Modeling Surface Hydrology for Hazard Mitigation in Open Pit Mines Using High-Resolution Drone Photogrammetry

James McNabb

Senior Research & Development Engineer
Geotechnical Center of Excellence
University of Arizona

jcmcnabb@arizona.edu

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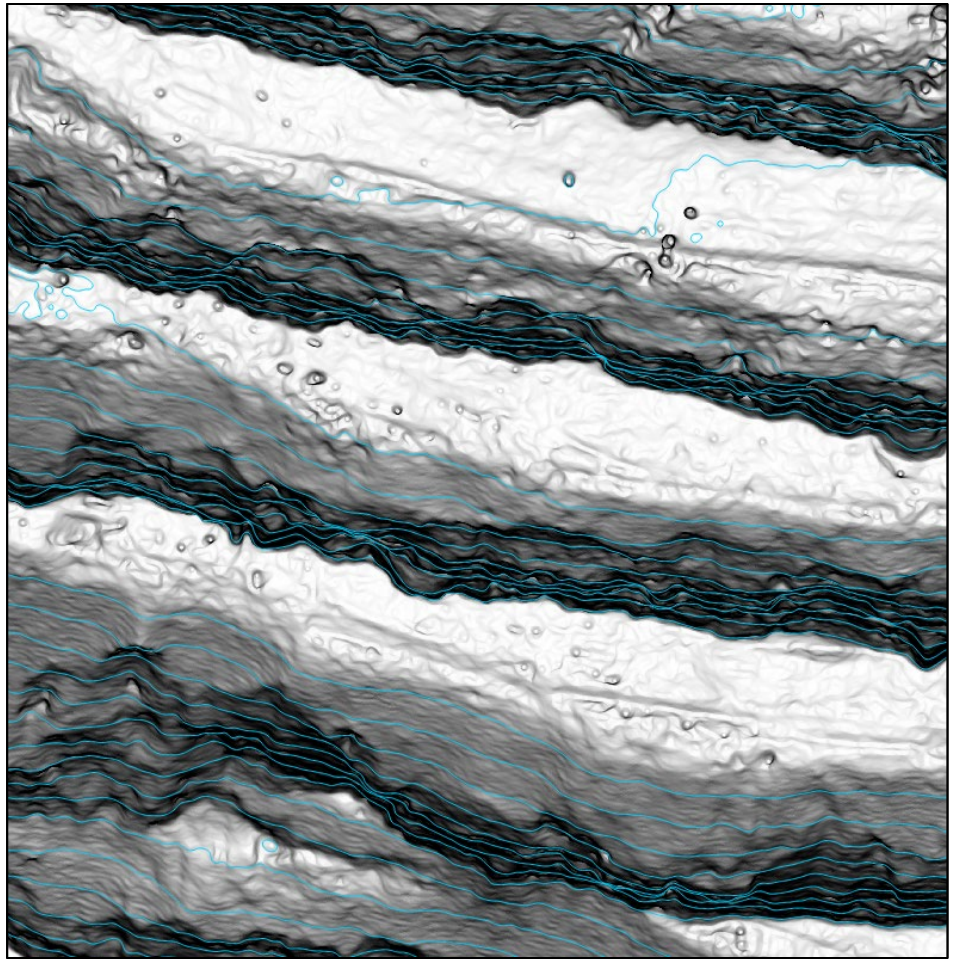
Drone Data is Underutilized in Mining

- Most mine sites use drones in some capacity
- Many collect data for photogrammetry



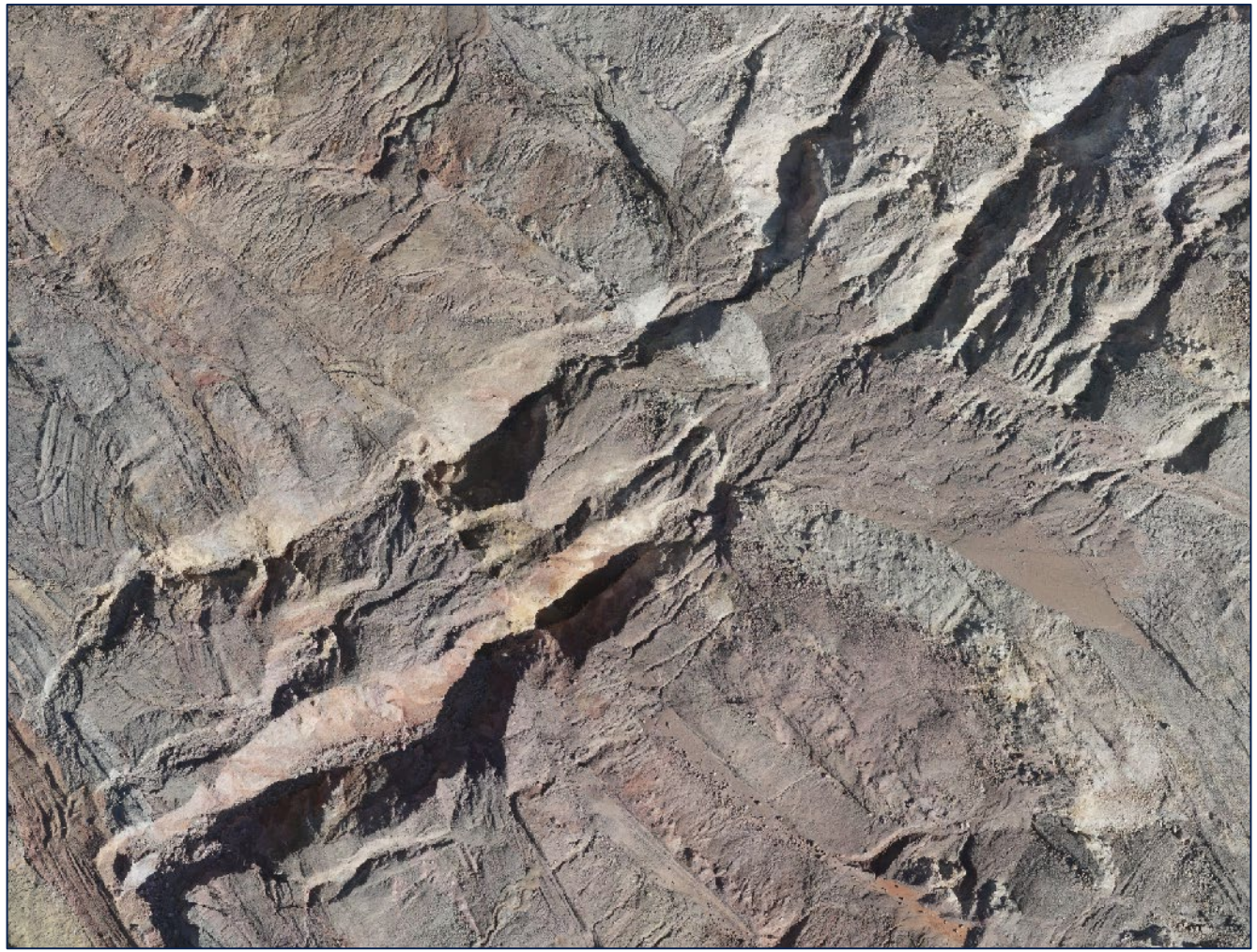
But how is the data utilized?

- Operations / situational awareness
- Highwall performance
- Mapping

Surface Runoff Hazards in Mining Operations

Surface runoff hazards:

- Erosion and deposition
- Water ingress into geologic structures
- Ponding



Need a *proactive and engineered approach* to surface water management

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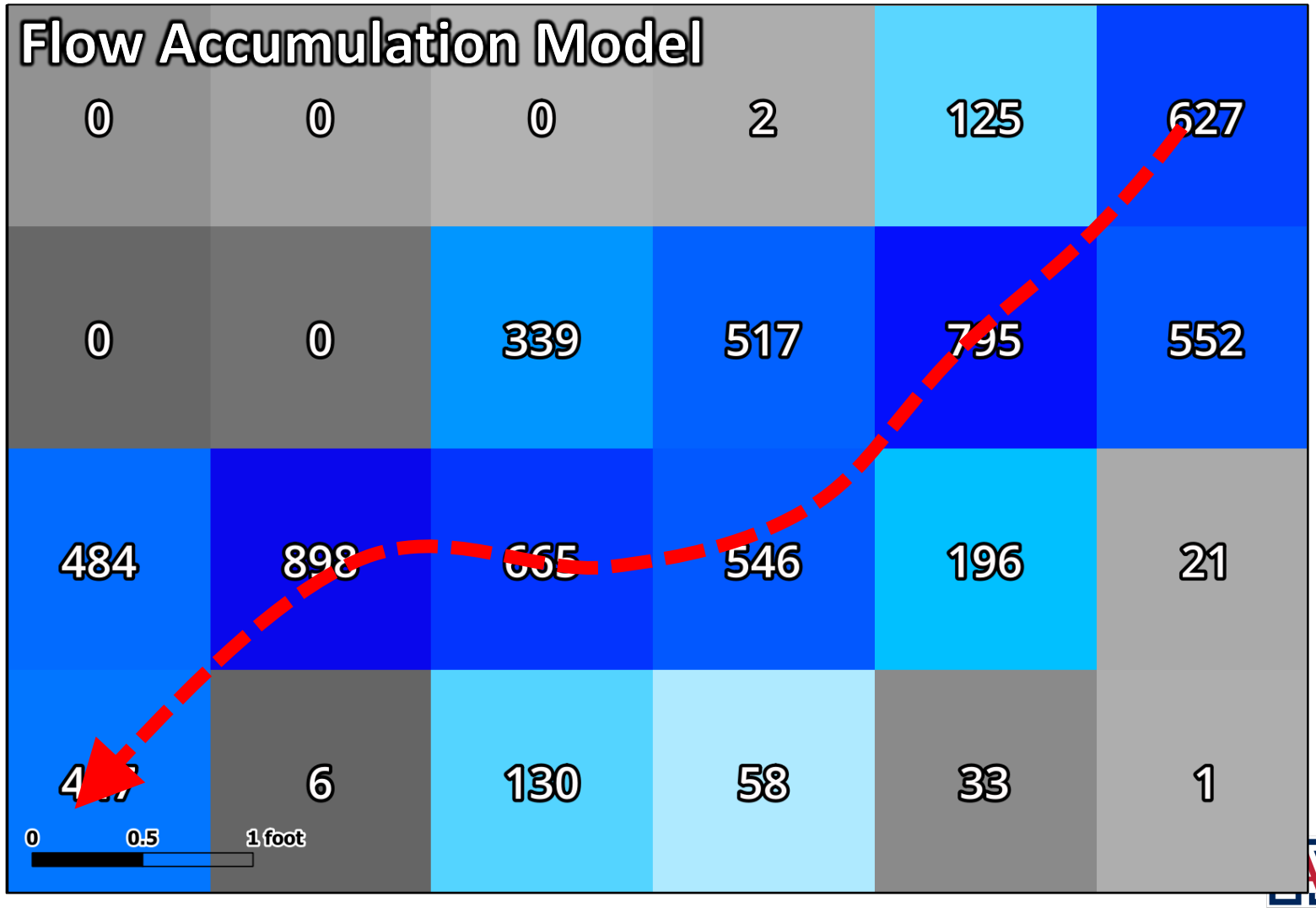
Flow Accumulation Model - QGIS



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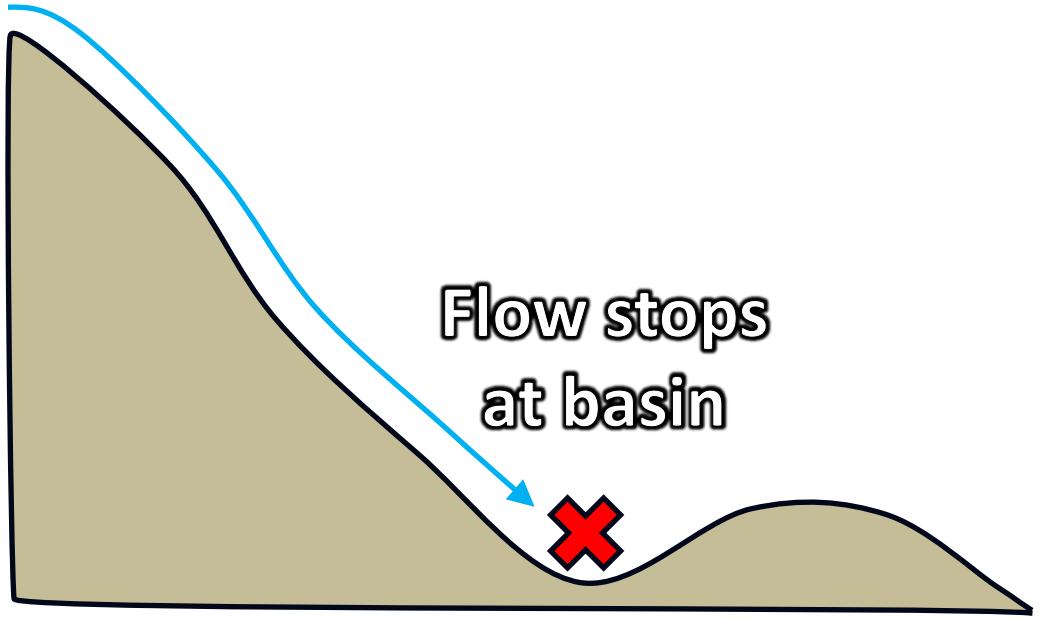
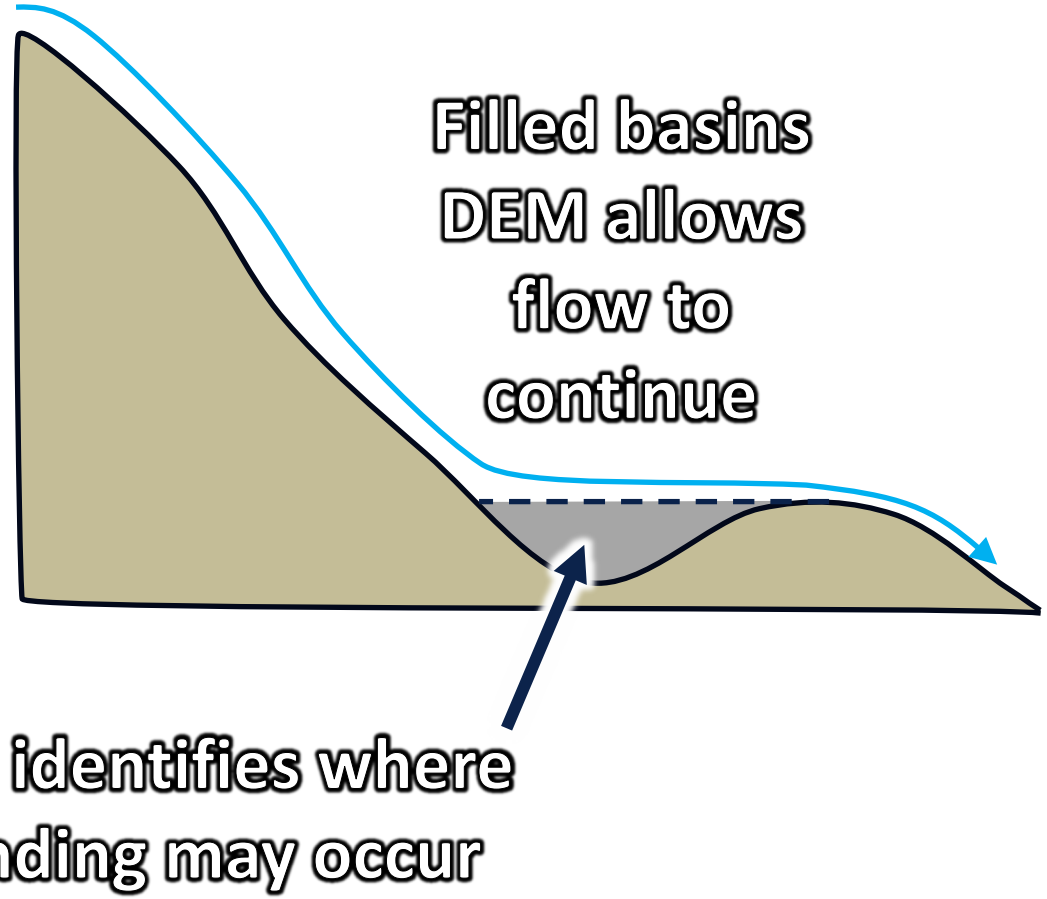
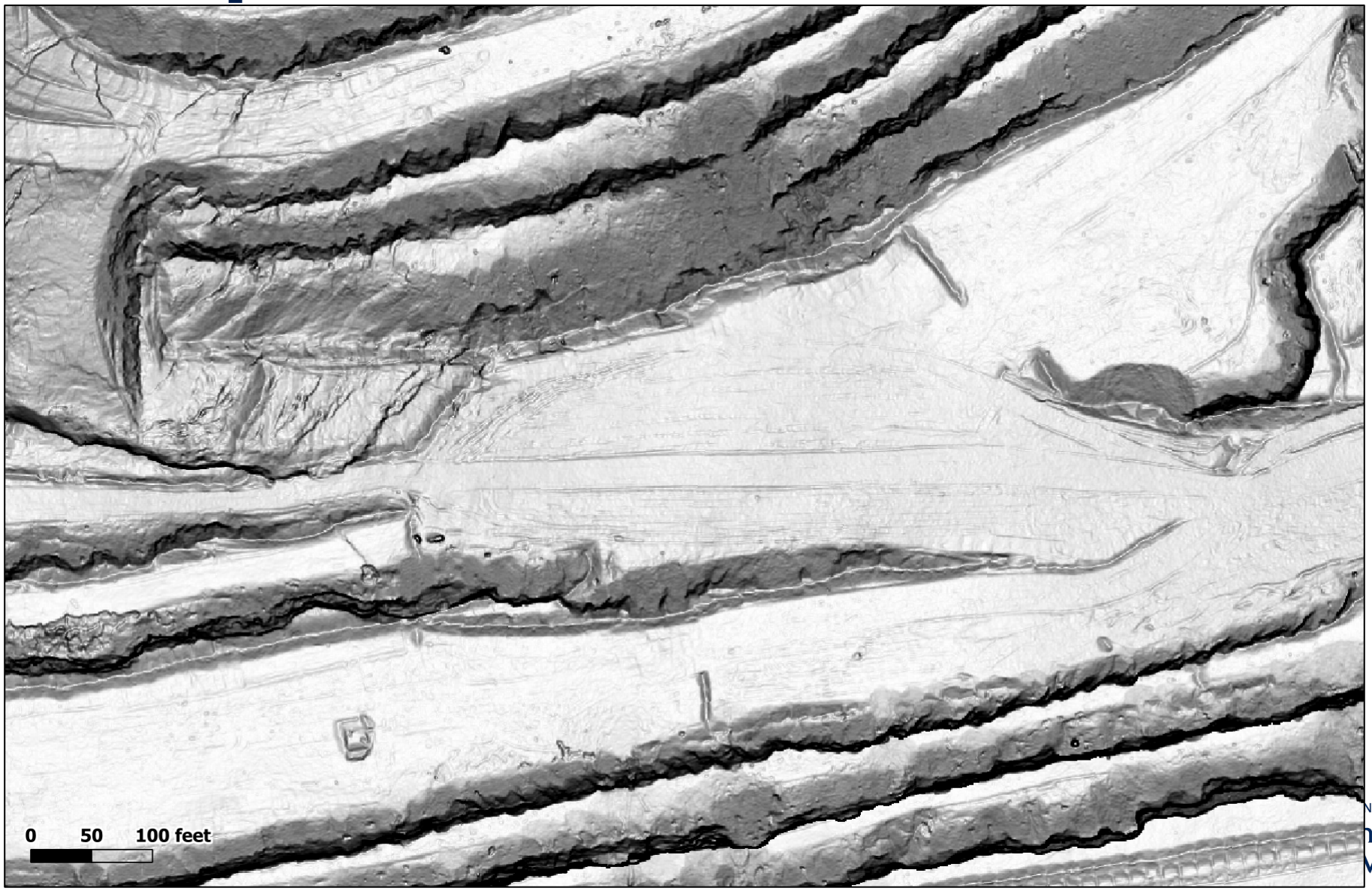
Fill Sinks


Flow stops
at basin

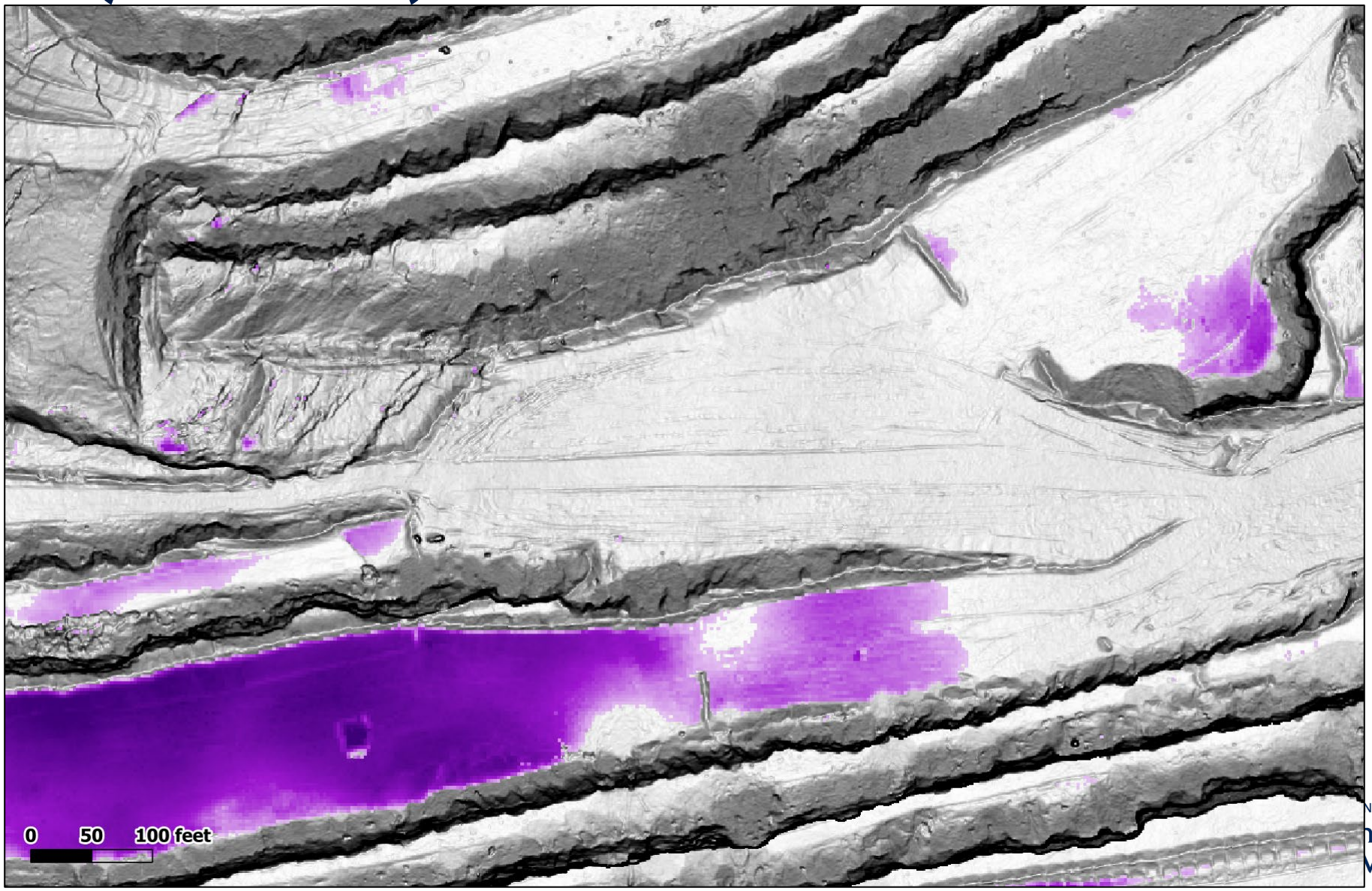

Filled basins
DEM allows
flow to
continue
Also identifies where
ponding may occur

Orthomosaic

Slope Map

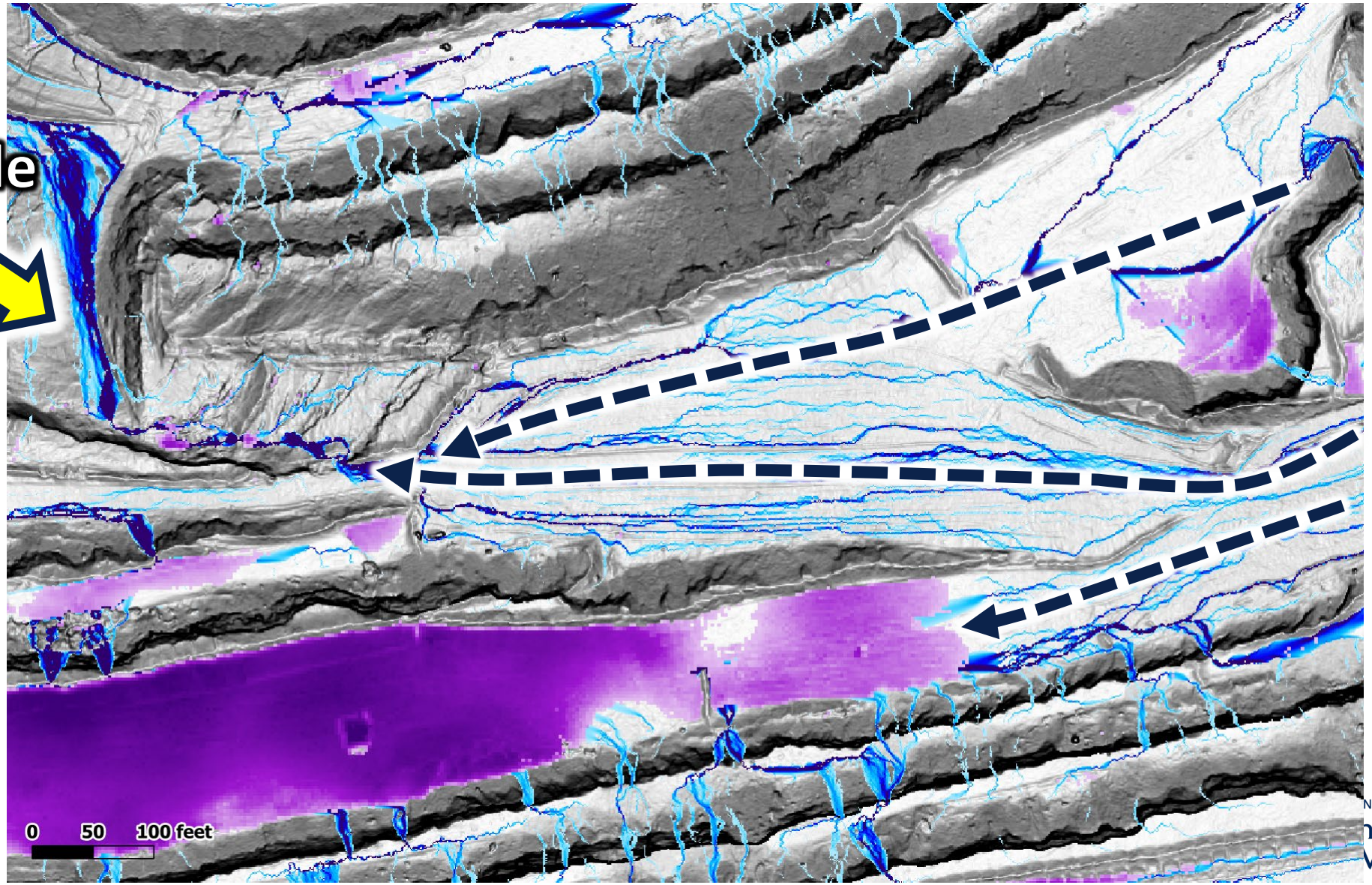


Sinks (Basins)

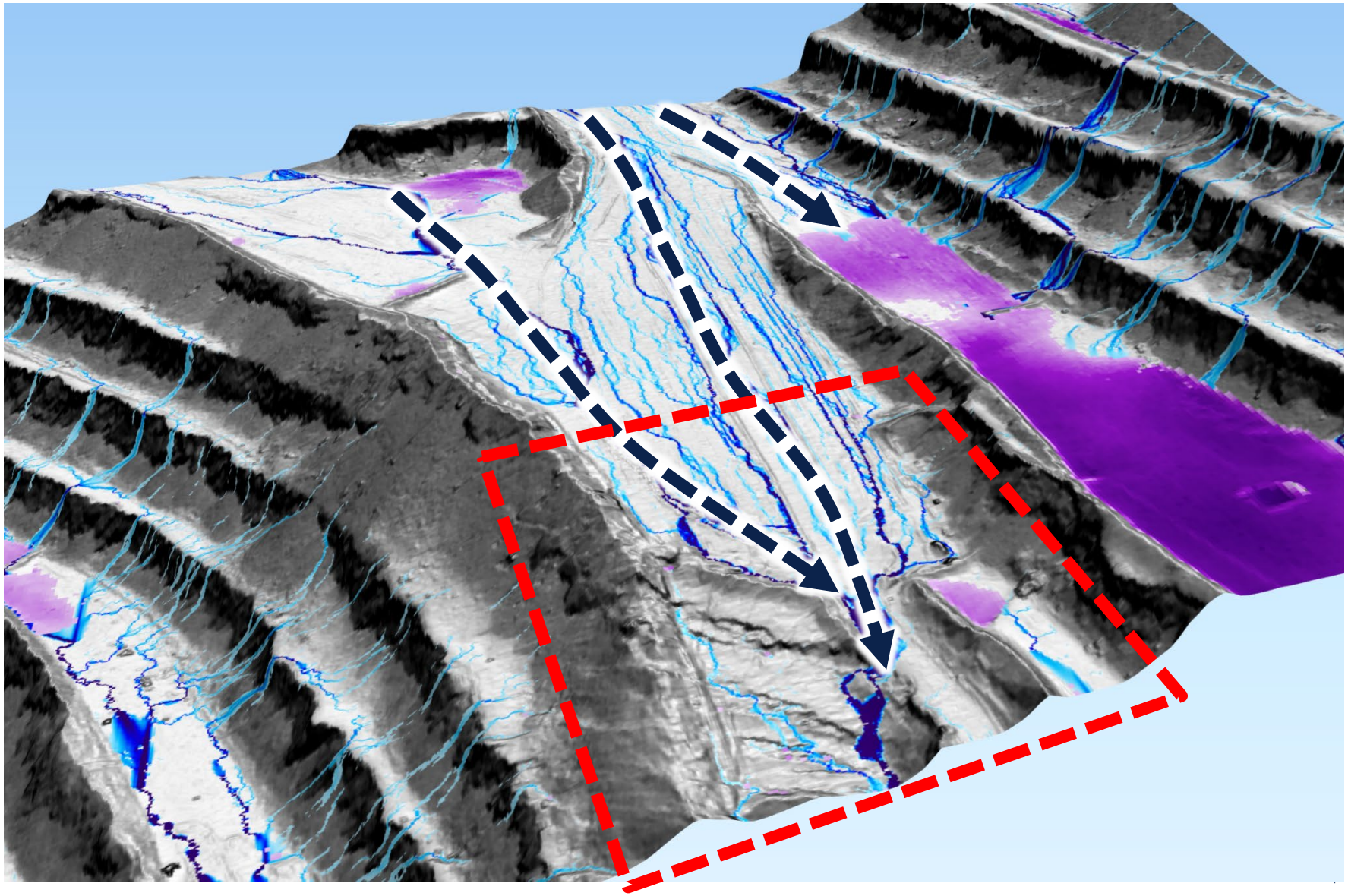


Flow Accumulation Model

Next Slide



Flow Accumulation Model – 3D Persepective



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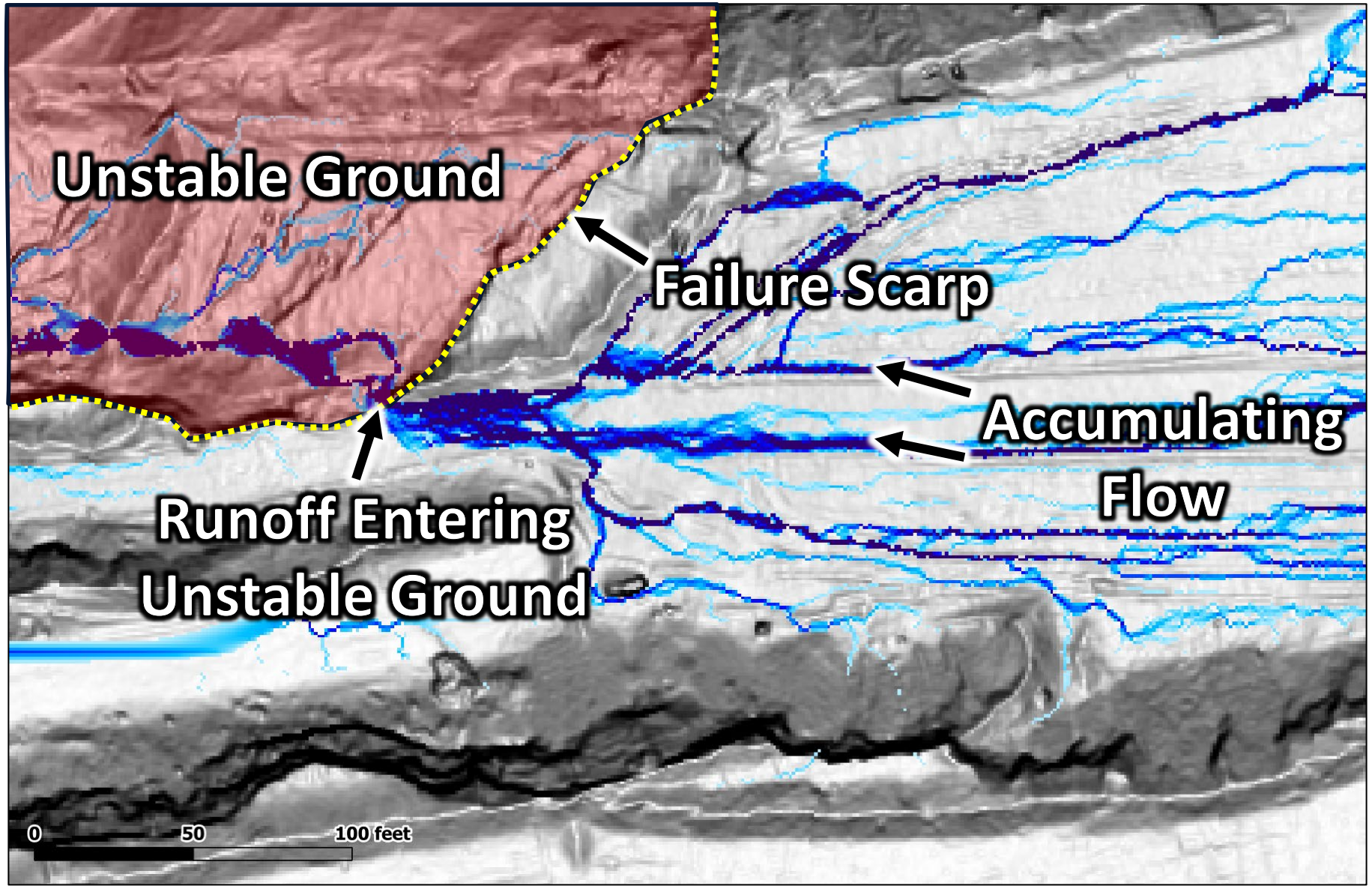
Water Ingress Into Unstable Ground

- Failed area above a low-angle fault.
- Displacement known to occur after precipitation events.
- Flow accumulation modeling highlights areas of concern and guides mitigation.

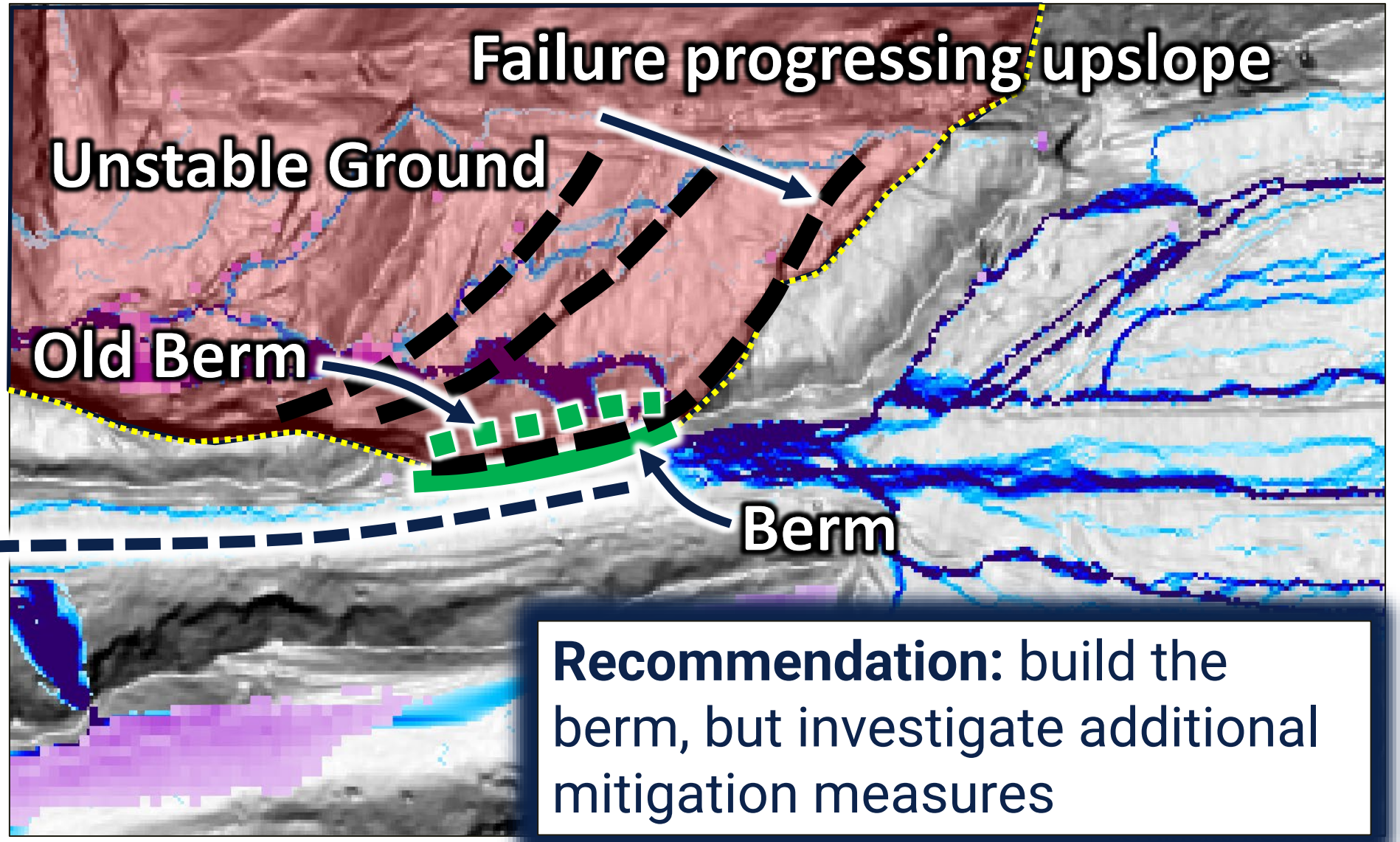


Diversion Berms

Build diversion berm to redirect flow down ramp

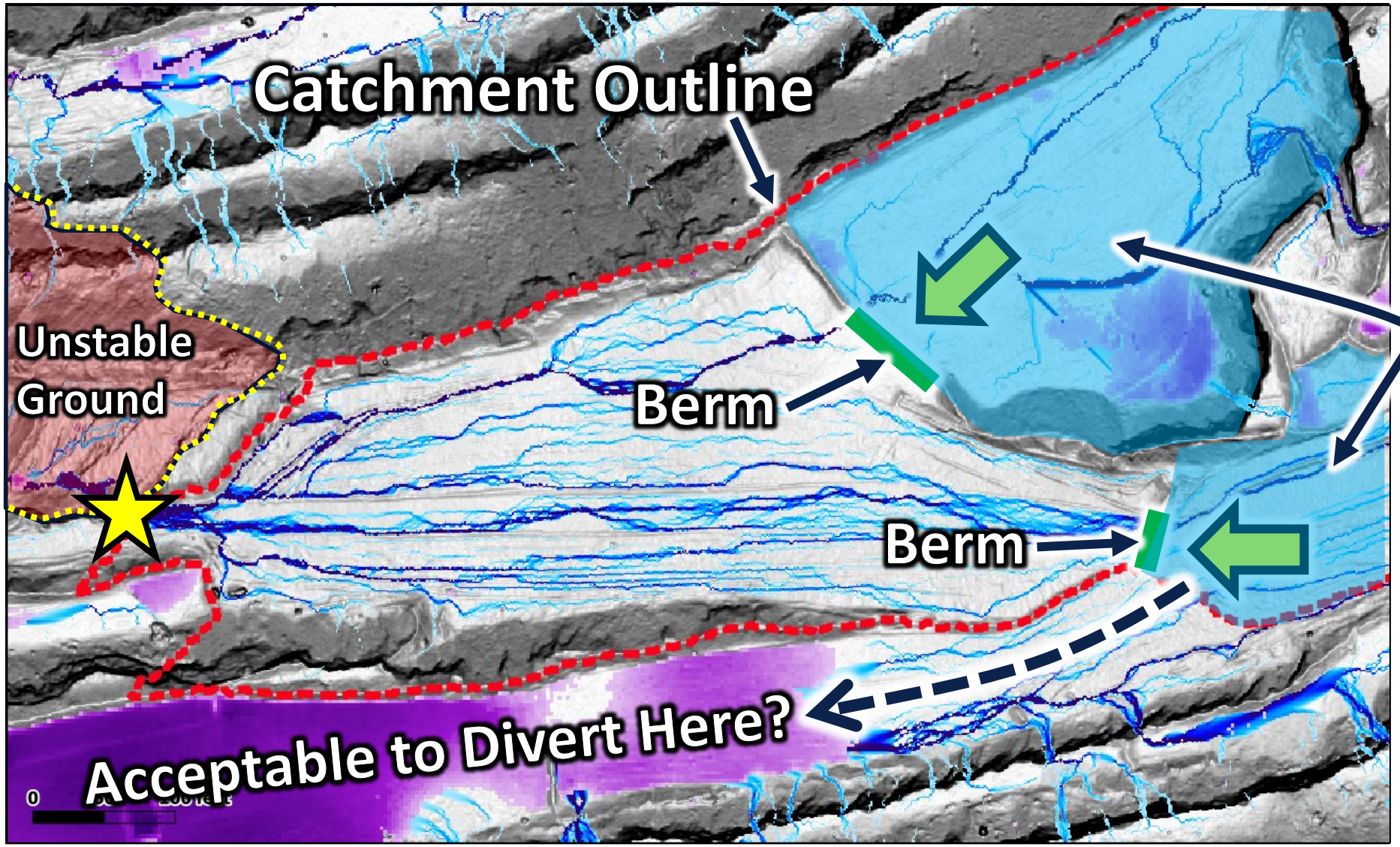
Failure progression means berm likely temporary

Is it acceptable to direct flow here?



Recommendation: build the berm, but investigate additional mitigation measures

Upslope Berms



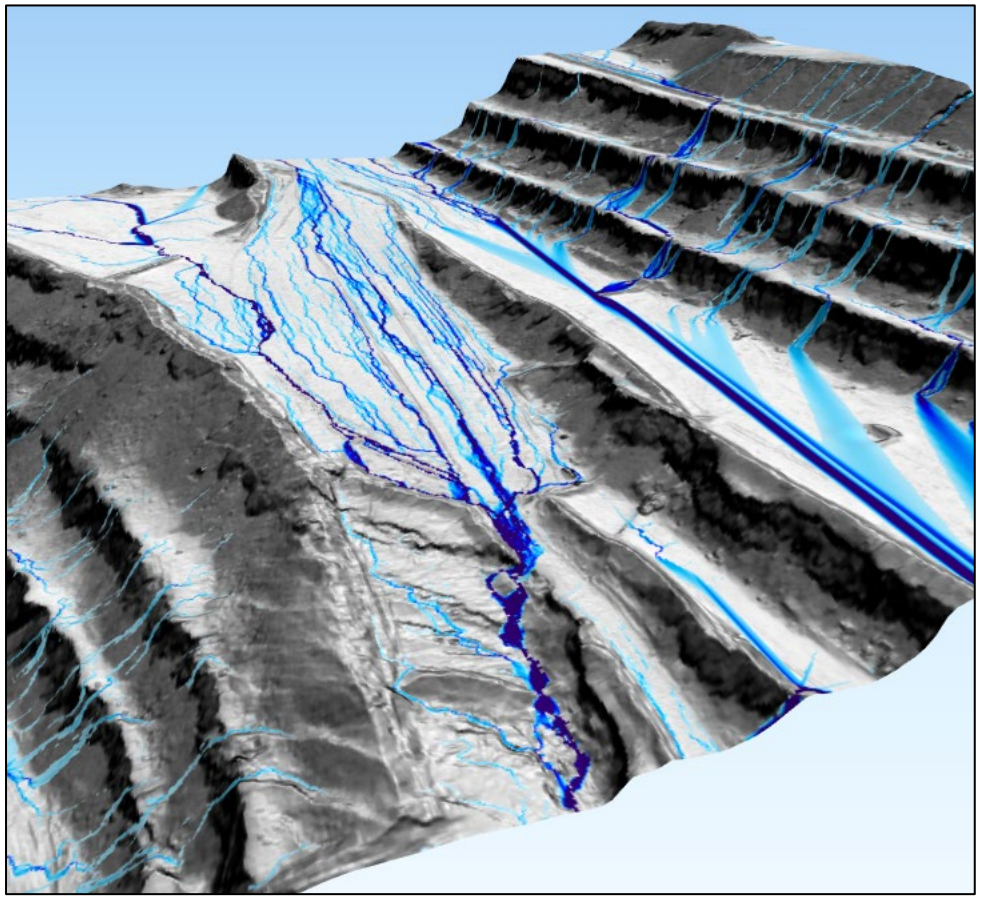
Build berms to limit upslope accumulation

Is it acceptable to pond water upslope?

What about access?

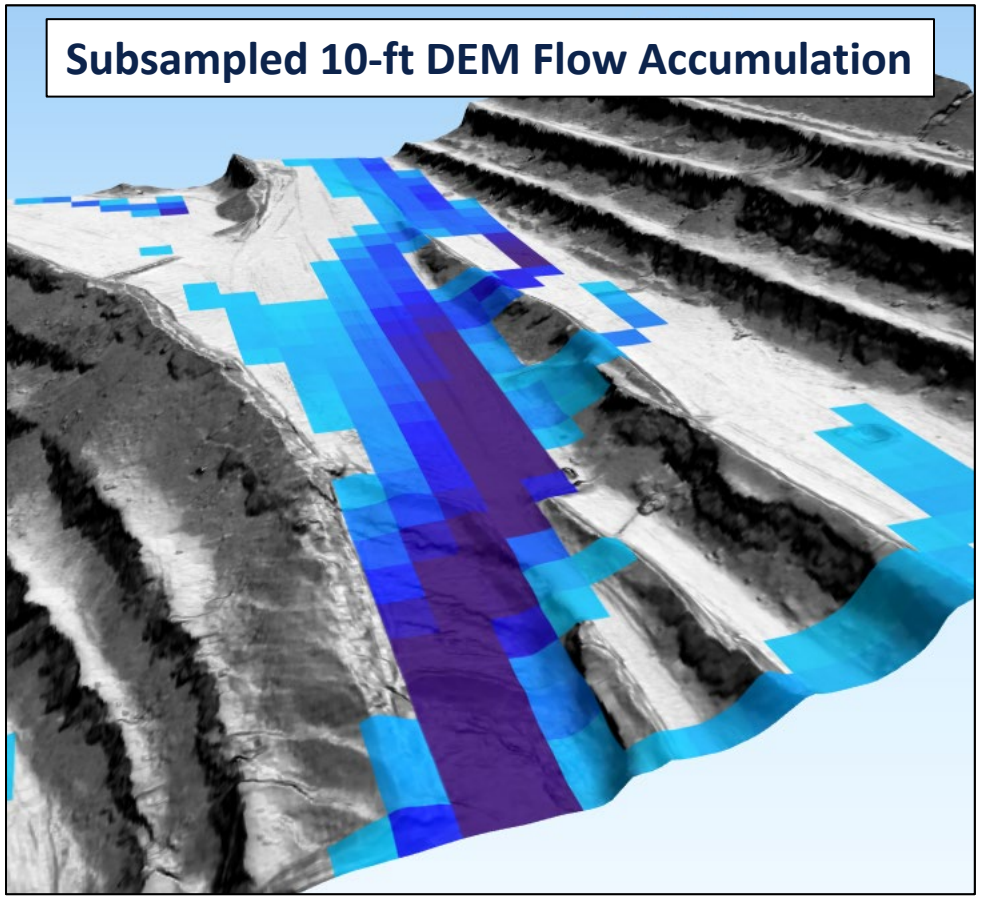
Considerations & Caveats

- Flow accumulation models are ***not*** sophisticated hydrologic models.
- Static topography = no erosion / deposition



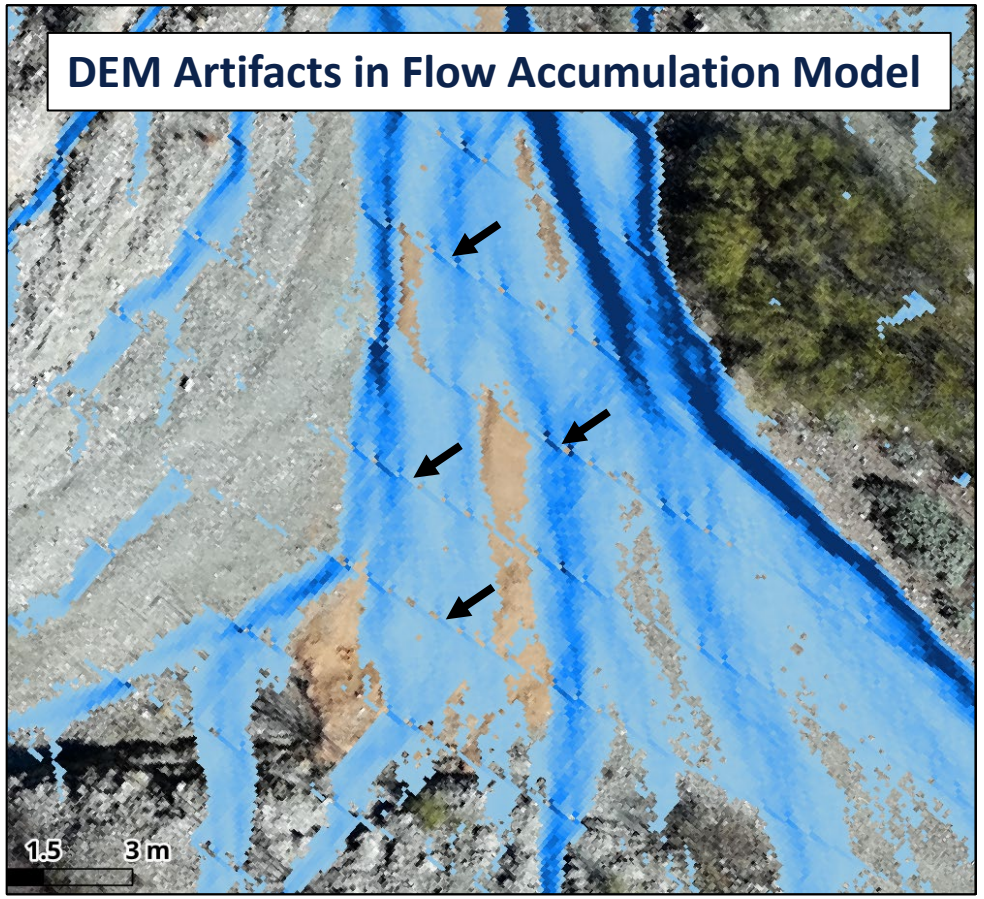
Considerations & Caveats

- Requires decent resolution to be useful for mining
  - Most drone data is sufficient



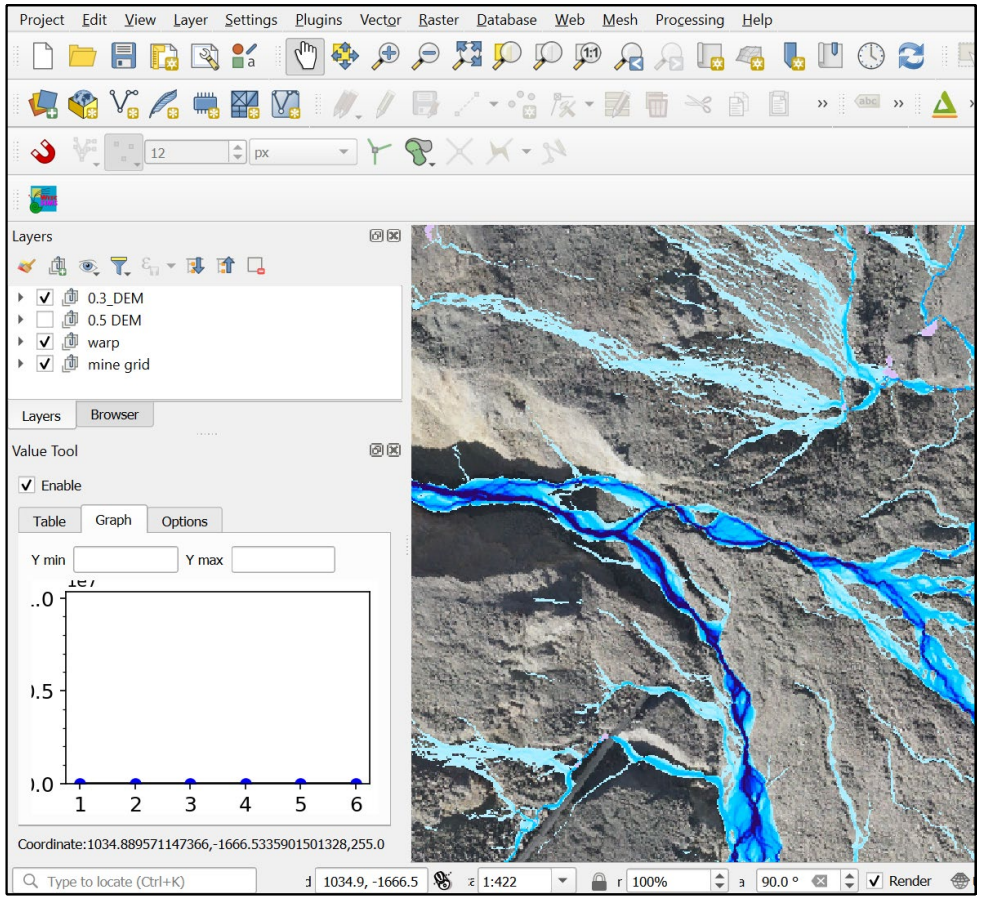
Considerations & Caveats

- Drone survey quality matters, but maybe not that much



Considerations & Caveats

- Easy to learn, off-the-shelf software
  - QGIS (open source)
  - ArcGIS
- DEM data likely exists if you have photogrammetry surveys



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Conclusions

- We can extract a lot more information from our drone data

- Flow accumulation models are one example of getting more from our existing drone datasets
  - Provide proactive and targeted means of surface flow hazard mitigation
  - Relatively easy to learn with off-the-shelf software (can be free)