conductivity Values



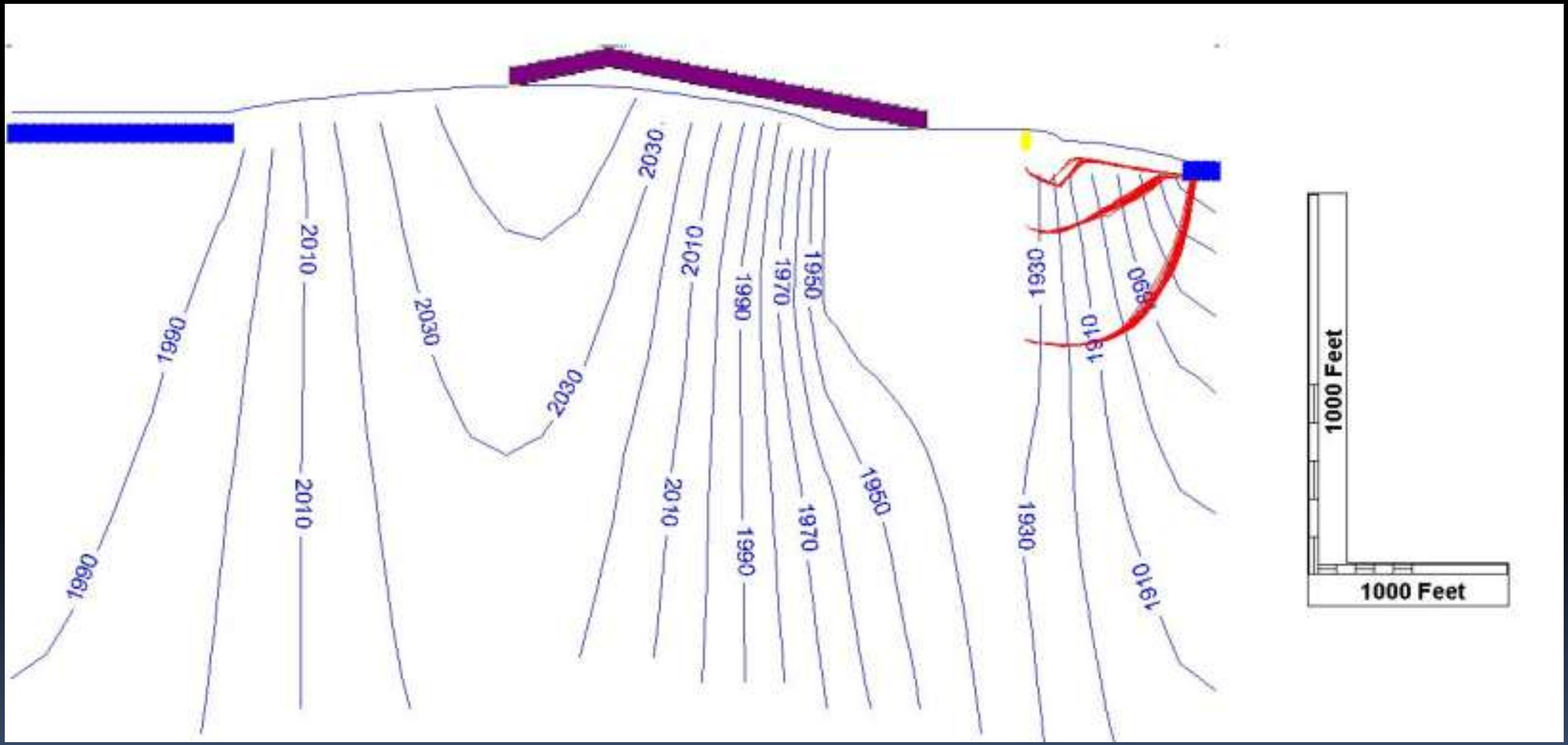
Open Pit: Phreatic Surface Equipotentials



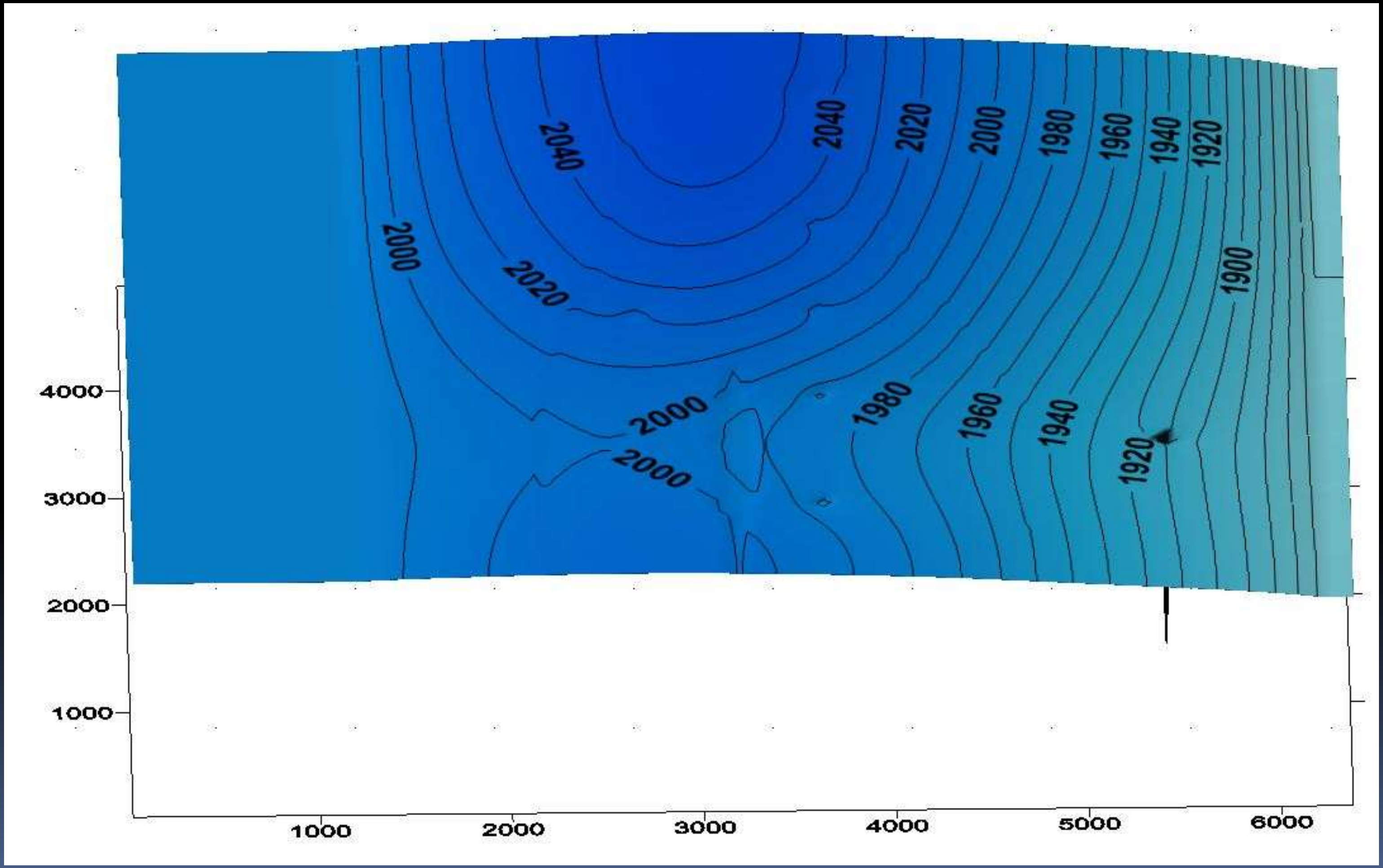
Open Pit DD at maximum



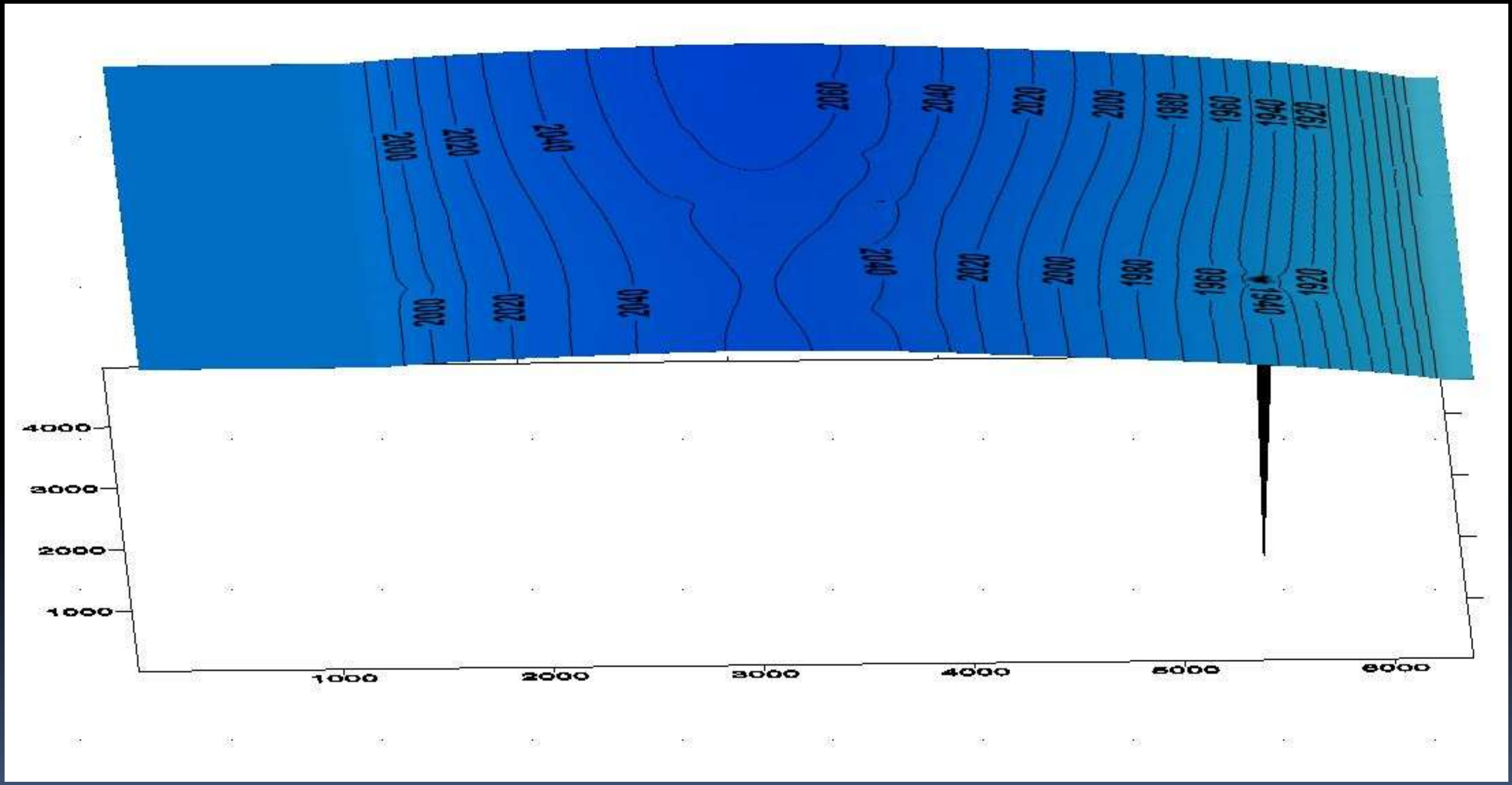
X-sec Open Pit Mine, post closure equipotentials



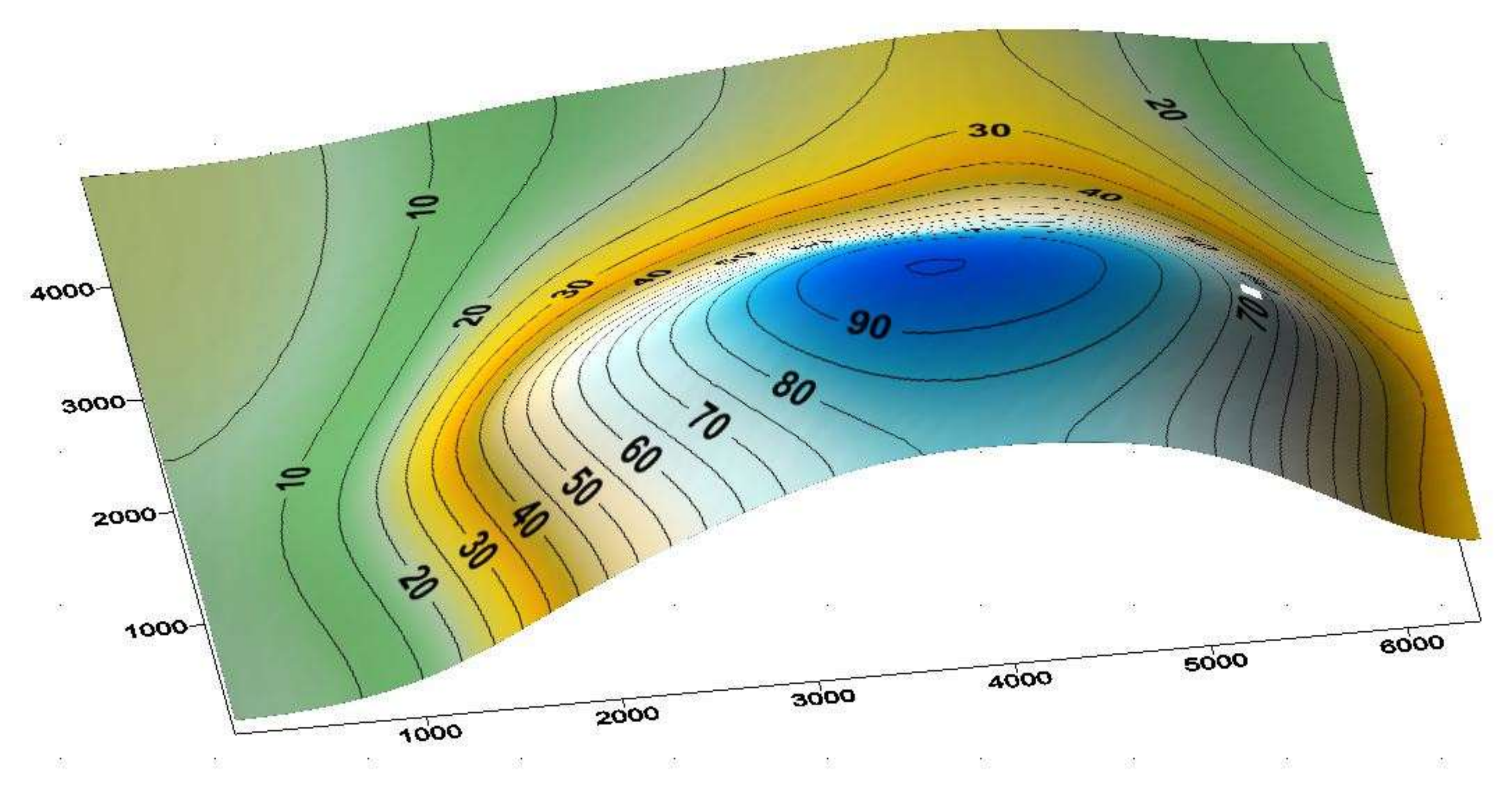
Shallow E-W tunnel L1 heads



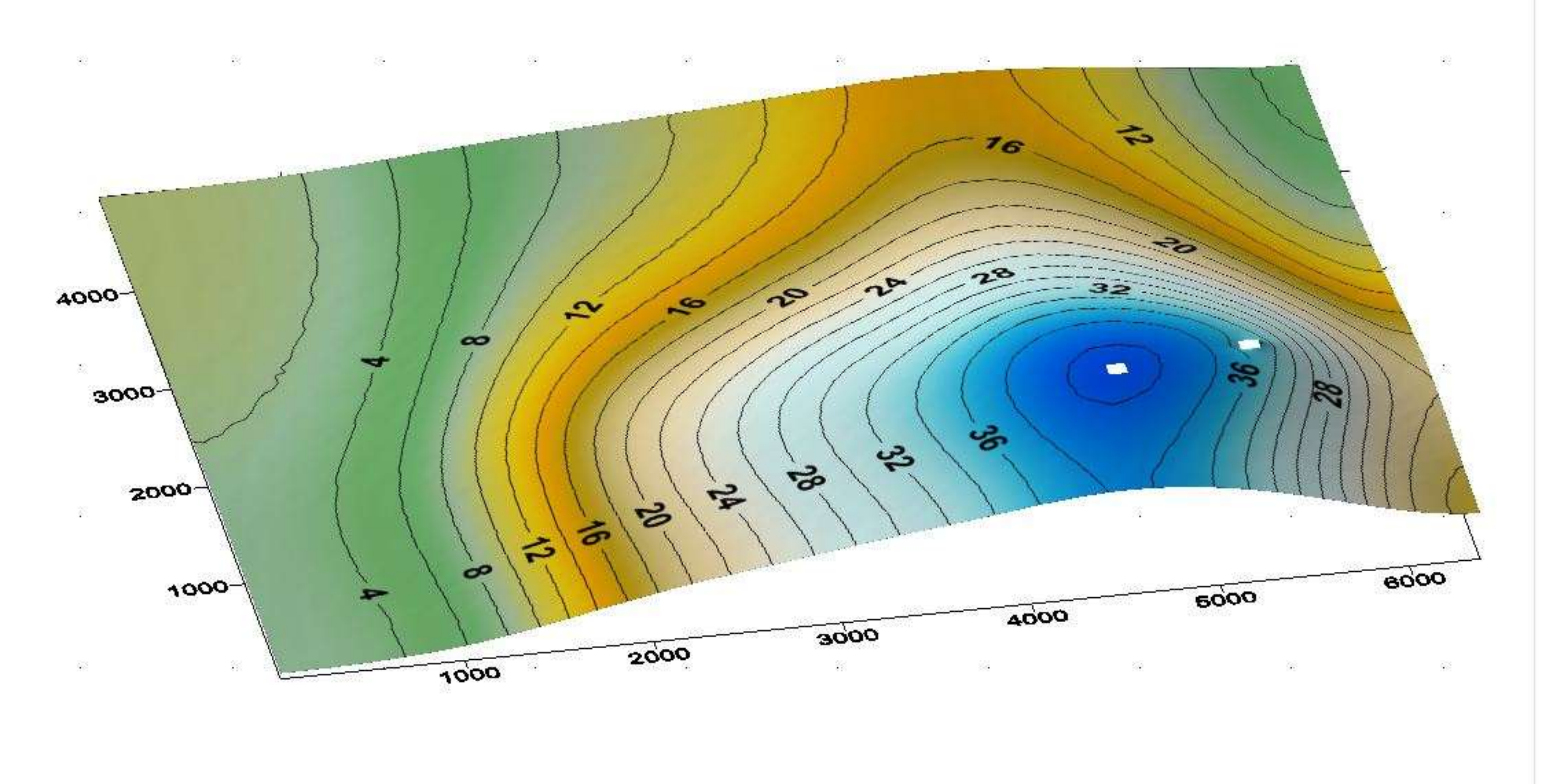
Deep E-W tunnel L1 heads



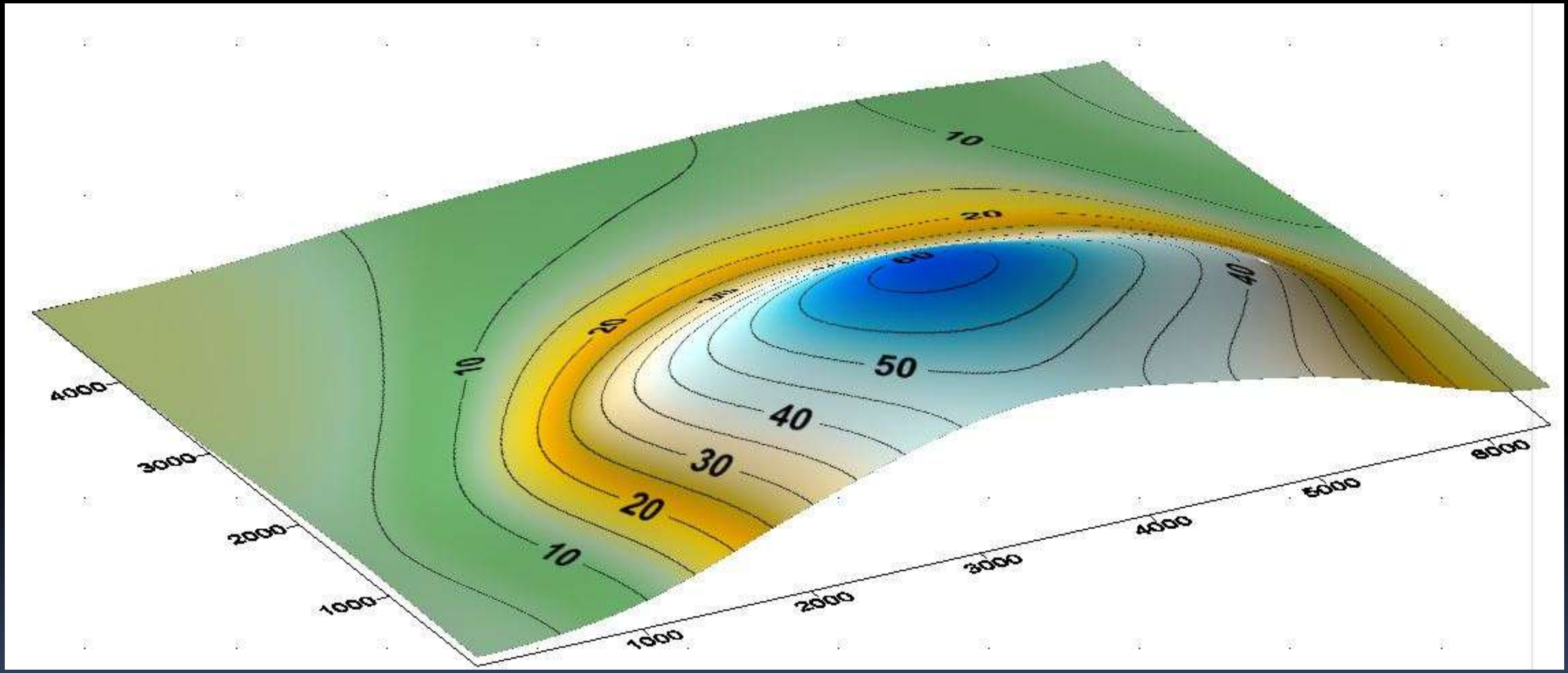
Shallow E-W shallow L4 DD



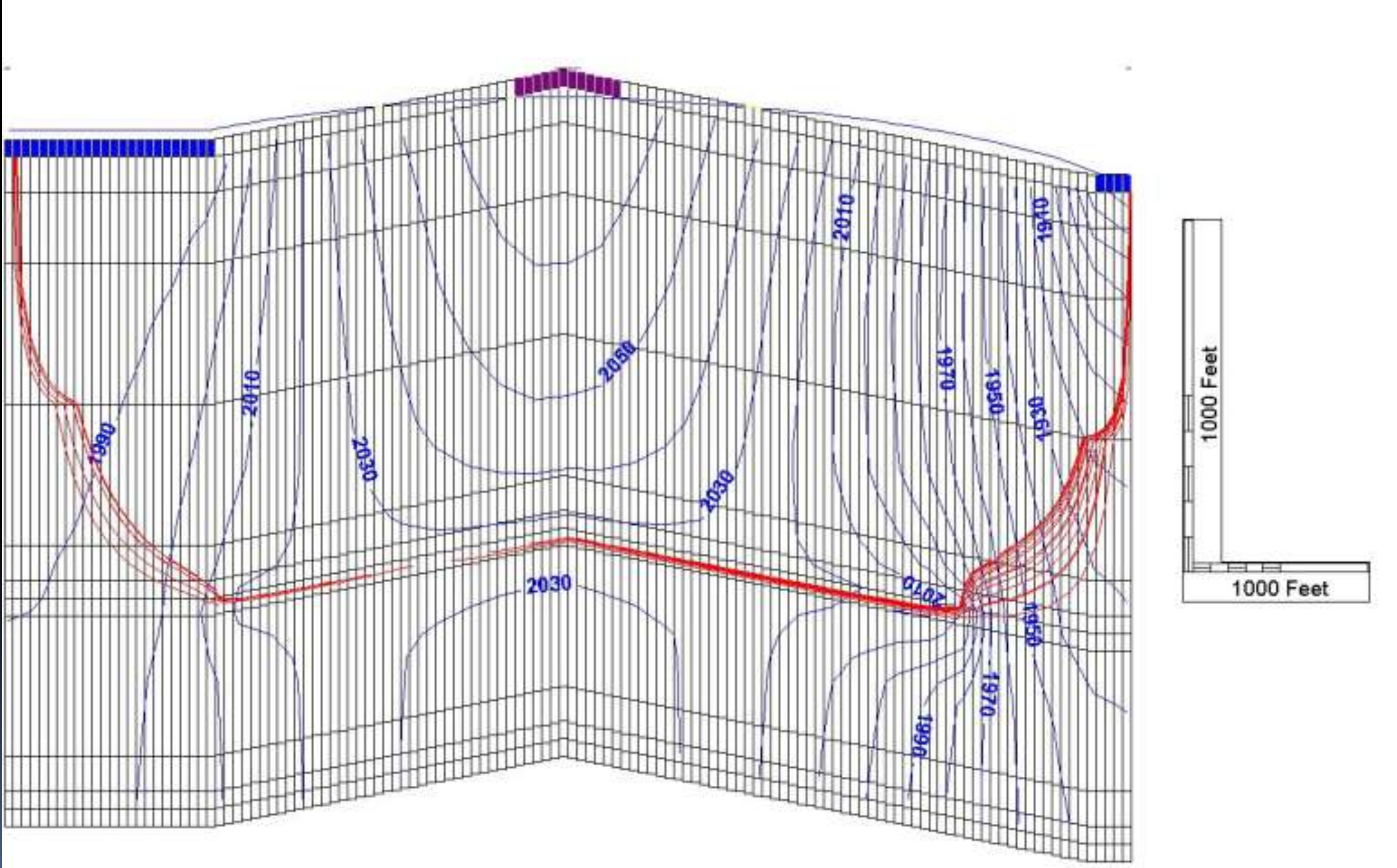
Deep E-W tunnel L4 DD



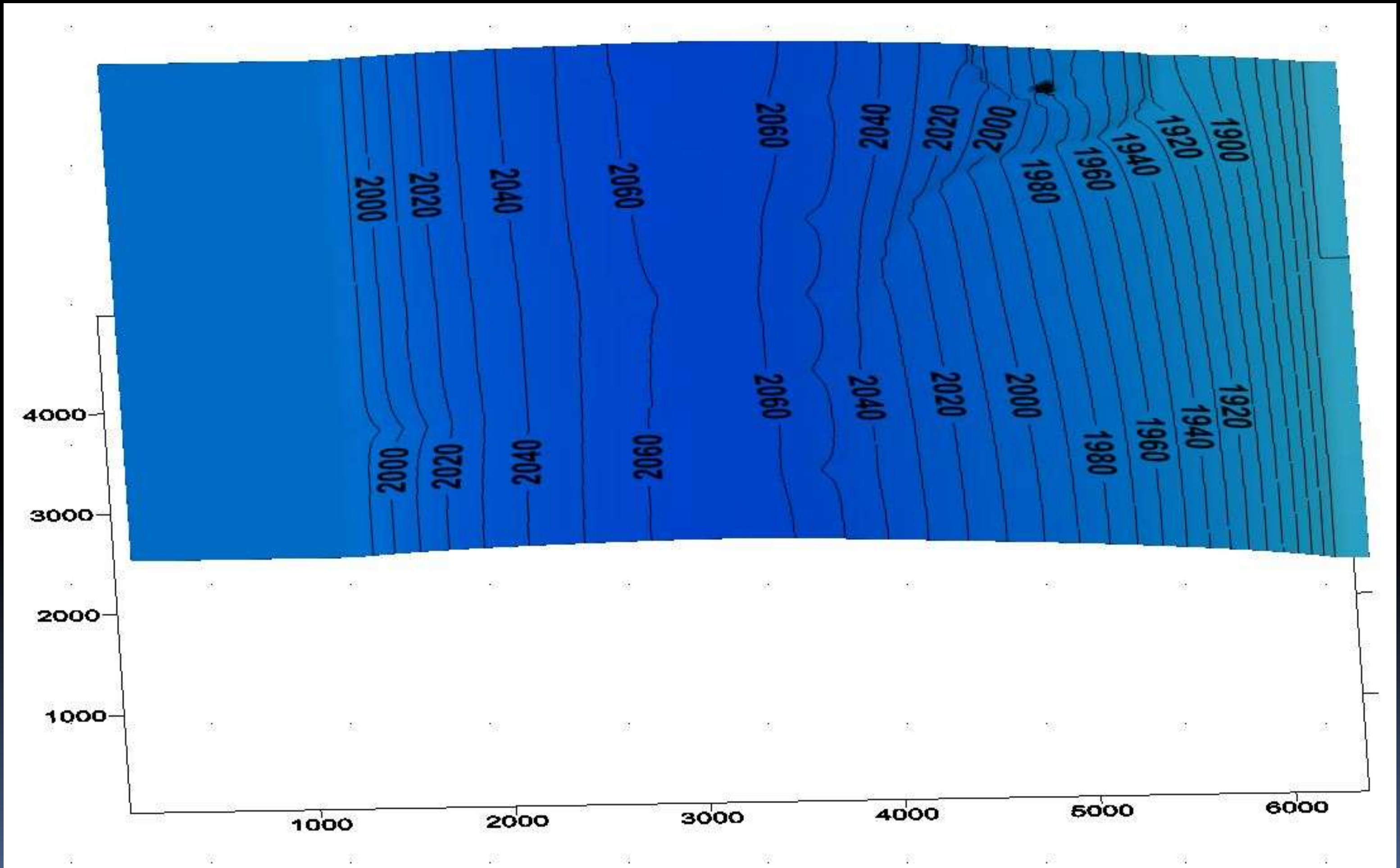
E-W tunnel L4 DD differential between deep and shallow



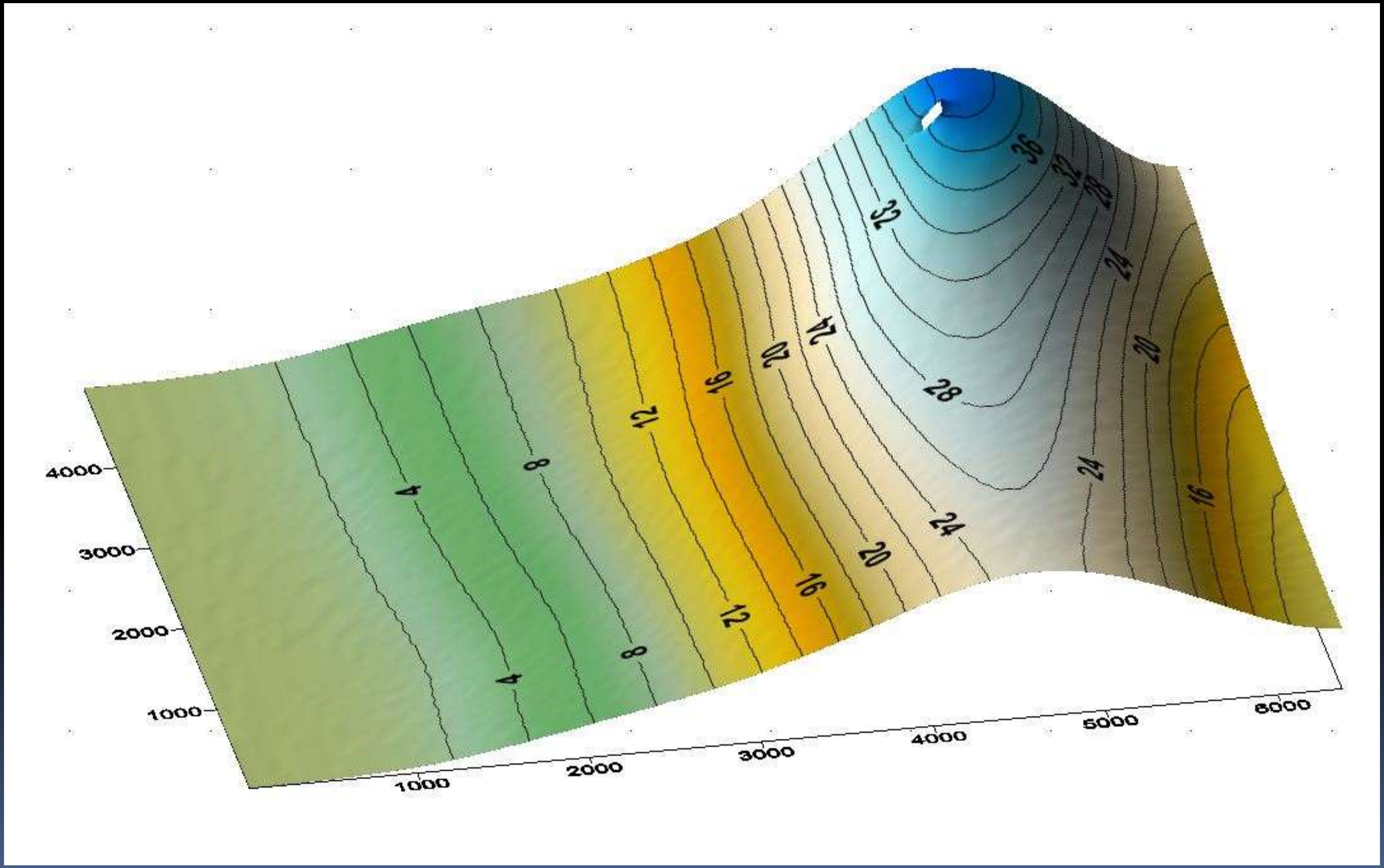
E-W tunnel Xsec post mine equipotentials looking N



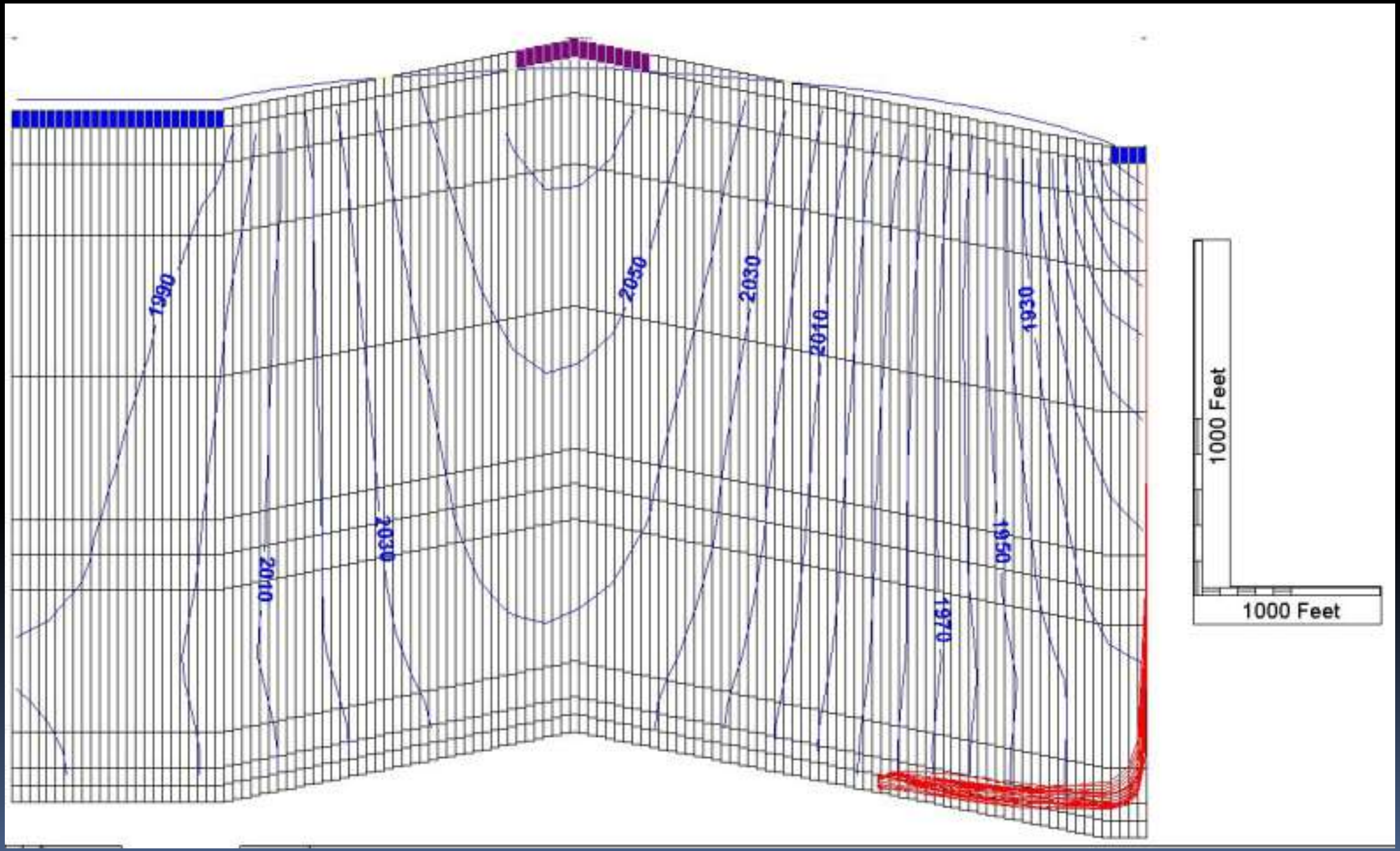
Deep N-S tunnel L1 heads



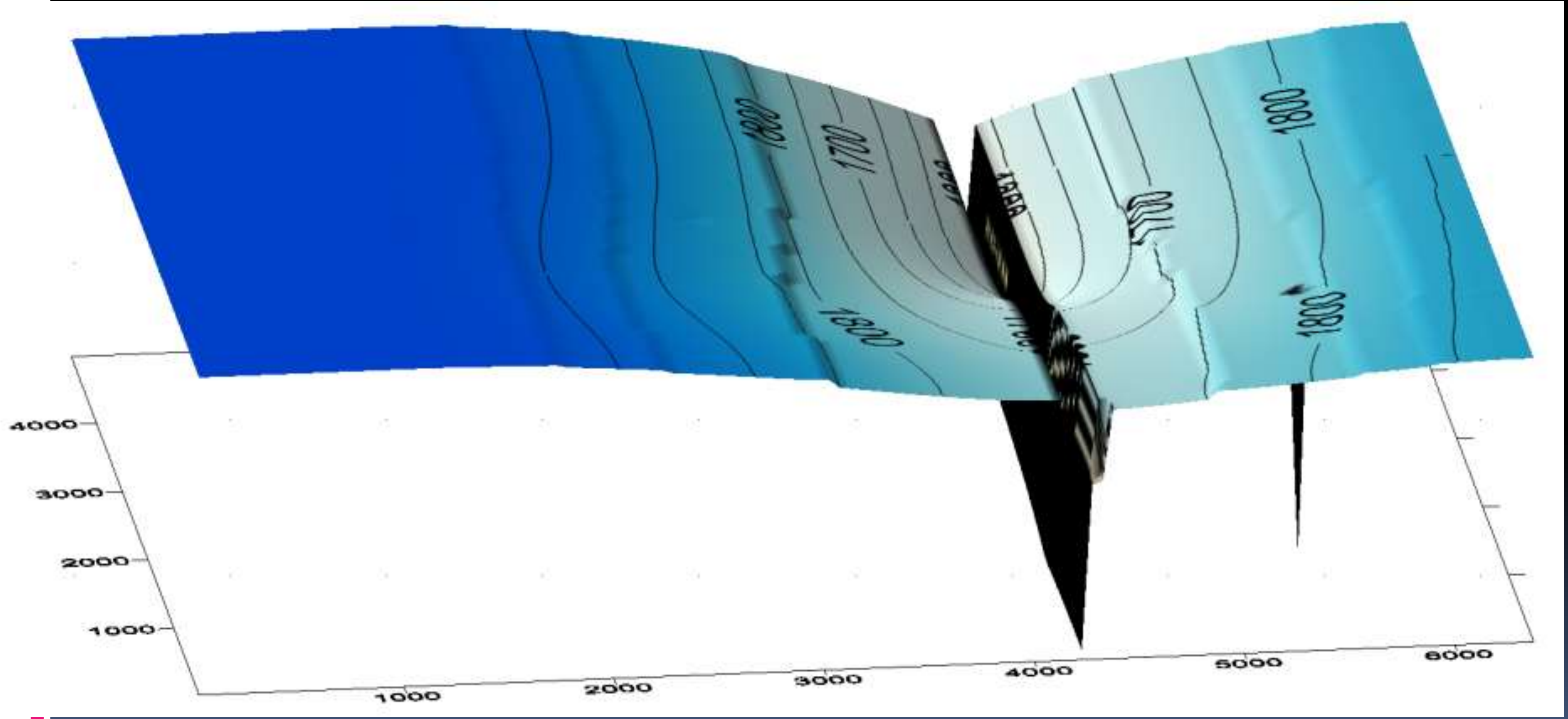
Deep N-S tunnel L4 DD



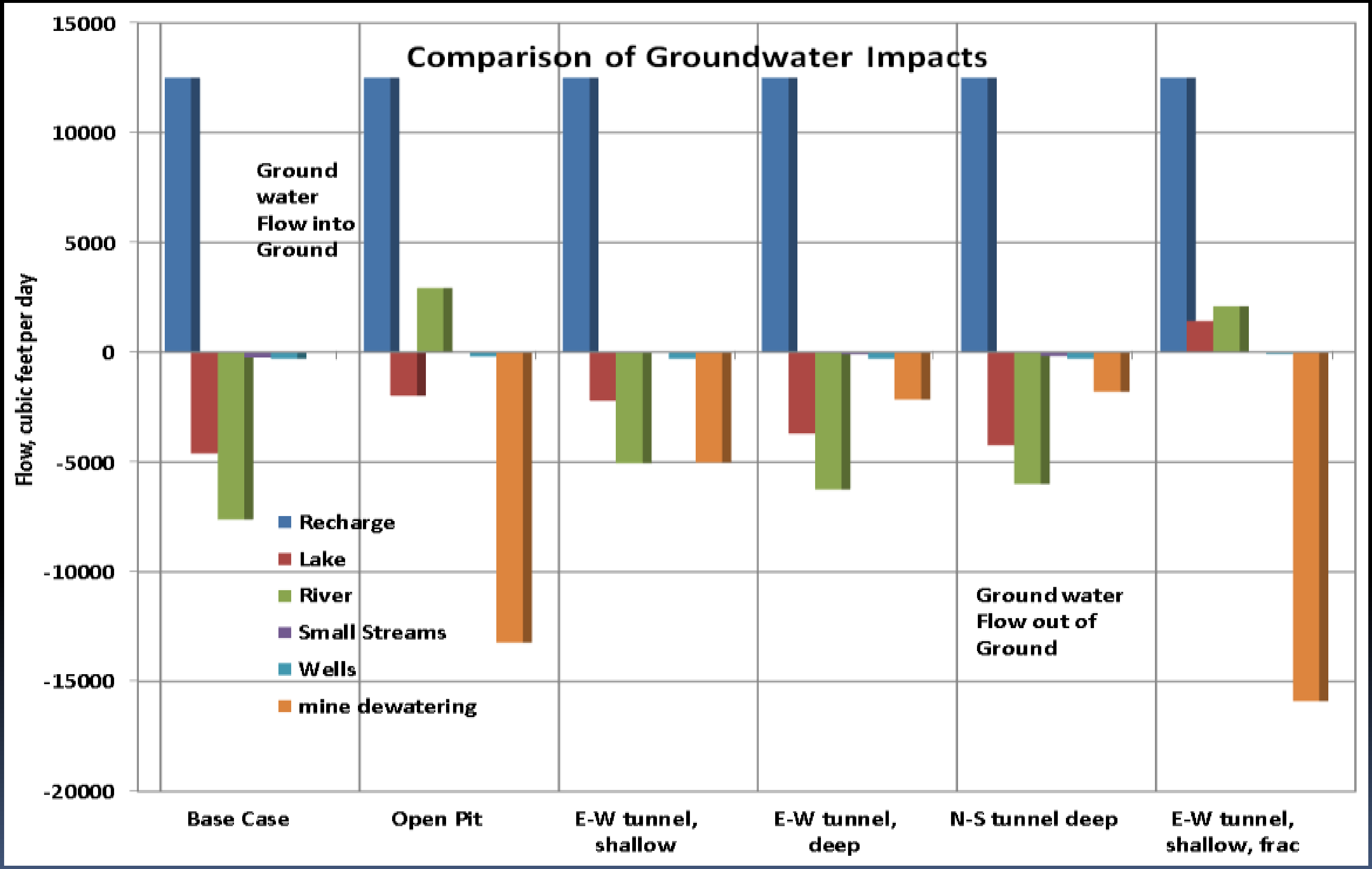
Deep N-S tunnel Xsec post dev equipotentials



E-W tunnel @1200’ deep with single fracture zone cutting across



Groundwater Impact Comparison



Summary

- Can use porous media models to simulate most Maine bedrock hydrogeologic terrains except at small scales < ~100'
- The rate of water flow into mines decreases with depth, with time, and with radius of openings
- The near-surface groundwater impact of a mine decreases with depth
- Tunnels located parallel to groundwater flow may have a greater drawdown impact than normal to flow

Summary (con't)

- Open pit mines permanently change the groundwater phreatic surface, lowering it on the upgradient side and raising it on the downgradient side
- Singular fracture systems often cause the largest potential water infiltration to mines and need to be sealed off from the mine to reduce dewatering needs and large potential hydraulic impacts