

# Designing Forest Roads for a Changing World



*Presenter: Matthew Dickie, P.Eng*

# Who Are We

- R&D-focused civil engineering software company
- Born in Forestry in the steep slopes of British Columbia, Canada
- Solve a problem ---- Unbuildable roads, high cost roads, safety issues



Matthew Dickie, P.Eng.



Ministry of Forests,  
Lands & Natural  
Resource Operations



**TOLKO**  
INDUSTRIES LTD.



**Rayonier**



# What we are talking about today...

- Forestry Roads:
  - Their importance
  - Their cost (Financial and Environmental)
- How our forest road needs & environment are changing
- Technology advancements that support improved design



# Forest & Resource Roads are Massive in Scale:

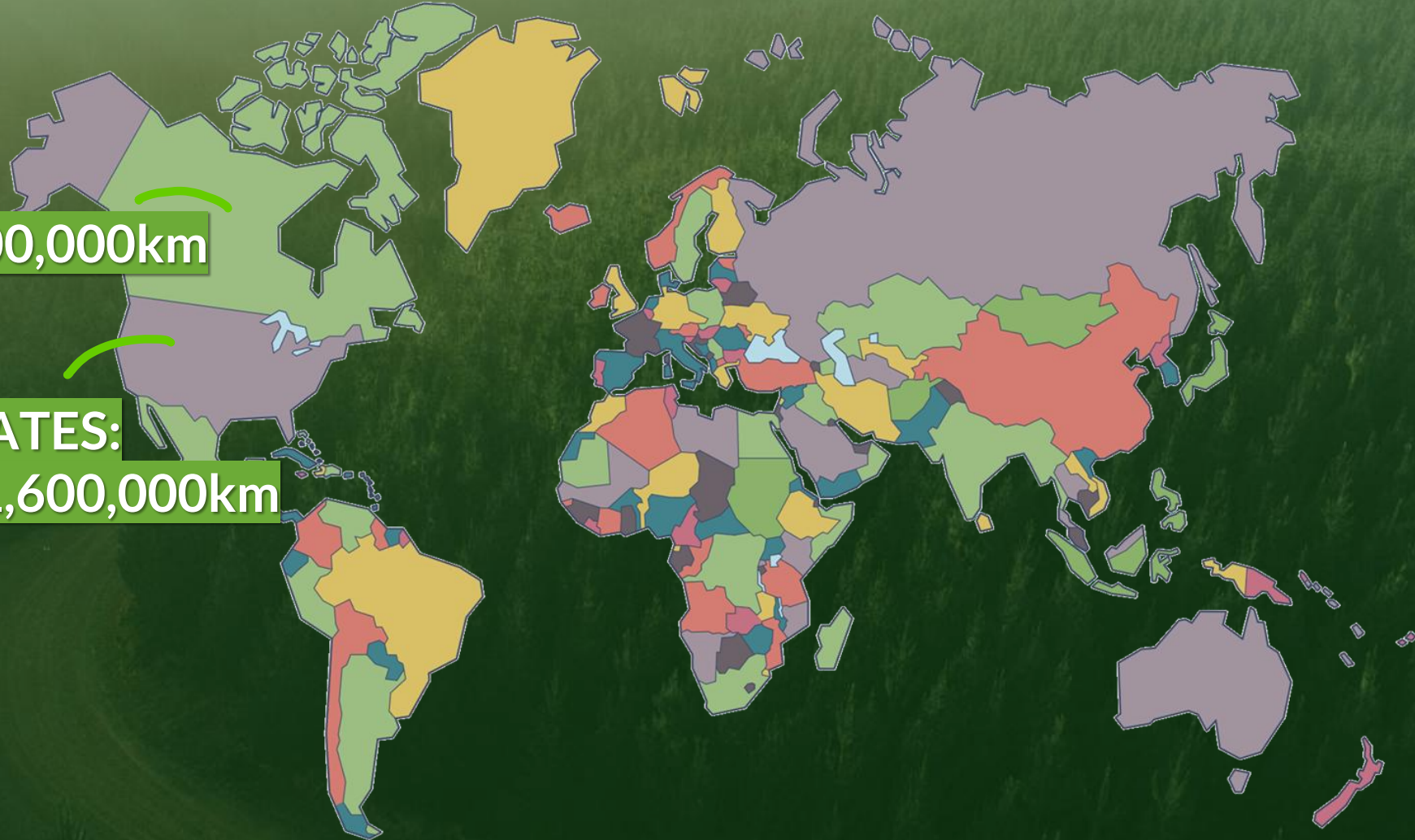
**GLOBALLY: 25 - 30 Million km**

**CANADA:**

**600,000-800,000km**

**UNITED STATES:**

**1,200,000-1,600,000km**



# High Cost, Potential for Severe Impacts



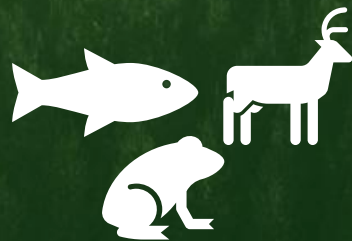
**ROAD SURFACE  
EROSION**



**SLOPE FAILURES /  
SLIDES**



**WATER POLLUTION &  
ALTERED STREAM  
CHARACTERISTICS**

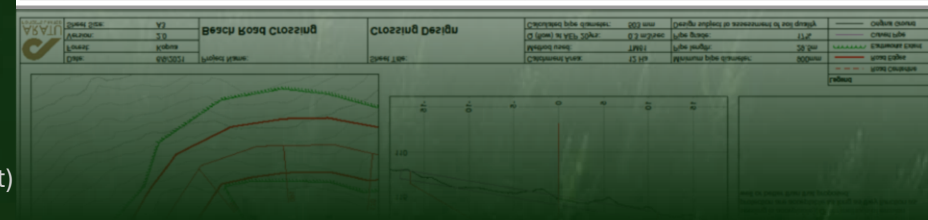
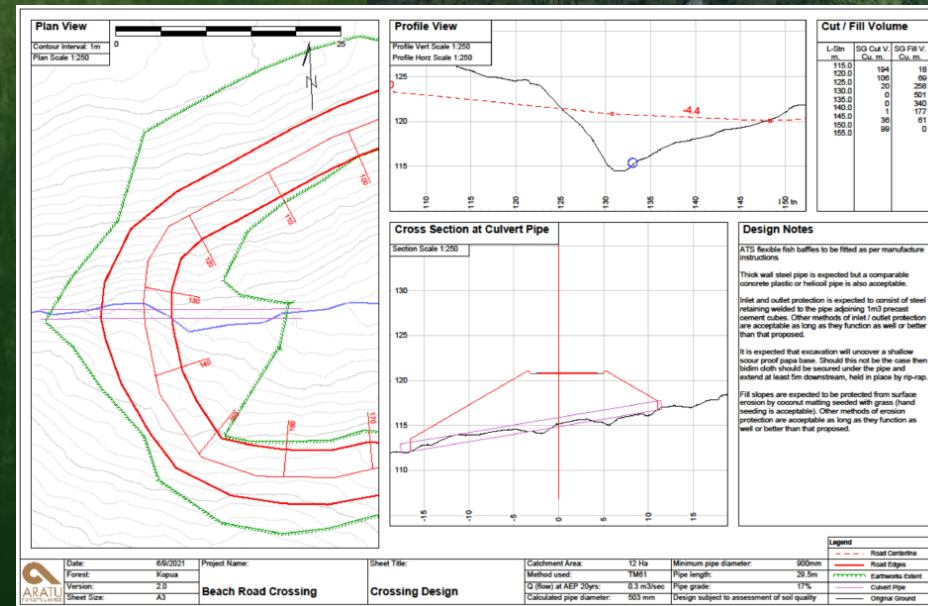


**HABITAT LOSS**

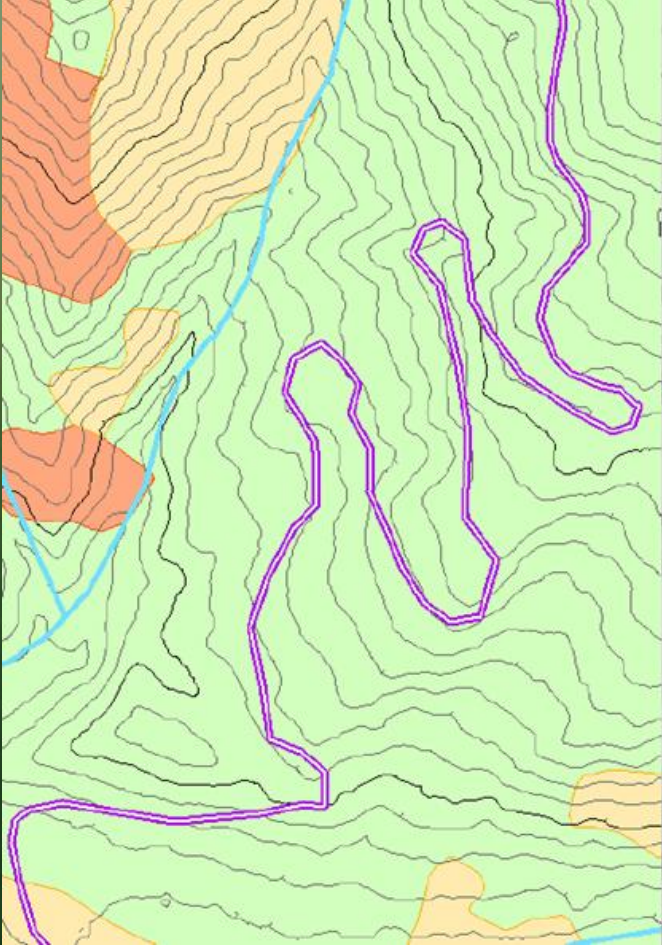


# Road Design

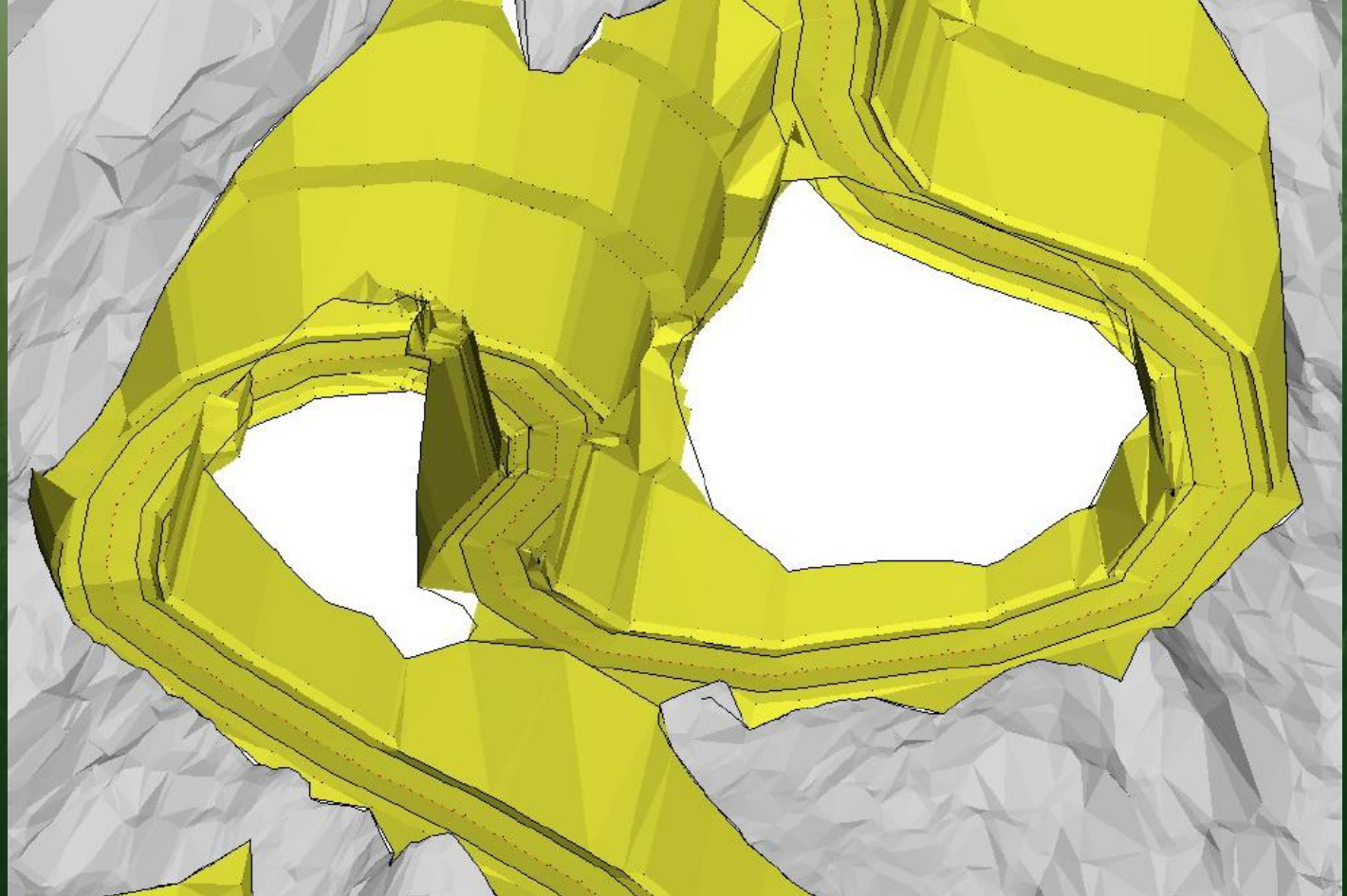
- What you think it is:
  - Drawn out process
  - Completed by team of drafters
- What we actually do:
  - Practical
  - Fast
  - Efficient



# Road Design is an Important Tool



Alignment In GIS Software



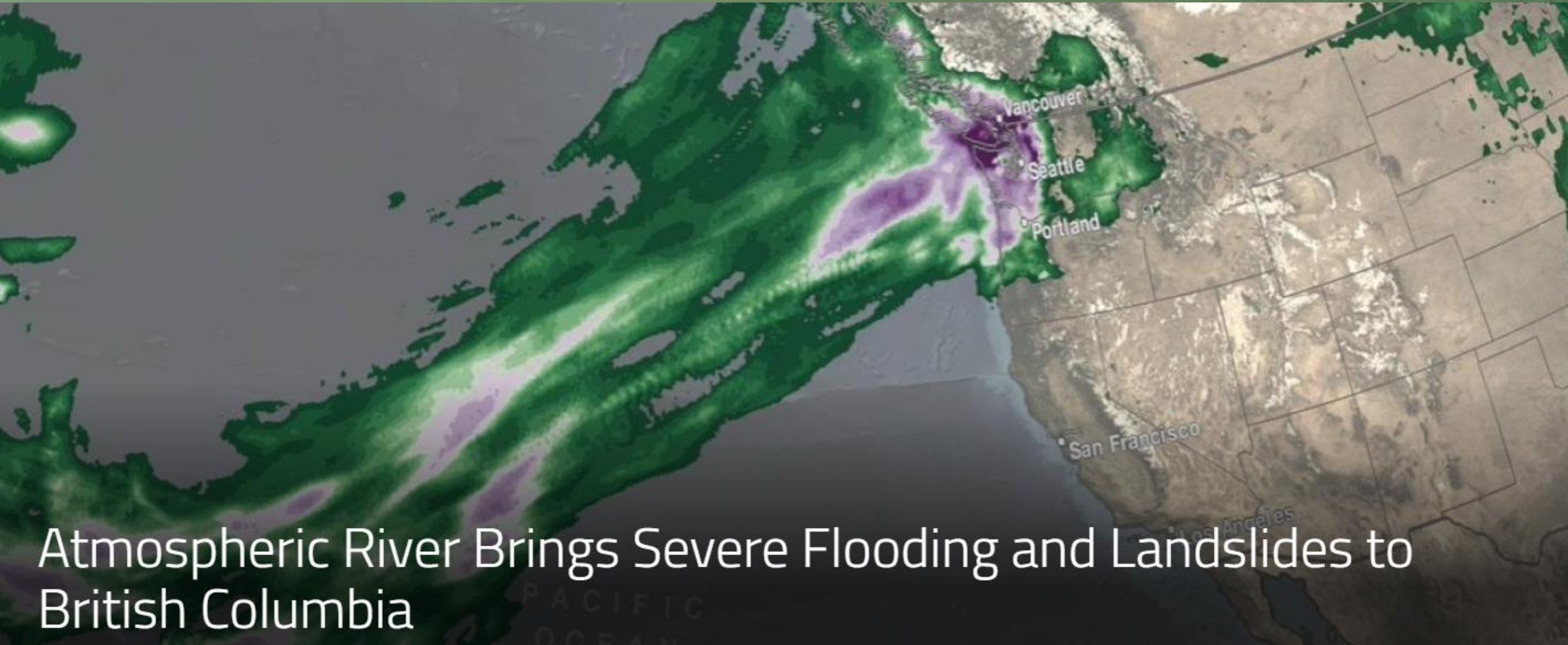
Alignment in Geometric Design Software

# Poorly Designed or Constructed Roads – Impact Safety, Cost & Environment

- Increase Cost
  - To Construct,
  - To Maintain,
  - To Repair,
- Disrupt Operational Efficiency
- Impact Environment
- Reduce Safety



# Case Study: 2021



# Case Study: 2021 Atmospheric River in BC, Canada

Landslides



Flooding



Lateral Channel Movement

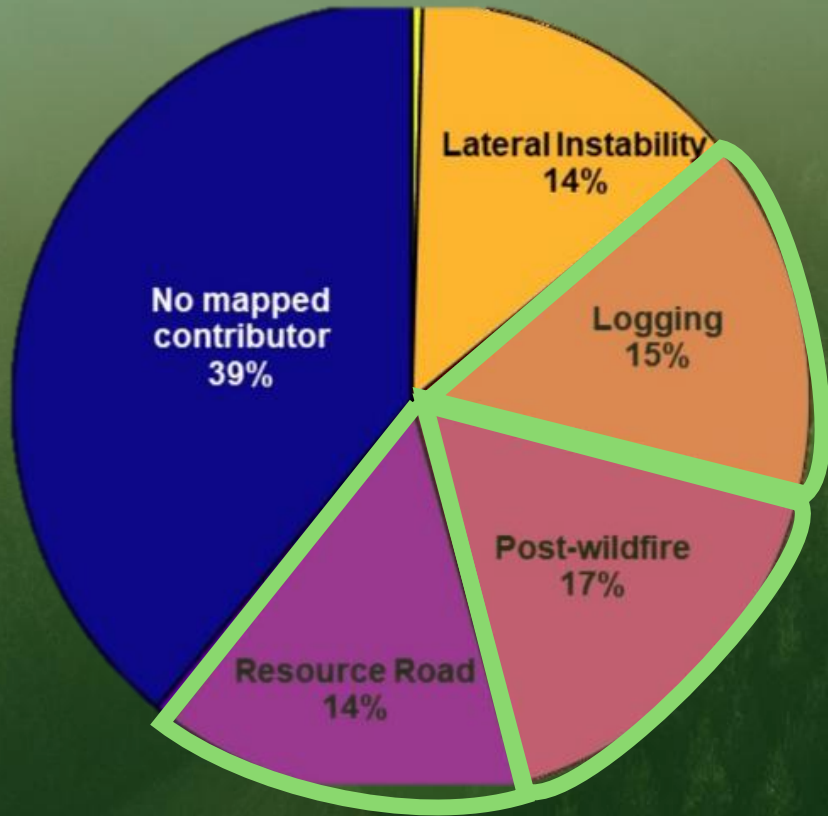


# Severed Access to Every Major Highway



Photo Credit: BC Ministry of Transportation

# Landslides Attributed to Forestry Roads



## Nearly half of B.C. landslides linked to logging, wildfires, study finds

Posted by Merritt Herald | Mar 18, 2025 | News, Fires, Forestry, Trending | 0



Geoscientist Carrie-Ann Hancock surveys a debris flow in the Fraser Canyon triggered by an atmospheric river in November 2021. Photo/Beatrice Collier-Pandya

Geoscientist Carrie-Ann Hancock surveys a debris flow in the Fraser Canyon triggered by an atmospheric river in November 2021. Photo/Beatrice Collier-Pandya

**1,300** landslides & debris flows during 2021 event:  
**46 % (~600)** were found to originate in disturbed forests.

# 6-Hour Rainfall and Major Highway Slide Locations

★ Major Highway Slide Locations

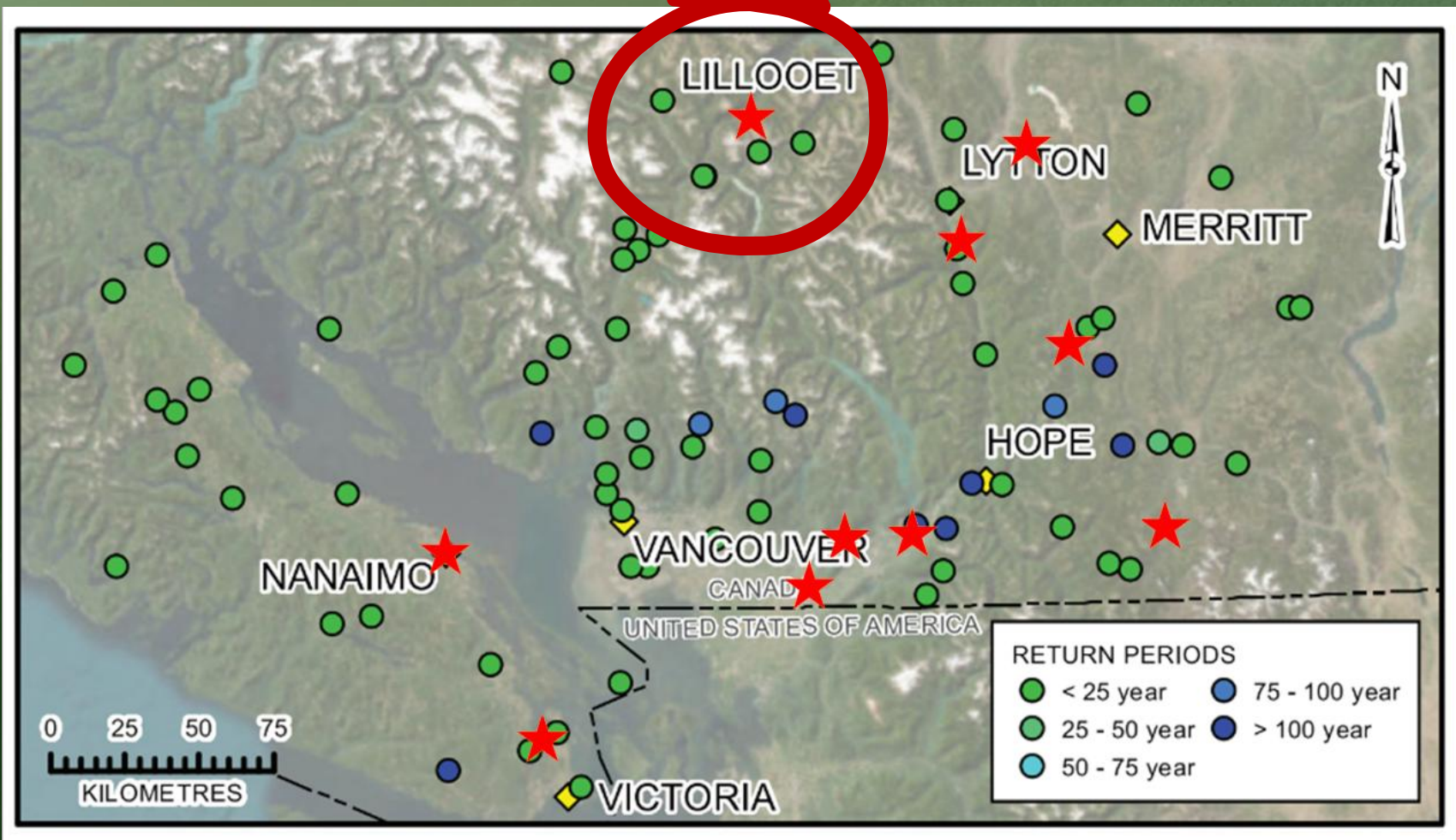



Photo Credit: Hancock Wlodarczyk 2025

# Duffey Lake Road Slide Claims 5 Lives



Photo credit: CNN (left) & CBC (right)


Menu 


**NEWS** Top Stories Local Climate World Canada

British Columbia


## Fatal landslide blamed on old logging road raises fears about hidden risks near Canada's highways

Mother furious she lost her son to a potentially preventable landslide

 [Yvette Brend, Lyndsay Duncombe](#) · CBC News ·  
Posted: Oct 27, 2022 1:00 AM PDT | Last Updated: October 27, 2022




Canada's old logging roads: thousands of kilometres of danger

 3 years ago | 9:53

A CBC News investigation into the landslide that killed five people in B.C. in November 2021 uncovers serious concerns about the logging roads across Canada.

uncovers serious concerns about the logging roads across Canada.  
A CBC News investigation into the landslide that killed five people in B.C. in November 2021

 2 years ago | 8:22

Canada's old logging roads: thousands of kilometres of danger



600m

FORESTRY ROAD

Slide location

HIGHWAY 99  
(DUFFY LAKE ROAD)

Province of BC/Geographic Information Centre  
| Department of Geography UBC

# This is Not a One-off Event

2015:

BC News

## Logging truck swept off road

The Canadian Press - Nov 19, 2015 / 6:02 am




Photo: Contributed - file photo


Photo: Contributed - file photo

2017:

## Road collapse from heavy rain leads to logging truck fatality near Lake Cowichan

by Mary Griffin  
November 16, 2017 5:53 pm

Facebook X Bluesky Share Reddit Mail



Not just safety → **Environmental** Damage / Cost, **Financial** Cost

# Example: Yeo Island Incident



## Monetary costs:

- **\$27,000** to repair excavator
- **\$48,000** in lost production (6 day shutdown x \$8,000/day)
- **\$32,000** in transportation costs (crew, investigators, professionals)
- **\$16,500** in other professional and administrative costs
- **\$26,000** to build tote road to recover excavator
- Lost harvest opportunity – gross value **\$400,000**

**Total direct cost of this landslide: \$549,500 plus human impact**

# Key Considerations Influencing Road Impacts:

**Water**



**Gravity**



**Geology & Topography**



ALL ROADS HAVE IMPACTS.  
**Goal: Minimize Impact.**

# Water Impacts All Roads

**Erosion**



**Sediment**



**Debris Flows  
& Floods**



**Landslides**



**Disturbance  
Areas**



**Altered Stream  
Characteristics**



**Water Flow**



**Weakened  
Road Prism**

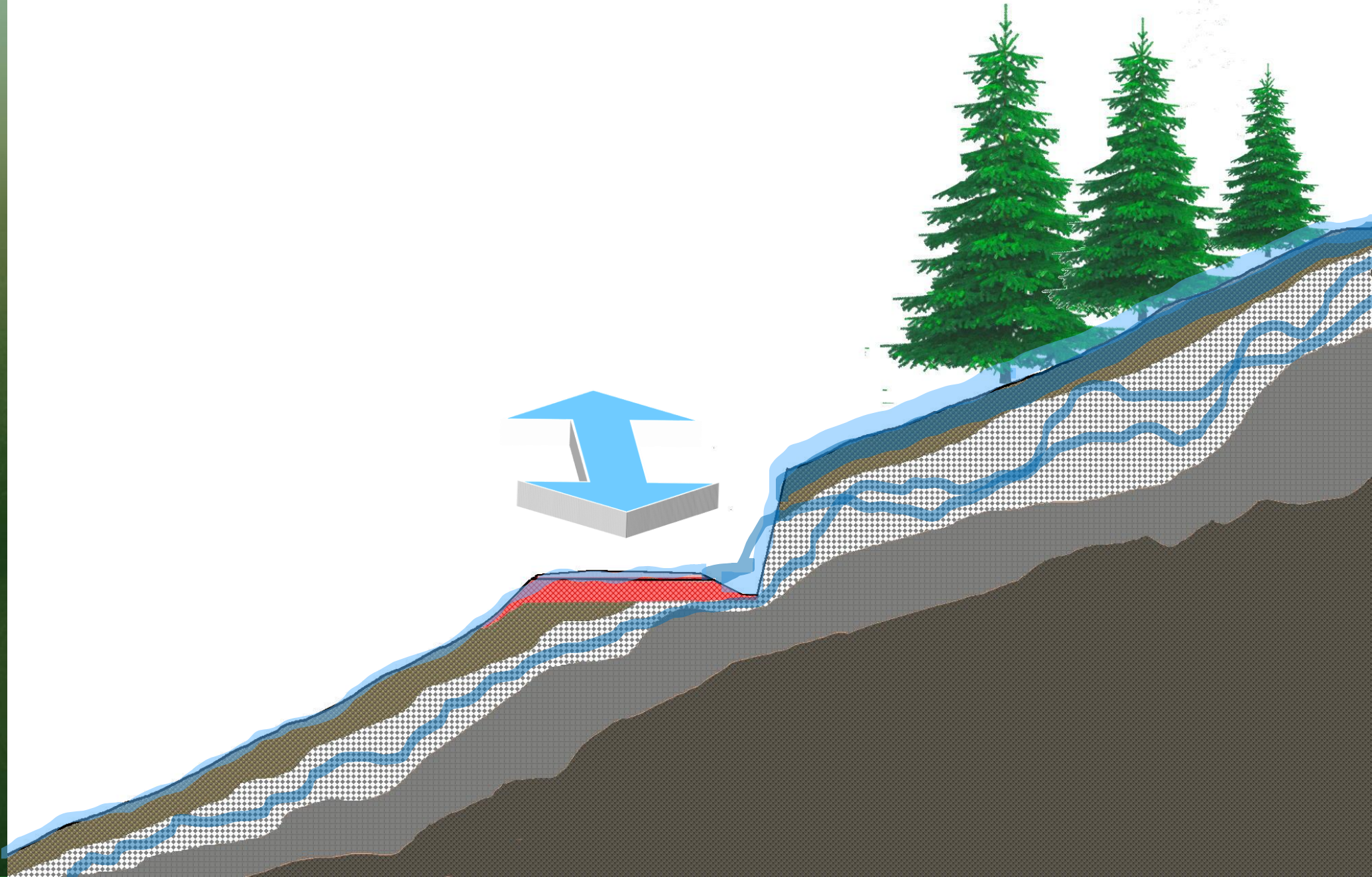


# Water

Interception of  
water

Accumulation  
of water

Redirection of  
water



# This is not a new problem, or a problem unique to BC

## 2008 Report:

### 1. INTRODUCTION

Forest harvesting in British Columbia's coastal forest lands moved on to steep terrain in the 1960s and early 1970s without a systematic method for the identification of unstable terrain or down slope risks associated with road construction and timber harvesting. **The results were devastating; many landslides initiated in cut blocks and from roads during west coast rain storms** (Figures 1 and 2). These landslides had a considerable cost with the loss of life, degradation of fish habitat and forest land, lost investment in forest roads, and lost silviculture investment (Schwab 1988; Hogan *et al.* 1998).

Landslides from forestry occurring across US according to OSU Study:



NSF Stories

### Forest landslide frequency, size influenced more by road building, logging than heavy rain

Forest management history affects how often landslides occur and how severe they are

February 14, 2023

February 14, 2023

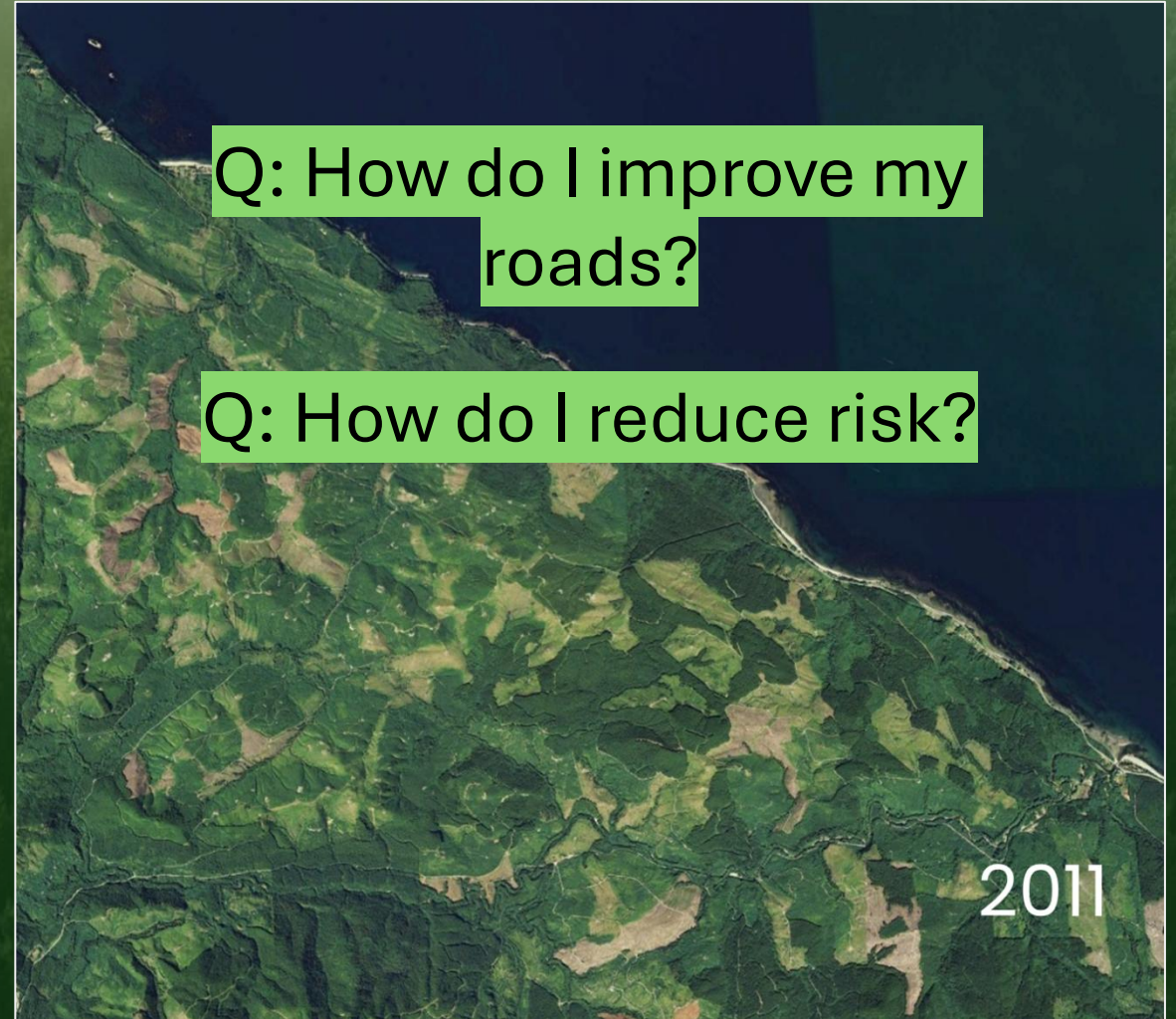
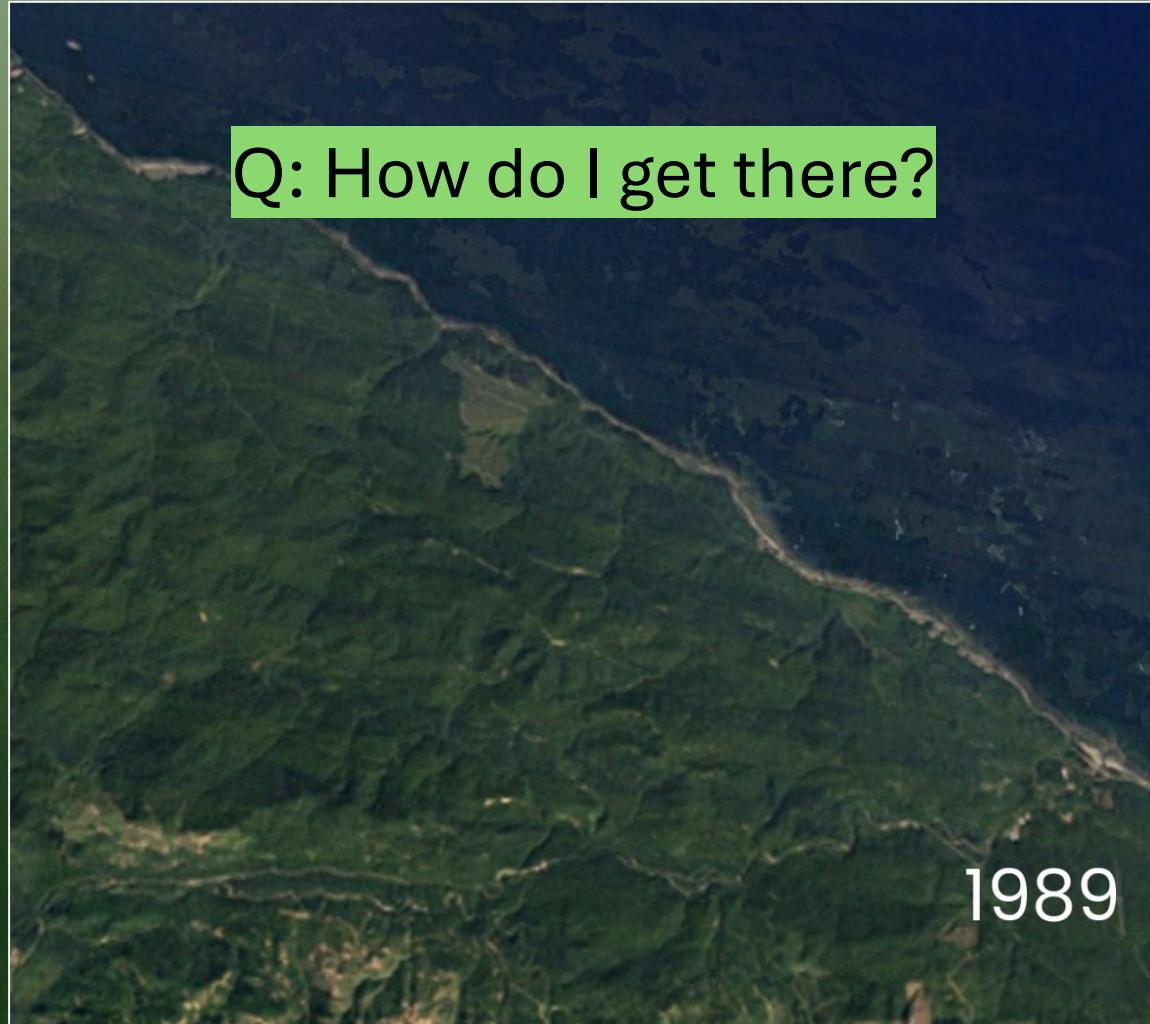
February 14, 2023

Forest management history affects how often landslides occur and how severe

logging than heavy rain

influenced more by road building

# Changing Industry Needs: Road Network Maturity





# 10 years after the deadly Oso landslide, climate change is increasing the danger

AT THE EXTREME  
CALIFORNIA STORM WORSENER BY CLIMATE CHANGE AND EL NINO  
LIVE CNN



Deadly wildfires in Northern California  
Firefighters walk along State Route 24, one of two roads closed by a fast-moving wildfire near Clear Lake in California on Sunday. The fire has burned about 87,000 acres and destroyed more than 20 homes. About 12,000 firefighters are battling the blaze.

MOTHERBOARD  
Planet at Risk

'We've got to plan' for floods as climate changes  
Story by Christine Butler - BBC News Cornwall and Julia Gregory - BBC News South West · 1w ·  
3 min read Summarize



Climate change  
Tragedy

Temperatures near or pass  
time records  
heat wave

Newsweek

WORLD  
SWEDEN DROPS  
EXTINGUISH FOREST FIRES

Climate change  
Devastating effects could be felt within 15 years

house conditions, new report says

Heat  
Quebec

Domino-effect of climate

El Niño-effect  
climate events  
the Earth into  
'house' state

the artists warn

The Washington Post

The Washington Post  
Democracy Dies in Darkness

Capital Weather Gang

WORLD

Planet at risk of heading

Not secure

Standard.

time hottest  
temperature records set  
er the world this week  
g towards irreversible

Arctic Circle on Edge

By Adam K.

f t p

Cal  
rem

By Brad Hamilton

Secure

News Drive

# Climate is Changing



**Precipitation:**  
Heavier & Intense Events



**Atmospheric Rivers:**  
Longer, Wider, Wetter



**More Storms:**  
Frequency & Strength



**More Wildfires:**  
Larger Areas & Longer Seasons



**Droughts:**  
Drier & Longer

Photo Credit: : Wildlands League (left), Brian Chow (centre), Diana Vieira (right)

# Designing Roads That Balance What Matters

## Sustainable:

- **Capable of Continuing For Perpetuity**
- ...Without degrading the **environment**.

## Operational Needs:

- Safe
- Traffic Volume
- Design Vehicle
- Seasonality of Use
- Duration of Use

## Resilient:

- Withstand future weather events, or
- Decommissioned

# Key Considerations To Find Solutions:

**Water**



**Gravity**



**Geology & Topography**



# Key Considerations To Find Solutions:

**Water**



**Gravity**



**Geology & Topography**



**Cost**



**“THE MOST IMPORTANT TIME  
IN THE LIFE OF A ROAD IS THE MOMENT  
YOU DECIDE WHERE IT IS GOING TO GO.”**

Brian Chow, P.Eng. FEC  
Chief Engineer

British Columbia Ministry of Forests, Lands, Natural Resource Operations & Rural Development

# The Next Pivotal Moment:

Do you keep the road  
as-is?



# The Next Pivotal Moment:

Do you repair and improve a road?



# The Next Pivotal Moment:

Do you relocate the road?



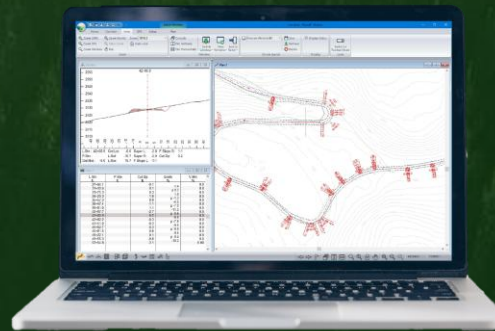
# Technology Advancements

## Understanding the Problem:

- **LiDAR** Availability
- Field Data Collection
- GIS Improvements

## Finding the Best Solution:

- Road Design Software Improvements

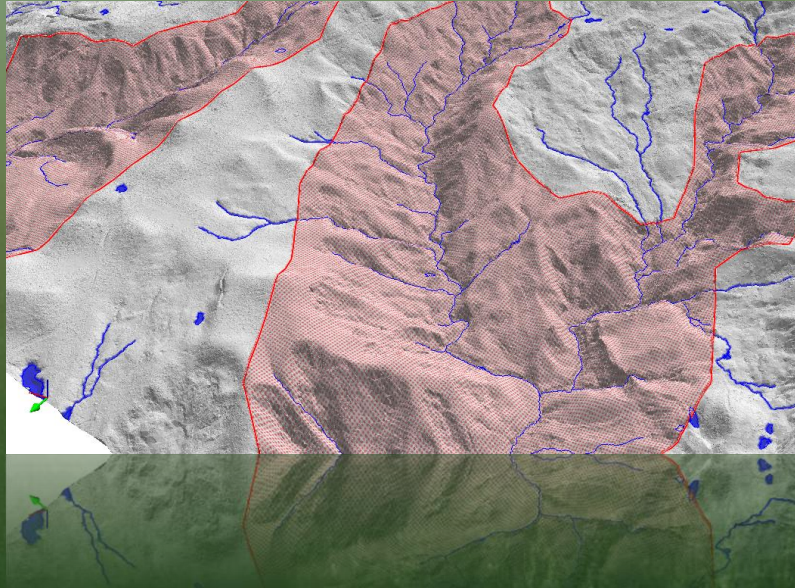


## Implementing the Solution:

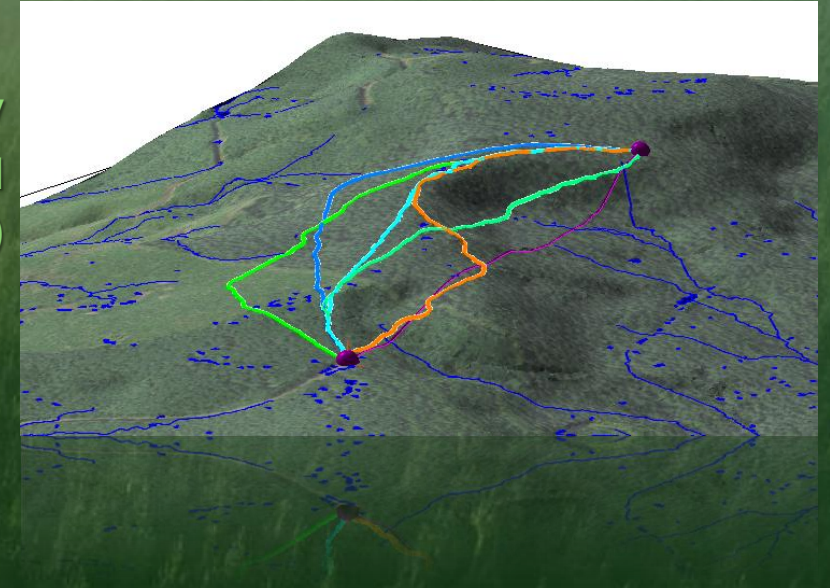
- Detailed construction plans
- GPS Accuracy & availability
- Machine Control
- Geosynthetics & material sciences

# Road Design Software is Advancing

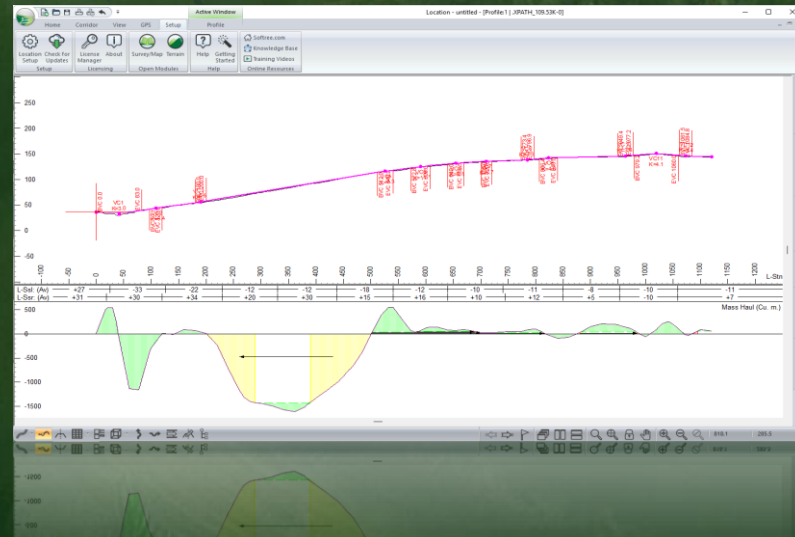
**TERRAIN  
ANALYSIS**



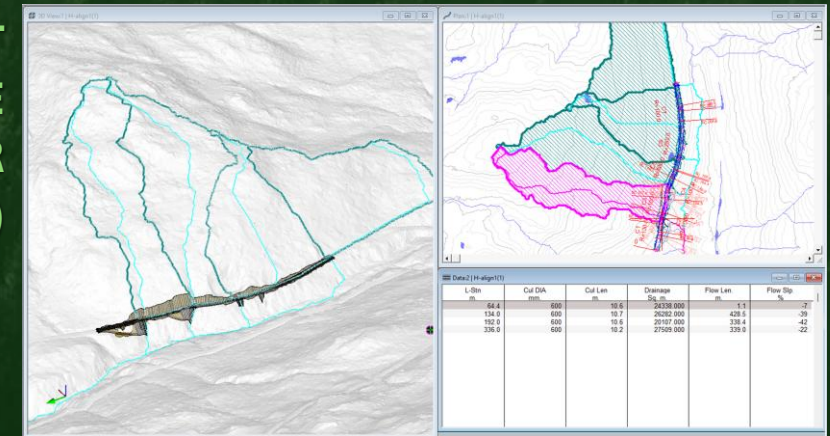
**ROAD LOCATING /  
PRELIMIN DESIGN  
(Path Explorer AI)**



**EARTHWORKS  
OPTIMIZATION**



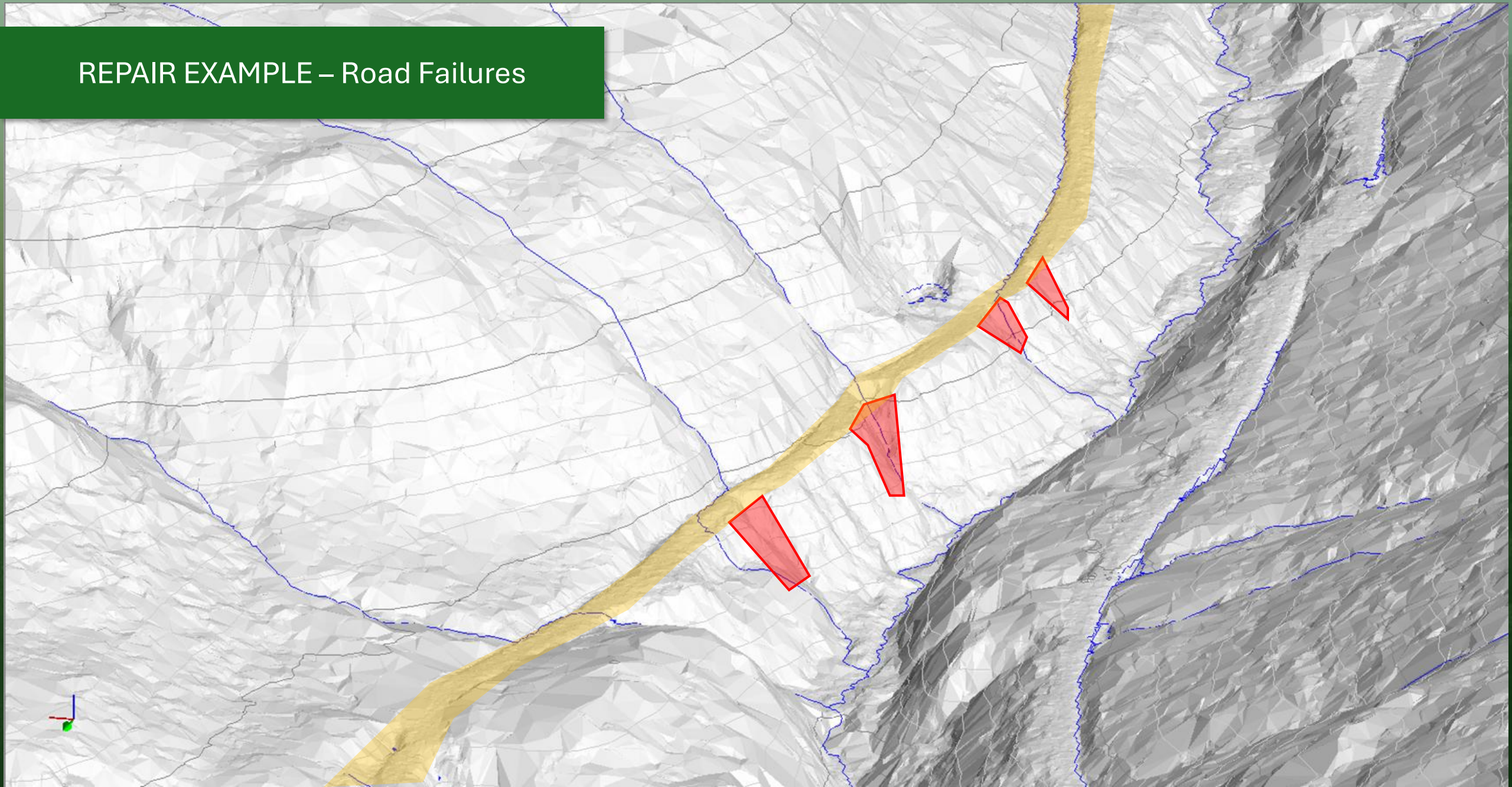
**ROAD'S IMPACT  
ON SURFACE  
WATER  
(Hydrology Tools)**



An aerial photograph of a vast, green field, possibly a farm or a natural landscape. A dirt road or path is visible in the lower-left quadrant, winding through the field. The overall scene is captured in a soft, slightly hazy light, giving it a serene and somewhat ethereal quality. The text is overlaid in the center of the image.

# Example: Repairing a Road Failure

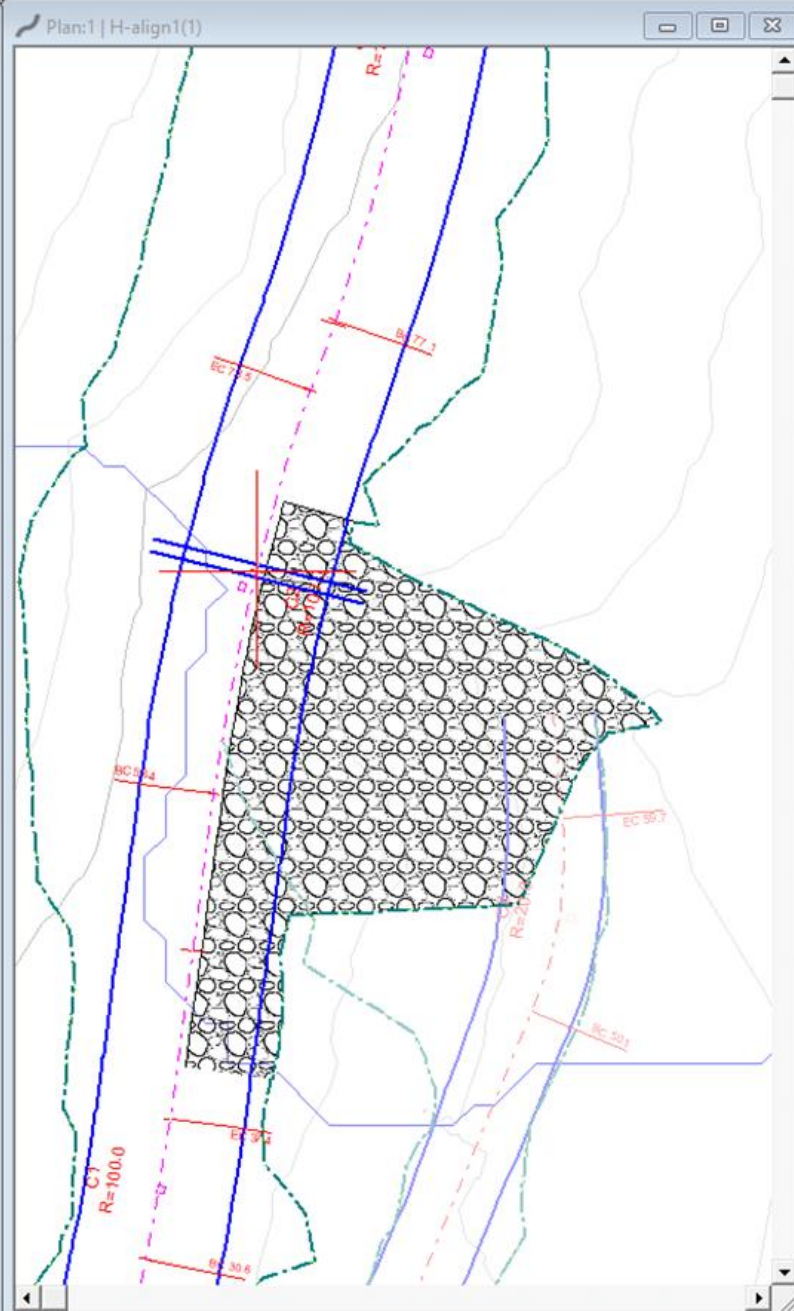
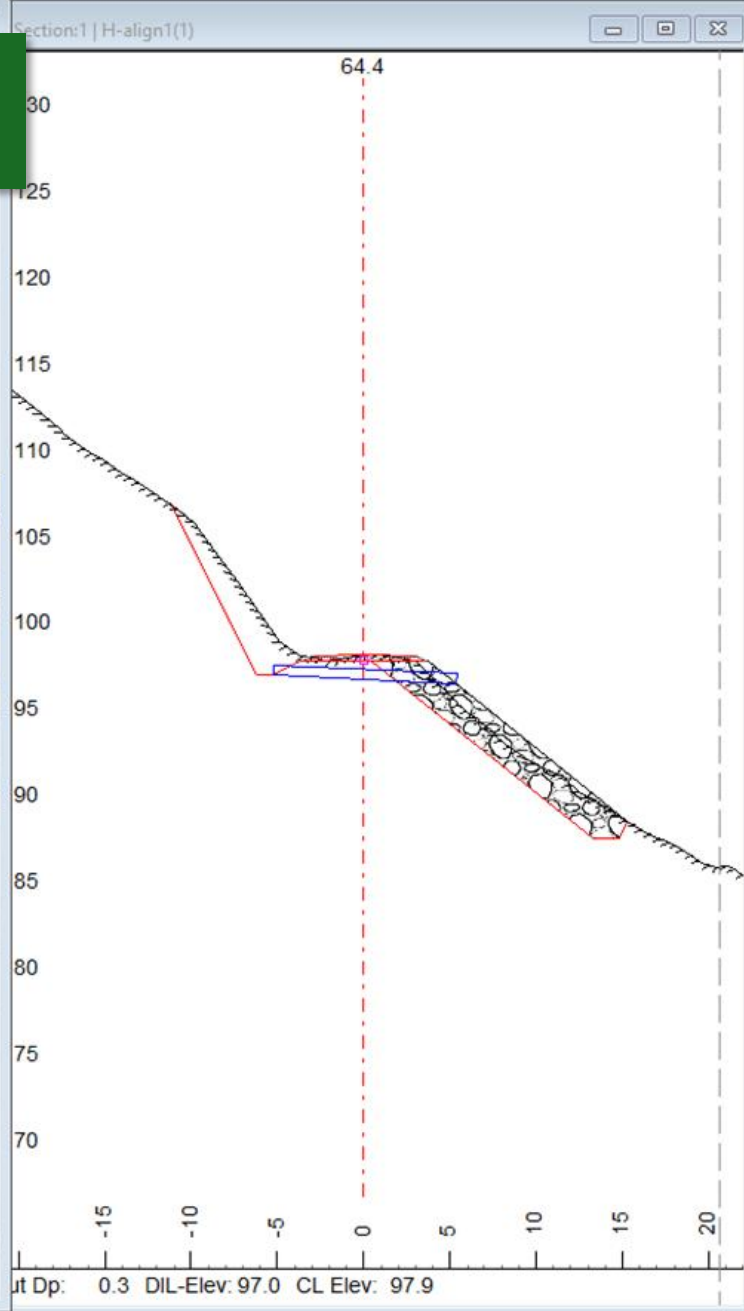
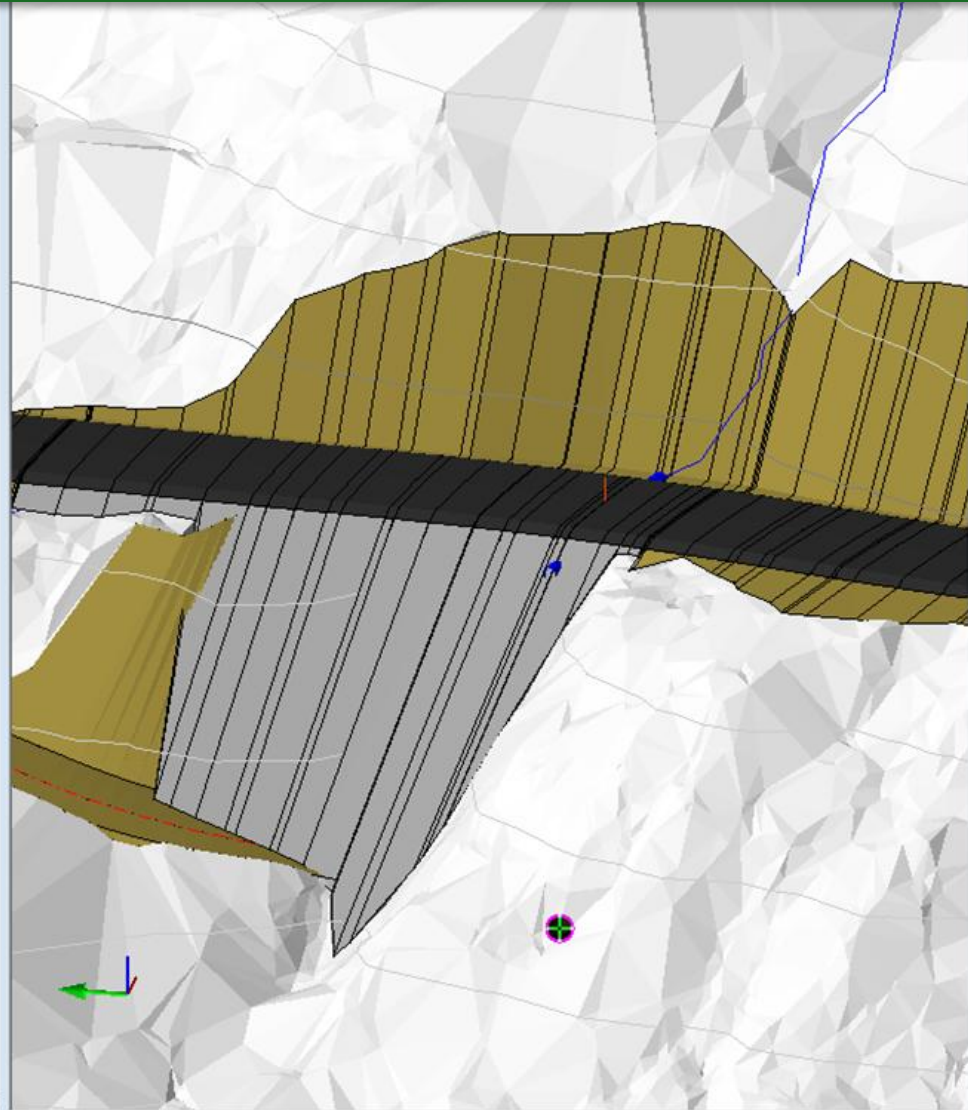
# REPAIR EXAMPLE – Road Failures



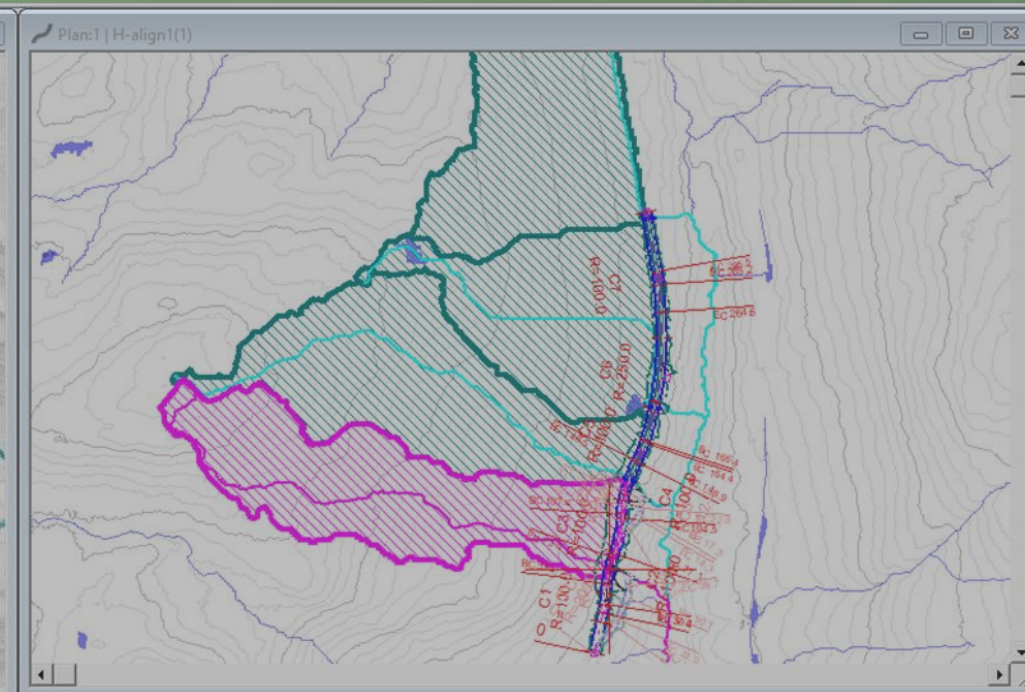
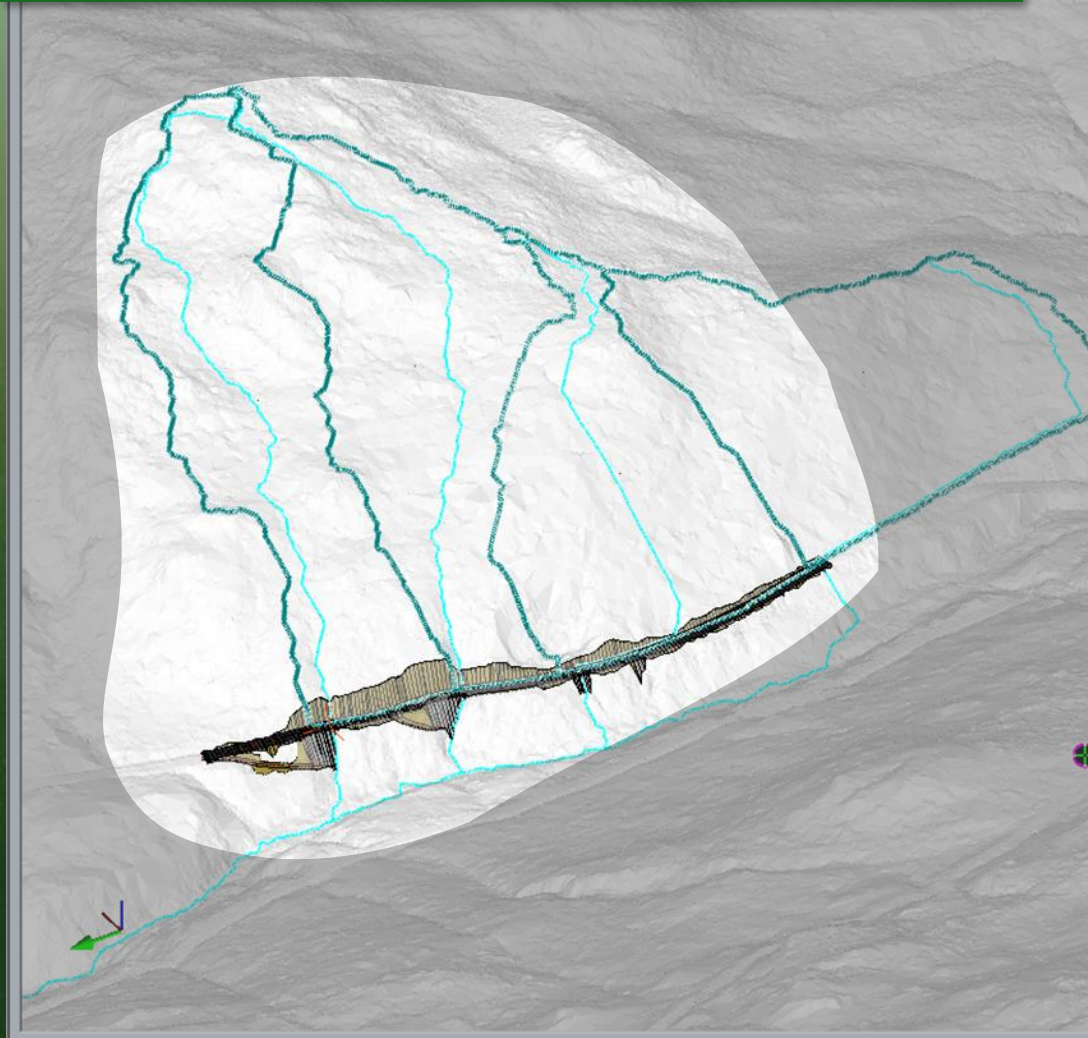
# Ability to Add a Tote Road



# Repair Section in Detail



# Hydrology – Understand Water Interception by Road



Data:2 | H-align1(1)

L-Stn m.	Cul DIA mm.	Cul Len m.	Drainage Sq. m.	Flow Len. m.	Flow Sp. %
64.4	600	10.6	24338.000	1.1	-7
134.0	600	10.7	26282.000	428.5	-39
192.0	600	10.6	20107.000	338.4	-42
336.0	600	10.2	27509.000	339.0	-22

Culverts

	64.4	600 mm	Cross Drain
Add...			
Properties...	134.0	600 mm	Cross Drain
Delete	192.0	600 mm	Cross Drain
	336.0	600 mm	Cross Drain

Apply  
Help...

Defaults  
Get  
Save...

Description:

Length:  
 Auto + Left: 5.23 Right: 5.37

Vertical Position:  
Depth: 0.00 Attach to upper ditch/catch poin

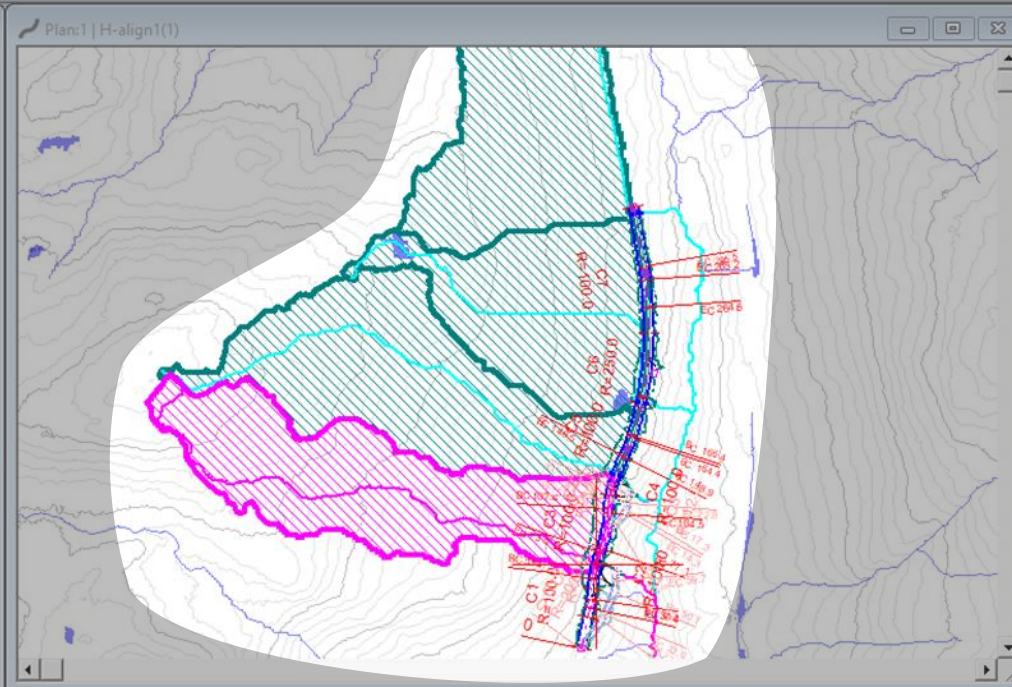
Skew:  
 Auto 90 Deg. from C/L (0-180)

Gradient:  
 Auto 5 %  Semi Auto

----- Hydrology Calculations -----  
 Include Options...

\*\*\*Drainage area extends beyond TIN boundary\*\*\*

# Hydrology – Culvert & Drainage Area



Data:2 | H-align1(1)

L-Stn m.	Cul DIA mm.	Cul Len m.	Drainage Sq. m.	Flow Len. m.	Flow Slp. %
64.4	600	10.6	24338.000	1.1	-7
134.0	600	10.7	26282.000	428.5	-39
192.0	600	10.6	20107.000	338.4	-42
336.0	600	10.2	27509.000	339.0	-22

Culverts

Add...	64.4	600 mm	Cross Drain
Properties...	134.0	600 mm	Cross Drain
Delete	192.0	600 mm	Cross Drain
	336.0	600 mm	Cross Drain

Apply  
Help...

Defaults  
Get  
Save...

Description:  
[Empty text box]

Length:  
 Auto + Left: 5.23 Right: 5.37

Vertical Position:  
Depth: 0.00 Attach to upper ditch/catch poin

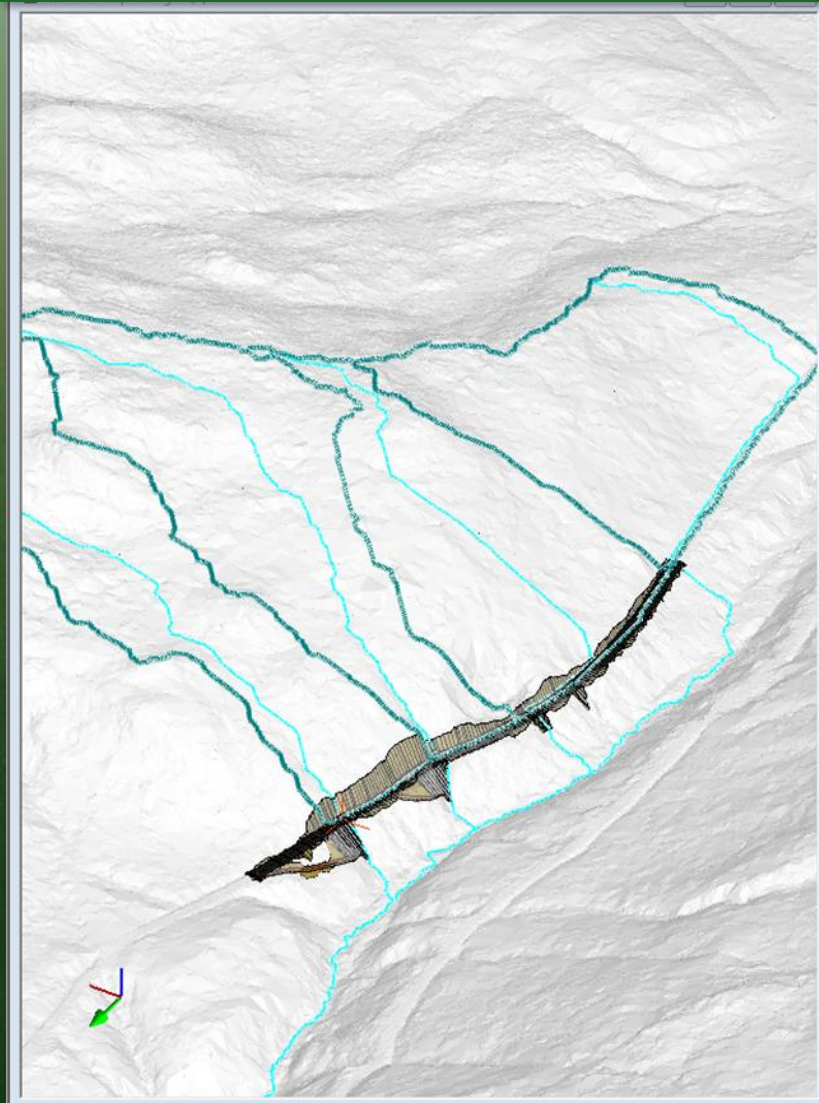
Skew:  
 Auto 90 Deg. from C/L (0-180)

Gradient:  
 Auto 5 %  Semi Auto

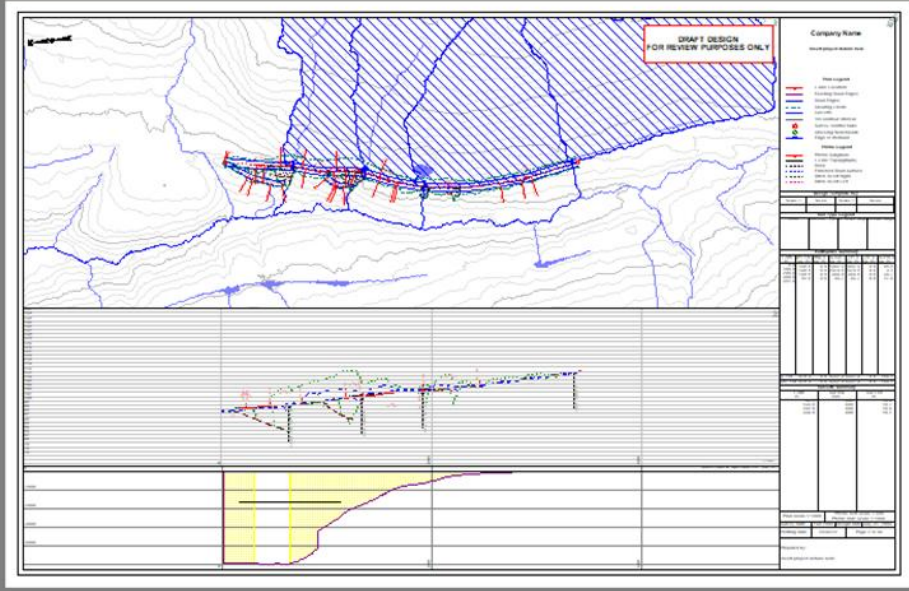
----- Hydrology Calculations -----  
 Include Options...

\*\*\*Drainage area extends beyond TIN boundary\*\*\*

# Earthworks Quantities, Costs, Output



- Book
  - D\_Size\_Block\_T
    - Page 1
    - MD - Size D P C
      - Page 2
    - MD - Size D XS
      - Page 3
      - Page 4
      - Page 5
      - Page 6
      - Page 7
      - Page 8
      - Page 9
      - Page 10
      - Page 11
      - Page 12
      - Page 13
      - Page 14
      - Page 15



Data:1 | H-align1(1)

L-Stn m.	SG Cut V. Cu. m.	SG Fill V. Cu. m.	Srf4 Fill V. Cu. m.	SR-Fill <sup>A</sup> Cu. m.	SR-Cut <sup>A</sup> Cu. m.	Mass H. <sup>A</sup> Cu. m.	B/W Site Vol.
0.0	0.1	2.0	0.0	2.0	0.1	0.0	
1.0		2.2	0.0	2.2		-1.9	
2.0	0.1		0.0		0.1	-4.1	
92.0	1350.4	84.6	527.5	612.1	1350.4	-4188.2	-4922.4
100.0	301.9	0.0	13.4	13.4	301.9		940.0
100.0	2975.8	3.1	575.4	578.6	2975.8	-2959.7	
200.0	655.0	35.7	94.2	129.8	655.0	-562.4	
300.0						-37.2	
341.5	54.7	17.5	0.0	17.5	54.7	0.0	
Cum. Tot.	5338.0	145.1	1210.5	1355.6	5338.0		

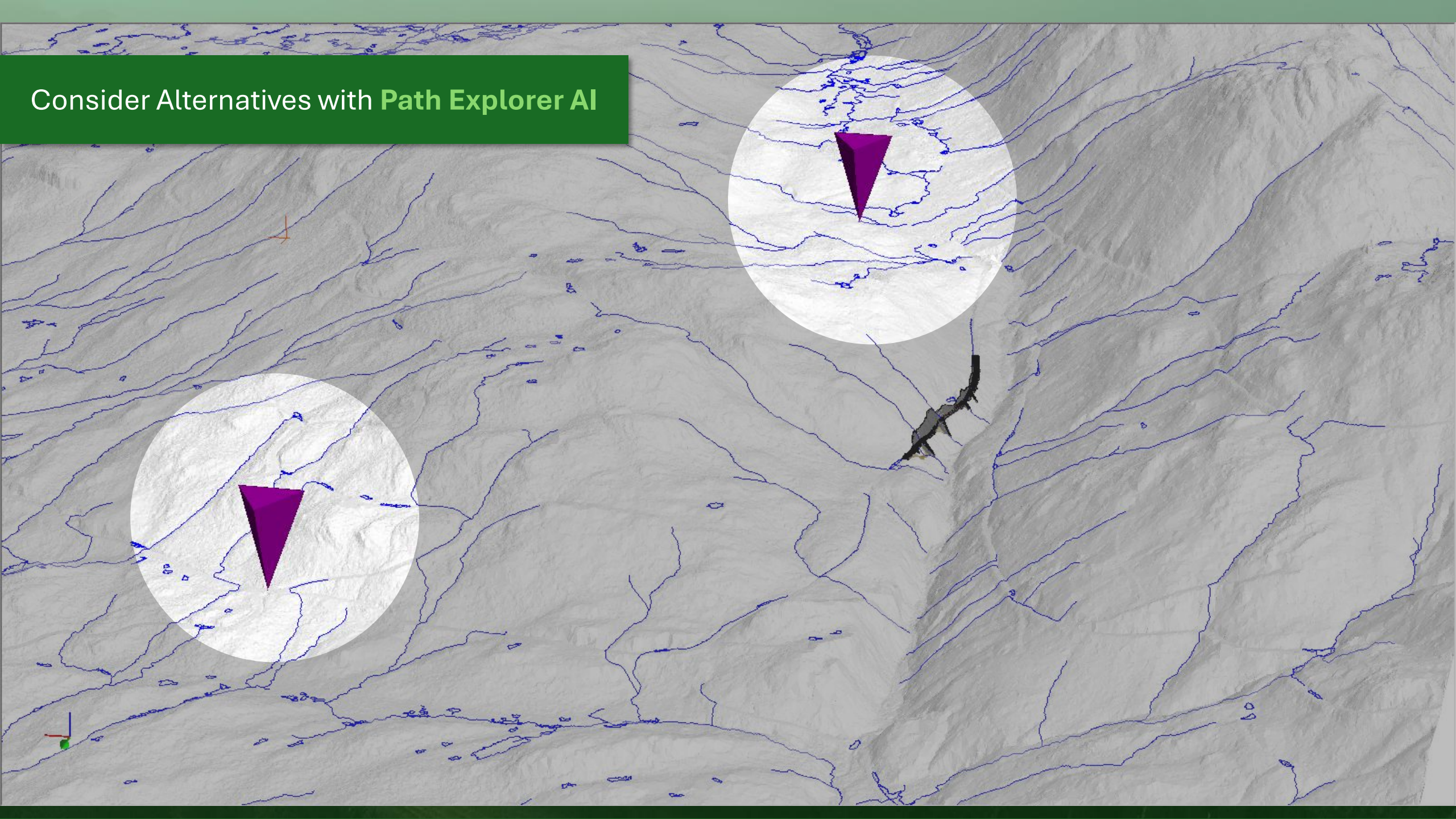
Project Explorer

Crossing sections detected in corridor surface

- Design:Road Failure\_Repair
  - Tote1 ~>merge
  - Tote2 ~>merge
  - H-align1(1) ~>merge
  - Spoil
  - Empty

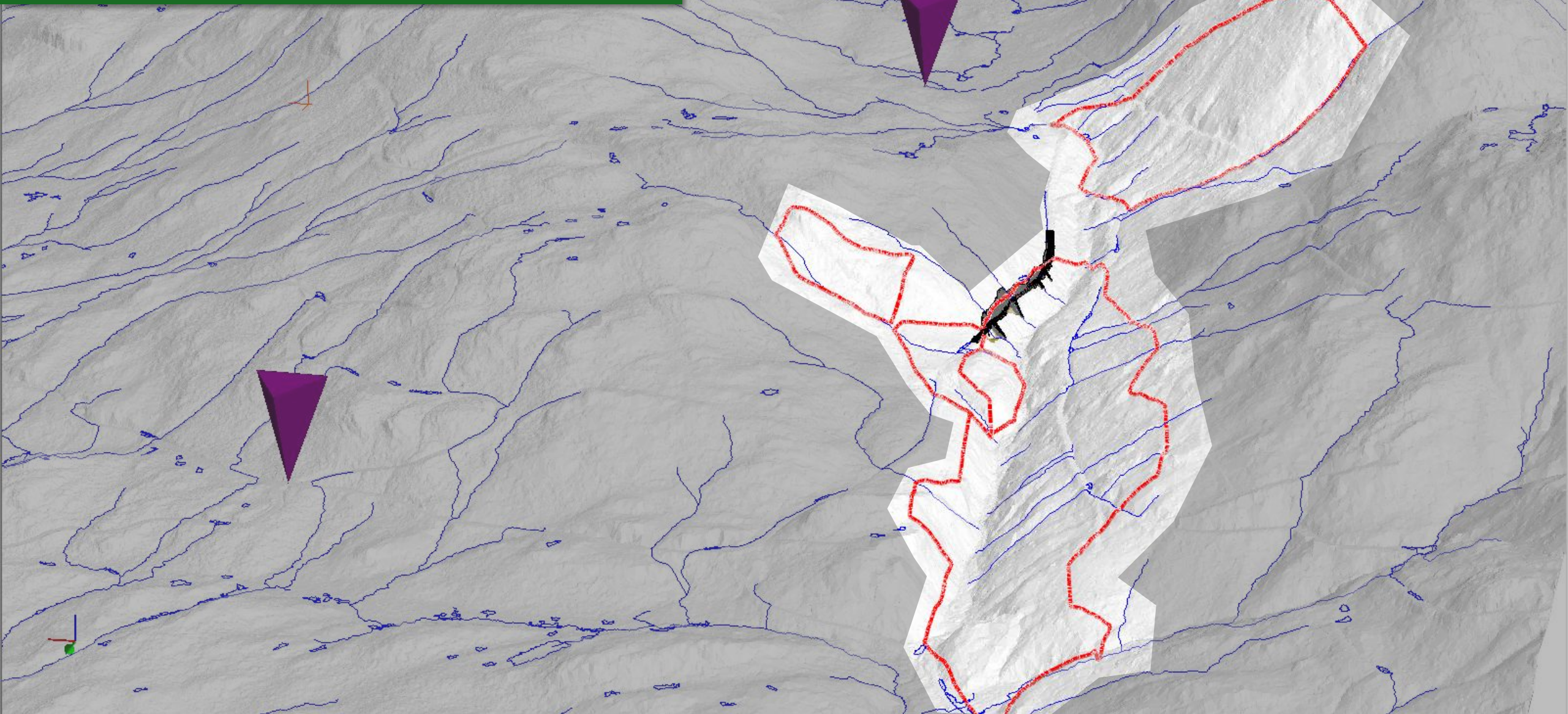
	H-align1(1)	Units
Cost status	Determined	
Last Process	Failed	
Total cost	322.09	1000's \$
Cut cost	301.34	1000's \$
Fill cost	5.42	1000's \$
Haul cost	15.33	1000's \$
Pit preparation ...	0.00	1000's \$
Freehaul volum...	1355.6	Cu. m.
Overhaul volume	4922.4	Cu. m.
Endhaul volume	0.0	Cu. m.
Process time	-	HH:MM:SS

# Consider Alternatives with Path Explorer AI

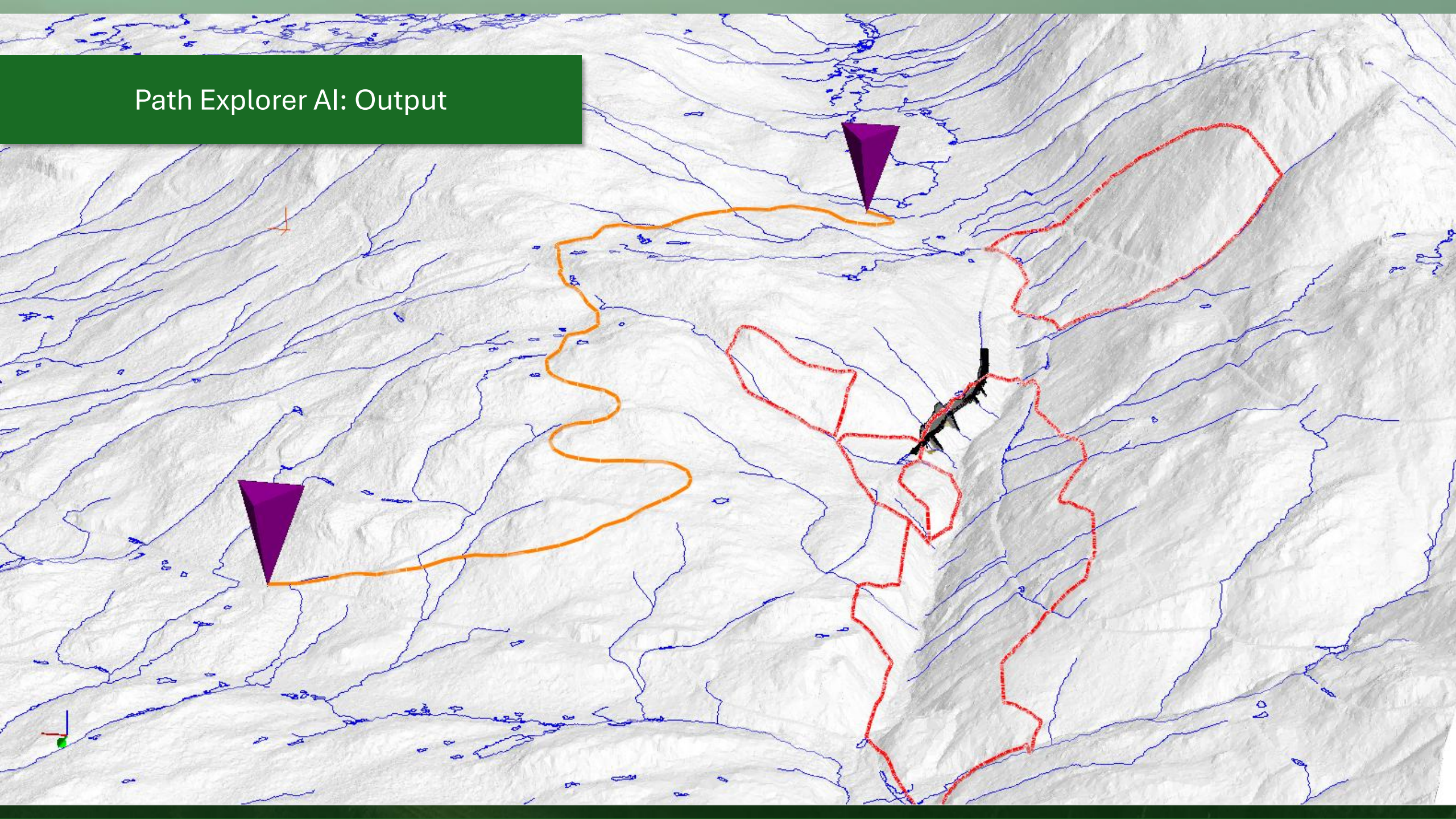


## Define & Include No-Go Zones:

Geotechnically unsuitable, environmentally sensitive, etc.

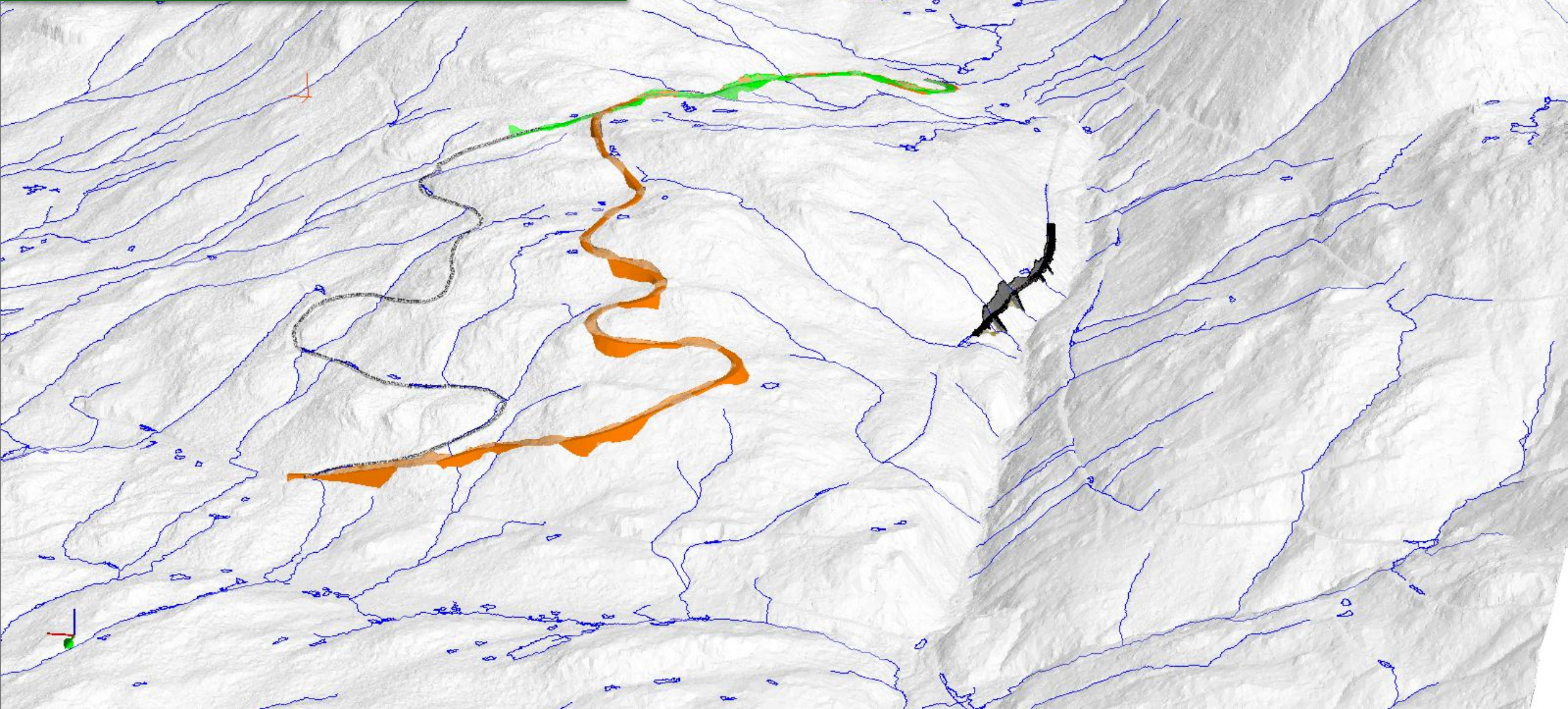


# Path Explorer AI: Output





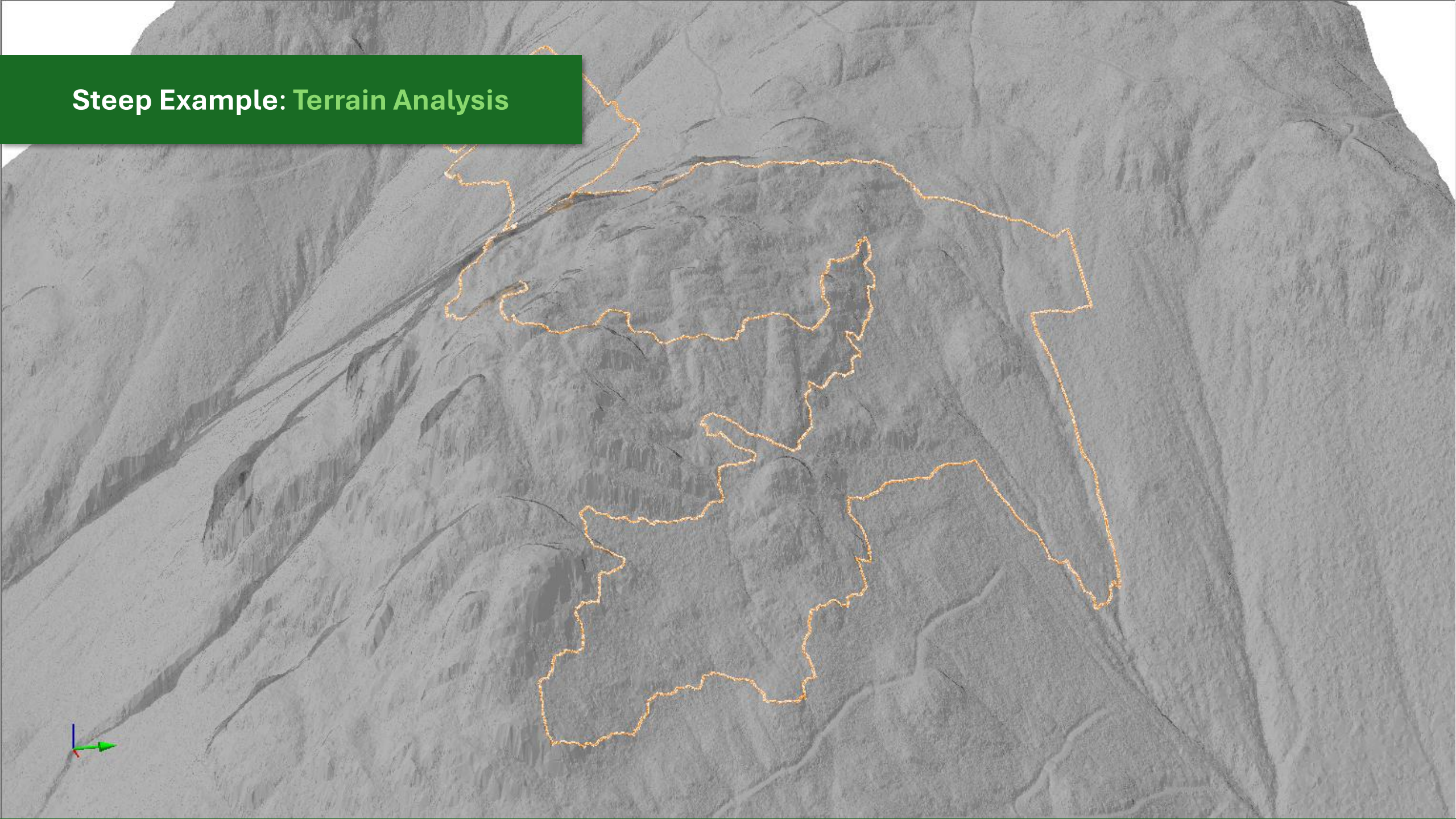
# Optioneering



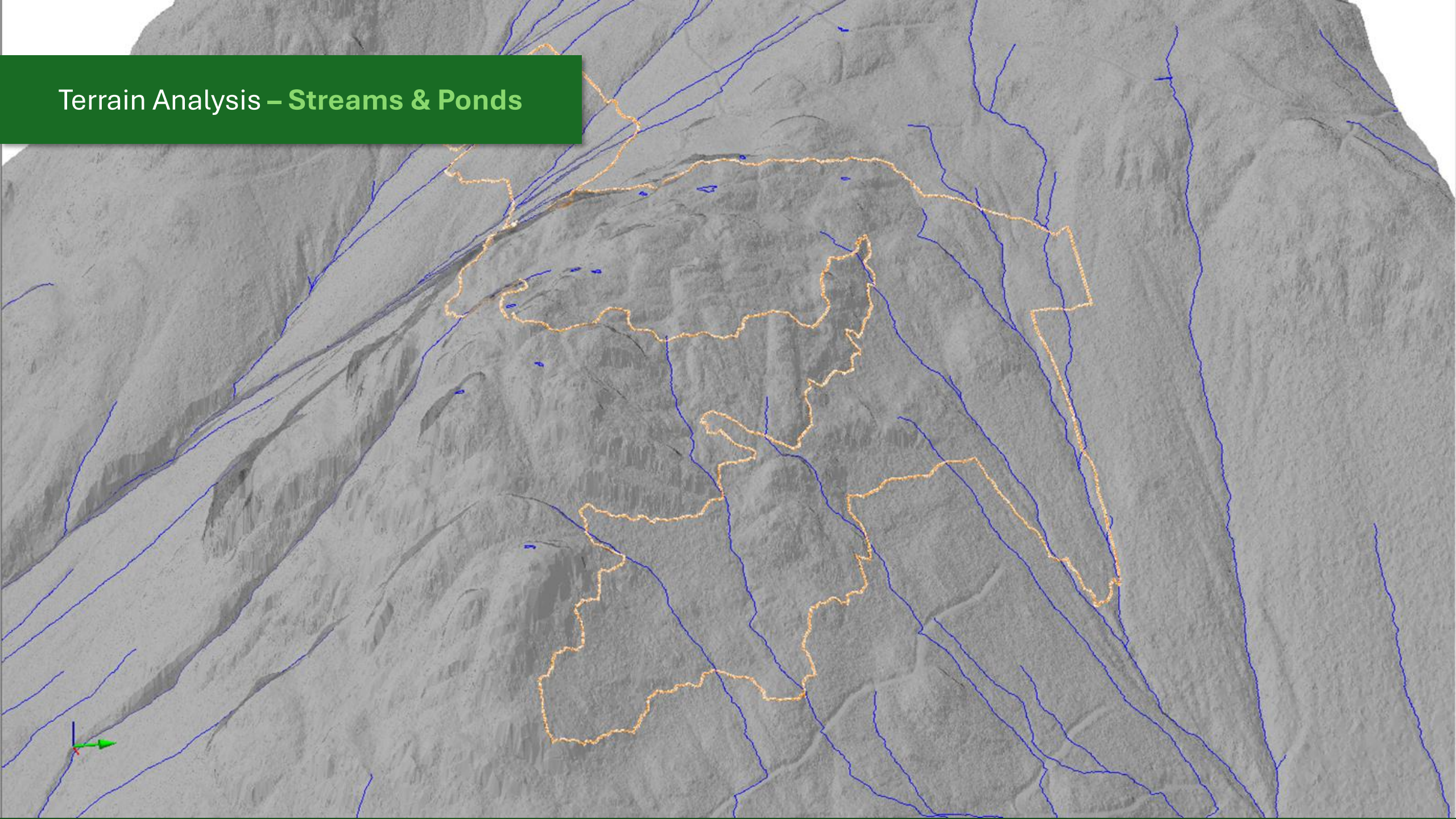
An aerial photograph of a dense, green forest covering a steep, sloping hillside. The terrain is rugged, with visible ridges and valleys. The text "Example: Steeper Terrain" is overlaid in white, centered on the image.

Example: Steeper Terrain

**Steep Example: Terrain Analysis**



## Terrain Analysis – Streams & Ponds



# Path Explorer AI

**Path Explorer**

Target TIN Surface:  File  Current TIN

Source/Destination:

Auto (always use current feature)

Resolution: Horizontal:  m. Vertical:

Est. Problem Size: Very Large (11.2)

General: # of paths:  Min. Hz. Curve Radius:  m. Road Width:  m.

Construction Parameters: Max. Cut:  m. Max. Fill:  m. Min. Grade:  % Max. Grade:  %

Cut Cost:  \$/Cu. m. Cut Slope:  % Fill Slope:  %

Fill Cost:  \$/Cu. m. Surfacing Cost:  \$/Sq. m.

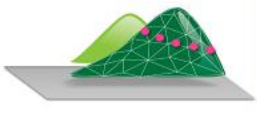
Remove existing features  Warn when out of memory

**Properties**

Name:  -0

Displayed (Plan/Profile)  Displayed (3D)  Connected  Elevations  Modelled  Breakline  Negative  TIN Boundary  Surf./Vol. Boundary  3D Facet  Hydro-Enforcement

**Draped Feature**



**Symbol**

Type:  Color:  3D Type:

**Color/Line**

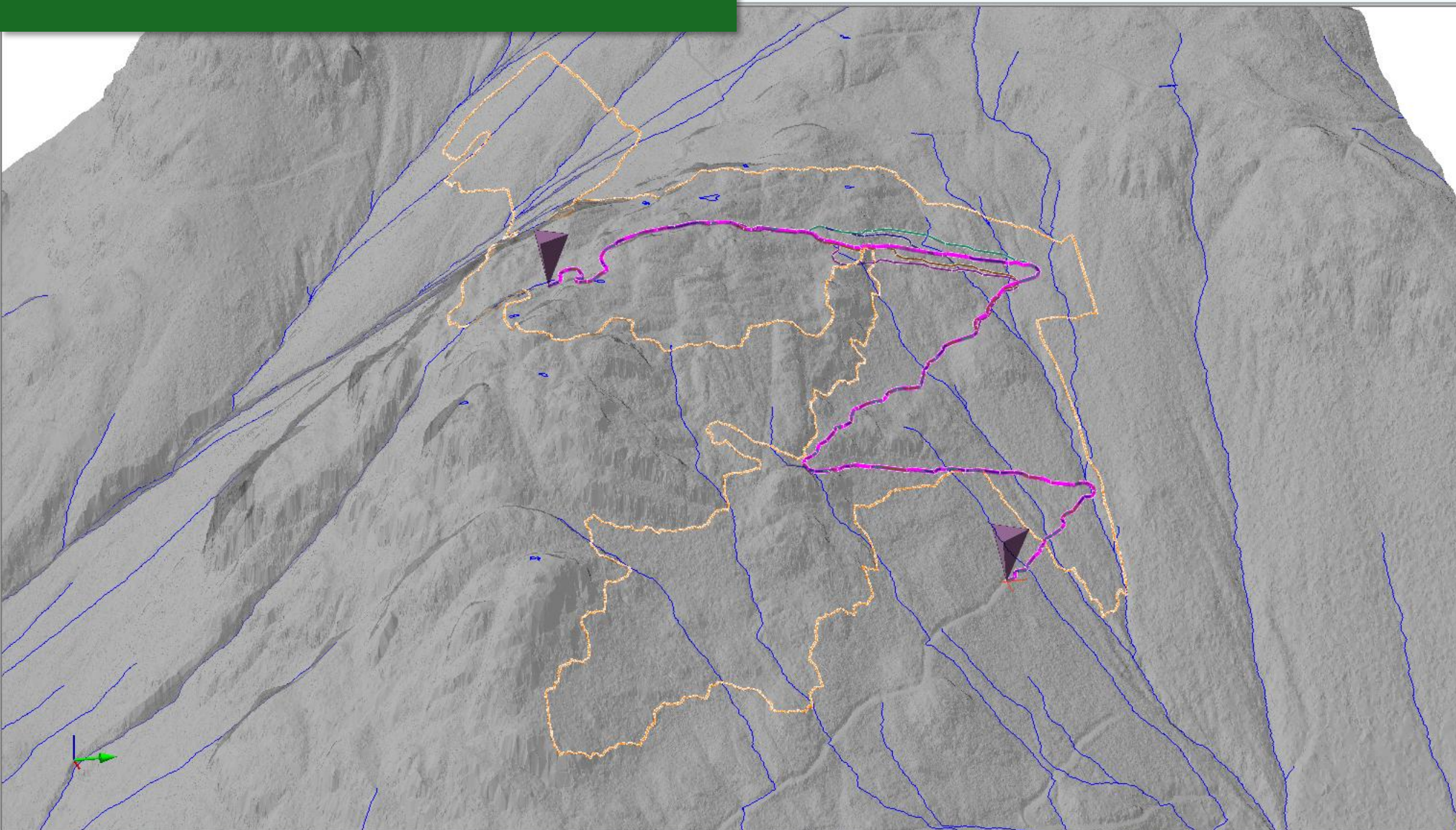
Type:  Color:

**Hatching**

Also Set Profile

Field	Value	Units
Full name	A to B-0	
Easting	981187.8	
Northing	596820.9	
Elevation	694.2	
Area	0.0	Ha.
Length	670.0	m.

# Path Explorer AI

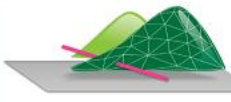


Properties

Name: .XPATH\_970K -0 +

- Displayed (Plan/Profile)
- Displayed (3D)
- Connected
- Elevations
- Modelled
- Breakline
- Negative
- TIN Boundary
- Surf./Vol. Boundary
- 3D Facet
- Hydro-Enforcement

3D Non TIN Feature



- Symbol

Type: None

Color: Auto

3D Type: None

- Color/Line

Type: 6 - thick (heavy)

Color: (95,127,32)

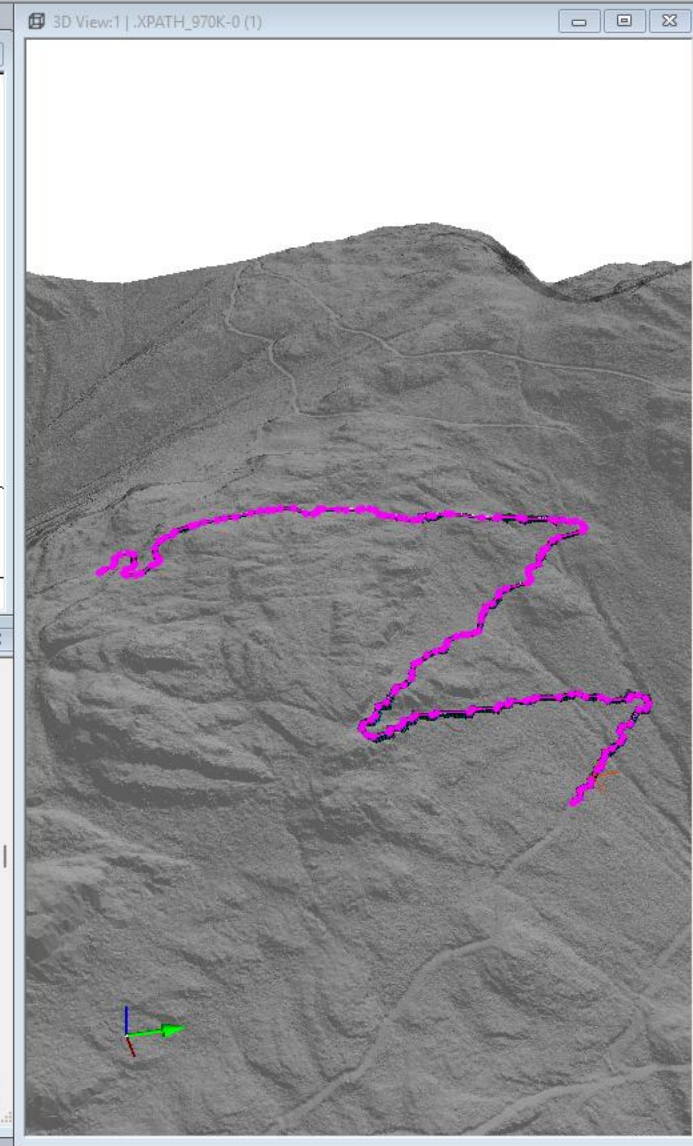
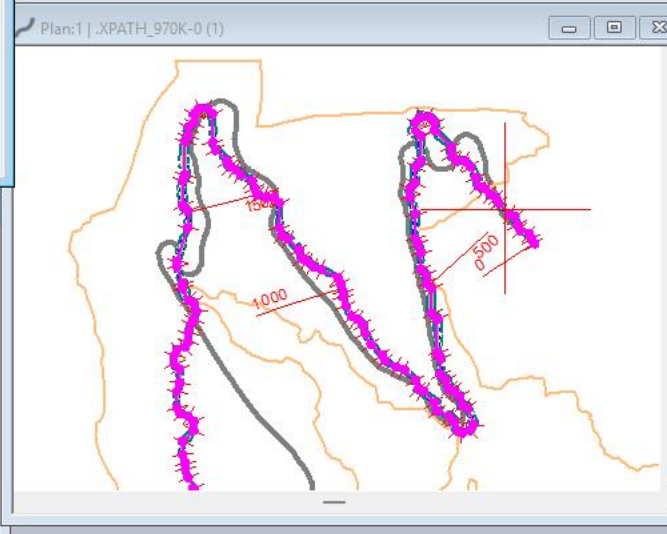
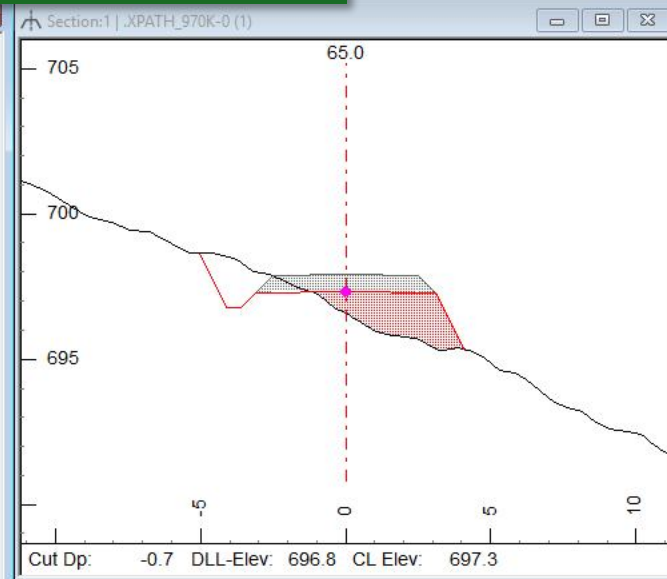
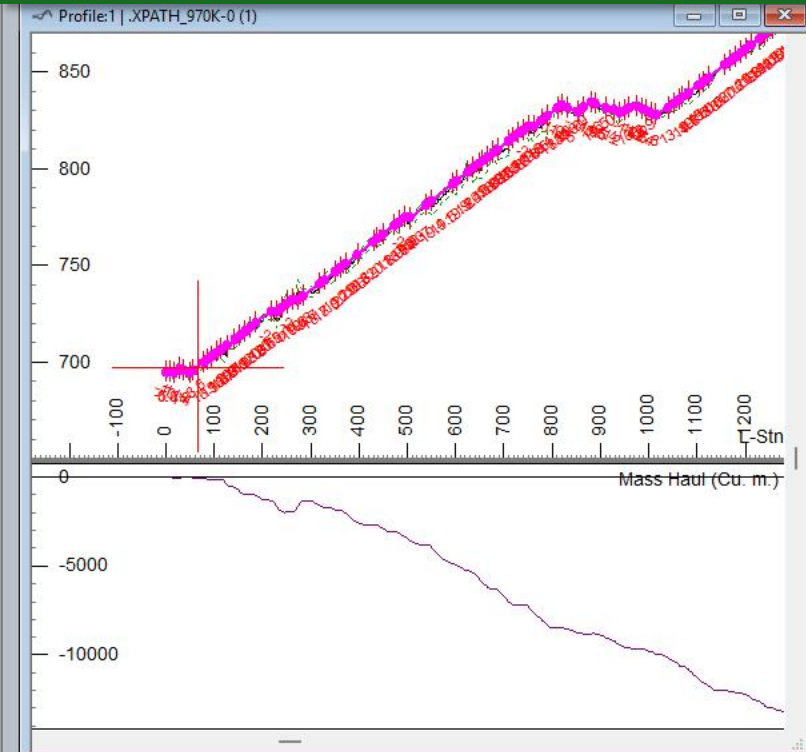
+ Hatching

Also Set Profile Apply

Field	Value	Units
Full name	.XPATH_970K-0	
Easting	981187.8	
Northing	596820.9	
Elevation	694.8	
Area	15.0	Ha.
Length	2316.5	m.

980489.3 | 597057.6 | .XPATH\_970K-0 (3d)

# Converting into a Full 3D Alignment



Project Explorer

Cost out of date for at least one alignment

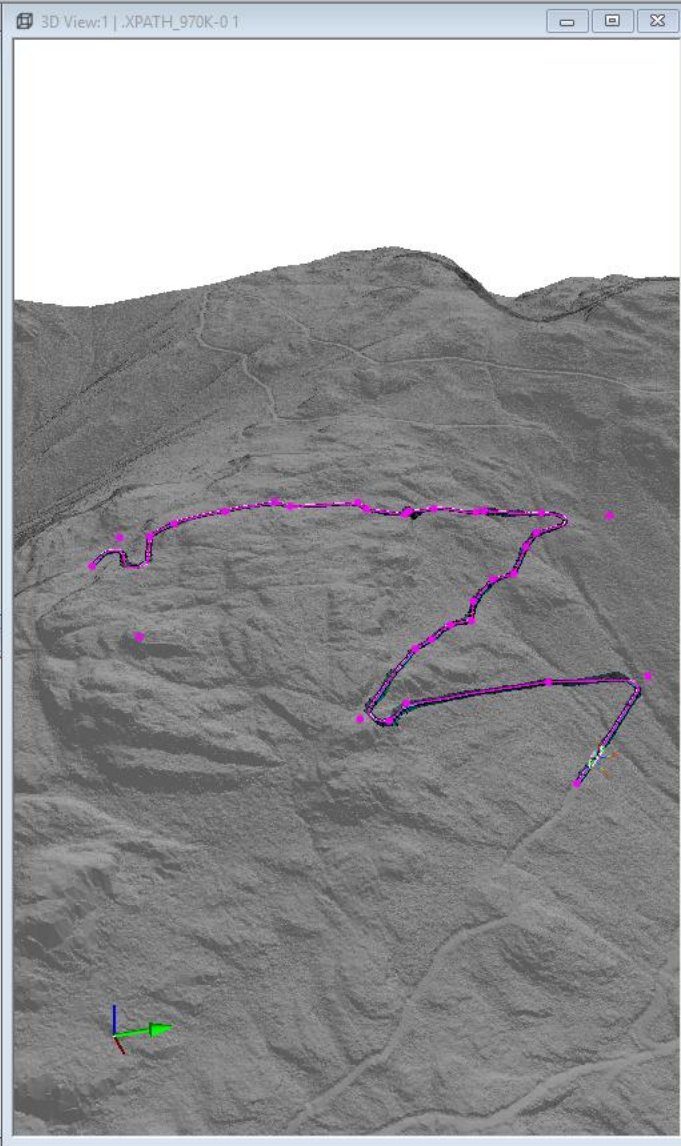
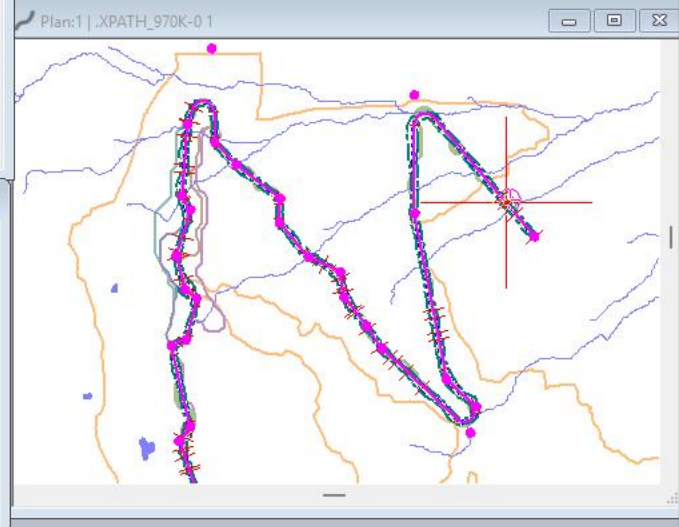
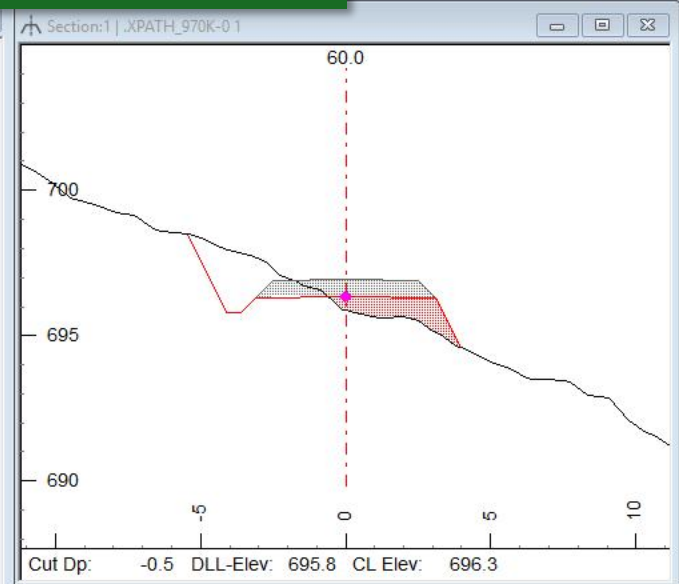
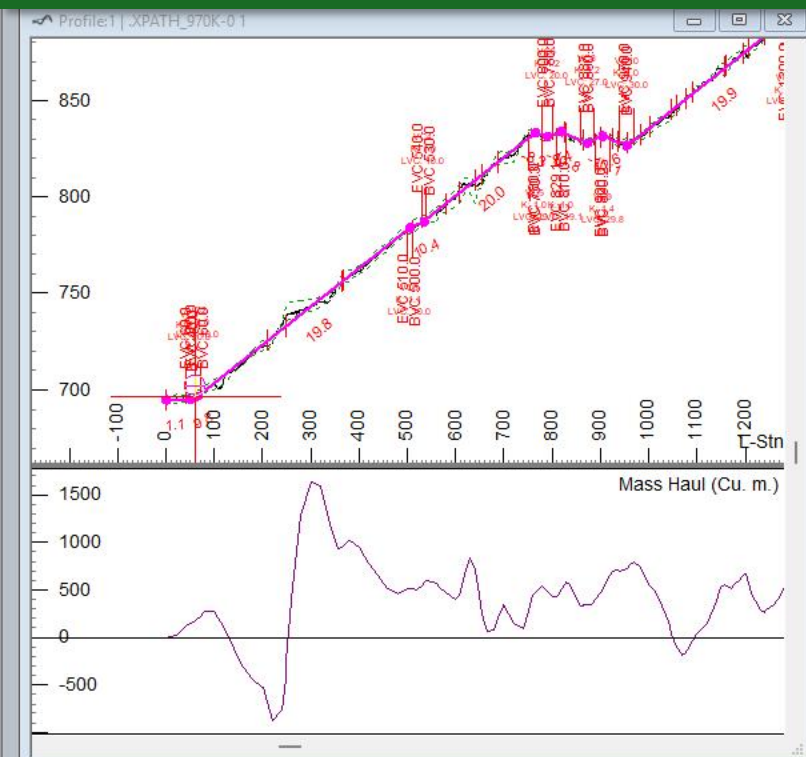
- Design:RID18RoadAlignment - MD From Scratch
  - .XPATH\_970K-0 (1)

.XPATH_970K-0 (1)		Uni
V-align 1		
Cost status	Unprocessed	
Last Process	Unprocessed	
Total cost	-	100
Cut cost	-	100
Fill cost	-	100
Haul cost	-	100
Pit preparation ...	-	100
Freehaul volum...	-	Cu.
Overhaul volume	-	Cu.
Endhaul volume	-	Cu.
Process time	-	HH

Data:1 | .XPATH\_970K-0 (1)

L-Stn m.	SG Cut V. Cu. m.	SG Fill V. Cu. m.
0.0	319.7	464.9
100.0	190.8	1301.2
200.0	900.2	996.5
300.0	145.1	1381.0
400.0	213.7	1108.1
500.0	155.9	1591.9
600.0	163.0	1924.5
700.0	130.4	1921.1
800.0	114.2	530.6
900.0	23.9	917.3
1000.0		
Cum. Tot	2366.9	12137.1

# Converting into a Full 3D Alignment



Project Explorer

Cost out of date

Design:RID18RoadAlignment - MD From Scratch

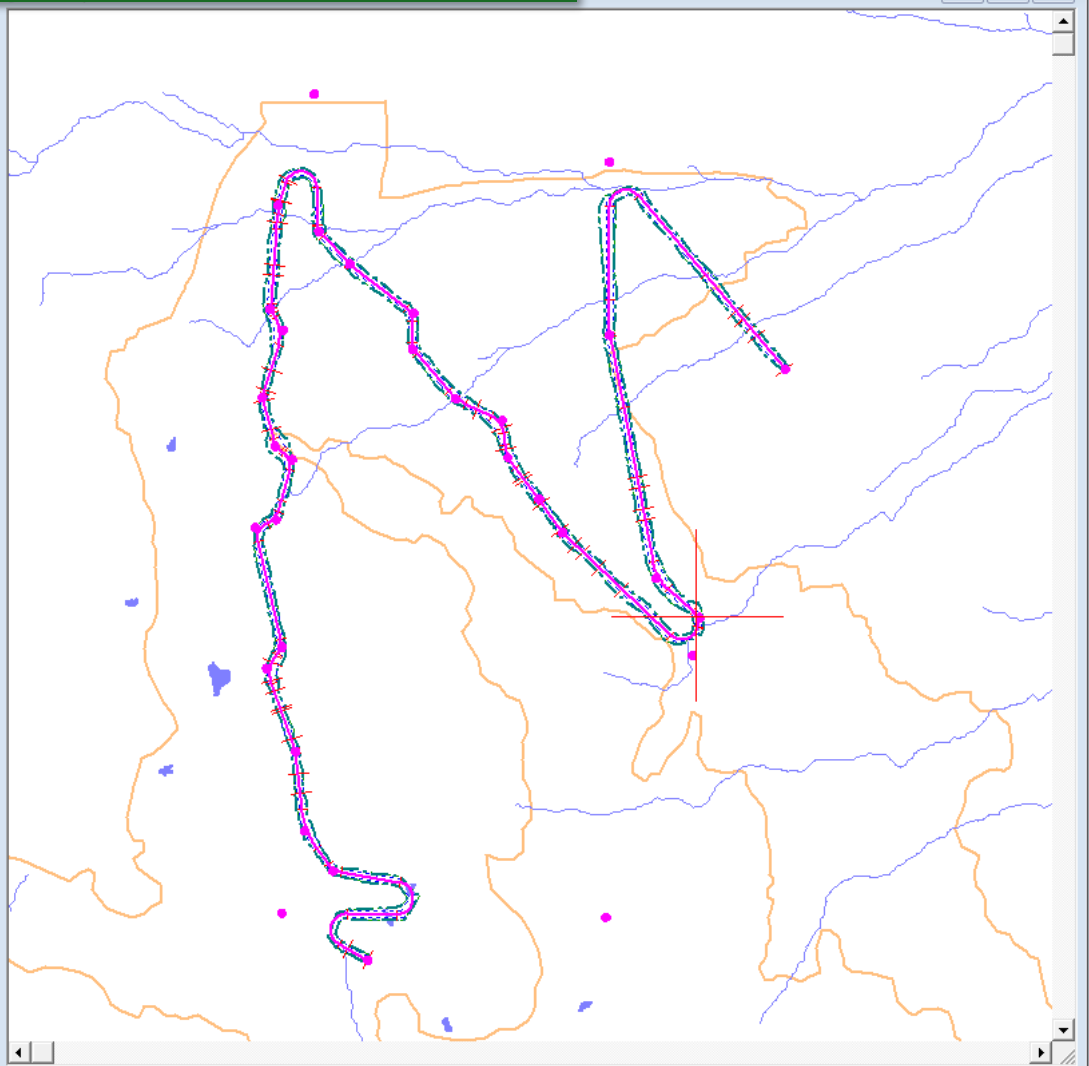
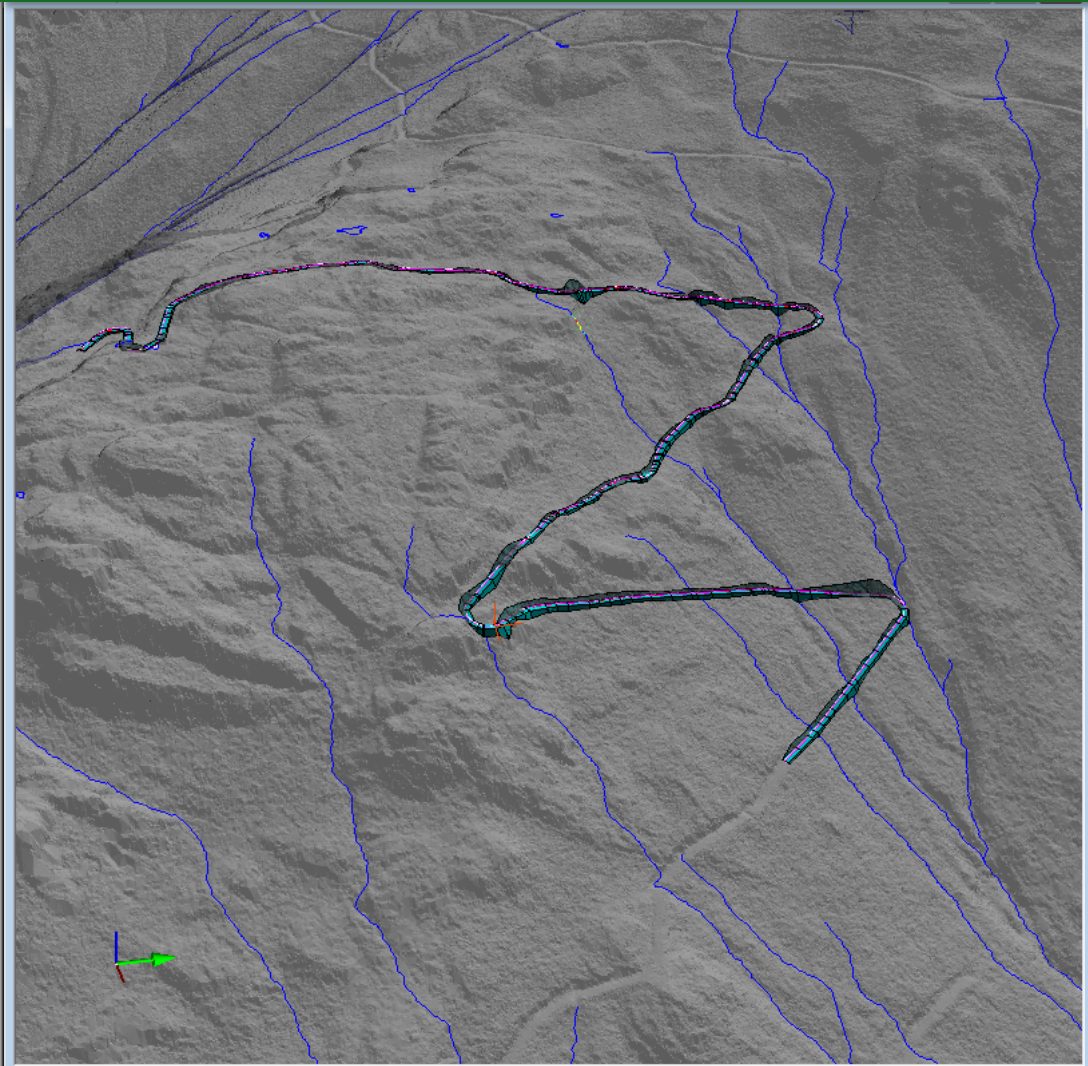
.XPATH\_970K-0 1

Property	Value	Unit
Cost status	Cost out of date	
Last Process	Partially Optimized	
Total cost	231.30	100
Cut cost	172.03	100
Fill cost	54.50	100
Haul cost	4.76	100
Pit preparation ...	0.00	100
Freehaul volum...	-	Cu.
Overhaul volume	-	Cu.
Endhaul volume	-	Cu.
Process time	00:00:01	HH

Data:1 | .XPATH\_970K-0 1

L-Stn m.	SG Cut V. Cu. m.	SG Fill V. Cu. m.
250.0	2627.7	1872.9
500.0	2100.1	2342.0
750.0	1252.3	968.8
1000.0	1338.5	1582.4
1250.0	1480.7	1164.9
1500.0	1645.7	1770.3
1750.0	474.7	1088.3
2000.0	1844.7	1023.4
2181.2		
<b>Cum. Tot</b>	<b>14336.3</b>	<b>13626.0</b>

# (Dark Blue) Natural Drainage Patterns BEFORE the Road



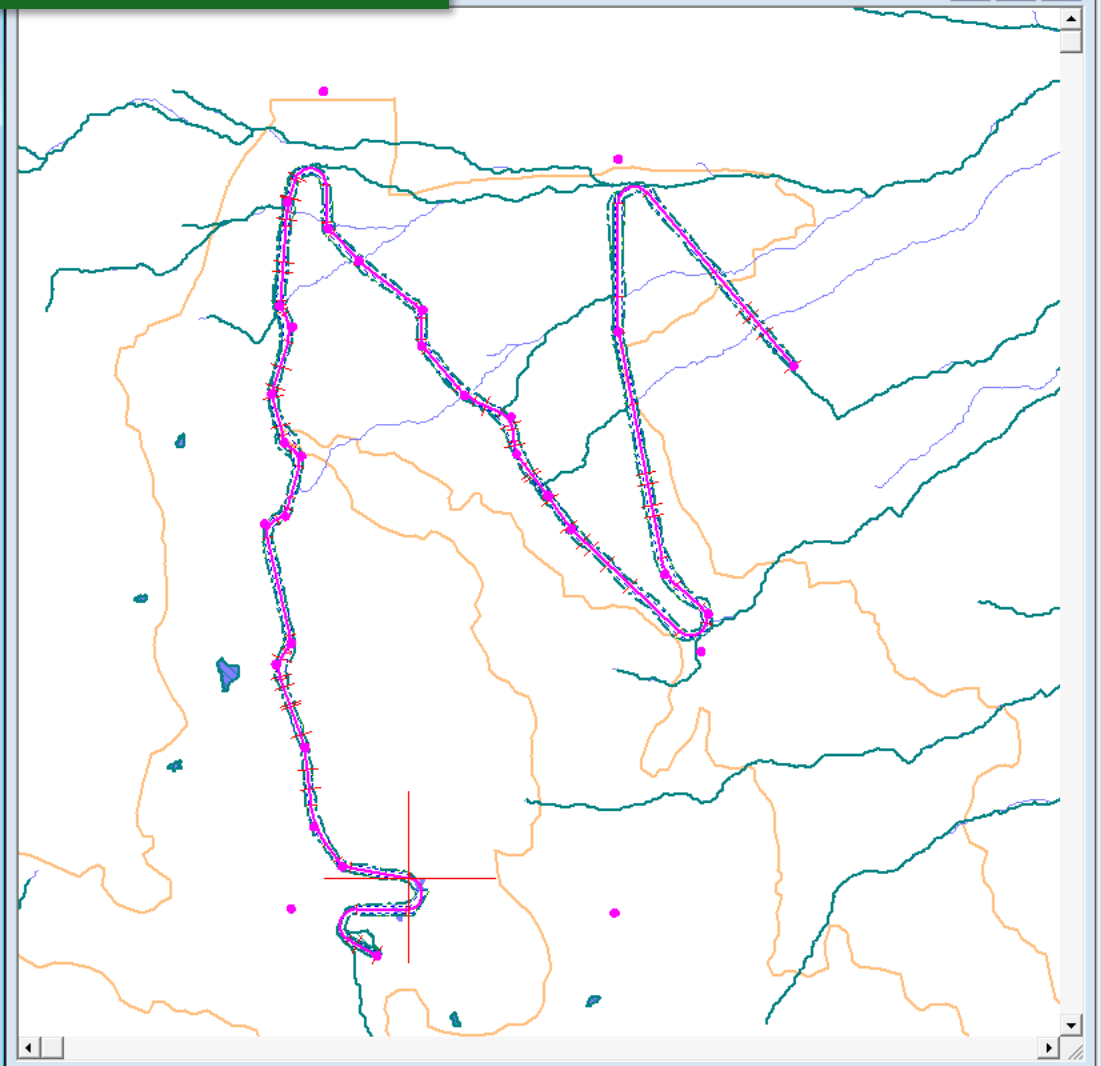
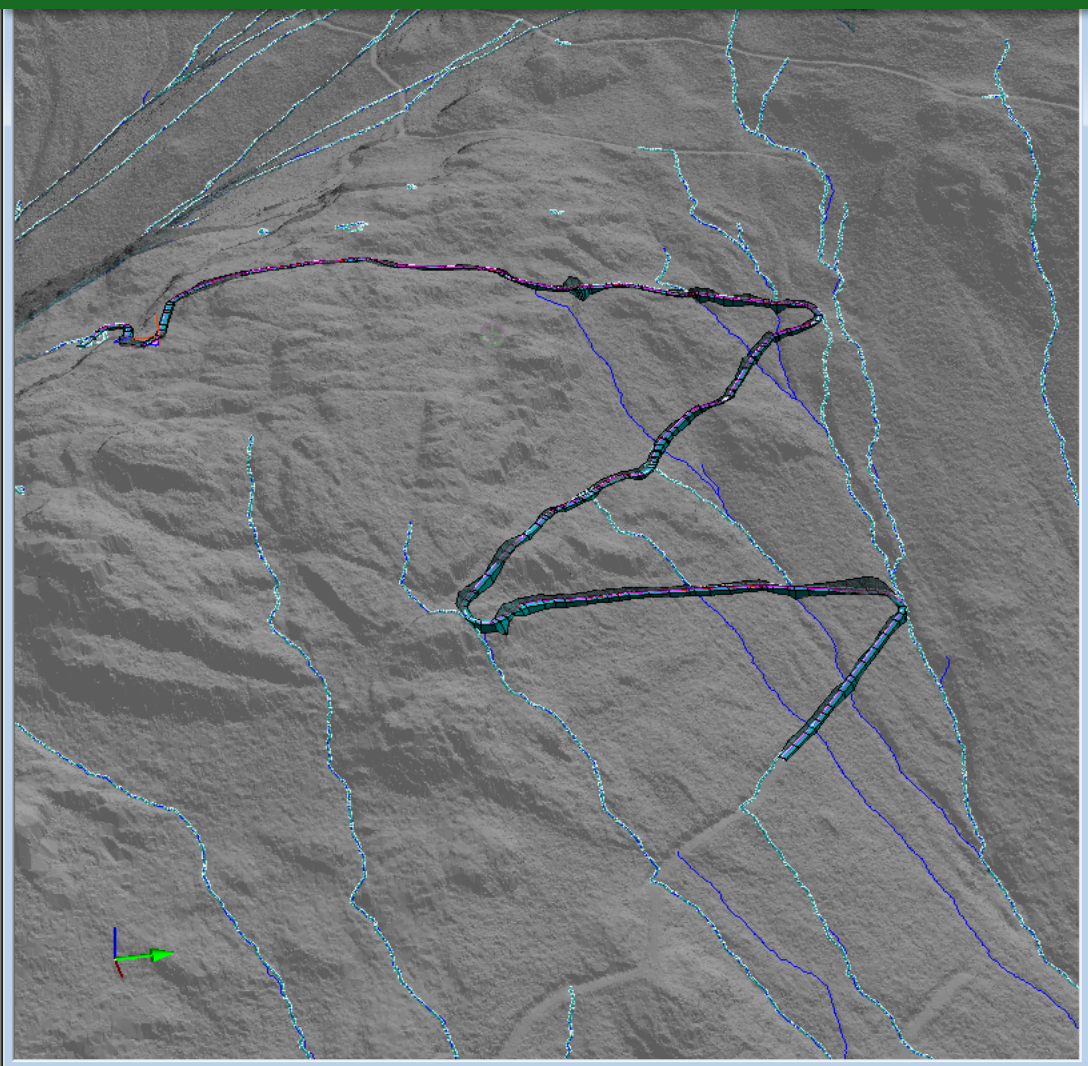
Project Explorer

Hydrology calculations out of date

- Design:RID18RoadAlignment - MD Hydro
  - .XPATH\_970K-0 1 ~>merge
  - RID18-0 (\*)

	.XPATH_970K-0 1	Unit
Cost status	Cost out of date	
Last Process	Partially Optimized	
Total cost	231.30	100C
Cut cost	172.03	100C
Fill cost	54.50	100C
Haul cost	4.76	100C
Pit preparation...	0.00	100C
Freehaul volum...	-	Cu. f
Overhaul volume	-	Cu. f
Endhaul volume	-	Cu. f
Process time	00:00:01	HH:M

# (Light Teal) Hydrology Impact FROM Road Design



Project Explorer

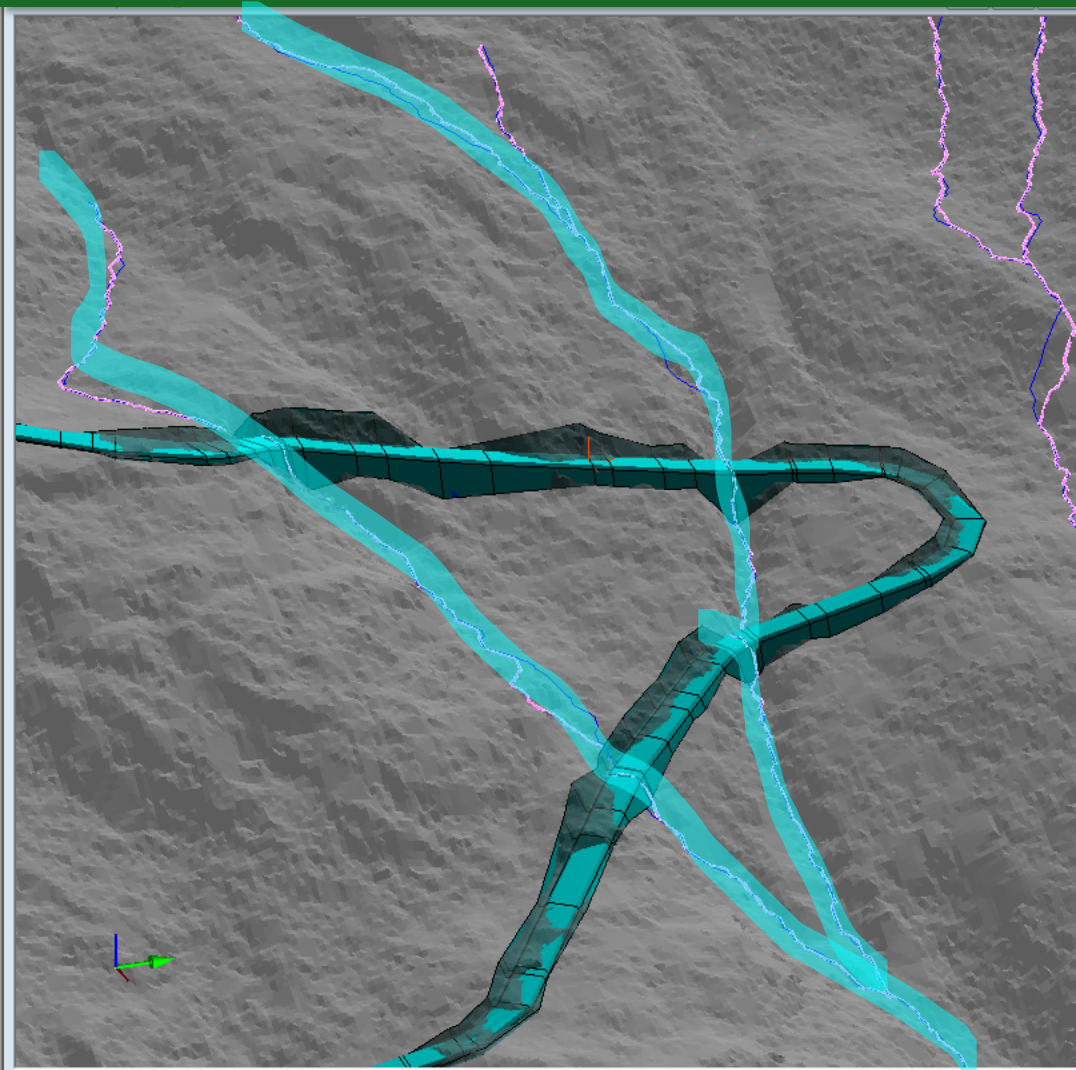
Crossing sections detected in corridor sur

- Design:RID18RoadAlignment - MD Hydro
  - .XPATH\_970K-0 1 ~>merge
  - RID18-0

.XPATH_970K-0 1		Units
V-align 1		
Cost status	Cost out of date	
Last Process	Partially Optimized	
Total cost	231.30	1000
Cut cost	172.03	1000
Fill cost	54.50	1000
Haul cost	4.76	1000
Pit preparation...	0.00	1000
Freehaul volum...	-	Cu. yd
Overhaul volume	-	Cu. yd
Endhaul volume	-	Cu. yd
Process time	00:00:01	HH:MM



# The Important Role of Culverts



Location - RID18RoadAlignment - MD Hydro Start

XPATH\_970K-0 1

**Culverts**

Add...	49.1	600 mm	Cross D
Properties...	113.5	600 mm	Cross D
Delete	333.4	600 mm	Cross D
	433.1	600 mm	Cross D
	874.4	600 mm	Cross D
	955.1	600 mm	Cross D
	986.0	600 mm	Cross D
Apply	1024.9	600 mm	Cross D
Help...	1158.0	600 mm	Cross D
	1203.6	600 mm	Cross D
	1313.0	600 mm	Cross D
Defaults	1370.0	600 mm	Cross D
Get	1401.6	600 mm	Cross D
	1517.7	600 mm	Cross D
Save...	1583.0	600 mm	Cross D
	2155.0	600 mm	Cross D

Description:

Length:  Auto + Left: 7.51 Right: 4.27

Vertical Position:  Auto  Attach to upper ditch/catch

Depth: 0.00

Skew:  Auto 70 Deg. from C/L (0-180)

Gradient:  Auto -53 %  Semi Auto

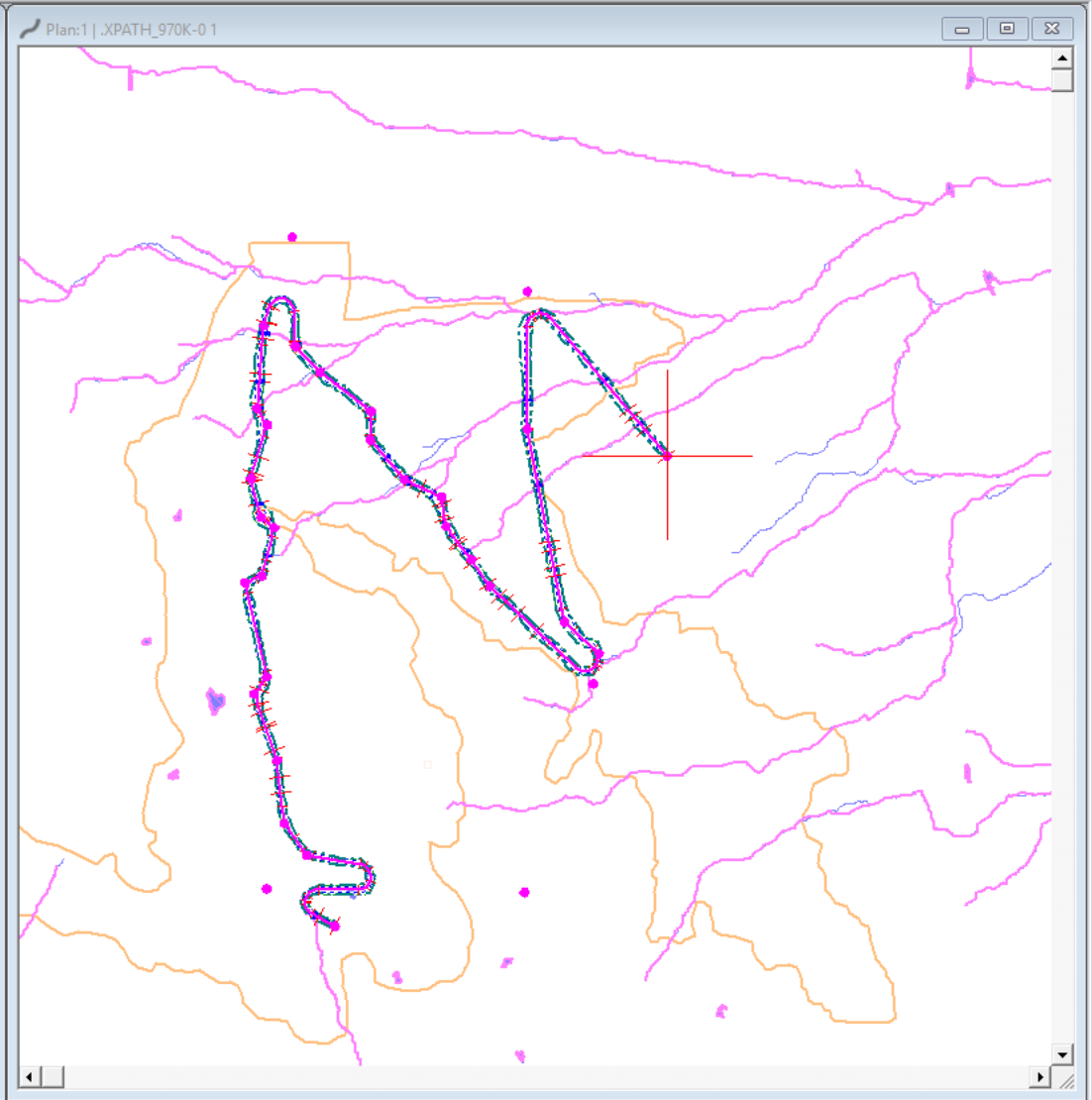
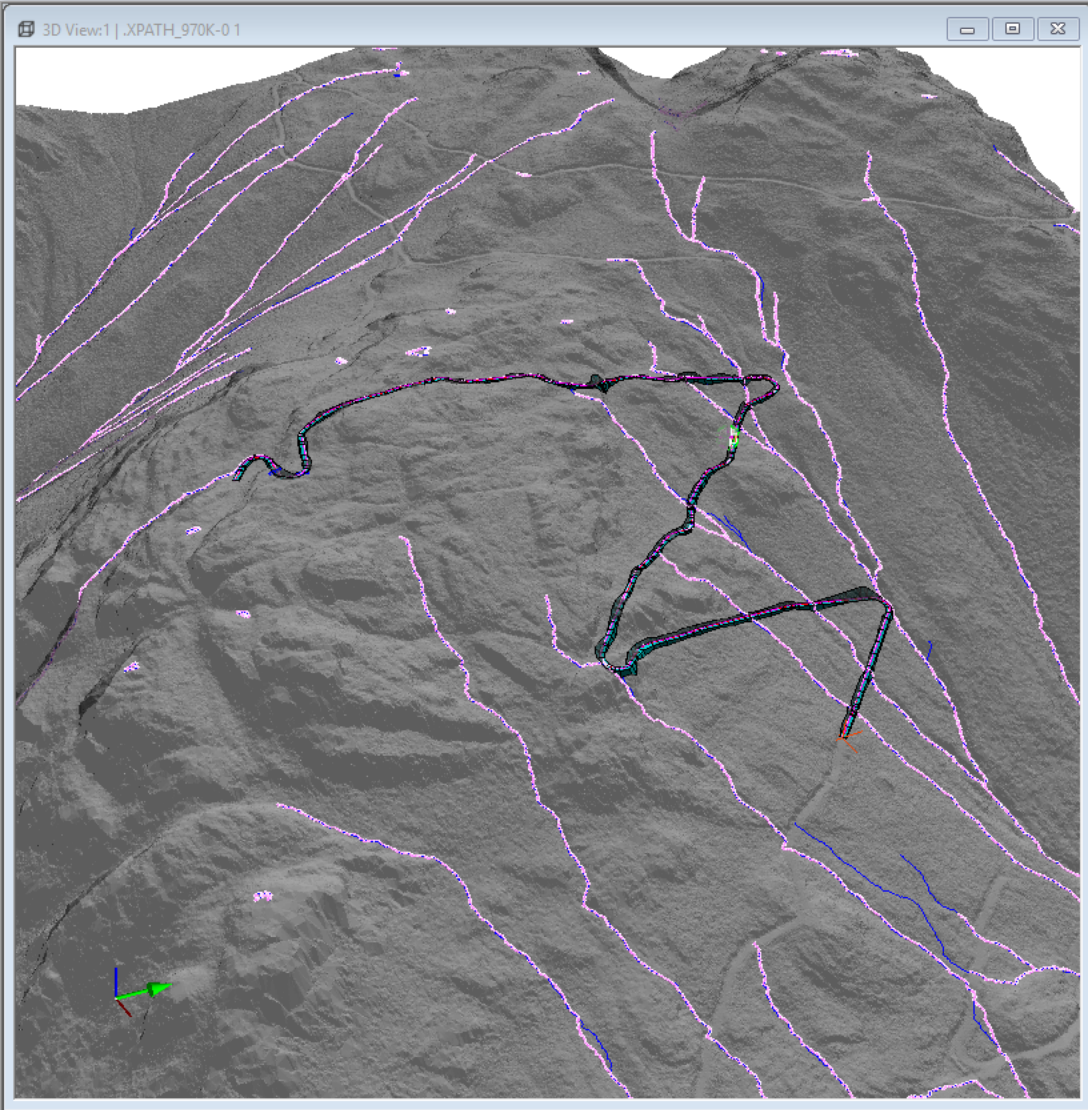
----- Hydrology Calculations -----

Include

980645.0 596999.2

Home Corridor View GPS Setup Plan

Tool Selection Mode  
 Read Terrain(s)  
 Read Traverse  
 Edit External Files External Files  
 Insert File Import  
 Recalculate Range Alignment  
 Assign by Range Alignment  
 Templates Design  
 Ground Types  
 Reference Surfaces  
 Hydrology  
 Az:   
 HD: 
 Measure Mode  
 Polar / Delta Mode  
 Export  
 Web Mapping



Culverts

Add...	49.1	600 mm	Cross D
Properties...	113.5	600 mm	Cross D
Delete	333.4	600 mm	Cross D
	433.1	600 mm	Cross D
	874.4	600 mm	Cross D
	955.1	600 mm	Cross D
	986.0	600 mm	Cross D
Apply	1024.9	600 mm	Cross D
Help...	1158.0	600 mm	Cross D
	1203.6	600 mm	Cross D
Defaults	1313.0	600 mm	Cross D
Get	1370.0	600 mm	Cross D
	1401.6	600 mm	Cross D
Save...	1517.7	600 mm	Cross D
	1583.0	600 mm	Cross D
	2155.0	600 mm	Cross D

Description:

Length:  Auto + Left: 7.51 Right: 4.27

Vertical Position:  Auto  Attach to upper ditch/catch

Skew:  Auto 70 Deg. from C/L (0-180)

Gradient:  Auto -53 %  Semi Auto


----- Hydrology Calculations -----

Include

**Real Project from BC Ministry of Forests:  
Original Design Completed by a Consultant**

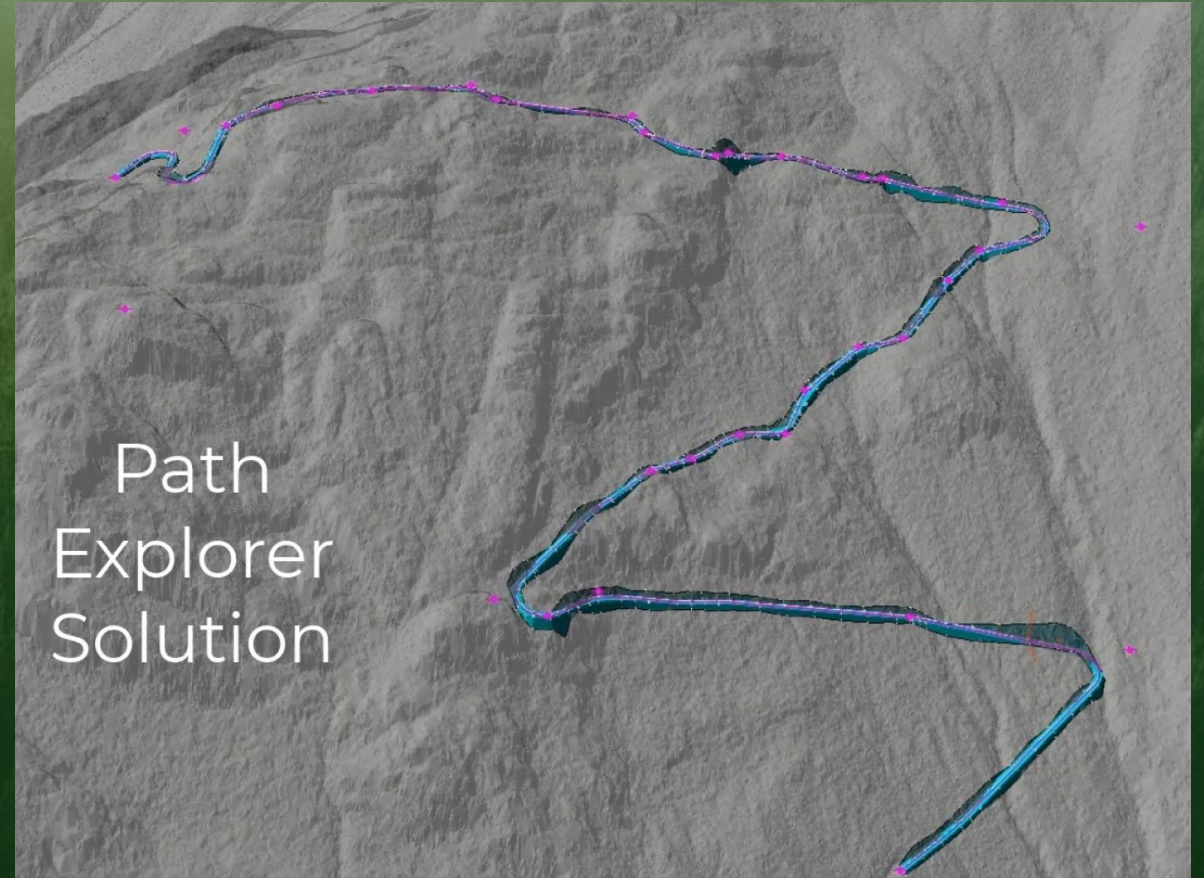
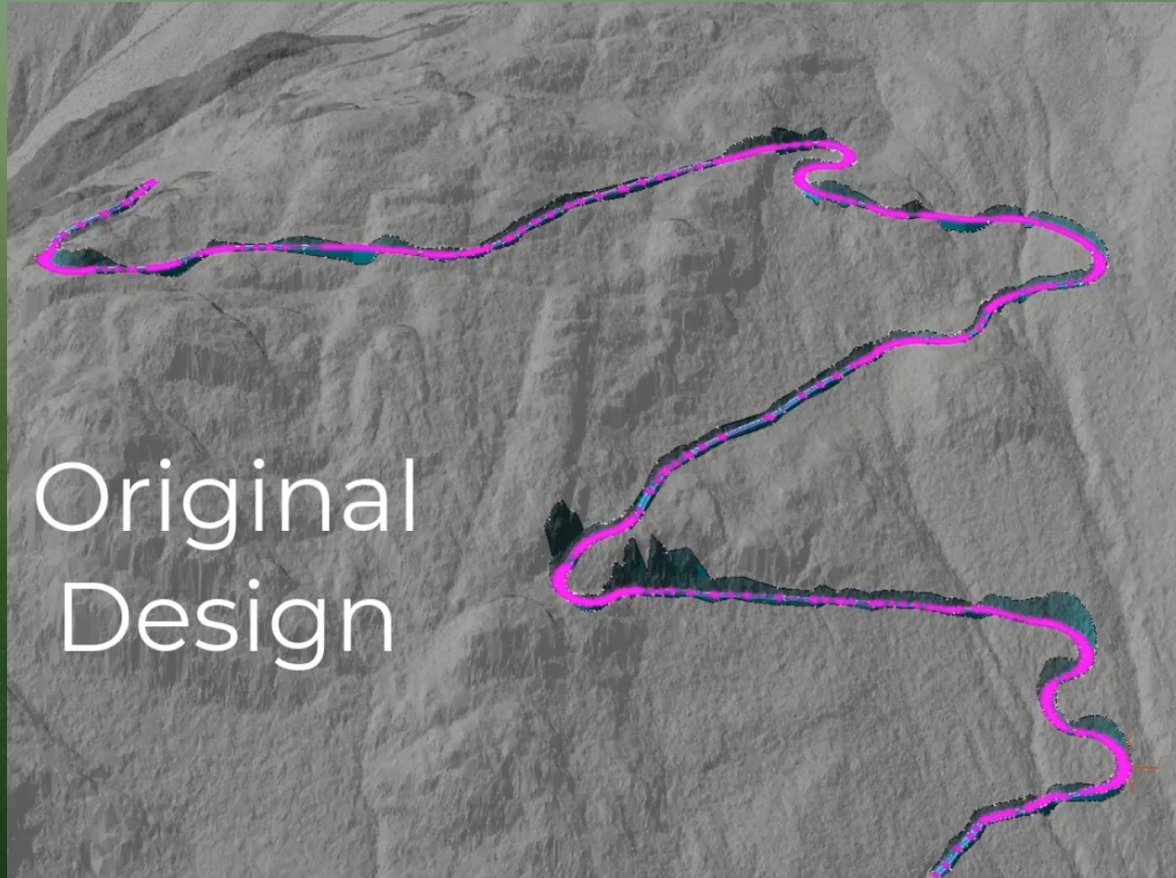
Original  
Design

An aerial topographic map of a forested area. A stream channel is highlighted with a thick magenta line, and a narrower cyan line follows its path. The terrain is shown in shades of gray, with darker areas indicating higher elevations. The stream flows from the top left towards the bottom right, with several meanders. A small orange crosshair is visible at the bottom right end of the stream.



The revised, OPTIMIZED design was done quickly in RoadEng by BC MOF with support from Softree)

# Manual Design vs. Optimized Design



**12% Reduction In Length. 21% Reduction In Disturbance Area.  
67% Reduction In Earthworks.**

# Why Am I Here & How Does This All Connect?

## Goals:

- Share technology advancements!
- Emphasize **THIS STUFF MATTERS!**

## Connections:

- Roads can have an enormous impact.
- We strive to minimize negative impacts.
- Could changes have been made to prevent case study events?
- Determining Best Solution?
  - Hindsight = Investigation
  - Foresight = Design...  
*(and no case-study)*

# Summary

- All roads are going to have an impact
- Goal is to minimize those impacts amidst all the changes: climate, industry needs
- Leverage changes and improvements in technology
- Informed Decision-Making:  
Use Design → Design Smarter

## **BENEFITS OF IMPROVING ROAD DESIGN:**

- ✓ More resilient road systems
- ✓ Reduced environmental impact
- ✓ Cost-effective operations
- ✓ Alignment with modern forestry practices