FINAL REPORT: MITCHELL POINT FEASIBILITY & COST STUDY

June 30, 2015

Photo Credit: J.A. Elliot (1929)

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1. INTRODUCTION

The Oregon Department of Transportation (ODOT) is leading an effort to reestablish the Historic Columbia River Highway & State Trail (HCRH) from Troutdale to The Dalles. The ongoing design and construction activities along the HCRH have reduced the length of HCRH remaining to be reestablished substantially and funding has been obtained for the design and construction of all but approximately 5 miles of the remaining future alignment. The Mitchell Point section of the future HCRH is within the alignment that is yet to be funded.

Mitchell Point is located in the Columbia River Gorge, about 3 miles west of Hood River, and is accessible from I-84 (WB) exit number 58, within the Wygant State Natural Area.

2. SCOPE/PURPOSE

Parsons Brinckerhoff has been retained to provide subject matter expertise to conduct a feasibility and cost study to quantify potential alignments, their associated risks and order-of-magnitude costs for the Agency to use in determining the preferred approach for the trail alignment in this area. The work is authorized by Work Order Contract #2 of Price Agreement #B31270.

The scope of services includes:

- Confirm design criteria
- Identify environmental and other site constraints
- Perform a preliminary alignment study, a fatal flaw assessment and risk evaluation based on the alignment study

ODOT has provided Parsons Brinckerhoff with documentation that contains information regarding the historic Mitchell Point Tunnel and Viaduct, current HCRH planning documents, news articles, and other information relevant to this effort. This documentation is cited in Section 9 – References. This study does not evaluate the trail alignment options against the National Scenic Area (NSA) resource criteria.

3. DESIGN STANDARDS

The basis for the design of the trail stems primarily from the Historic Columbia River Highway (HCRH) State Trail Guidelines (2011) with additional guidance drawn from AASHTO Guide for the Development of Bicycle Facilities (2012). Specific criteria from Section 2B.1 of the HCRH State Trail Guidelines were used in conjunction with engineering judgment in the development of the options. Below is a summary of the criteria used for this project:

- Pavement width: 12 feet paved with 2 foot aggregate shoulders, 16 feet paved in tunnels
- Surface: 4 inches Asphaltic Concrete Pavement (level 3, ½" mix) with 8 inches aggregate base
- Grade: 0.5% to 5% where feasible; Grades between 5% and 12% permissible with special considerations by the current guidelines; periodic resting areas required whenever grades exceed 5%; efforts have been made throughout the corridor to limit grades to 8% maximum and

should be considered the upper limit for conceptual planning purposes; specific vertical design of switchback options to be developed if chosen for further study

- Cross slope: 2% shed toward land slope on open trail, 1% crowned inside tunnel for drainage purposes
- Centerline Radius: Ranges from 42 feet to 2000 feet where feasible (20 foot minimum with superelevation is used on switchbacks where 42 foot minimum introduces excessive wall heights)
- Sight Distance: 150 feet preferred
- Vertical Clearance: 12 feet preferred, 10 foot minimum
- Structure Live Load: AASHTO pedestrian loading or an H-10 (maintenance) vehicle.
- Railings: Applied on a case by case basis, 42-54 inches

As outlined in the HCRH State Trail Guidelines the following regulating plans are applicable to trails within the Columbia River Gorge:

- Columbia River Highway Historic District, 1983
- Columbia River Gorge National Scenic Area Corridor Visual Inventory, 1990
- Columbia River Gorge National Scenic Area Sign System Design, 1991
- Columbia River Gorge National Scenic Area Management Plan, 1991 (updated 2007)
- Oregon Parks and Recreation Department Columbia Gorge Management Unit Master Plan, 1994
- Design Guidelines, Columbia River Gorge National Scenic Area, USDA Forest Service, 1996
- Historic Columbia River Highway Master Plan, 1996 (updated 2006)
- I-84 Corridor Strategy, ODOT, 2005
- Historic Columbia River Highway Cultural Landscape Inventory, 2009

Additional project elements such as structures or tunnels should be designed to meet the current edition of the following codes, as appropriate.

- AASTO LRFD Guide Specifications
- ODOT Bridge Design and Drafting Manual
- ODOT Geotechnical Design Manual
- ODOT Roadway Design Manual
- ODOT Hydraulic Manual
- AASHTO Technical Manual for Design and Construction of Road Tunnels – Civil Elements

4. SITE DESCRIPTION

4.1 HISTORIC TUNNEL

A National Park Service HAER record of the Mitchell Point Tunnel provides the following description of historic infrastructure (Brooks, 1995)

> In 1915, John Arthur Elliott designed and engineered one of the most difficult, and beautiful, sections of the Historic Columbia River Highway – Mitchell Point. Because the OWRR&N

(Oregon-Washington Railroad & Navigation Co.) occupied the water-level route, Elliott built a viaduct and tunneled through Lower Mitchell Point (Mitchell Spur) to achieve the most direct and economical route possible. The new section replaced a tortuous wagon route, and reduced the journey around Mitchell Point by almost three miles.

Mitchell Point Viaduct spanned a natural break in the cliffs of Lower Mitchell. Built entirely of reinforced concrete, the viaduct rested on six sets of columns with footings in a steep talus slope. A series of six 32 foot slab spans carried the viaduct 192 feet to the west portal of the tunnel. From curb-to-curb, the roadway measured 20 feet, and paving brick decorated the railing posts. Standifer-Clarkson, of Portland, completed the viaduct in 1915 at a cost of $9,201.

Mitchell Point Tunnel was 390 feet long, 18 feet wide and 19 feet high at the crown. It was one of the first highway tunnels to use adits, or “windows”, to light the interior and allow views of a scenic landscape. Early motorists stopped their cars inside the “Tunnel of Many Vistas” to gaze out one of the five windows, enjoy the view, or walk a short trail leading from the fifth window. A 10° curve about halfway through the tunnel allowed motorists a view of the landscape from moving cars. The tunnel cost $16,221, and was completed by Standifer-Clarkson in 1915.

By 1953, larger vehicles had rendered the tunnel obsolete, while unstable rock had made it dangerous. As a result, the route was relocated to water-level, the tunnel was filled, and the Mitchell Point section of the Historic Columbia River Highway abandoned. In 1966, the widening of Interstate 84 required that the cliff be scaled back. As a result, the tunnel and viaduct were destroyed.

4.2 SITE CONDITIONS

Mitchell Point is a prominent cape extending to the Columbia River within the Columbia River Gorge. It consists of a lower peak, known as Mitchell Spur, which is close to the river and extends to an elevation of approximately 500 feet. A saddle is located between the Mitchell Spur and the higher peak, Mitchell Point, which climbs to the south with a peak elevation of over 1,000 feet. The saddle between the two peaks has a minimum elevation of about 400 feet.

North facing slopes are generally steeper than south facing slopes, likely due to the rock dipping toward the southeast. North facing rock cuts approach vertical for heights up to 100 feet in the vicinity, primarily below the existing bench. Above the bench rock cuts and slopes generally range from 4V:1H to 1V:1H and may be several hundred feet in height. South facing slopes are generally vegetated and not as steep.

Drainage occurs to the east and west from Mitchell Point and then north toward the Columbia River.

The Friends of the Historic Columbia River Highway have commissioned past efforts to study a new alignment which have included preliminary geotechnical reconnaissance, details are provided in GRI (2008).

4.3 SITE VICINITY GEOLOGY

Several members of the Miocene aged Columbia River Basalt Group are mapped in the project vicinity. Mitchell Spur is composed of Grande Ronde Basalt with the Frenchman Springs Member of the Wanapum Basalt, Troutdale Formation, and the Pomona Member of the Saddle Mountains Basalt mapped above at Mitchell Point (Anderson, 1980; Korosec, 1987), as shown in Figure 1. Talus slopes and Troutdale Formation clasts were observed during the site visit on the eastern flank of Mitchell Point. The saddle between Mitchell Spur and Mitchell Point formed the southern branch of the Bridal Veil channel of the ancestral Columbia River (the northern branch was destroyed when the present day Columbia River began incising the Gorge) (Tolan et al., 1984). It is assumed Grand Ronde Basalt is the bedrock material that would be encountered along any chosen alignment.

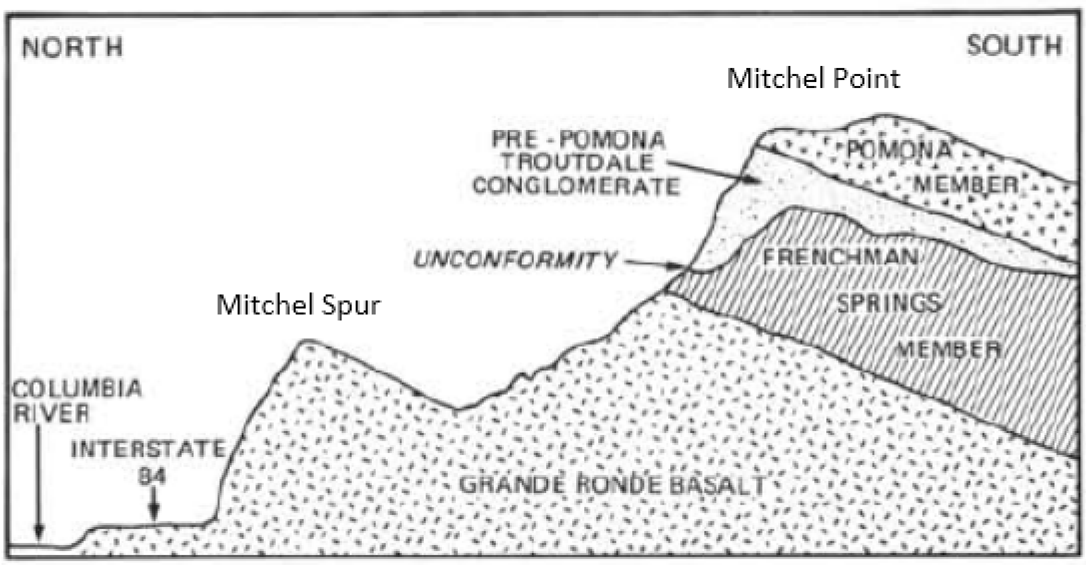

Figure 1 – Cross section through Mitchell Point showing the preserved southern portion of the Bridal Veil channel of the ancestral Columbia River (Anderson, 1980)

The best readily available information and description of the character and structure of the Grand Ronde basalt in the immediate vicinity of Mitchell Point and as it relates to possible tunnel alignments through the point can be found in the geotechnical evaluation performed by GRI in their 2008 study of a tunnel option through Mitchell Point. Selected excerpts on the site conditions from the GRI report that are particularly relevant to judging the general tunnel constructability and estimating ground support requirements are the following (GRI 2008):

- "The rock is typically hard (R4) and fresh to slightly weathered. Four basalt flows are visible in the outcrops located parallel Interstate I-84 and adjacent the parking lot at the west end of the project.
- …. the rock dips down to the southeast generally at about 26 degrees with a strike of about 30 degrees.

- Fracture patterns and spacing vary depending on the location within each basalt flow. In general, columnar fracture patterns are well defined within approximately the bottom quarter to third of each flow. Fractures within the columnar zones are typically moderately close to widely spaced with about 1 to 4 feet between fractures.
- Fractures in the upper two-thirds of each basalt flow appear randomly oriented and are very close to close, typically about 1 to 6 in. The randomly oriented fractures are interconnected, but do not appear to form persistent linear fractures through the rock mass.
- A weathered contact between two basalt flows will likely be encountered about 400 feet from the west portal. … The rock below this contact is predominantly decomposed for a thickness of about 15 ft. "

Figure 2 illustrates the variation in jointing and general competence at the contact between flow units as described in the preceding excerpts from the GRI study.

Figure 2 – Grande Ronde Basalt at Mitchell Spur as viewed from west

4.4 ROCKFALLS

Numerous rockfalls have occurred in the vicinity of Mitchell Point, documentation of which precedes the original construction of Mitchell Point Tunnel as described by J.A. Elliot in 1929:

> On each side of the point was a talus slope, two hundred or more feet high, and beyond was rolling ground. On the point proper, in a bowl-shaped area bounded by the rock cliffs, was another talus slope about 125 feet high, the toe of which was at the edge of the railroad. This had given the railroad considerable trouble, and during the winter that location survey was made a slide occurred which buried the railroad under three feet of debris for a distance of 150 feet. The eastern wall of the bow-shaped area was formed by a vertical cliff 200 feet high, at the foot of which the railroad was built. (Elliot, 1929)

Rockfalls continue to occur occasionally to this day, ODOT has responded to rockfalls recently (2010, 2011) that have originated on the rock face both above and below the existing bench at Mitchell Point. In the 2011 event "golf ball-sized" rocks have reached the EB I-84 travel lanes. The 2010 event was estimated to be approximately 50 cubic yards of material (ODOT, 2010, 2011). Figure 3 and Figure 4 display the 2010 and 2011 rockfall events.

Figure 3 – Rockfall debris on west bench, facing east (ODOT, 2011)

Figure 4 – Rockfall adjacent to I-84 EB travel lanes (ODOT, 2010)

5. OPTIONS

A brief discussion of each alignment option is presented within this section. Plan and profile sheets of each option are provided at the end of this report.

Table 1 – Options Summary

Option	Approximate Length (feet)	Notes
Alignment 1 – Tunnel	2,000	Tunnel Length – 1,225 feet
Alignment 2A – Shelf & Bridge	2,100	Shelf Length – 950 feet Bridge Length – 300 feet
Alignment 2B – Shelf & Short Tunnel	2,200	Shelf Length – 950 feet Tunnel Length – 380 feet
Alignment 2C – Shelf & Intermediate Tunnel	2,100	Shelf Length – 470 feet Tunnel Length – 825 feet
Alignment 3A – Overland	9,100	~
Alignment 3B – Overland w/Rock Cut	7,500	Rock Cut Length – 300 feet
Alignment 4 – I-84 Adjacent	4,300	~

5.1 ALIGNMENT 1 – TUNNEL OPTION

5.1.1 OVERVIEW

This option depicts the approximate alignment of the tunnel described in the GRI study (GRI, 2008). The west portal of the tunnel begins about 80 feet north of the existing parking lot. The alignment then bears eastward in a straight line toward approximately the center of the shallow gully in the north face of the cliffs. Side adits allowing for views of the river may be constructed at this location. The tunnel then bears in a straight line through the next segment of the cliffs to the east, ending on the far eastern side of the point for a total length of approximately 1,225 feet.

5.1.2 STRUCTURAL/TUNNEL DISCUSSION

A drill and blast mined horseshoe shaped tunnel section is anticipated for this option. A suitably sized roadheader may be able to mine the tunnel, and a hoe ram could be used to conduct limited excavation. However, given the observed rock quality and fracture patterns, it is anticipated drill and blast methods would be a more economical means to excavate the tunnel.

For purposes of assessing tunnel options and estimating their costs we have developed a trial tunnel cross section (see Detail 1) and conceptual ground support schemes (Details 2-5) for a typical portal in rock plus three ground support categories that together provide a representative range of what we consider to be reasonable, cost effective and readily constructible support methods to address the range of anticipated ground conditions as inferred from our site visit and the limited available geologic information. Table 2 summarizes the main attributes and intended setting for reach ground support category.

All categories assume a functional but simple shotcrete final lining. While not watertight without a membrane system, the shotcrete will serve to deflect groundwater. Where active seepage is encountered localized treatment using geocomposite drain materials can be used to drain the groundwater to the invert and allow the shotcrete to then be placed.

Considering the relatively dry conditions a dedicated subdrain pipe system is not considered necessary. Gutters at the base of each sidewall combined with a slight crown in the pavement are considered sufficient to keep collected flows off of the traveled portions of the invert pavement and efficiently deliver it to the downhill portal.

The rock formation may provide adequate support to allow portions of the sidewall to be exposed for aesthetics. However, it is anticipated the majority of the tunnel will require shotcrete, especially the crown, to protect users against possible rockfall.

Table 2 – Summary of Ground Support Systems

Support Category [Detail No.]	General Description of Initial Support Elements	Final Lining	Commentary
MPP Portals in Rock [Detail 2]	Fiber reinforced shotcrete (FRS) brow followed by cement-grouted spiles around perimeter of tunnel	Plain shotcrete tinted to match native basalt placed to cover all exposed FRS over brow.	Intended for portals placed in rock as envisioned for Options 1, 2B and the west portal of Option 2C. Aim of concept is for a functional but minimal structure that preserves stability of rock face during turn under and minimizes visibility of portal from highway and river.
MP1 Good rock [Detail 3]	Spot rock dowels, welded wire mesh and mine straps, all as required	FRS placed continuously above springline, and intermittently below springline as required	Envisioned to be used in the less fractured, fresh to slightly weathered lower portions of the intersected flow units. All dowels would be fully anchored with polyester resin.
MP2 Fair to Poor Rock [Detail 4]	Pattern rock dowels and 4 to 6 inches FRS over full perimeter of tunnel. Supplemental welded wire mesh and mine straps as required.	Additional fiber reinforced shotcrete placed to achieve 6 inches over full perimeter of tunnel.	Applicable where tunnels intersect the more fractured and weathered flow contact zones. This category most closely resembles the ground support concepts described in the GRI study.
MP3 Poor to Very Poor Rock [Detail 5]	Spiles, steel sets and FRS lagging between sets as required.	Additional shotcrete to encapsulate and cover steels sets and achieve 8 inches minimum for full perimeter.	Envisioned to be employed at the eastern ends of tunnel Options 1 and 2C where tunnels extend farther east towards the weaker and more fractured upper portion of the flow unit

5.1.3 ENVIRONMENTAL DISCUSSION

The following zoning designations apply to this option:

- Special Management Area –Public Recreation
- Special Management Area – Open Space
- Special Management Area – Forest
- Geologic Hazards

Land use approval from Hood River County for development within the National Scenic Area is anticipated to be a Type II review for compliance with Article 75 (National Scenic Area Ordinance) and Article 45 (Geologic Hazard). This option would be visible from key viewing areas, likely on and across the Columbia River, and to a lesser extent I-84. The aesthetic experience within the tunnel would need to meet the design guidelines of the I-84 Corridor Strategy. Any adits would improve the experience by increasing the amount of natural light in the central portion of the tunnel and would allow trail users viewpoints into the Columbia River Gorge. This option avoids the need for separate rockfall hazard mitigation as the tunnel provides rockfall protection. This option would have minimal vegetation removal, primarily at the east portal of the tunnel.

5.2 ALIGNMENT 2 – SHELF & BRIDGE/TUNNEL OPTION

5.2.1 OVERVIEW

Alignment 2 intends to take advantage of the remnant shelf along the basalt face from the original HCRH construction. Alignment 2 is further subdivided into three different options using a combination of shelf structure, bridge structure and tunnel. Given the rockfall hazard and intended use of the trail, Alignment 2 concepts consider that all exposed sections of the trail will be protected through some means of rockfall mitigation. Mitigation concepts considered include a rockfall shelter, similar to the Mosier Twin Tunnels east of Mitchell Point, or mesh and cable net slope protection, which could also include rock bolting and shotcrete as necessary.

Alignment 2 begins at the existing trail terminus and continues coincident with the existing historic highway past the parking lot. The trail continues along the river-facing shelf, making use of the existing rockfall catchment area.

Where the shelf ends and the cliff face begins to curve back toward the south, Alignment 2 splits into Options 2A and 2B. Option 2A continues east over a proposed bridge structure for approximately 300 feet before touching down again on the eastern, existing shelf. Option 2B rounds the inside of the cliff face within a curved tunnel for approximately 380 feet and ends at the same point as the bridge abutment. The tunnel alignment adds about 80 feet to the total length compared to Option 2A. Both 2A and 2B continue easterly along the shelf following the same alignment to the terminus chosen for this study.

Option 2C follows the same alignment as the tunnel in Option 2B but breaks off from the curve at approximately the halfway point of the 2B alignment and continues east through the rock in a tunnel for a total length of approximately 825 feet. This alignment daylights on the far eastern side of Mitchell Point. The total length of alignment 2C is approximately the same as 2A.

5.2.2 STRUCTURAL/TUNNEL DISCUSSION

Option 2A- Shelf and Bridge: Option 2A utilizes the shelf of the original HCRH alignment to the fullest extent. A gouge or chute, forming a chasm in the rock face exists where the original highway's bridge structure was located and later was removed. In this option, a bridge is used to cross the chasm. As mentioned above, rockfall mitigation in the form of rock shelters or mesh and cable net slope protection are considered for both the eastern and western trail approaches to the bridge.

Bridge:

Option 2A includes adding a bridge across the chasm in the shelf. The gap that the bridge would need to span is approximately 300 feet in length. This estimated bridge length of 300 feet accounts for an assumed weathered rock zone near the existing edges of the chasm. Since the original Columbia River Highway alignment was along the shelf, it is reasonable to assume that the shelf consist of competent material suitable for a bridge foundation.

Both single and multi-span bridge types are feasible for spanning the 300 feet. For a conventional type of bridge (deck and girder), this span length would require one or two intermediate bents. With the shelf elevation approximately 75 feet above the elevation of I-84, these long intermediate bents, would be fairly expensive.

It is feasible to span the 300 foot gap with a single span bridge and avoid intermediate bents. At the approximate span length of 300 feet, the family of feasible bridge types includes a deck arch, tied arch, cable stayed and suspension bridges.

Examples of deck arch style bridges include the Shepperd's Dell Bridge and the 1915 Moffett Creek Bridge (see Figure 5 – Moffett Creek Bridge, circa 1920).

Figure 5 – Moffett Creek Bridge, circa 1920

Local examples of the other bridge types mentioned include:

- The Fremont Bridge is a tied arch bridge.
- TriMet's new Tilicum Crossing Bridge is a cable stayed bridge
- St. John's Bridge is a suspension bridge.

The usable trail width is 16 feet. Including bridge railing outboard of the trail, the overall bridge deck width is considered to be 19 feet wide.

The adjacent weathered rock face creates a rockfall hazard for pedestrians using the trail as well as the structural integrity of the bridge. A geotechnical/geologic investigation of the rockfall, as well as refinement of the trail alignment would be needed to determine the risk to the bridge related to rockfall. It is recommended to investigate mitigation measures such as locating the bridge's alignment outside of the rockfall zone or using mesh and cable net slope protection.

Rockfall Mitigation:

From site visit observations, both the western and eastern approach shelves contain debris from rockfalls. Figure 6 shows some of the debris from rockfalls. From this observation, it is prudent to consider rockfall mitigation and can be achieved through several means such as rock shelters or mesh and cable net slope protection.

Figure 6 – Rockfall Debris along the Trail

For ODOT's 1997 Hood River-Mosier Connection Phase 2 project, rock shelters were used for rockfall mitigation.

In order to estimate rock shelter lengths, satellite photos and available contour maps were used. The western approach rock shelter is estimated to extend approximately 440 feet in length. The eastern approach rock shelter is estimated to extend approximately 390 feet in length.

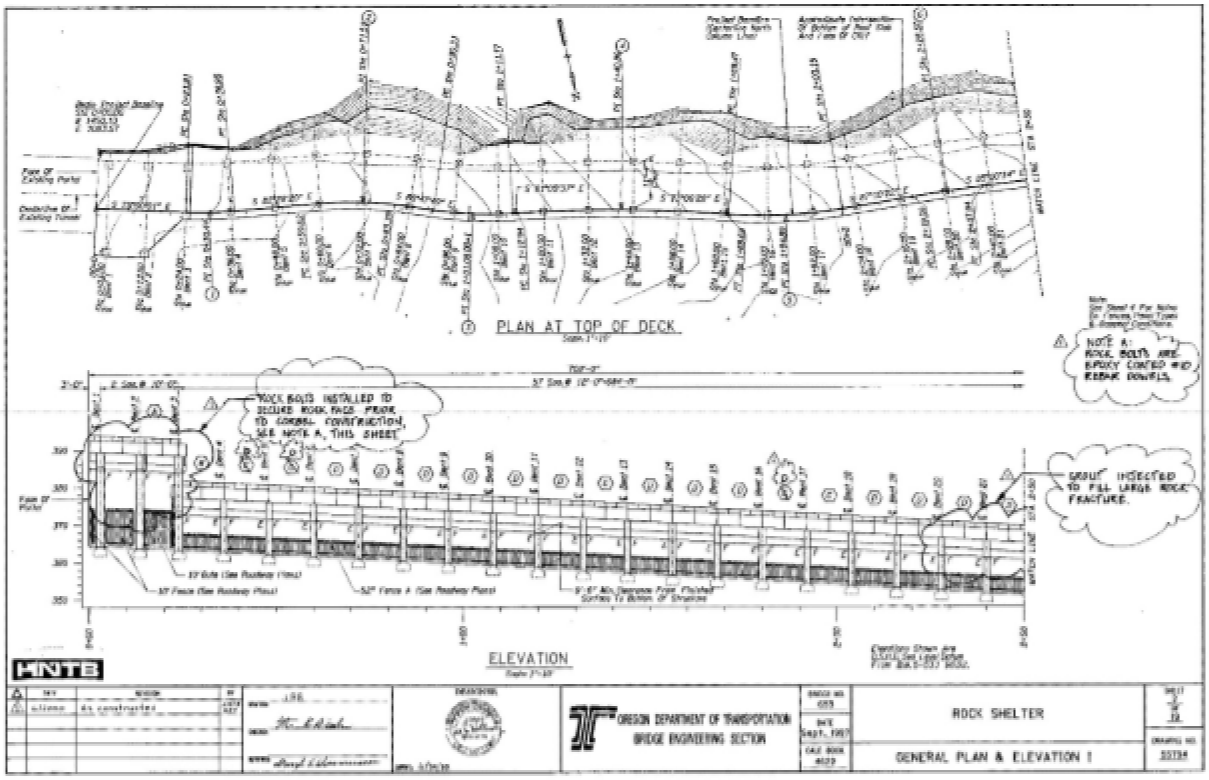

Figure 7 – Mosier Tunnel Rock Shelter

An illustration of the use of mesh and cable net slope protection for rockfall mitigation from ODOT's 2005 I-84 Corridor Strategy is shown in Figure 8. The rock face area that would likely need rockfall mitigation in the form of mesh and cable netting was estimated from rough concept level ground contours and quantified in the cost estimate. Netting is estimated to be approximately 225,000 square feet.

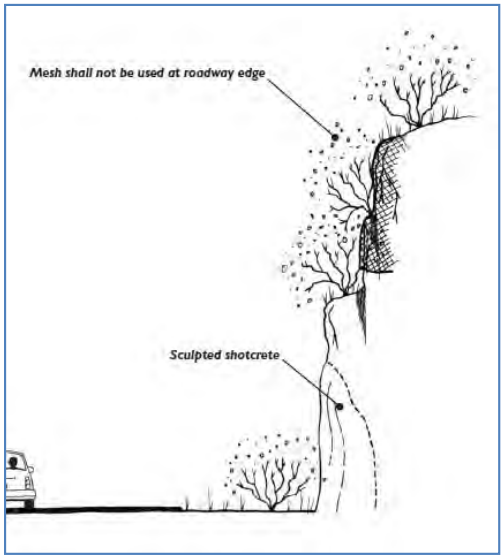

Figure 8 – *Mesh and Cable Net Slope Protection*

Shelf Widening:

From site visit observations, the width of the existing shelf, in many locations, is less than the required 16 feet of usable trail width.

Possible strategies to provide a usable trail width of 16 feet include:

- Cantilevered decking over the shelf edge,
- Scaling the rock face to achieve the 16 foot trail width and mesh and cable net for slope protection or
- Rock shelter with localized rock scaling or excavation to achieve the 16 foot trail width.

Cantilevered Decking: In this concept, concrete deck panels would be anchored vertically into the existing shelf and cantilever over the edge of the shelf edge. With the rockfall hazard still present, mesh and cable net slope protection is added to mitigate the hazard.

Scaling and Mesh and Cable Net: In this concept, the rock face is scaled to remove loose and weathered rock. Mesh and cable netting is installed for slope protection. Some rock bolting and shotcrete may also be needed to complete the rockfall mitigation. Mesh and cable net slope protection is discussed in further detail in ODOT's 2005, I-84 Corridor Strategy.

Rock Shelter and Localized Scaling: In this concept, a rock shelter is utilized to mitigate the rockfall hazard. The roof edge of the shelter follows the contour of the rock facing. There will be some localized areas, perhaps as wide as 6 to 7 feet, where rock scaling will need to occur in order to achieve a usable trail width of 16 feet.

Scaling is a common practice to remove weathered, loose, and hanging material from a rock slope in a relatively controlled, proactive fashion. The work can proceed manually using picks and prybars, or mechanically using hoe rams. Specialized techniques are also used depending on rock type including hydro-scaling and expansive (non-explosive) compounds. Workers usually gain access to the slope via crane-supported baskets or suspended on ropes. Scaling is typically specified after controlled blasting of a new rock cut, or as part of a periodic maintenance program on existing slopes.

<u>Option 2B- Shelf and Short Tunnel:</u> Option 2B is similar to Option 2A except that a curved tunnel structure is used to bypass the chasm instead of a bridge.

Short Tunnel:

The curved tunnel hugs the rock face and could include one or more adits for viewing ports. See discussion in Section 5.1.2, except that the ground support for the east portal would mimic that for the west (that is, lattice girders are not anticipated).

Rockfall Mitigation:

Similar to Option 2A, rockfall mitigation is recommended for both the eastern and western trail approaches to the tunnel. As in Option 2A, Mitigation measures range from mesh and cable netting to rock shelters.

The rock face area that would likely need rockfall mitigation in the form of mesh and cable netting was estimated from rough concept level ground contours and quantified in the cost estimate. Netting is estimated to be approximately 225,000 square feet.

In order to estimate rock shelter lengths, satellite photos and available contour maps were used. The western approach rock shelter is estimated to extend approximately 440 feet in length. The eastern approach rock shelter is estimated to extend approximately 390 feet in length.

Shelf Widening:

From site visit observations, the width of the existing shelf, in many locations, is less than the required 16 feet of usable trail width.

Possible strategies to provide a usable trail width of 16 feet include:

- Cantilevered decking over the shelf edge,
- Scaling the rock face to achieve the 16 foot trail width and mesh and cable net for slope protection or
- Rock shelter with localized rock scaling to achieve the 16 foot trail width.

Cantilevered Decking: In this concept, concrete deck panels would be anchored vertically into the existing shelf and cantilever over the edge of the shelf edge. With the rockfall hazard still present, mesh and cable net slope protection is added to mitigate the hazard.

Scaling and Mesh and Cable Net: In this concept, the rock face is scaled to remove loose and weathered rock. Mesh and cable netting is installed for slope protection. Some rock bolting and shotcrete may also be needed to complete the rockfall mitigation. Mesh and cable net slope protection is discussed in further detail in ODOT's 2005, I-84 Corridor Strategy.

Rock Shelter and Localized Scaling: In this concept, a rock shelter is utilized to mitigate the rockfall hazard. The roof edge of the shelter follows the contour of the rock facing. There will be some localized areas, perhaps as wide as 6 to 7 feet, where rock scaling will need to occur in order to achieve a usable trail width of 16 feet.

<u>Option 2C- Shelf and Intermediate Tunnel:</u> Option 2C's western approach utilizes the original HCRH alignment for the trail and then constructs an intermediate length tunnel along a portion of the rock face and then on to the east, along the Option 1 alignment.

Rockfall Mitigation:

Similar to Options 2A and 2B, rockfall mitigation is recommended, but in this option, only the western trail approach to the intermediate tunnel would need rockfall mitigation. The existing eastern shelf (trail approach) is not utilized, as the intermediate tunnel alignment veers away from the rock face.

The rock face area that would likely need rockfall mitigation in the form of mesh and cable netting was estimated from rough concept level ground contours and quantified in the cost estimate. Netting is estimated to be approximately 155,000 square feet.

In order to estimate rock shelter lengths, satellite photos and available contour maps were used. The western approach rock shelter is estimated to extend approximately 440 feet in length.

Intermediate Tunnel:

For a discussion of the Intermediate Tunnel, see discussion in Section 5.1.2.

Shelf Widening:

From site visit observations, the width of the existing shelf, in many locations, is less than the required 16 feet of usable trail width.

Possible strategies to provide a usable trail width of 16 feet include:

- Cantilevered decking over the shelf edge,
- Scaling the rock face to achieve the 16 foot trail width and mesh and cable net for slope protection or
- Rock shelter with localized rock scaling to achieve the 16 foot trail width.

Cantilevered Decking: In this concept, concrete deck panels would be anchored vertically into the existing shelf and cantilever over the edge of the shelf edge. With the rockfall hazard still present, mesh and cable net slope protection is added to mitigate the hazard.

Scaling and Mesh and Cable Net: In this concept, the rock face is scaled to remove loose and weathered rock. Mesh and cable netting is installed for slope protection. Some rock bolting and shotcrete may also be needed to complete the rockfall mitigation. Mesh and cable net slope protection is discussed in further detail in ODOT's 2005 I-84 Corridor Strategy.

Rock Shelter and Localized Scaling: In this concept, a rock shelter is utilized to mitigate the rockfall hazard. The roof edge of the shelter follows the contour of the rock facing. There will be some localized areas, perhaps as wide as 6 to 7 feet, where rock scaling will need to occur in order to achieve a usable trail width of 16 feet.

5.2.3 ENVIRONMENTAL DISCUSSION

Option 2A - Shelf and Bridge: The following zoning designations apply to this option:

- Special Management Area –Public Recreation
- Special Management Area – Open Space
- Special Management Area – Forest
- Geologic Hazards

Land use approval from Hood River County for development within the National Scenic Area is anticipated to be a Type II review for compliance with Article 75 (National Scenic Area Ordinance) and Article 45 (Geologic Hazard). This option would be visible from key viewing areas, likely on and across the Columbia River, and I-84. The bridge would be a new structure but the alignment would be within a developed roadway prism which would soften this introduction of a new structure. The aesthetic experience for the trail and bridge would need to meet the design guidelines of the I-84 Corridor Strategy. This option provides the most viewpoints into the Columbia River Gorge within this segment. This option requires separate rockfall hazard mitigation structures such as those constructed for the Mosier Tunnel or mesh and cable net slope protection, which would also be visible from key viewing areas. This option would have minimal vegetation removal, primarily at the eastern end of the eastern shelf.

Option 2B - Shelf and Short Tunnel: The following zoning designations apply to this option:

- Special Management Area –Public Recreation
- Special Management Area – Open Space
- Special Management Area – Forest
- Geologic Hazards

Land use approval from Hood River County for development within the National Scenic Area is anticipated to be a Type II review for compliance with Article 75 (National Scenic Area Ordinance) and Article 45 (Geologic Hazard). This option would be visible from key viewing areas, likely on and across the Columbia River, and I-84. This option avoids the bridge but would still require separate rockfall hazard mitigation structures such as those constructed for the Mosier Tunnel or mesh and cable net slope protection, which would be visible from key viewing areas. The alignment of the rockfall hazard mitigation structures would be within a developed roadway prism. The aesthetic experience for the trail and tunnel would need to meet the design guidelines of the I-84 Corridor Strategy. This option provides many viewpoints into the Columbia River Gorge within this segment. This option would have minimal vegetation removal, primarily at the eastern end of the eastern shelf.

Option 2C- Shelf and Intermediate Tunnel: The following zoning designations apply to this option:

- Special Management Area –Public Recreation
- Special Management Area – Open Space
- Special Management Area – Forest
- Geologic Hazards

Land use approval from Hood River County for development within the National Scenic Area is anticipated to be a Type II review for compliance with Article 75 (National Scenic Area Ordinance) and Article 45 (Geologic Hazard). This option would be generally visible from key viewing areas, likely on and across the Columbia River, and I-84. This option avoids the bridge but would still require separate rockfall hazard mitigation structure for the western trail, such as those constructed for the Mosier Tunnel or mesh and cable net slope protection, which would be visible from key viewing areas. The alignment of the rockfall hazard mitigation structures would be within a developed roadway prism. The aesthetic experience for the trail and tunnel would need to meet the design guidelines of the I-84 Corridor Strategy. This option provides partial viewpoints into the Columbia River Gorge within this segment. This option would have minimal vegetation removal, primarily at the east portal of the tunnel.

5.3 ALIGNMENT 3 – OVERLAND OPTION

5.3.1 OVERVIEW

Alignment 3 consists of overland options constructed through the saddle between Mitchell Point and Mitchell Spur. Alignment 3 options consist heavily on switchback trails instead of tunnels or structures. Option 3A is the overland option with the least amount of earthwork. Alignment geometry is laid out to hug existing contours while meeting existing design guidance to the extent feasible. Due to the steepness of the slope being traversed, in many areas a shorter radius curve of 20’ was used to avoid excessively tall walls and extra earthwork at these locations. The path location and alignment geometry is highly subjective, meaning each designer may decide to lay it out differently. For this study the primary goal is to show the approximate length and impact of a 16’ wide overland path if an average of 5% grade is used from the bottom up to the saddle, and back down. A detailed design of this path could result in the use of 8%-12% grade runs as allowed by design guidance. Additionally, consideration of a narrower path could potentially reduce earthwork or the need for walls in some locations.

The switchback path approaching and exiting the saddle is approximately 5,000 feet long on each side to accommodate about 250 feet of grade change at 5% grade. Landing areas of 2% grade at each switchback are needed and could increase the required path length. This would require further study and layout during subsequent phases of the project should the overland options be preserved. Retaining structures with railing will be required at the switchbacks because the surface colluvium (talus) would not likely support a cut slope at these locations. Earthwork quantities for the Alignment 3 options were estimated using average cut and fill amounts for typical path locations on the slope. Exact modeling using design software was not performed. On the east side of the saddle, switchbacks are used to touch down at approximately the same location as the other alignment options.

Option 3B features a through-cut near the saddle as a means of reducing the length of the approach trails. For this specific case, a 50 foot high cut was considered. The cut is based on slopes of 0.5H to 1V. Rock bedding and fracturing may require different slope inclinations on one or both cut faces. By cutting out 50 feet of height, the path length can be reduced by approximately 1,600 feet. The alignment of Option 3B leading up to and away from the saddle is approximately the same as 3A up to the 350 foot elevation mark. The total alignment length of option 3B with the cut is approximately 7,500 feet versus the length of 9,100 feet for option 3A.

A short tunnel near the saddle was briefly considered as a means similar to a cut at reducing the trail length. A tunnel feature was dropped from further evaluation because of the likely presence of poor ground conditions that would make portal and tunnel excavation difficult. The two aerial views of Mitchell Point below (Figure 9 and Figure 10) show the saddle to be comprised of a less erosion and weathering-resistant unit of the Grand Ronde Basalt than the prominent underlying outcrop that makes up Mitchell Spur and through which the original tunnel was constructed. The northeast strike and south-southwest dip of the lower flow unit suggest:

- Any tunnel alignment through the spur that trends more easterly than the strike of the lower flow unit is likely to encounter more of the overlying weaker rock unit that makes up the saddle and east facing talus slopes
- A tunneled variation to the surface trench in Option 3B would have to be much deeper and trend in a more northerly direction to remain in the same flow unit as the original tunnel was excavated and as Options 1 and 2 would encounter.

Figure 9 – Mitchell Point looking east-southeast

Figure 10 – Mitchell Point looking south-southwest

It is conceivable that the number of switchbacks (and associated walls) could be reduced by extending the Option 3 alignments to the east and west beyond the areas shown. However, these were not considered further due to the presence of talus slopes and outcrops that would make such routes difficult to achieve.

5.3.2 STRUCTURAL DISCUSSION

Option 3A- Overland Trail: Option 3A connects west to east by using an overland trail. Due to the steepness of the terrain, trail design requirements call for many switchbacks, as the trail carves its way up the hillside.

The steep terrain also requires retaining walls as the trail traverses switchbacks. Generally, feasible retaining walls include gravity or mechanically stabilized earth (MSE) types of walls with an approximate 4 foot exposure height. Figure 11 shows a gabion wall that is used along the trail near eastbound Moffett Creek Bridge. With the estimated length of retaining walls approximately 13,200 feet, cut and fill walls are necessary throughout this 9,100 foot long trail.

Figure 11 – Gabion Wall at Moffett Creek

Option 3B- Overland Trail with Saddle Cut: Option 3B connects west to east with a similar overland trail, but reduces some trail switchbacks and trail length, by excavating a portion of the area known as the “saddle”. The cut depth at the saddle is approximately 50 feet.

As in Option 3A, the steep terrain also requires retaining walls as the trail traverses switchbacks. Generally, feasible retaining walls include gravity or mechanically stabilized earth (MSE) types of walls with an approximate 4 foot exposure height. With the estimated length of retaining walls approximately 8,750 feet, cut and fill walls are necessary throughout this nearly 7,500 foot long trail.

5.3.3 ENVIRONMENTAL DISCUSSION

Option 3A- Overland Trail: The following zoning designations apply to this option:

- Special Management Area –Public Recreation
- Special Management Area – Open Space
- Special Management Area – Forest
- Geologic Hazards

Land use approval from Hood River County for development within the National Scenic Area is anticipated to be a Type II review for compliance with Article 75 (National Scenic Area Ordinance) and Article 45 (Geologic Hazard). This option would be visible from key viewing areas, likely on and across the Columbia River, and I-84 westbound. This alignment is substantially different from the alignment proposed in the 2011 State Trail Plan. This option avoids the bridge and tunnel but could provide viewpoints into the Columbia River Gorge via spur trails to the north from the main trail within this segment. This alignment also provides enhanced views of the saddle and Mitchell Point. This option avoids the need for rockfall protection structures. This option crosses a large area of land within the Geologic Hazard Zone. Slope stabilization to address geologic hazards would occur during final design and would likely include cut and fill wall. Walls that are visible from I-84 would need to meet the design guidelines of the I-84 Corridor Strategy, similar to the walls at the Moffett Creek Bridge segment. This option would also have more vegetation impacts within the Special Management Area – Forest zoning and would require more revegetation for restoration than non-overland trail options.

Option 3B- Overland Trail Plus 50-Foot Cut at Saddle: The following zoning designations apply to this option:

- Special Management Area –Public Recreation
- Special Management Area – Open Space
- Special Management Area – Forest
- Geologic Hazards

Land use approval from Hood River County for development within the National Scenic Area is anticipated to be a Type II review for compliance with Article 75 (National Scenic Area Ordinance) and Article 45 (Geologic Hazard). This option would be visible from key viewing areas, likely on and across the Columbia River, and I-84 westbound. This alignment is substantially different from the alignment proposed in the 2011 State Trail Plan. The new alignment of the trail veers away from this option avoids the bridge and tunnel but could provide viewpoints into the Columbia River Gorge via spur trails to the north from the main trail within this segment. This alignment also provides enhanced views of the saddle and Mitchell Point. This option may need rockfall protection catchment areas at the rock cut at the saddle. This option crosses a large area of land within the Geologic Hazard Zone. Slope stabilization to address geologic hazards would occur during final design and would likely include cut and fill wall and cut walls directly into bedrock, potentially with catchment areas. Walls that are visible from I-84 would need to meet the design guidelines of the I-84 Corridor Strategy, similar to the walls at the Moffett Creek Bridge segment. This option would also have more vegetation impacts within the Special Management Area – Forest zoning and would require more revegetation for restoration than non-overland trail options.

5.4 ALIGNMENT 4 – I-84 ADJACENT OPTION

5.4.1 OVERVIEW

Alignment 4 attempts to take fullest advantage of the existing I-84 right-of-way. It is a roadside option with some earthwork. A preliminary look at available right-of-way next to the roadway shoulder indicates enough space exists for a path and barrier. The trail begins near the parking lot and swings wide with a large radius curve, then nearly parallels the roadway ramp down to I-84. The 75’ vertical difference between the trail beginning and the bottom of the slope is traversed using a series of 8% grade runs and 2% grade resting areas. The portion of the alignment along the I-84 shoulder will be separated by a crash-worthy barrier with a pedestrian railing attached. At the east end of the point, the trail curves southward with a series of large radius switchbacks to tie into the existing access road. The grade difference is similarly achieved through a series of 8% runs with resting areas. Fill slopes of 2H:1V and railing were used in this alignment option at both the beginning and end alignment curves. Similar to the Alignment 2 options, the rockfall hazard along Alignment 4 suggests mitigation measures are necessary to protect trail users.

5.4.2 STRUCTURAL DISCUSSION

Option 4 connects west to east with a trail, whose grade is essentially off the shoulder of eastbound I-84.

Rockfall Mitigation:

Similar to Options 2A and 2B, utilizing the original HCRH alignment for the trail, the proximity of the eroding rock face to the trail necessitates the consideration of rockfall mitigation. However, in the vicinity of the chasm, the rock face moves away from the trail alignment. It is reasonable to consider rockfall mitigation unnecessary in the vicinity of the chasm.

The rock face area that would likely need rockfall mitigation in the form of mesh and cable netting was estimated from rough concept level ground contours and quantified in the cost estimate. Netting is estimated to be approximately 326,600 square feet.

In order to estimate rock shelter lengths, satellite photos and available contour maps were used. The western approach rock shelter is estimated to extend approximately 560 feet in length. The eastern approach rock shelter is estimated to extend approximately 600 feet in length.

5.4.3 ENVIRONMENTAL DISCUSSION

The following zoning designations apply to this option:

- Special Management Area –Public Recreation
- Special Management Area – Forest
- Geologic Hazards

Land use approval from Hood River County for development within the National Scenic Area is anticipated to be a Type II review for compliance with Article 75 (National Scenic Area Ordinance) and Article 45 (Geologic Hazard). This alignment is slightly different from the alignment proposed in the 2011 State Trail Plan as the new alignment of the trail veers away from the Historic Highway. This option would be visible from key viewing areas, likely on I-84, and on and across the Columbia River. The trail would be a new structure but the alignment would be within a developed roadway prism which would soften this introduction of new structures. This option requires separate rockfall hazard mitigation structures such as those constructed for the Mosier Tunnel or mesh and cable net slope protection, which would also be visible from key viewing areas. The aesthetic experience for the trail would need to meet the design guidelines of the I-84 Corridor Strategy. This option provides limited viewpoints into the Columbia River Gorge within this segment due to the lack of elevation and the foreground transportation facilities (I-84 and UP Mainline). This option would have limited vegetation removal at the east and west ends.

6. COST ASSESSMENT

The following tables provide a rough order of magnitude cost estimate for the conceptual alignments considered in this assessment. These estimates would require verification if any of these options are considered further.

Table 3 – Cost Estimate Summary

Option	Cost
Alignment 1 – Tunnel	**$17,109,359**
Alignment 2A – Shelf & Bridge*	**$11,250,804- $13,849,007**
Alignment 2B – Shelf & Short Tunnel*	**$13,807,709- $16,405,912**
Alignment 2C – Shelf & Intermediate Tunnel*	**$17,098,315- $18,445,379**
Alignment 3A – Overland	**$11,450,342**
Alignment 3B – Overland w/Rock Cut	**$22,200,426**
Alignment 4 – I-84 Adjacent	**$8,378,504**

*Note – A range of cost estimates has been developed for differing shelf widening/rockfall mitigation options presented in Section 5.2.2 for Alignments 2A, 2B, and 2C.

Table 4 – Alignment 1, Tunnel: Rough Order of Magnitude Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Mobilization	LPSM	1	10%	$828,196
Drainage Contingency (based on civil elements)	%	1	10%	$13,923
Erosion Control	%	1	1.5%	$124,229
Aggregate Base (section 0640)	TON	1,450	$30	$43,500
Asphalt Concrete Pavement (level 3 1/2" mix, section 0744)	TON	715	$115	$82,225
Barrier Railing	LF	0	$80	$0
Clearing & Grubbing	ACRE	0.2	$10,000	$2,000
Concrete Barrier	LF	0.0	$48	$0
Borrow	CY			$0
General Excavation	CY	460	$25	$11,500
Excavation (Rock Removal & Haul)	CY	0	58	$0
Excavation (Surface Rock Drill & Blast)	CY	0	144	$0
Bridge	SF	0	$500	$0
Mesh and Cable Net	SF	0	$9	$0
Retaining Walls	SF	0	$55	$0
Shelf Widening Option- High Range	LPSM	0	$0	
Shelf Widening Option- Low Range	LPSM	0	$0	$0
Excavation	CY	12,653	$360	$4,555,080
Ground Support/Lining	LF	1,225	$1,944	$2,381,400
Illumination	LF	1,225	$250	$306,250
		SUBTOTAL	**$9,248,302**	
ADDITIONAL ITEMS				
Design	%	1	30%	$2,774,491
Permitting	%	1	10%	$924,830
Construction Management	%	1	15%	$1,387,245
Contingencies	%	1	30%	$2,774,491
		SUBTOTAL	**$7,861,057**	
		OPTION TOTAL	**$17,109,359**	

Table 5 – Alignment 2A, Shelf and Bridge: Rough Order of Magnitude Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Mobilization	LPSM	1	10%	$669,598
Drainage Contingency (based on civil elements)	%	1	10%	$19,937.50
Erosion Control	%	1	1.5%	$100,440
Aggregate Base (section 0640)	TON	1,530	$30	$45,900
Asphalt Concrete Pavement (level 3 1/2" mix, section 0744)	TON	540	$115	$62,100
Barrier Railing	LF	950	$80	$76,000
Clearing & Grubbing	ACRE	0.2	$10,000	$2,000
Concrete Barrier	LF	0.0	$48	$0
Borrow	CY			$0
General Excavation	CY	535	$25	$13,375
Excavation (Rock Removal & Haul)	CY	0	58	$0
Excavation (Surface Rock Drill & Blast)	CY	0	144	$0
Bridge	SF	5,700	$500	$2,850,000
Mesh and Cable Net	SF	0	$9	$0
Retaining Walls	SF	0	$55	$0
Shelf Widening Option- High Range	LPSM	1	$3,646,600	$3,646,600
Shelf Widening Option- Low Range	LPSM	1	$2,312,649	$2,312,649
Excavation	CY	0	$420	$0
Ground Support/Lining	LF	0	$2,526	$0
Illumination	LF	0	$250	$0
		SUBTOTAL	**$6,151,999 - $7,485,950**	
ADDITIONAL ITEMS				
Design	%	1	30%	$2,245,785
Permitting	%	1	10%	$748,595
Construction Management	%	1	15%	$1,122,892
Contingencies	%	1	30%	$2,245,785
		SUBTOTAL	**$5,098,805 - $6,363,057**	
		OPTION TOTAL	**$11,250,804 - $13,849,007**	

Note – Scaling and mesh had the lowest estimated cost and a rock shelter had the highest estimated shelf widening cost for this option.

Table 6 – Alignment 2B, Shelf and Short Tunnel: Rough Order of Magnitude Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Mobilization	LPSM	1	10%	$793,403
Drainage Contingency (based on civil elements)	%	1	10%	$21,622.50
Erosion Control	%	1	1.5%	$119,010
Aggregate Base (section 0640)	TON	1,555	$30	$46,650
Asphalt Concrete Pavement (level 3 1/2" mix, section 0744)	TON	680	$115	$78,200
Barrier Railing	LF	950	$80	$76,000
Clearing & Grubbing	ACRE	0.2	$10,000	$2,000
Concrete Barrier	LF	0.0	$48	$0
Borrow	CY			$0
General Excavation	CY	535	$25	$13,375
Excavation (Rock Removal & Haul)	CY	0	58	$0
Excavation (Surface Rock Drill & Blast)	CY	0	144	$0
Bridge	SF	0	$500	$0
Mesh and Cable Net	SF	0	$9	$0
Retaining Walls	SF	0	$55	$0
Shelf Widening Option- High Range	LPSM	1	$3,646,600	$3,646,600
Shelf Widening Option- Low Range	LPSM	1	$2,312,649	$2,312,649
Excavation	CY	4,333	$480	$2,079,840
Ground Support/Lining	LF	380	$2,622	$996,360
Illumination	LF	380	$250	$95,000
			SUBTOTAL	**$7,534,109 - $8,868,060**
ADDITIONAL ITEMS				
Design	%	1	30%	$2,660,418
Permitting	%	1	10%	$886,806
Construction Management	%	1	15%	$1,330,209
Contingencies	%	1	30%	$2,660,418
			SUBTOTAL	**$6,273,599 - $7,537,851**
			OPTION TOTAL	**$13,807,709 - $16,405,912**

Note – Scaling and mesh had the lowest estimated cost and a rock shelter had the highest estimated shelf widening cost for this option.

Table 7 – Alignment 2C, Shelf and Intermediate Tunnel: Rough Order of Magnitude Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Mobilization	LPSM	1	10%	$892,597
Drainage Contingency (based on civil elements)	%	1	10%	$18,015
Erosion Control	%	1	1.5%	$133,890
Aggregate Base (section 0640)	TON	1,530	$30	$45,900
Asphalt Concrete Pavement (level 3 1/2" mix, section 0744)	TON	710	$115	$81,650
Barrier Railing	LF	470	$80	$37,600
Clearing & Grubbing	ACRE	0.2	$10,000	$2,000
Concrete Barrier	LF	0.0	$48	$0
Borrow	CY			$0
General Excavation	CY	520	$25	$13,000
Excavation (Rock Removal & Haul)	CY	0	58	$0
Excavation (Surface Rock Drill & Blast)	CY	0	144	$0
Bridge	SF	0	$500	$0
Mesh and Cable Net	SF	0	$9	$0
Retaining Walls	SF	0	$55	$0
Shelf Widening Option- High Range	LPSM	1	$2,157,268	$2,157,268
Shelf Widening Option- Low Range	LPSM	1	$1,465,668	$1,465,668
Excavation	CY	8,714	$420	$3,659,880
Ground Support/Lining	LF	825	$2,209	$1,822,425
Illumination	LF	825	$250	$206,250
		SUBTOTAL	**$9,278,875 - $9,970,475**	
ADDITIONAL ITEMS				
Design	%	1	30%	$2,991,142
Permitting	%	1	10%	$997,047
Construction Management	%	1	15%	$1,495,571
Contingencies	%	1	30%	$2,991,142
		SUBTOTAL	**$7,819,440 - $8,474,904**	
		OPTION TOTAL	**$17,098,315 - $18,445,379**	

Note – Scaling and mesh had the lowest estimated cost and a cantilevered decking had the highest estimated shelf widening cost for this option.

Table 8 – Alignment 3A, Overland: Rough Order of Magnitude Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Mobilization	LPSM	1	10%	$486,232
Drainage Contingency (based on civil elements)	%	1	10%	$191,432
Erosion Control	%	1	1.5%	$72,935
Aggregate Base (section 0640)	TON	7,033	$30	$210,990
Asphalt Concrete Pavement (level 3 1/2" mix, section 0744)	TON	2,942	$115	$338,330
Barrier Railing	LF	9,100	$80	$728,000
Clearing & Grubbing	ACRE	4.7	$10,000	$47,000
Concrete Barrier	LF	0.0	$48	$0
Borrow	CY			$0
General Excavation	CY	23,600	$25	$590,000
Excavation (Rock Removal & Haul)	CY	0	58	$0
Excavation (Surface Rock Drill & Blast)	CY	0	144	$0
Bridge	SF	0	$500	$0
Mesh and Cable Net	SF	0	$9	$0
Retaining Walls	SF	63,000	$55	$3,465,000
Shelf Widening Option- High Range	LPSM	1	$0	
Shelf Widening Option- Low Range	LPSM	1	$0	$0
Excavation	CY	0	$420	$0
Ground Support/Lining	LF	0	$2,526	$0
Illumination	LF	0	$250	$0
		SUBTOTAL	**$6,189,374**	
ADDITIONAL ITEMS				
Design	%	1	30%	$1,856,812
Permitting	%	1	10%	$618,937
Construction Management	%	1	15%	$928,406
Contingencies	%	1	30%	$1,856,812
		SUBTOTAL	**$5,260,968**	
		OPTION TOTAL	**$11,450,342**	

Table 9 – Alignment 3B, Overland w/Rock Cut: Rough Order of Magnitude Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Mobilization	LPSM	1	10%	$1,019,866
Drainage Contingency (based on civil elements)	%	1	10%	$146,216.50
Erosion Control	%	1	1.5%	$152,980
Aggregate Base (section 0640)	TON	6,086	$30	$182,580
Asphalt Concrete Pavement (level 3 1/2" mix, section 0744)	TON	2,549	$115	$293,135
Barrier Railing	LF	5,740	$80	$459,200
Clearing & Grubbing	ACRE	4.1	$10,000	$41,000
Concrete Barrier	LF	0.0	$48	$0
Borrow	CY			$0
General Excavation	CY	19,450	$25	$486,250
Excavation (Rock Removal & Haul)	CY	32,990	58	$1,896,925
Excavation (Surface Rock Drill & Blast)	CY	32,990	144	$4,742,313
Bridge	SF	0	$500	$0
Mesh and Cable Net	SF	0	$9	$0
Retaining Walls	SF	46,000	$55	$2,530,000
Shelf Widening Option- High Range	LPSM	1	$0	
Shelf Widening Option- Low Range	LPSM	1	$0	$0
Excavation	CY	0	$420	$0
Ground Support/Lining	LF	0	$2,526	$0
Illumination	LF	0	$250	$0
		SUBTOTAL	**$12,000,230**	
ADDITIONAL ITEMS				
Design	%	1	30%	$3,600,069
Permitting	%	1	10%	$1,200,023
Construction Management	%	1	15%	$1,800,035
Contingencies	%	1	30%	$3,600,069
		SUBTOTAL	**$10,200,196**	
		OPTION TOTAL	**$22,200,426**	

Table 10 – Alignment 4, I-84 Adjacent: Rough Order of Magnitude Cost Estimate

ITEM DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL COST
Mobilization	LPSM	1	10%	$396,944
Drainage Contingency (based on civil elements)	%	1	10%	$103,000
Erosion Control	%	1	1.5%	$59,542
Aggregate Base (section 0640)	TON	3,090	$30	$92,700
Asphalt Concrete Pavement (level 3 1/2" mix, section 0744)	TON	1,270	$115	$146,050
Barrier Railing	LF	4,690	$80	$375,200
Clearing & Grubbing	ACRE	0.5	$10,000	$5,000
Concrete Barrier	LF	2,100	$48	$100,800
Borrow	CY	8,700	$10	$87,000
General Excavation	CY	8,930	$25	$223,250
Excavation (Rock Removal & Haul)	CY	0	58	$0
Excavation (Surface Rock Drill & Blast)	CY	0	144	$0
Bridge	SF	0	$500	$0
Mesh and Cable Net	SF	326,604	$9	$2,939,436
Retaining Walls	SF	0	$55	$0
Shelf Widening Option- High Range	LPSM	1	$0	
Shelf Widening Option- Low Range	LPSM	1	$0	$0
Excavation	CY	0	$420	$0
Ground Support/Lining	LF	0	$2,526	$0
Illumination	LF	0	$250	$0
		SUBTOTAL	**$4,528,921**	
ADDITIONAL ITEMS				
Design	%	1	30%	$1,358,676
Permitting	%	1	10%	$452,892
Construction Management	%	1	15%	$679,338
Contingencies	%	1	30%	$1,358,676
		SUBTOTAL	**$3,849,583**	
		OPTION TOTAL	**$8,378,504**	

7. RISK ASSESSMENT

Parsons Brinckerhoff conducted a risk assessment for each of the options. The assessment was conducted by brainstorming among project participants possessing geotechnical, tunneling, structural, roadway, environmental, and blasting expertise. The resulting risks (or opportunities) are described in the accompanying risk register (Table 11), along with their potential impacts to the project. Each risk (or opportunity) is also categorized as to its phase (design, construction, or cost) and category or discipline (engineering, environmental, safety, etc.). The color-coded "Pre-Mitigation" assessment indicates the teams' collective view of the severity of each risk. The accompanying key relates the color (or score) of the assessment with the expected outcome if left in the unmitigated state. The response column provides the recommended disposition for each risk. The risk registry can be used to inform contingency decisions, and as a starting point for subsequent risk evaluations during the project development process. The threats rated moderate to high – those that pose the greatest risk to a successful project, are summarized below.

Aesthetics (Risks 1, 2, and 3). These are risks associated with obtaining approvals and cost certainty in delivering a visually-compliant connection at Mitchell Point. Options 1, 2A, 3A, and 3B are most-vulnerable to aesthetic related risks because of their extensive visibility, either by users or by distant viewers. Aesthetic risks are best managed by early development and socialization of key visual features such as tunnel portals, bridge profiles, wall facing, etc.

Rockfall Safety (Risks 1, 8, and 17). These are safety-related risks that arise from a trail system built within a known rockfall area. Among the options studied, 2A, 2B, 2C, and 4 possess the greatest risk to rockfall incidents. Mitigation to these risks would likely require some combination of slope protection (scaling and pinned netting) and rockfall shed (concrete shed with integral energy absorption and fence).

Rockfall Maintenance (Risk 21). Any rockfall mitigation requires maintenance, and there is a safety element involved. The options reliant on rockfall netting are most vulnerable to additional maintenance life cycle cost because it will require workers suspended the cliff face. Option 4 would conceivably have the greatest exposure to this risk (because it involves the most netting), but Options 2A, 2B, and 2C would also be affected by this risk. Mitigation could be addressed by implementing a more conservative design, or developing a site-specific maintenance plan that includes more frequent inspections.

Faults (Risks 4 and 15). Unknown faults pose significant risk to tunneling because they are often associated with poor ground conditions that can adversely affect construction cost and schedule. This is mostly associated with Option 2B, but is also relevant to the other tunneling options (1 and 2C). Mitigation is best achieved by conducting a thorough geotechnical investigation, which would include geologic mapping and selected horizontal borings in an attempt to detect the presence of unknown faults.

Difficult Construction Access (Risk 14). Sites not readily accessible to construction are exposed to cost and schedule risk because they require non-routine means and methods. This is mostly associated with Options 3A and 3B, which are the farthest removed from access roads, and where the footprint for construction will be much greater than that of the final connection. Effective mitigation of this risk would involve detailed staging plans and constructability review in order to adequately capture the construction scope.

Construction Adjacent to Freeway (Risks 16 and 17). Safety and mobility are both vulnerable to construction adjacent to I-84 from equipment and material movement and blasting operations. Options 2A, 2B, 2C, and 4 have the greatest exposure to I-84 and are thus most susceptible to these risks. Mitigation is best implemented by detailed staging plans, controlled blasting, and traffic control plans.

Table 11 – Mitchell Point Feasibility & Cost Study Risk Register

Options Legend:
- 1 – Tunnel
- 2A - Shelf & Bridge
- 2B - Shelf & Short Tunnel
- 2C - Shelf & Intermediate Tunnel
- 3A - Overland
- 3B – Overland w/Rock Cut
- 4 - I-84 Adjacent

	Opportunity						Threat				
	High	Moderate	Low	Very Low	Extreme Low	No Impact	Extreme Low	Very Low	Low	Moderate	High
Score	-5	-4	-3	-2	-1	0	1	2	3	4	5
Likelihood	> 60%	> 40%	> 20%	> 10%	<= 10%		<= 10%	> 10%	> 20%	> 40%	> 60%
Cost	> $1 M	> $500 K	> $250 K	> $100 K	<= $100 K		<= $100 K	> $100 K	> $250 K	> $500 K	> $1 M
Schedule	Major savings in critical activities	Minor savings in critical activities	Major savings in non-critical activities	Minor savings in non-critical activities	Minimal schedule savings		Minimal schedule impact	Minor delay in non-critical activities	Major delay in non-critical activities	Minor delay in critical activities	Major delay in critical activities

Risk Identification					Pre-Mitigation Assessment – Option / Risk Level							Risk Treatment		Notes
Risk ID	Phase	Category/ Discipline	Description	Impact	1	2A	2B	2C	3A	3B	4	Primary Response Type	Response Action	Comments
1	Design	Bridge Design	Rockfall protection of bridge structure would need to be unique to blend in to structure	Significant cost	0	4	0	0	0	0	0	Accept	• Investigate a number of design options to determine the least cost and least visual impact option.	Could have a significant cost to project.
2	Design	Environmental	Aesthetic requirements for infrastructure within a national scenic area (from user perspective / trail experience)	Additional design cost, additional construction cost, delayed project approvals	4	4	2	3	2	3	2	Mitigate	• Address early in design in order to limit impact to the permitting process. • Address tunnel lining, bridge structure, rock fall protection.	Tunnel structure would have the greatest impact to user perceptions of aesthetics due to length and lack of lighting.
3	Design	Environmental	Aesthetic requirements for infrastructure within a national scenic area from key viewing areas, I-84, Columbia River users and Washington side.	Additional design cost, additional construction cost, delayed project approvals	0	4	3	3	4	4	1	Mitigate	• Address early in design in order to limit impact to the permitting process. • Address public engagement comments	Bridge structure of 2A would be most visible from outside the trail, would have greatest need for possible mitigation.
4	Design	Geotechnical Design	Encountering fault during geotechnical investigation would have impact on design for windows (reinforcement, relocation, elimination) and the tunnel portion of Option 2B	Increased construction cost, modification of design	3	0	4	3	0	0	0	Mitigate	• Design geotechnical investigation such that fault is well understood in advance of construction.	Fault could have greatest impact on the short tunnel design given the location of the fault.
5	Design	Geotechnical Design	Trail stability concerns associated with options 3a and 3b	Cost for reinforced slopes (geotextile, other measures)	0	0	0	0	4	4	0	Mitigate	• Design will likely utilize extensive number of walls along trail. • Utilize reinforced slopes to maintain trail stability.	There is a high level of concern given the surface ground conditions and potential for erosion.
6	Design	Geotechnical Design	Slope/ grade issues associated with the cut/saddle in Option 3B	Additional cut volume	0	0	0	0	0	3	0	Mitigate	• Assume that additional cut volume will be required to maintain stability and grade.	
7	Design	Geotechnical Design	Additional costs associated with geotechnical investigation program due to remote location of critical drilling sites	Cost for drilling in exploration program	0	0	0	0	0	3	0	Mitigate	• Determine reasonableness of investigation program for option 3B before advancing the design to the point of needing geotechnical data.	It would be very challenging and possibly cost prohibitive to get a drill rig to the top of the cut/saddle to complete investigation.
8	Design	Post-Construction Safety and Maintenance	Rock fall hazards to trail users post-construction	Rock fall risk to public, trail users	2	4	4	4	1	3	5	Mitigate	• Plan for rock fall protection, potentially a structure on the ledge or rock face screening/draping/netting	Users would have highest level of exposure at the base of the rock face in Option 4

Table 11 – Mitchell Point Feasibility & Cost Study Risk Register (cont.)

Options Legend:
1 – Tunnel
2A - Shelf & Bridge
2B - Shelf & Short Tunnel
2C - Shelf & Intermediate Tunnel
3A - Overland
3B – Overland w/Rock Cut
4 - I-84 Adjacent

	Opportunity					No Impact	Threat				
	High	Moderate	Low	Very Low	Extreme Low		Extreme Low	Very Low	Low	Moderate	High
Score	-5	-4	-3	-2	-1	0	1	2	3	4	5
Likelihood	> 60%	> 40%	> 20%	> 10%	<= 10%		<= 10%	> 10%	> 20%	> 40%	> 60%
Cost	> $1 M	> $500 K	> $250 K	> $100 K	<= $100 K		<= $100 K	> $100 K	> $250 K	> $500 K	> $1 M
Schedule	Major savings in critical activities	Minor savings in critical activities	Major savings in non-critical activities	Minor savings in non-critical activities	Minimal schedule savings		Minimal schedule impact	Minor delay in non-critical activities	Major delay in non-critical activities	Minor delay in critical activities	Major delay in critical activities

Risk Identification					Pre-Mitigation Assessment: Option / Risk Level							Risk Treatment		Notes
Risk ID	Phase	Category/ Discipline	Description	Impact	1	2A	2B	2C	3A	3B	4	Primary Response Type	Response Action	Comments
9	Design	Roadway Design	Adequacy of the ledge width to accommodate the trail width	Blasting/trimming of the face adjacent to the ledge would be required or would require a cantilevered structure	0	3	3	2	0	0	0	Avoid	• Determine the width required on the ledge and investigate if the width can be accommodated through minor removal of rock at the base of the rock face.	
10	Design	Roadway Design	Reduction of required grade maximum would result in possible saved cost at switchbacks	Opportunity to save on construction costs.	0	0	0	0	-3	-3	0	Facilitate	• Determine if this would have a significant adverse impact to the trail's usability and revise accordingly.	This is an opportunity to save costs at the switchbacks by raising the maximum allowable grade from 5% to a greater (steeper) grade.
11	Design	Tunneling Design	Public desire for internal tunnel lighting	Cost of lighting system and connection to utilities	3	0	1	2	0	0	0	Mitigate	• Identify whether the need for lighting exists and determine cost impact.	Would likely be a factor on long tunnel portions only and primarily in curved sections where windows are not possible.
12	Cost	Procurement	General procurement risk / market conditions / attracting sufficient number of bidders	Possibility for increased cost due to decreased competition	1	0	2	2	0	0	0	Mitigate	• Early outreach to contracting community to engage interest	Shorter sections of tunnel would prove the most challenging at attracting interest from contractors.
13	Construction	Construction Cost	Tunneling risks associated with overbreak	Additional muck disposal, additional shotcrete quantities, rock reinforcement	2	0	1	2	0	0	0	Mitigate	• Blasting plan should address.	Overbreak risk will likely be well controlled based on current understanding of ground conditions.
14	Construction	Construction Cost	Difficult construction access due to remote location of portions of the planned trail	Temporary access roads / difficult hauling of materials and excavation	0	0	0	0	4	4	0	Mitigate	• Determine conceptual construction operations early in design to determine feasibility of option 3A and 3B.	Steep slopes, number of switchbacks, difficulty in delivering and removing material could make these options challenging.
15	Construction	Construction Cost	Encountering differing site conditions during construction (conditions not discovered during geotechnical investigation)	Shorter rounds of blasting, additional reinforcement and support for better control of excavation	4	0	3	3	0	2	0	Mitigate	• Establish thorough geotechnical investigation program.	Minor changes in ground conditions from base assumptions can be accommodated by changes to construction techniques. More significant diversions from assumptions could lead to significant design changes.

Table 11 – Mitchell Point Feasibility & Cost Study Risk Register (cont.)

Options Legend:
1 – Tunnel
2A - Shelf & Bridge
2B - Shelf & Short Tunnel
2C - Shelf & Intermediate Tunnel
3A - Overland
3B – Overland w/Rock Cut
4 - I-84 Adjacent

	Opportunity						Threat				
	High	Moderate	Low	Very Low	Extreme Low	No Impact	Extreme Low	Very Low	Low	Moderate	High
Score	-5	-4	-3	-2	-1	0	1	2	3	4	5
Likelihood	> 60%	> 40%	> 20%	> 10%	<= 10%		<= 10%	> 10%	> 20%	> 40%	> 60%
Cost	> $1 M	> $500 K	> $250 K	> $100 K	<= $100 K		<= $100 K	> $100 K	> $250 K	> $500 K	> $1 M
Schedule	Major savings in critical activities	Minor savings in critical activities	Major savings in non-critical activities	Minor savings in non-critical activities	Minimal schedule savings		Minimal schedule impact	Minor delay in non-critical activities	Major delay in non-critical activities	Minor delay in critical activities	Major delay in critical activities

Risk Identification					Pre-Mitigation Assessment: Option / Risk Level							Risk Treatment		Notes
Risk ID	Phase	Category/ Discipline	Description	Impact	1	2A	2B	2C	3A	3B	4	Primary Response Type	Response Action	Comments
16	Construction	Construction Safety	Work adjacent to an existing interstate freeway	Delays to traffic, more difficult construction with limited access (haul routes), safety concerns for workers	3	4	3	3	1	1	5	Mitigate	• Contractor to establish detailed working plans especially when in close proximity to the interstate or where construction operations would have a possible significant impact.	Impacts to traffic would be greatest in Option 4 where immediately adjacent to the roadway. The bridge structure of Option 2A would likely need some access from down below where impacts to traffic would be difficult to avoid.
17	Construction	Construction Safety	Rock fall hazards during construction (excluding blasting activity, covered elsewhere)	Safety risk to public, workers, trail users	2	4	4	4	1	1	5	Mitigate	• Pre-construction and periodic ongoing scaling required of contractor	Risk is greatest where construction crews would be exposed next to rock face (tunnel portals, ledges, rock faces).
18	Construction	Construction Safety	Tunneling risks associated with construction – fly rock; blasting-induced rock falls (tunnel portals and adits/windows)	Safety risk to public, workers. Stability of designed slopes. Extended interstate closure	3	2	3	3	2	2	0	Mitigate	• Require contractor plans for all blasting activities to be reviewed and approved.	This should be properly addressed by thorough contractor plans, but the risk remains high to the possibility for significant impact if not properly mitigated.
19	Construction	Environmental	Potential construction restrictions due to endangered species / peregrine falcon / salmon	Delays to construction due to limited windows of particular construction, restoration planting	1	1	1	1	2	2	0	Mitigate	• Establish no-work windows for tree removal and blasting activities if deemed necessary through the environmental process. • Reach out to resources agencies (NMFS, USFWS, ODFW) early for preliminary effects analysis on ESA species due to blasting.	These impacts can likely be worked around through construction scheduling without major impact to the critical path of the construction schedule.
20	Design	Archaeological	Archaeological survey fails to uncover cultural artifacts which are uncovered during construction	Delays to construction while cultural resources are handled or worked around	0	0	0	0	2	2	0	Mitigate	• Perform archaeological screenings.	Typically the rock face is not a place for cultural discoveries, though the peak is a possible location.
21	Maintenance	Post-Construction Safety and Maintenance	Periodic maintenance of rockfall protection system will be required. Access will be difficult and potentially dangerous for any protection system used.	Reduced functional life of the protection system if maintenance is not performed. Public and worker safety compromised if maintenance not properly carried out.	1	3	3	3	0	2	4	Mitigate	• Account for maintenance costs in analysis of rockfall protection systems during design. • Develop site-specific inspection and maintenance procedures	

8. RECOMMENDED NEXT STEPS

The following items should be considered among the next steps for the development of options at Mitchell Point:

- Refinement or prioritization of options based on agency evaluation and public input
- LIDAR survey to better define the geometry of the rock face. This would allow for detailed rockfall hazard evaluations and a refined estimate of mitigation measures such as mesh and cable net slope protection and shelf excavation needed to accommodate rockfall protection structures
- Geotechnical investigation to confirm soil and rock conditions. Of particular interest is confirmation of faults, interflows, and other geologic structures along tunnel alignments as well as thickness and nature of talus overburden along overland alignments
- Environmental surveys to confirm biological and cultural resources within the project area

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Unattributed 2 1915. I. N. Day Answers Highway Critics, 1915.

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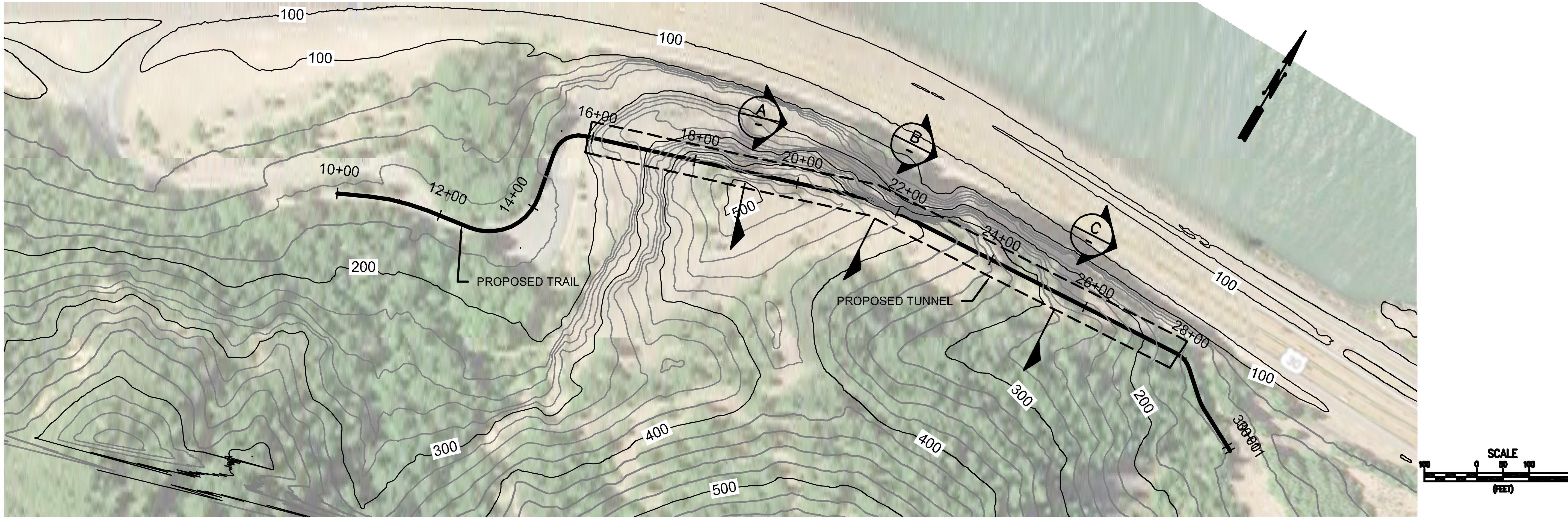
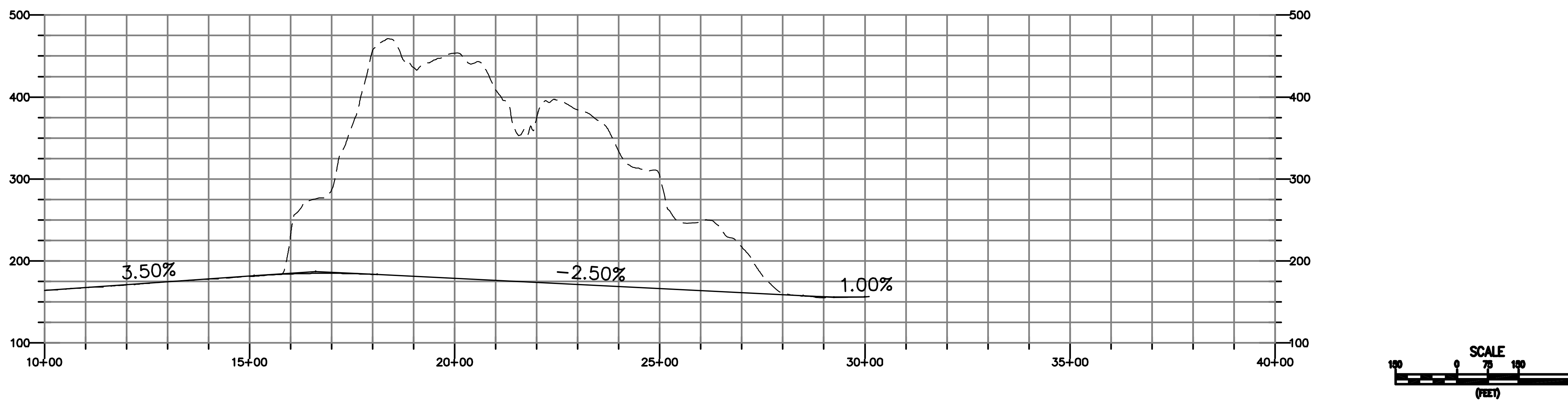
10. CONCEPTUAL ALIGNMENT DRAWINGS





HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

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OPTION 1
PLAN & PROFILE

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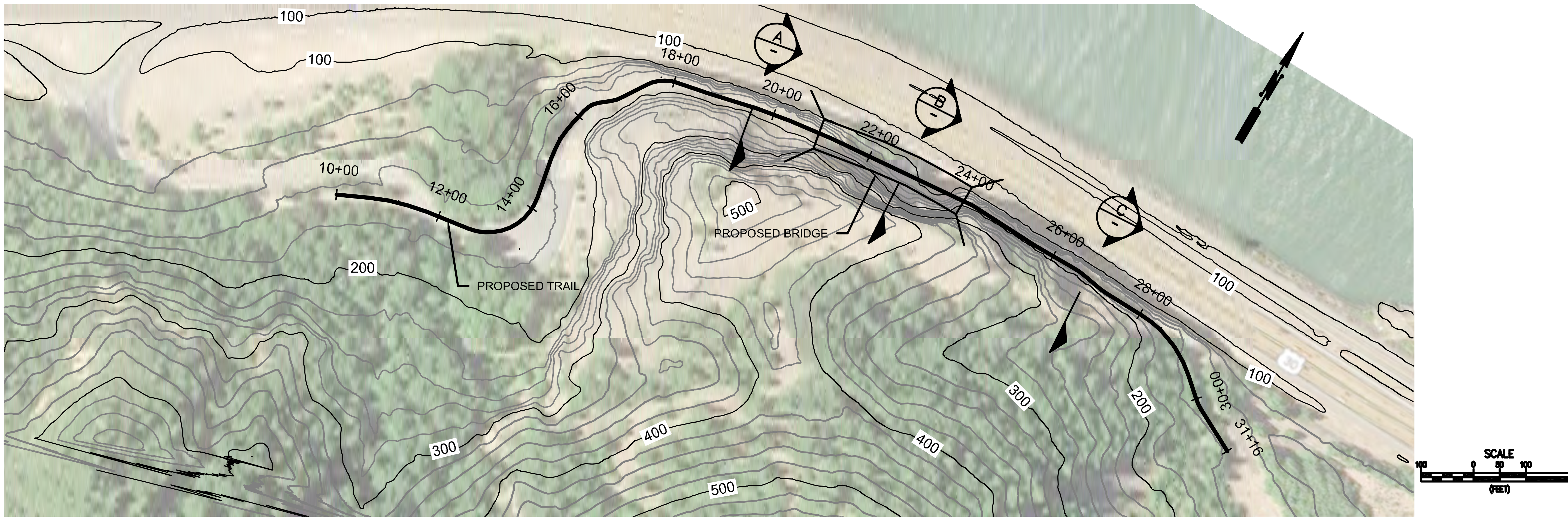

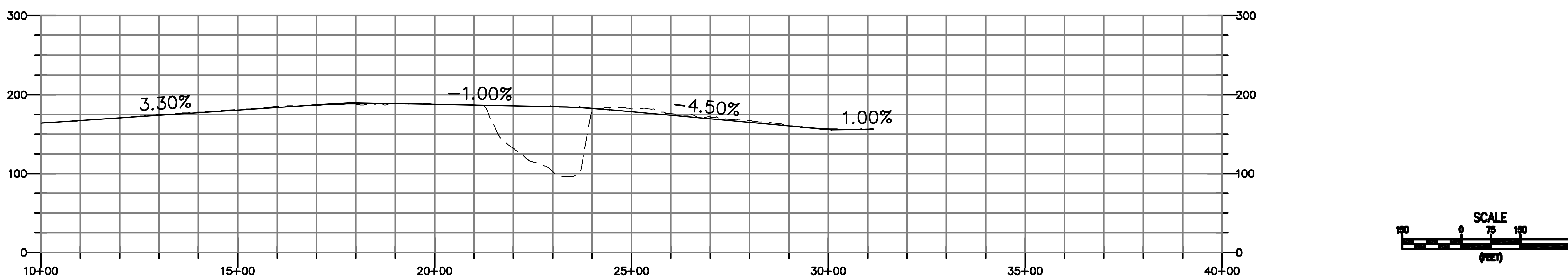

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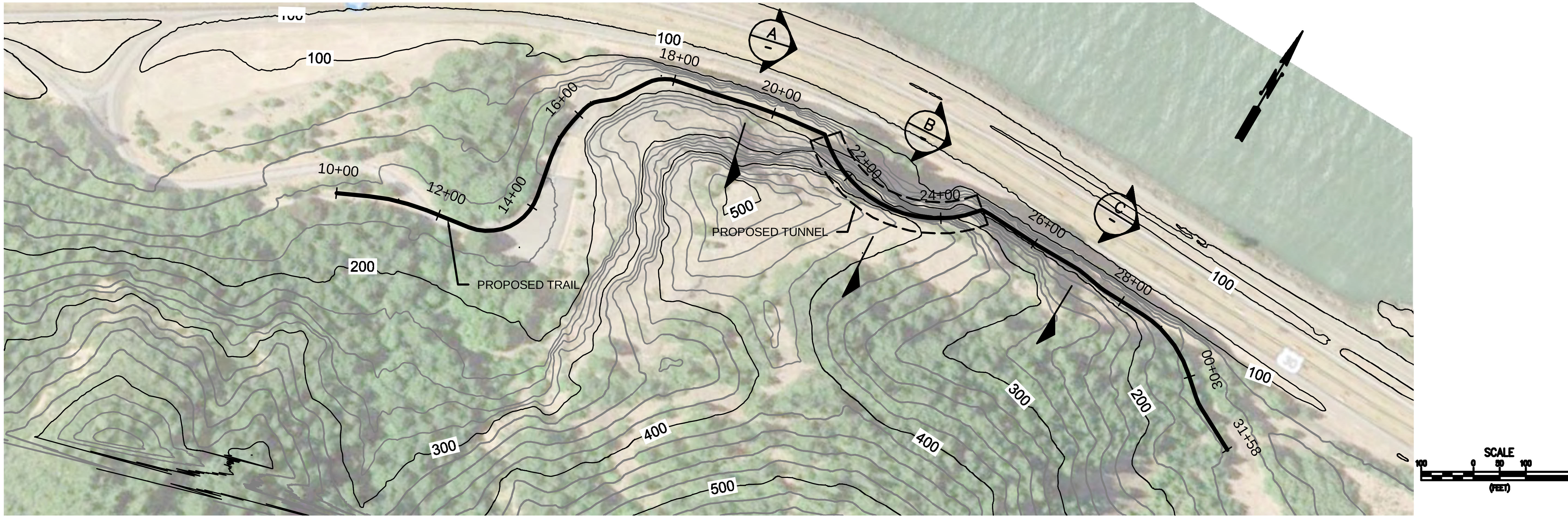
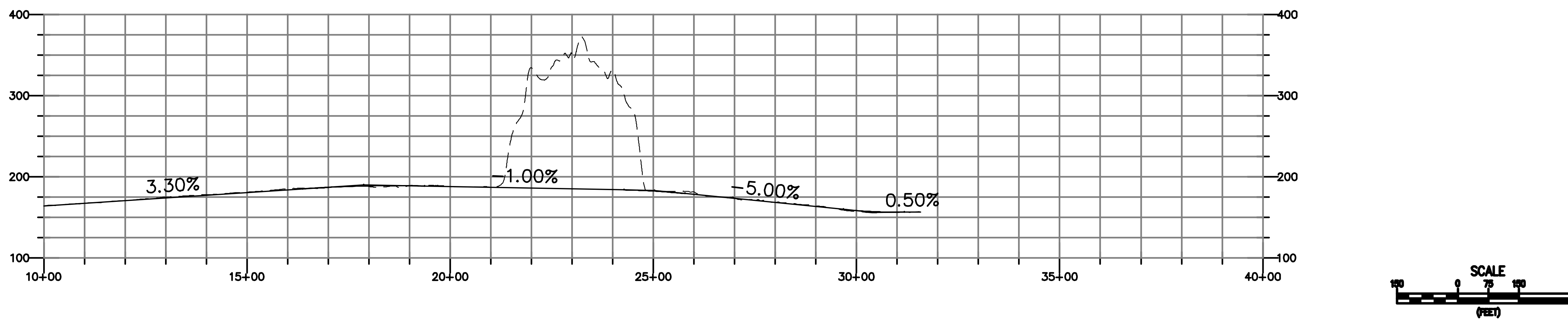
OPTION 2A
PLAN & PROFILE





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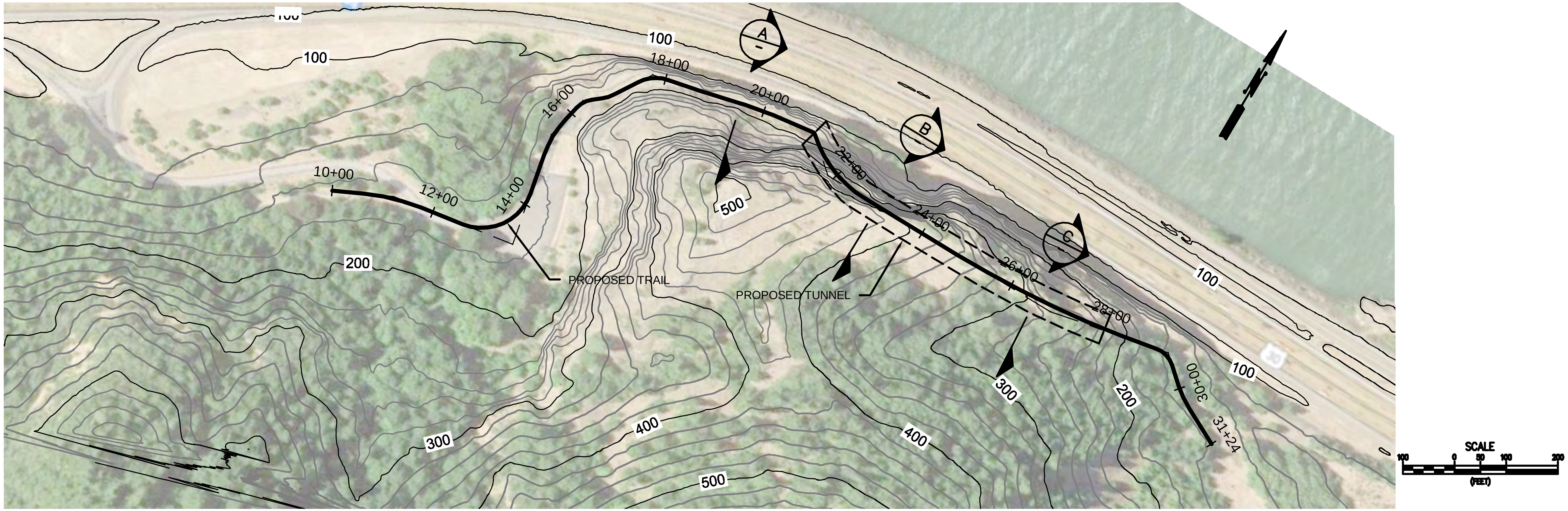
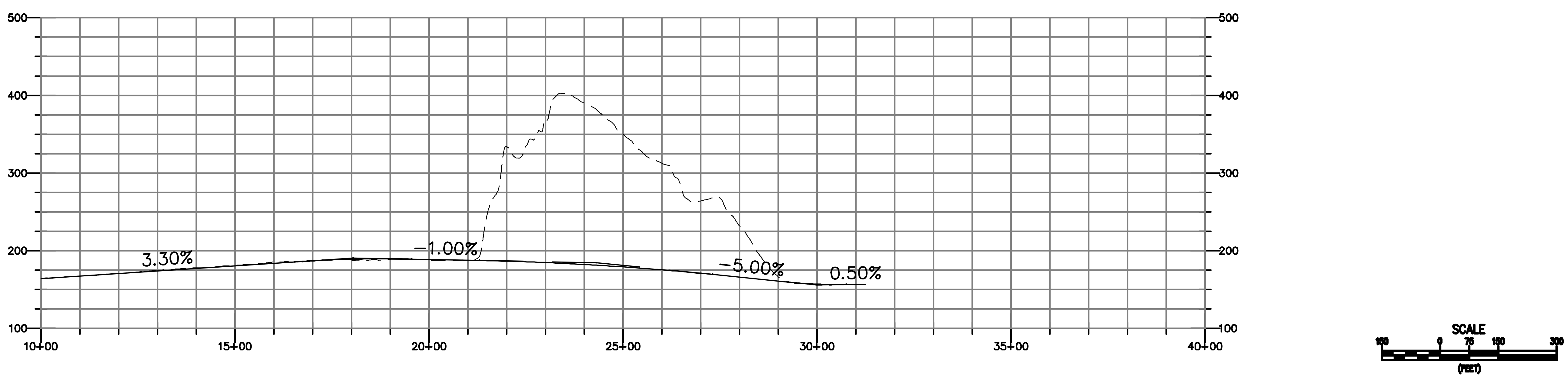
OPTION 2B
PLAN & PROFILE





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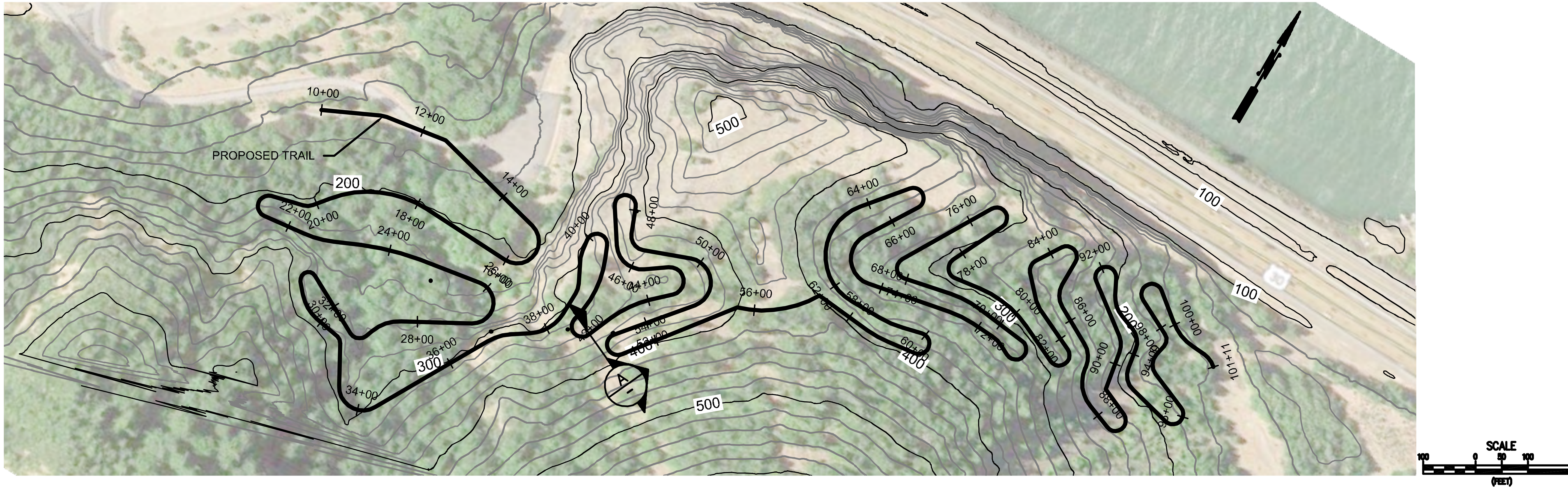
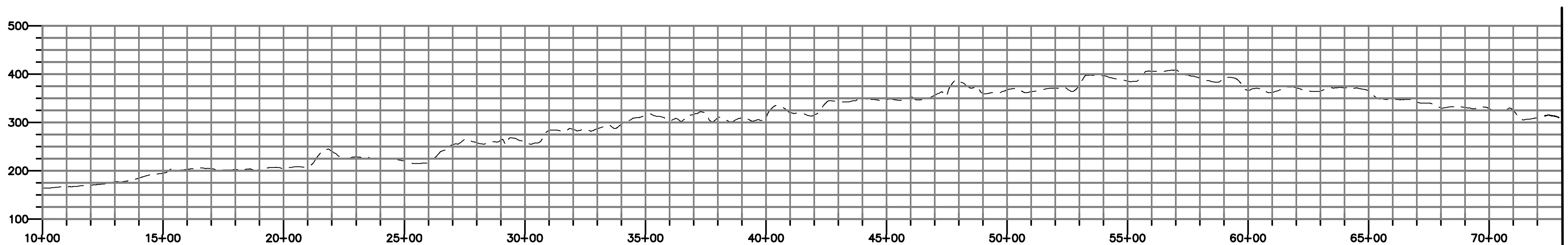
OPTION 2C
PLAN & PROFILE





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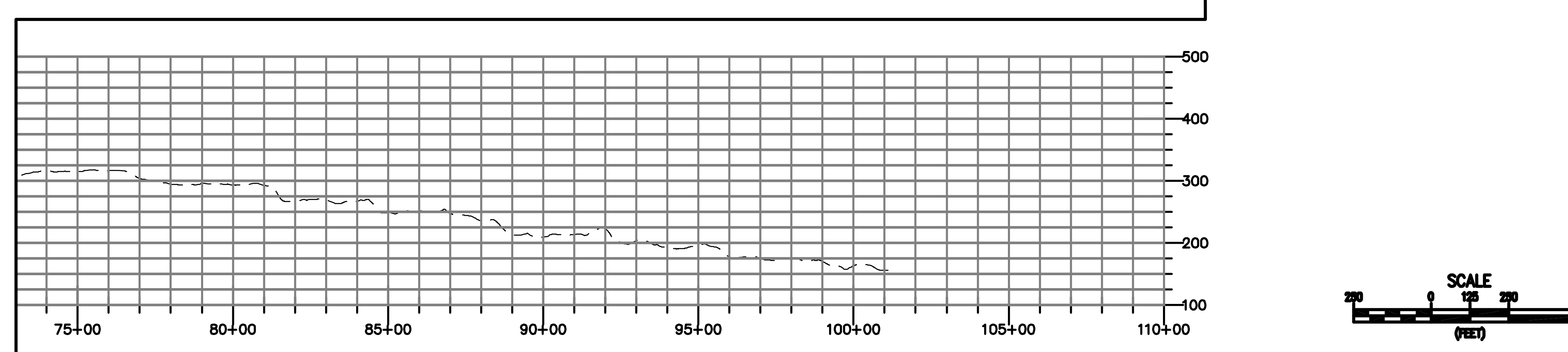

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OPTION 3A
PLAN & PROFILE

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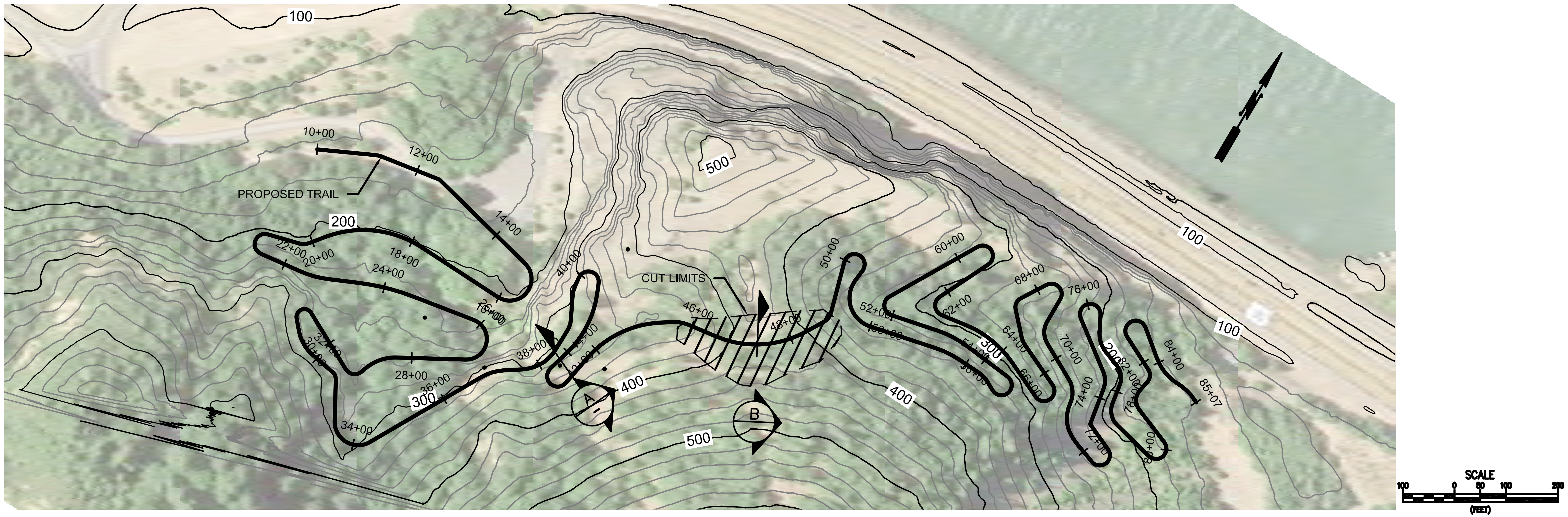

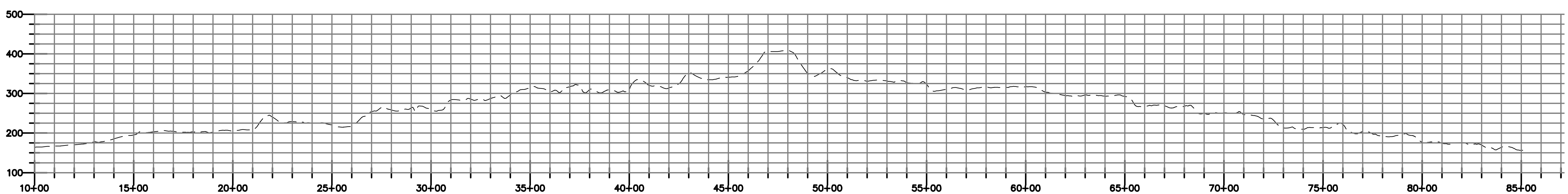

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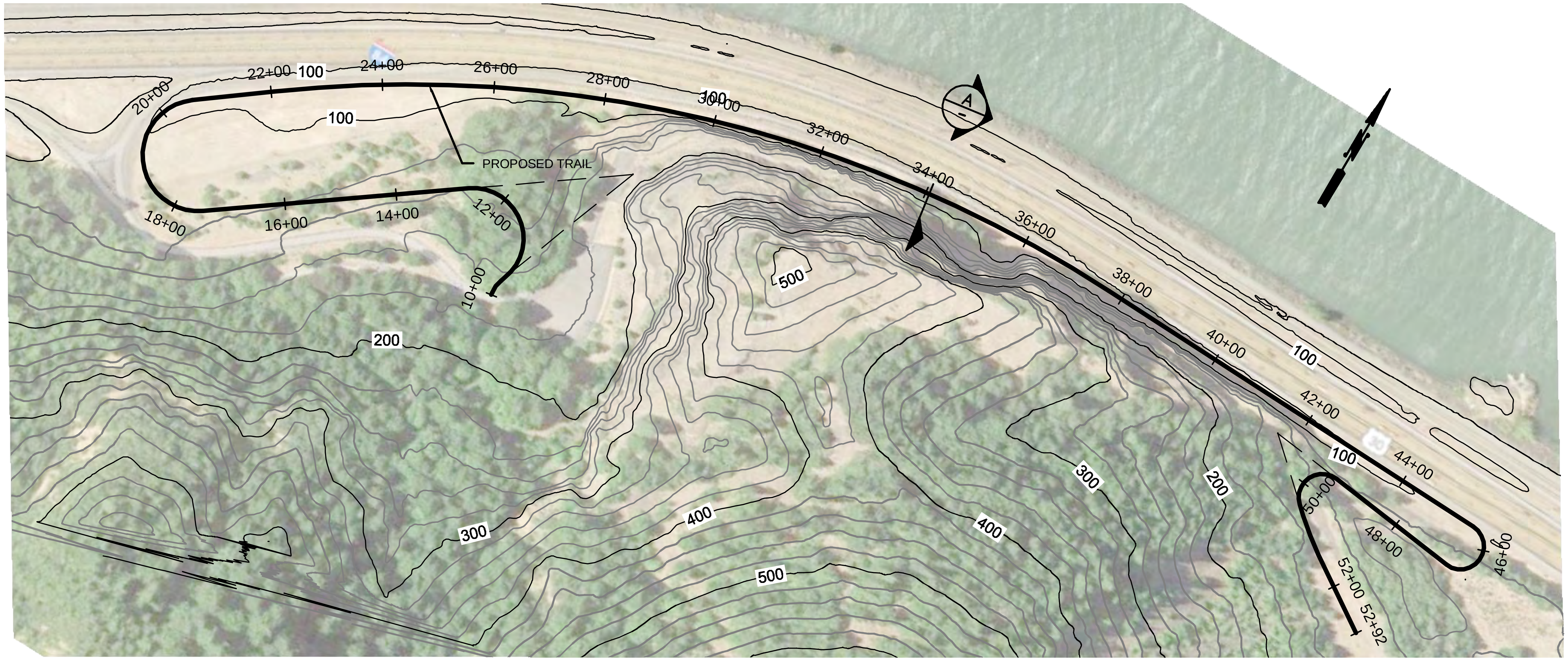
OPTION 3B
PLAN & PROFILE



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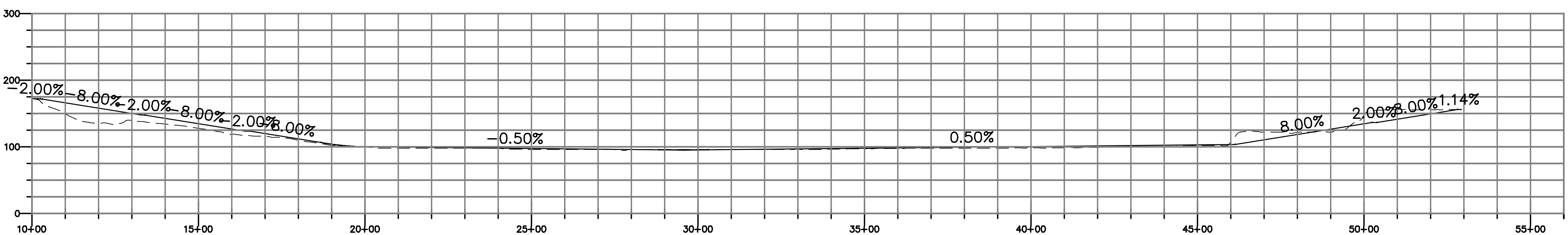

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MITCHELL POINT FEASIBILITY AND COST STUDY

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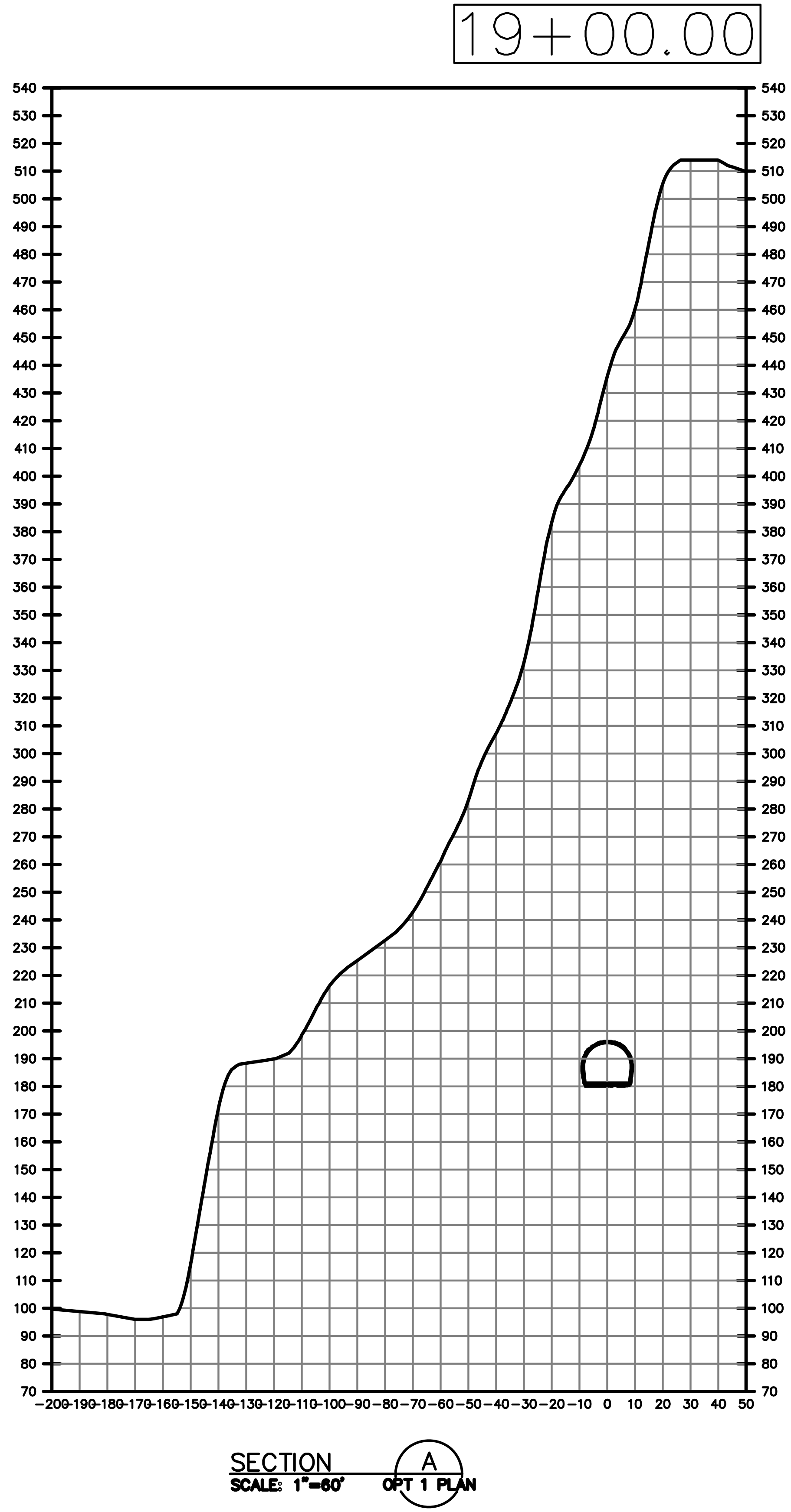
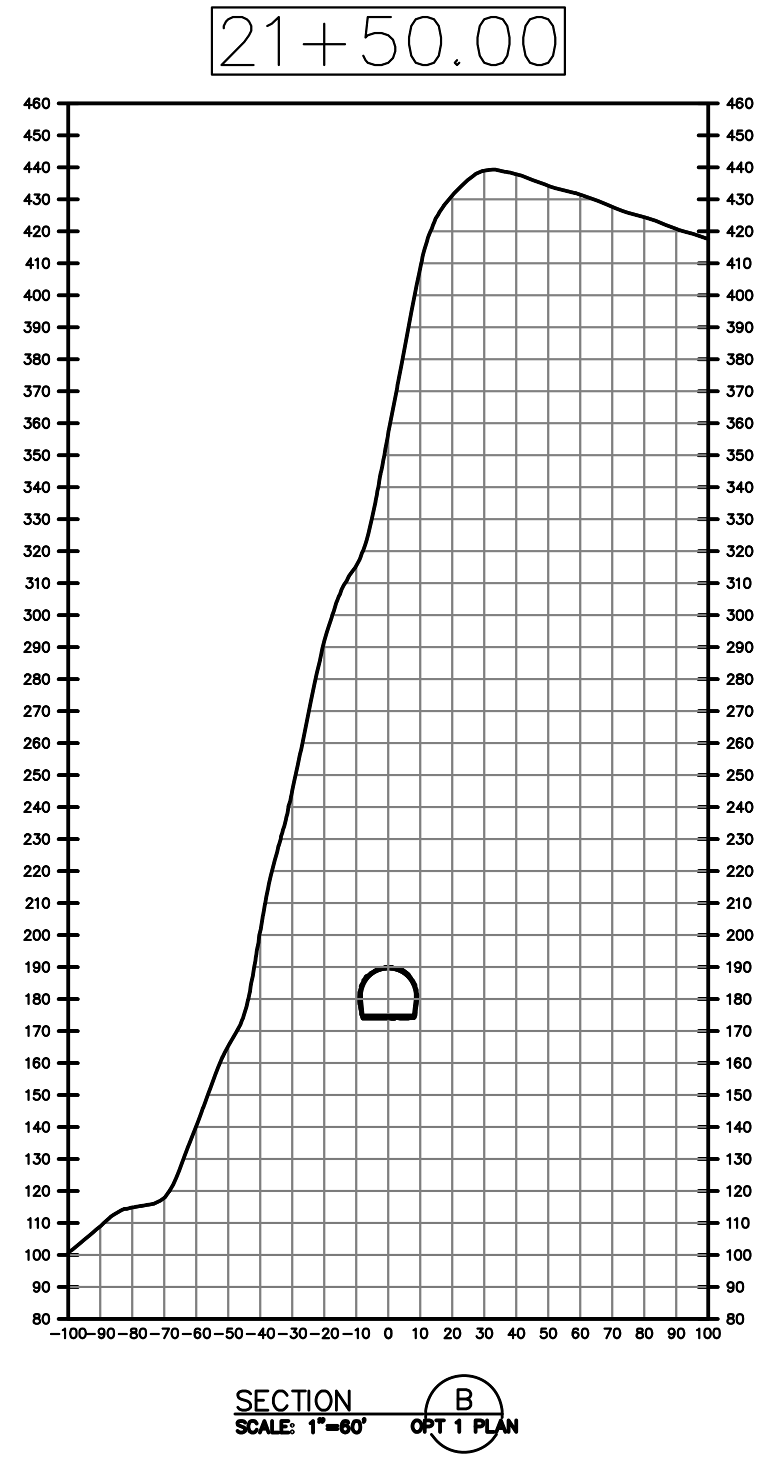
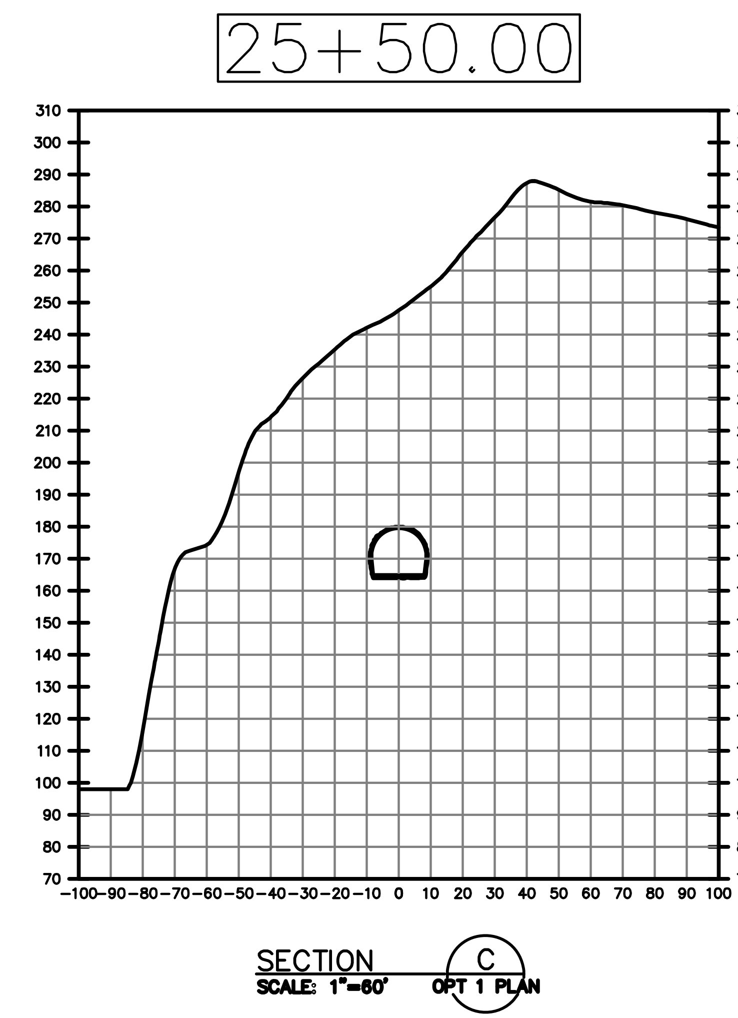
OPTION 4
PLAN & PROFILE







HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

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OPTION 1
SECTIONS

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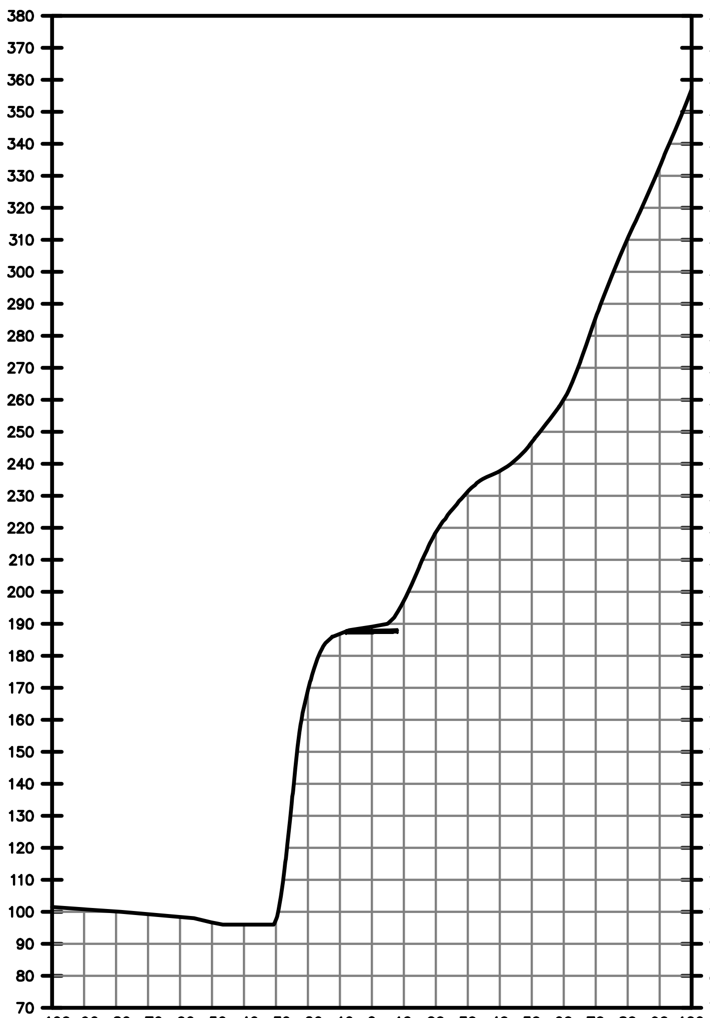

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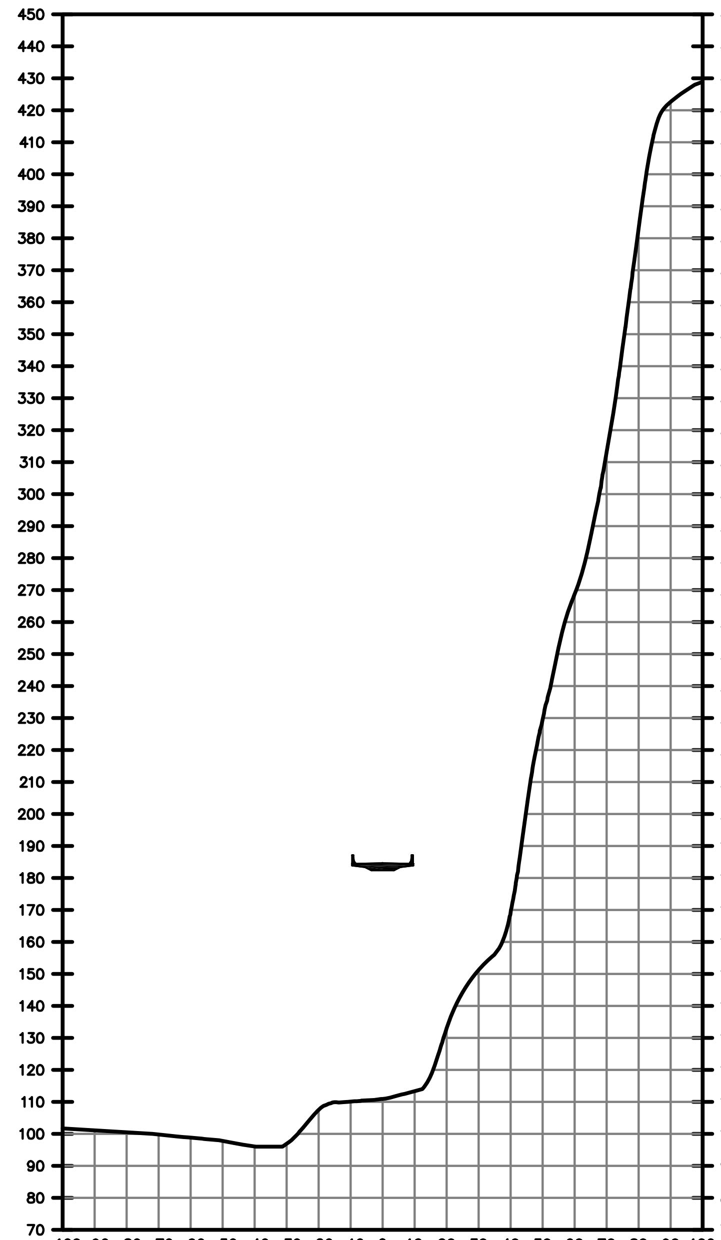

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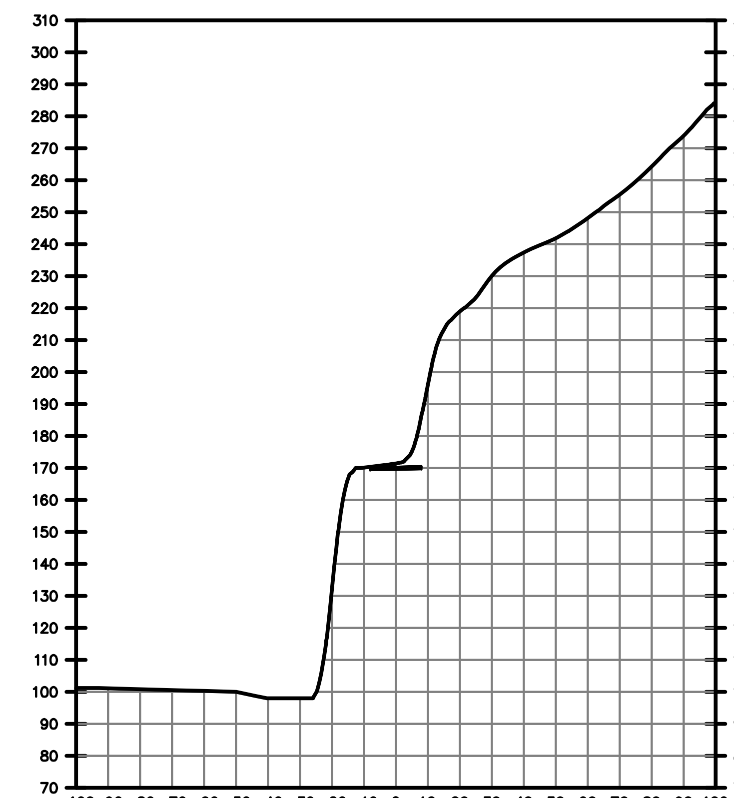

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SECTION (B)
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SECTION (C)
SCALE: 1"=60' OPT 2A PLAN

HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

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OPTION 2A
SECTIONS

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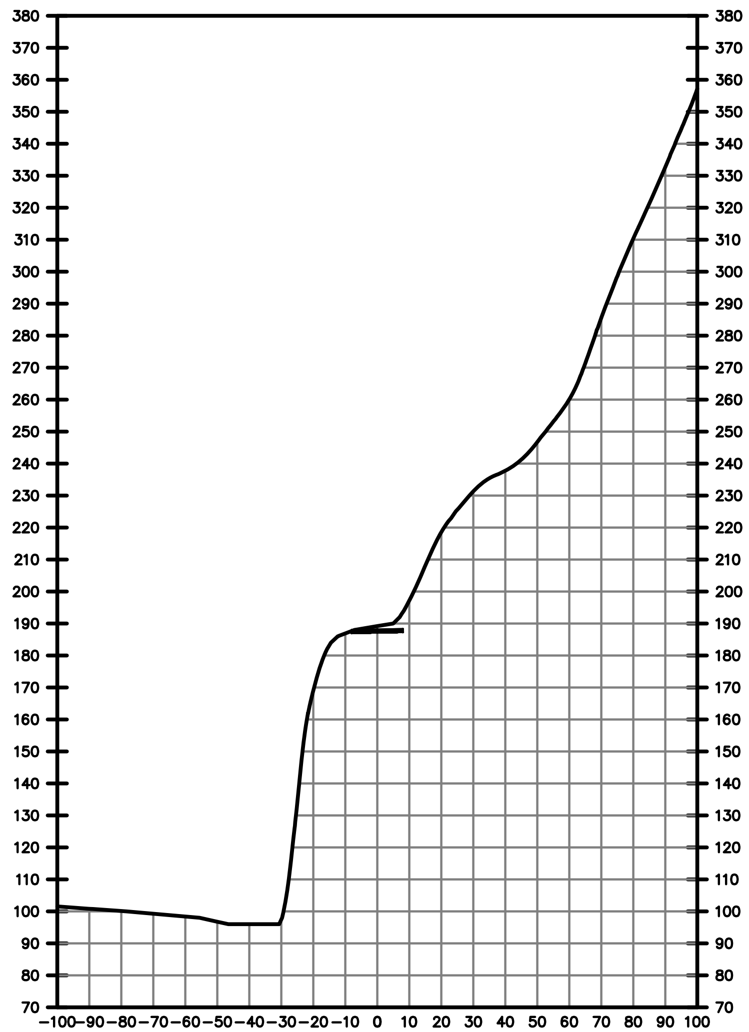

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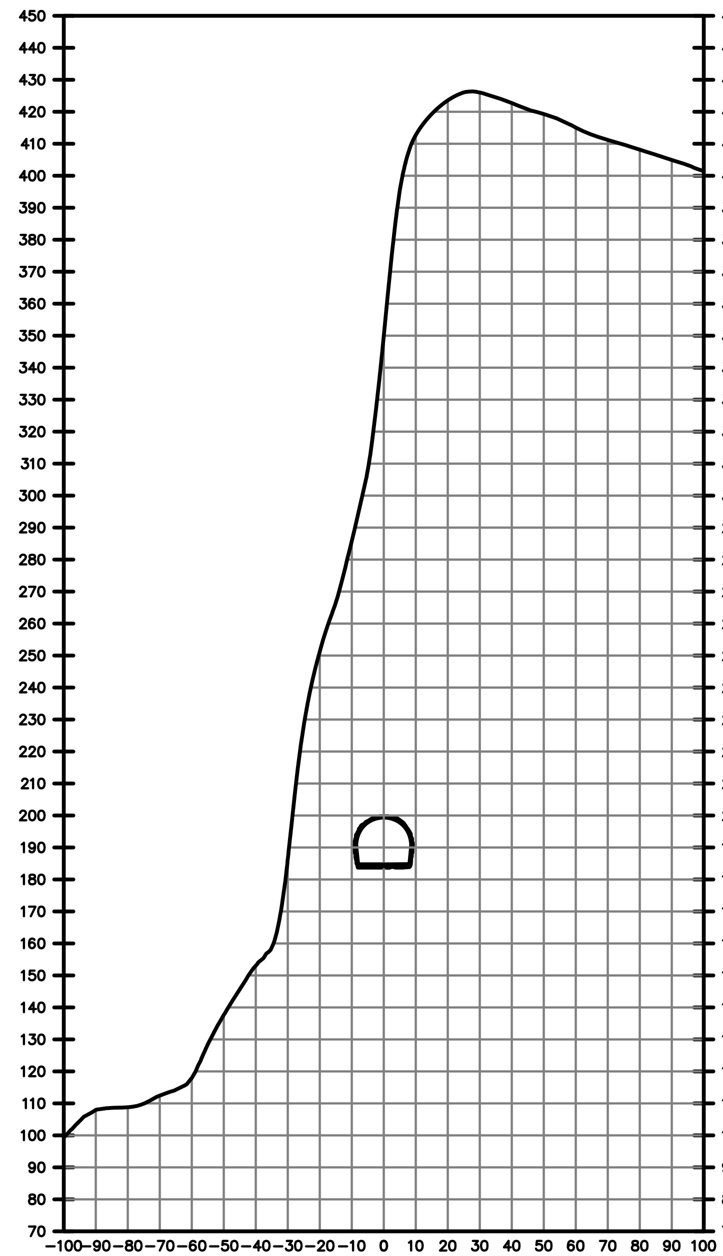

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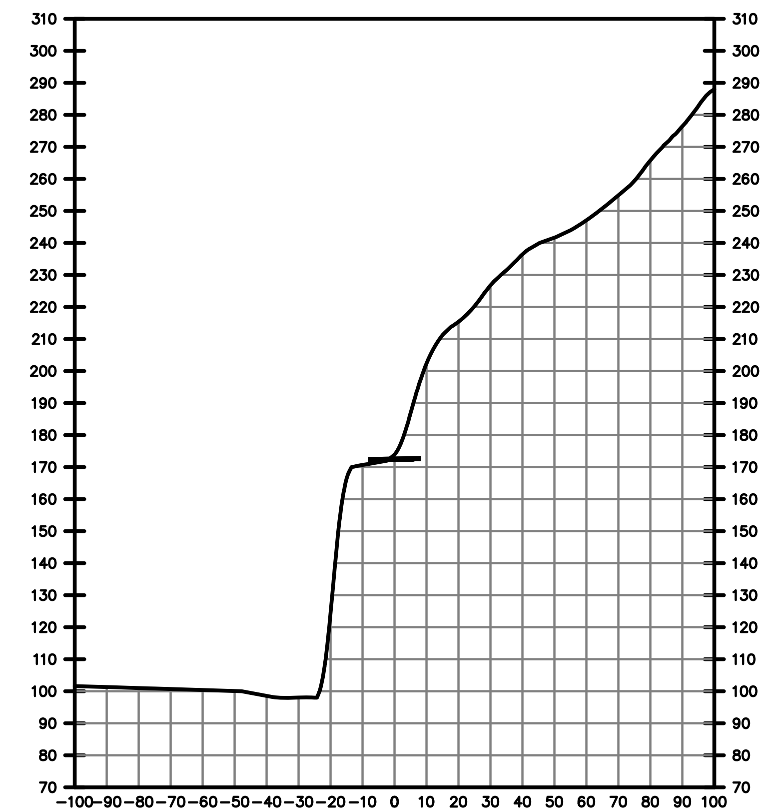

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HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

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OPTION 2B SECTIONS

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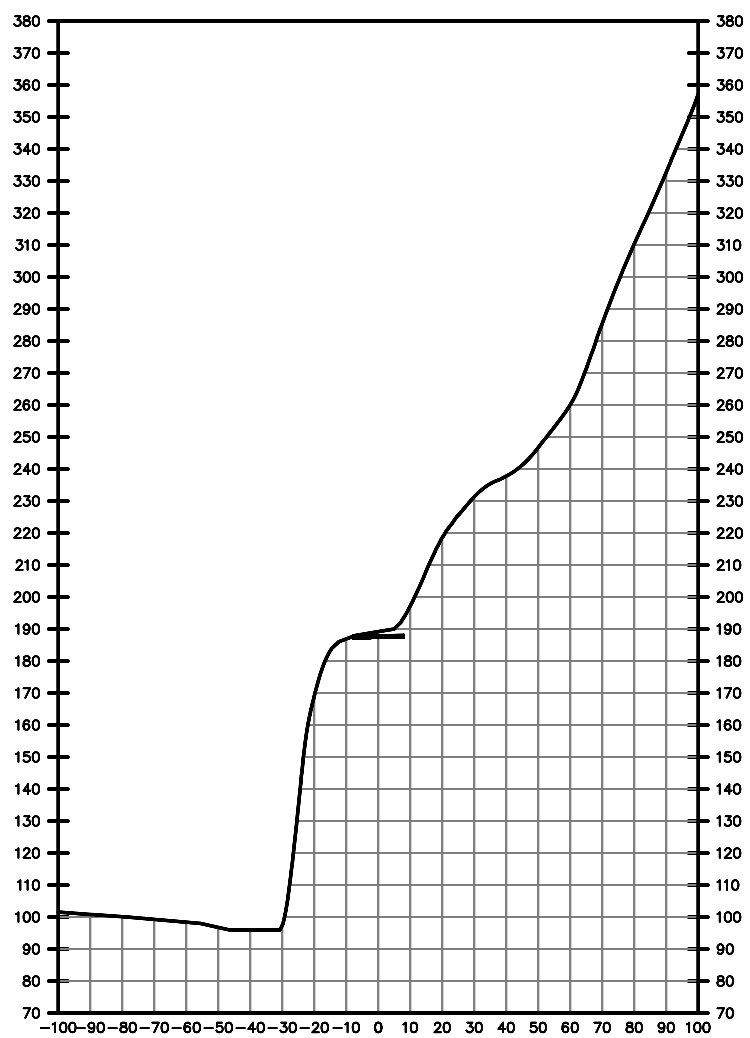

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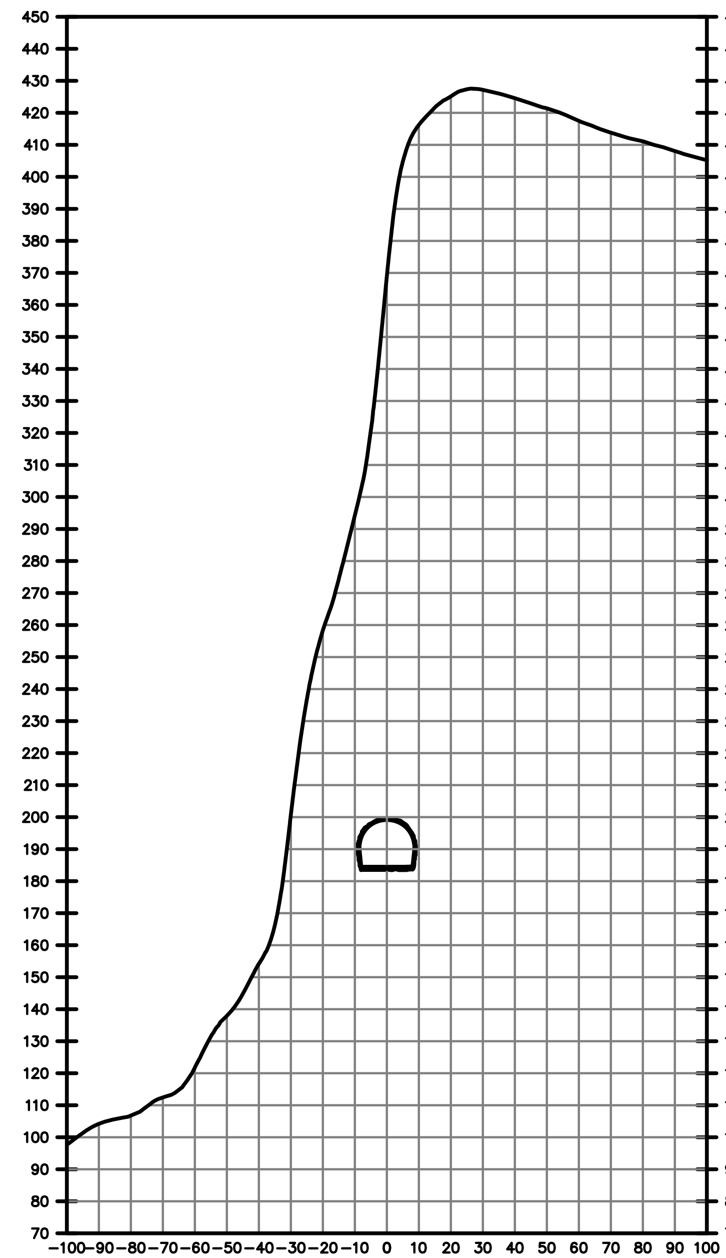

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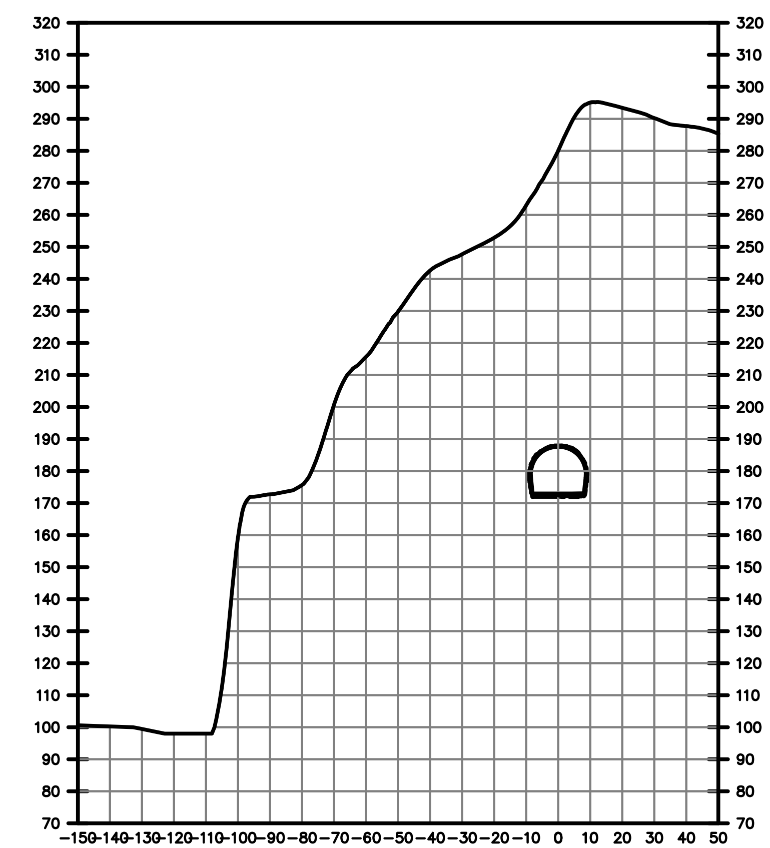

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HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

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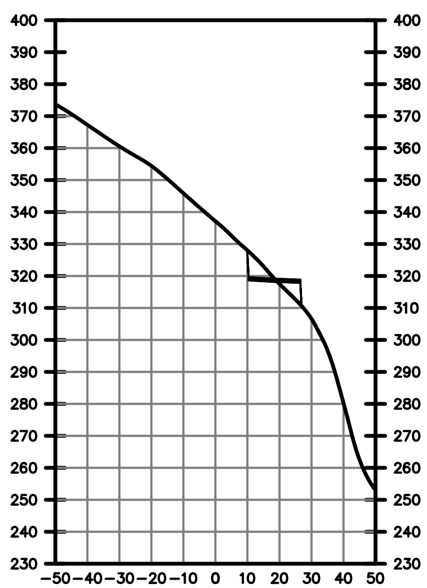
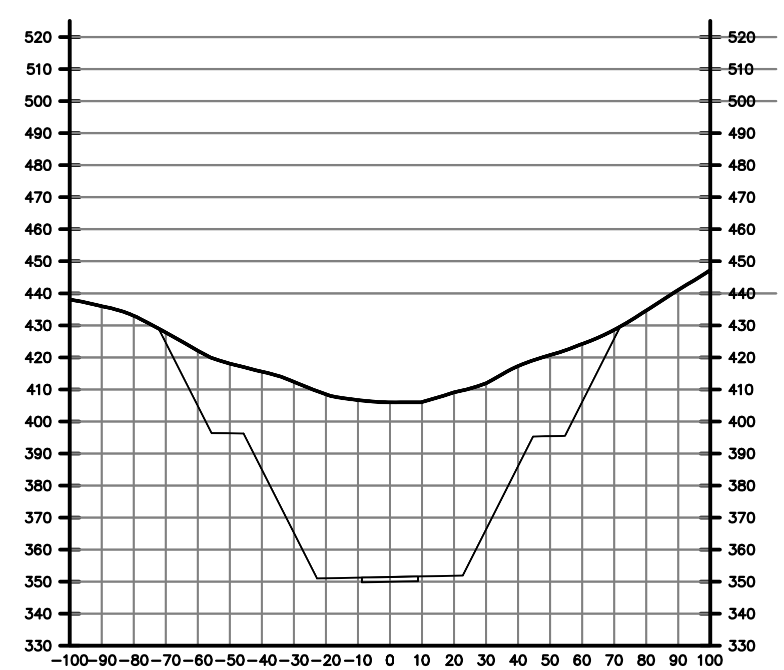
OPTION 2C
SECTIONS

42+50.00

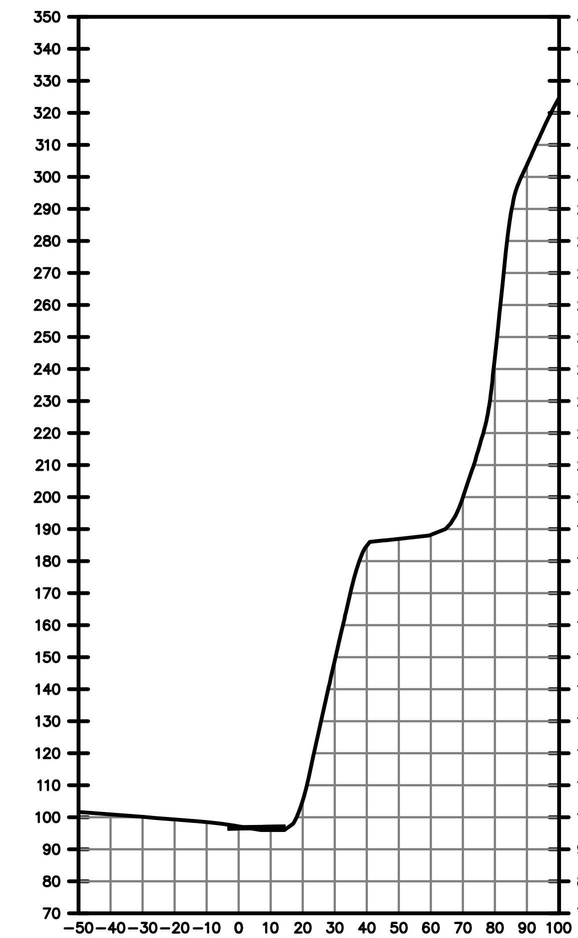


SECTION (A)
SCALE: 1"=60' OPT 3&4 PLAN



SECTION (B)
SCALE: 1"=60' OPT 3 PLAN

32+00.00



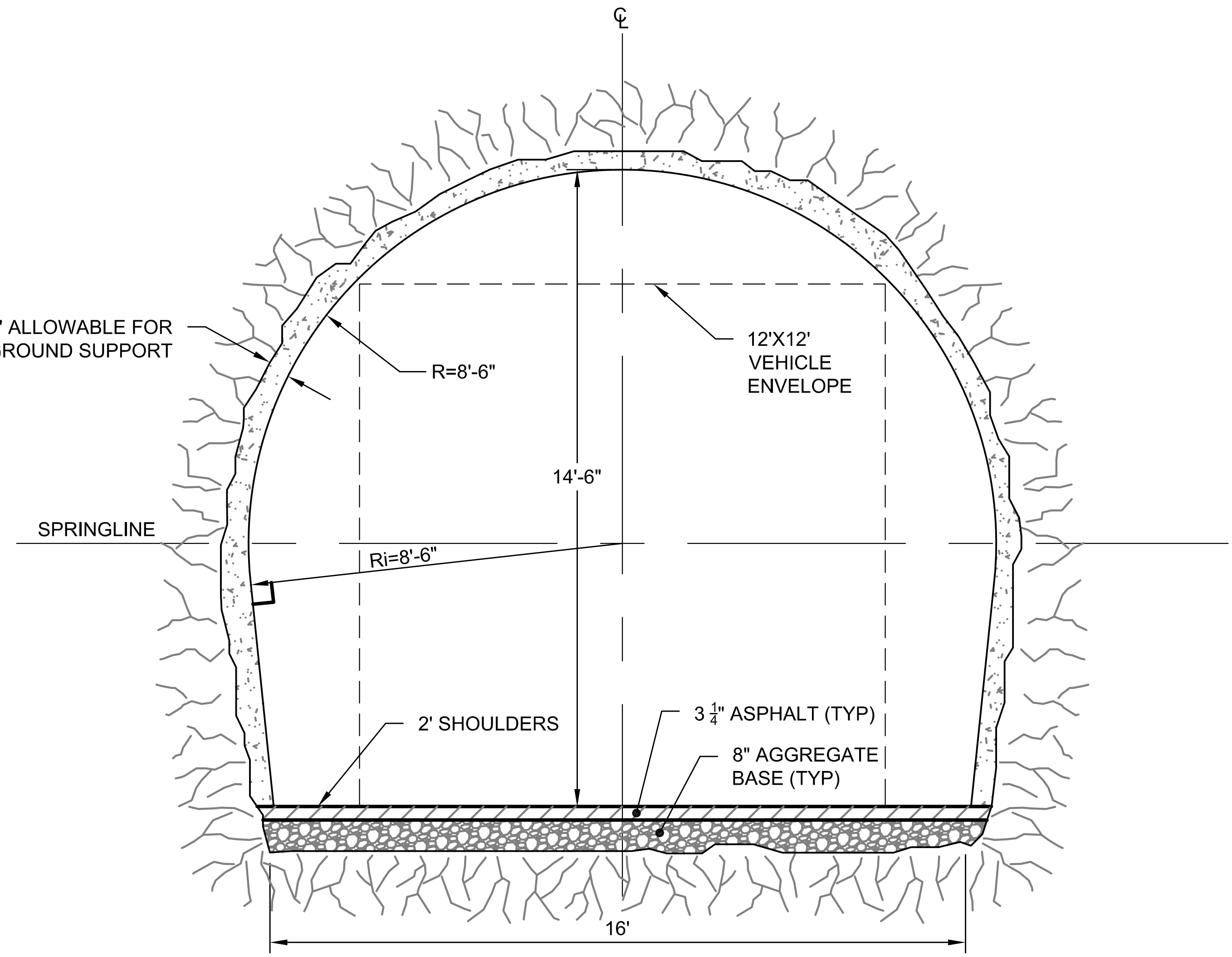
SECTION (A)
SCALE: 1"=60' OPT 4 PLAN

HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

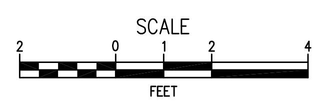
Oregon Department of Transportation

PARSONS BRINCKERHOFF

OPTIONS 3&4
SECTIONS



TUNNEL SECTION



HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

PARSONS BRINCKERHOFF

DETAIL 1

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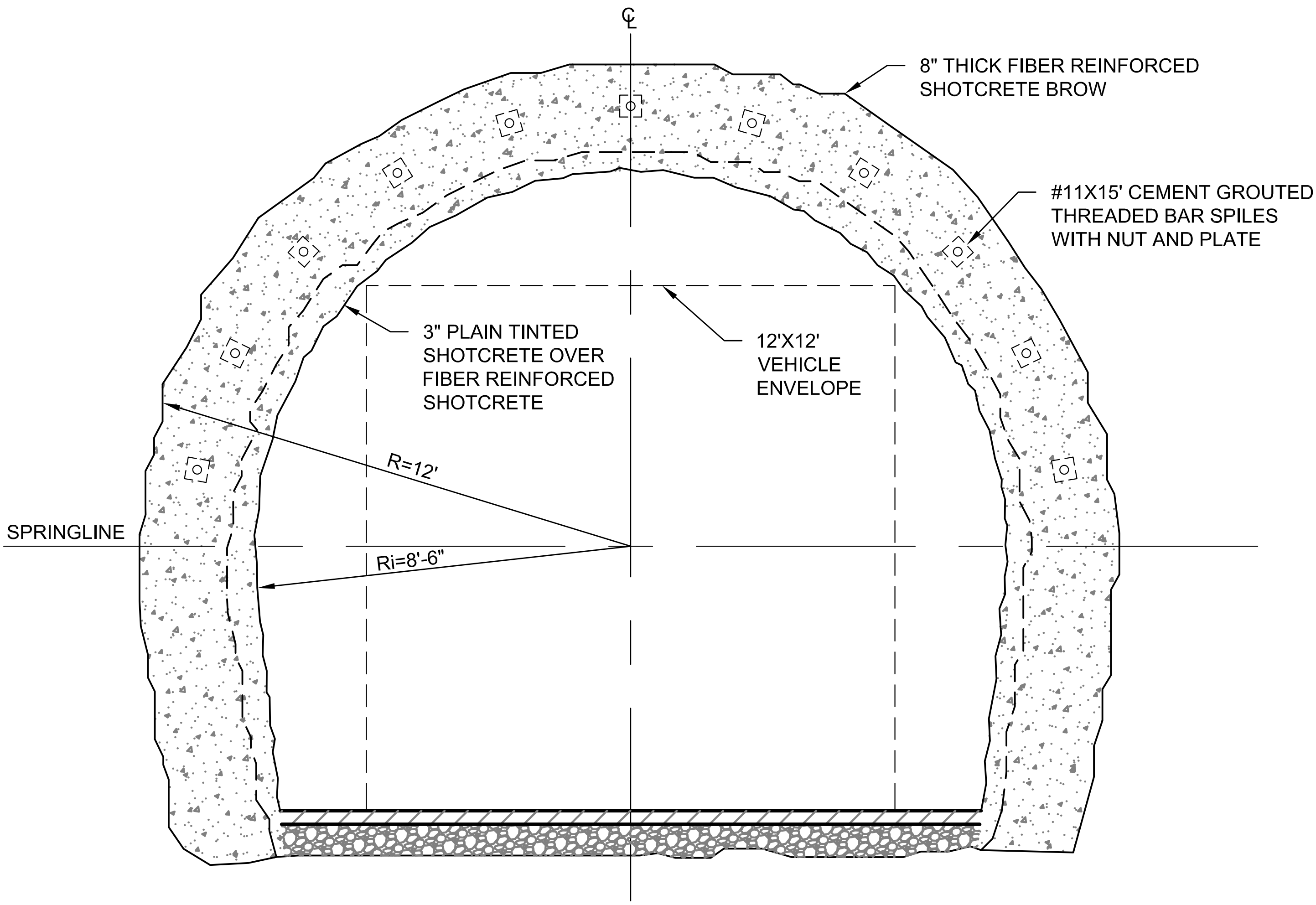

ELEVATION
TYPICAL PORTAL TREATMENT

SCALE
2 0 1 2 4
FEET

HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

PARSONS BRINCKERHOFF

DETAIL 2

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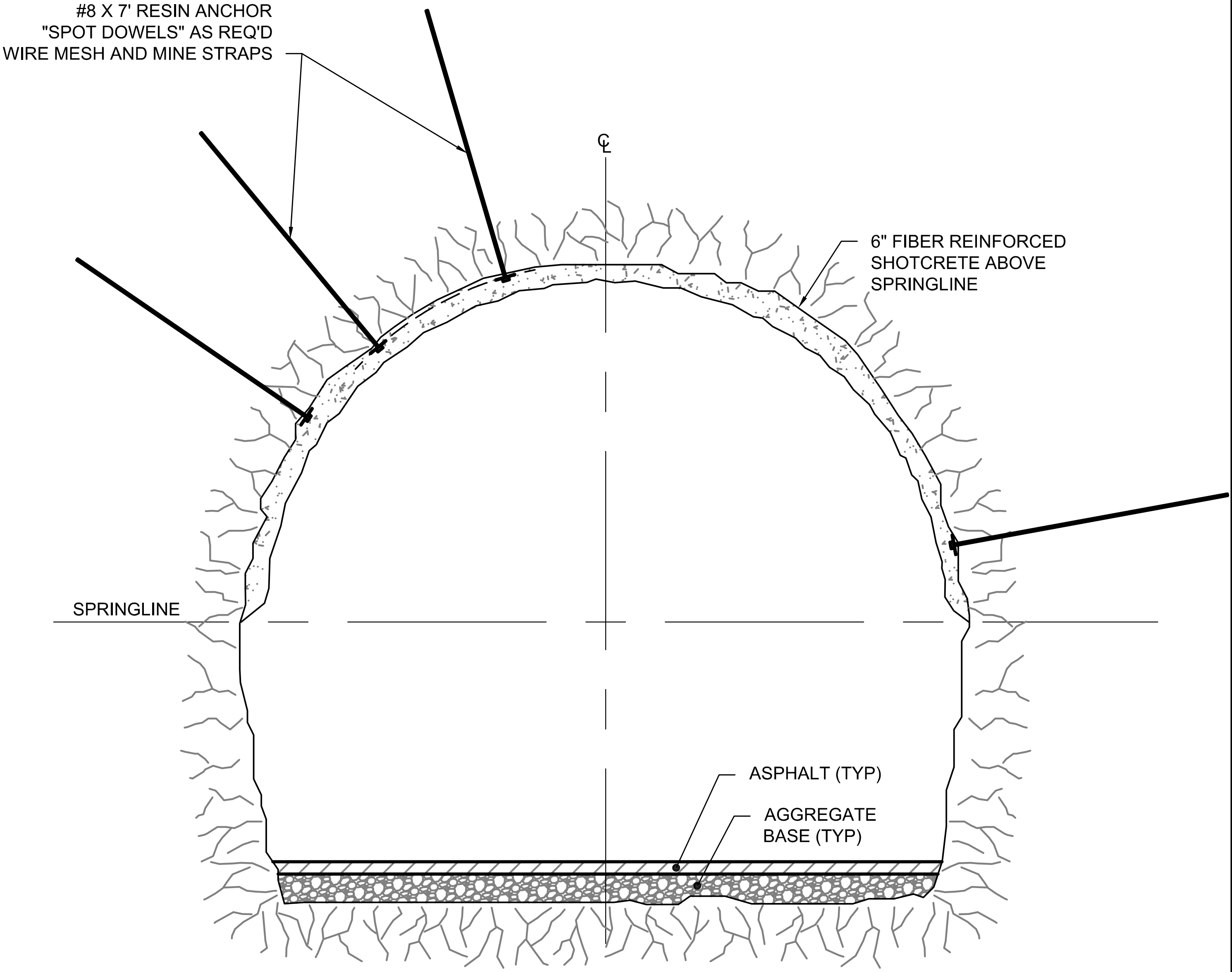

SUPPORT TYPE
MP1

SCALE 2 0 1 2 4 FEET

HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

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DETAIL
3

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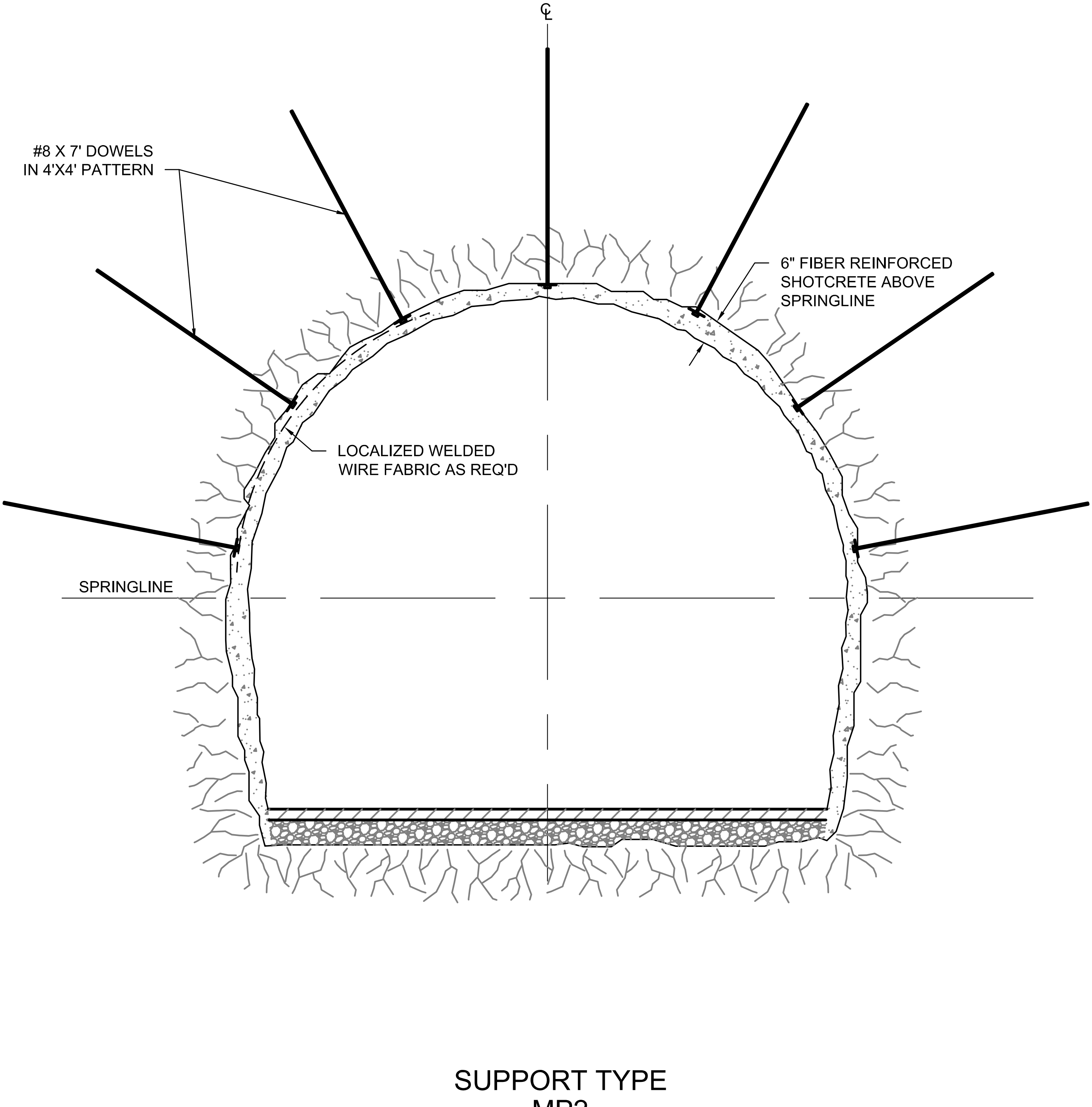

SUPPORT TYPE
MP2

SCALE
2 0 1 2 4
FEET

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HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

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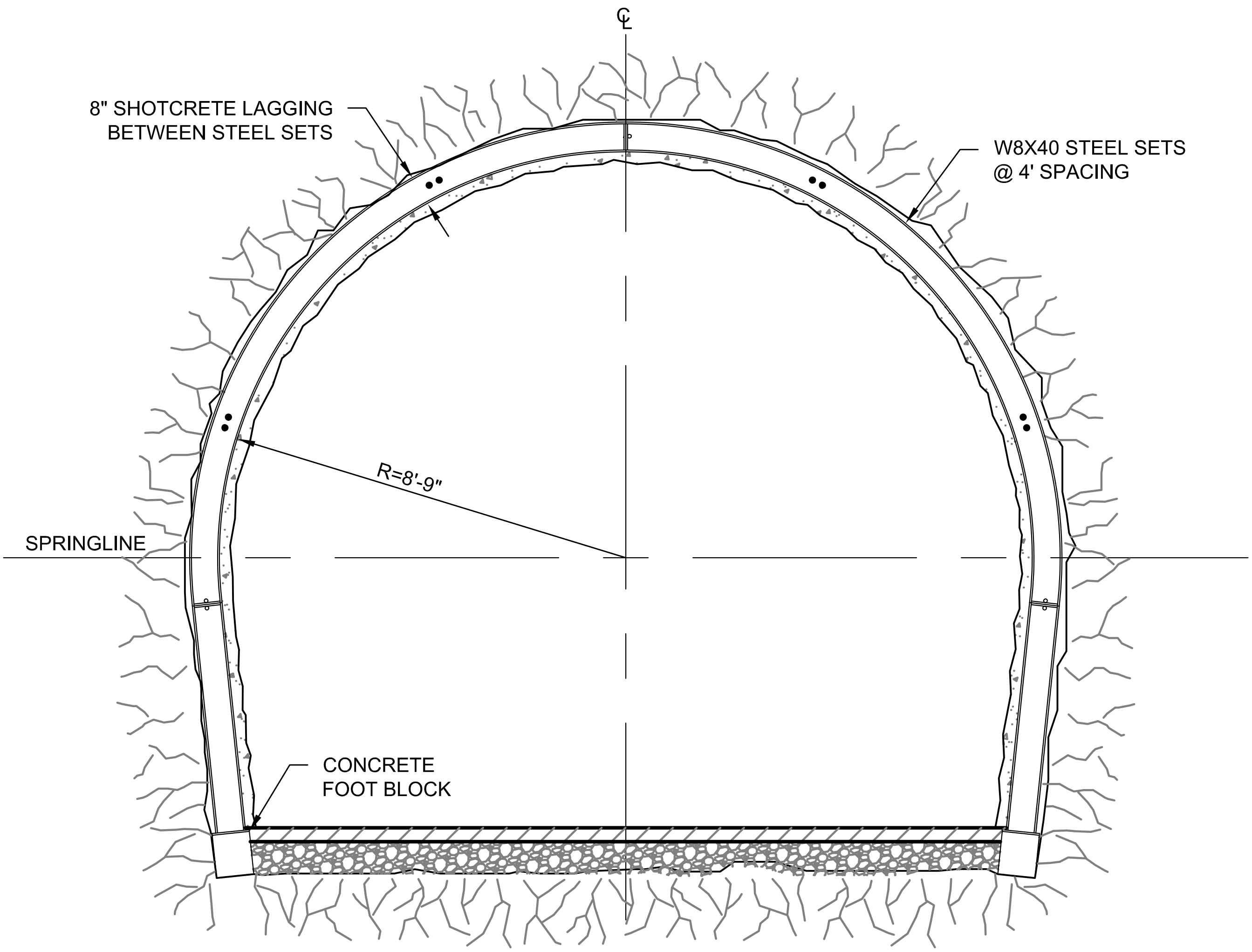
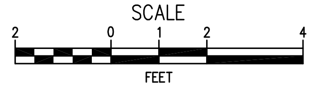
DETAIL
4



SUPPORT TYPE
MP3



HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

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DETAIL
5

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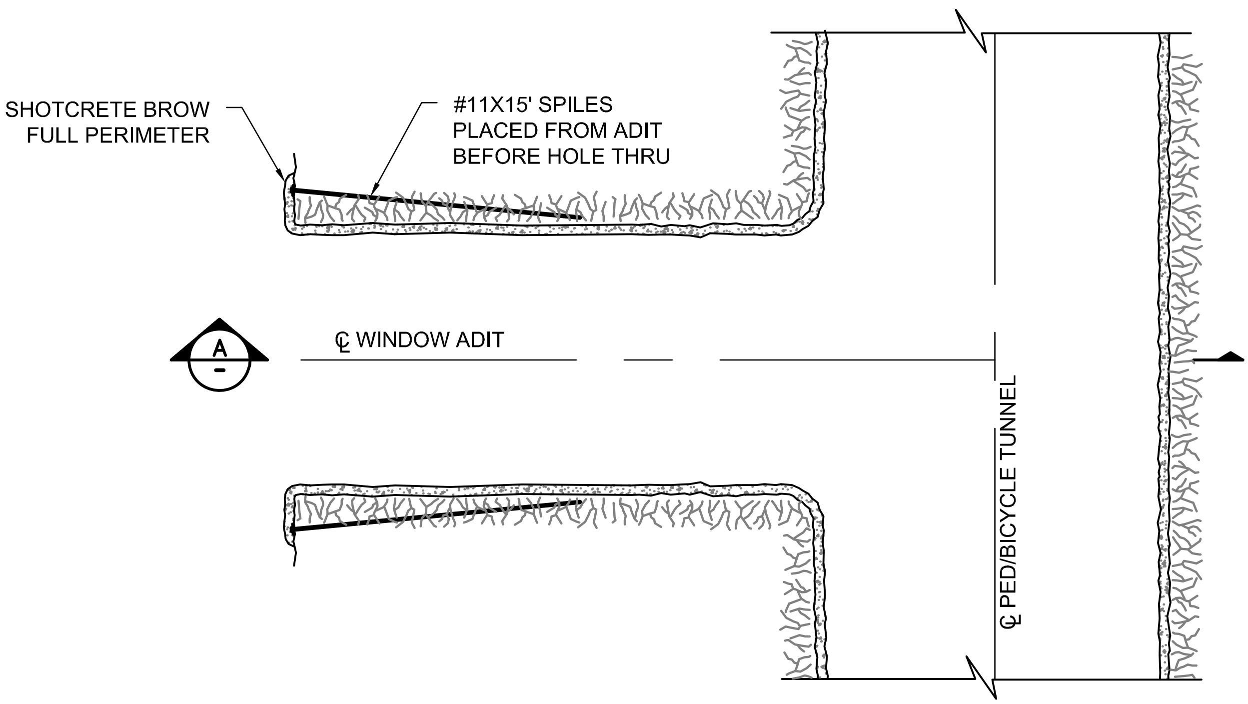
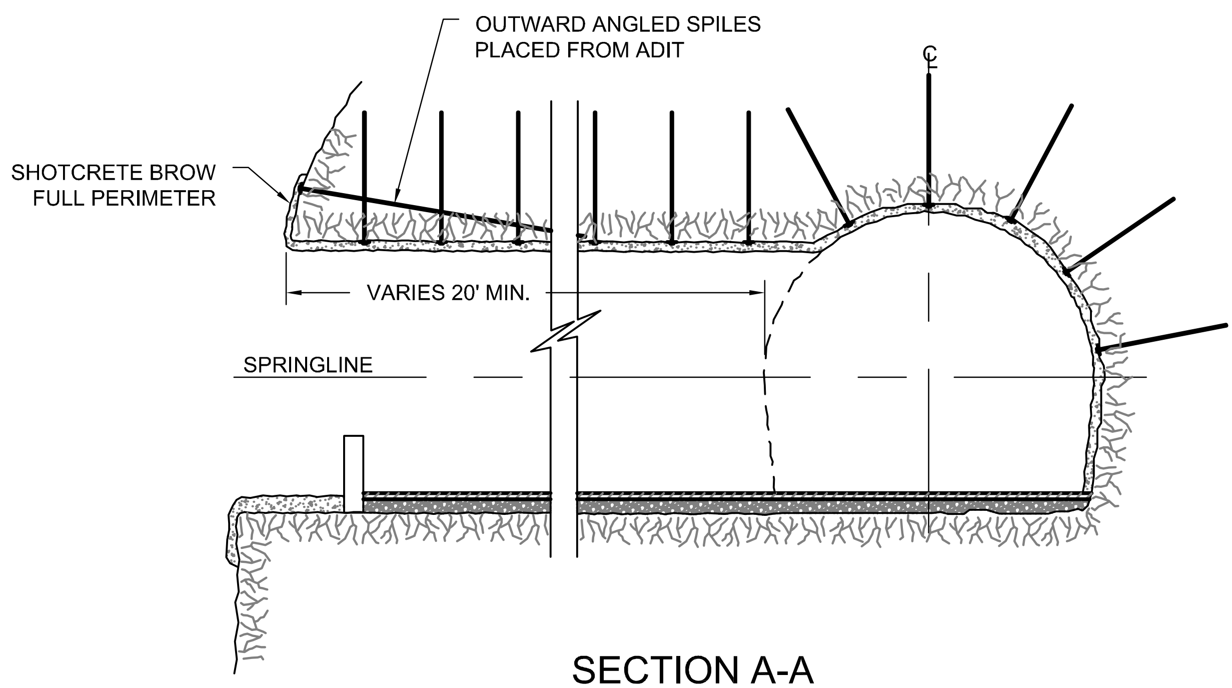
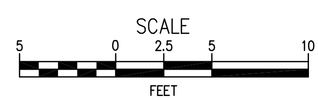


PLAN



SECTION A-A

TYPICAL WINDOW ADIT



HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

PARSONS BRINCKERHOFF

DETAIL
6

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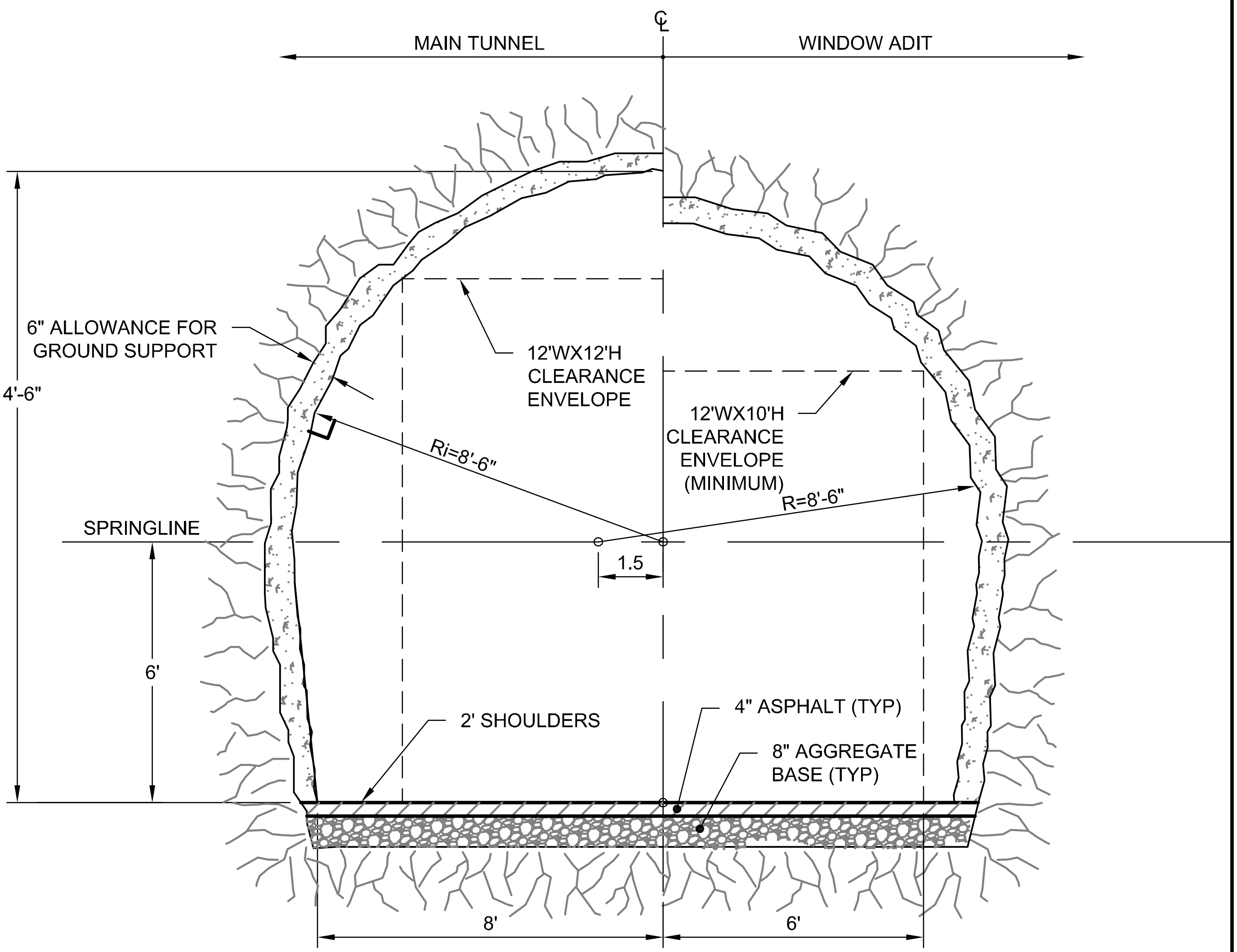


TYPICAL TUNNEL SECTIONS

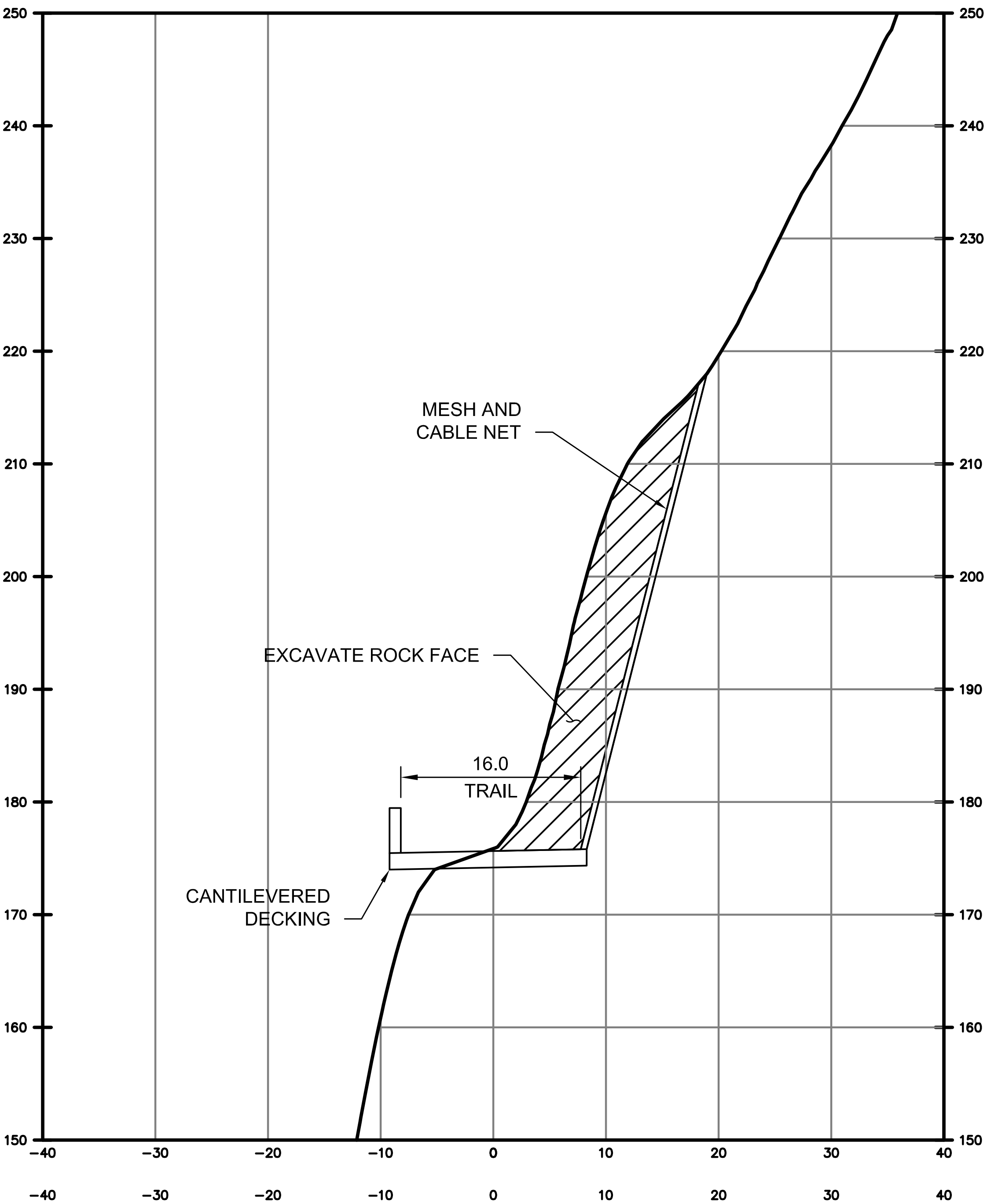
SCALE 2 0 1 2 4 FEET

HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

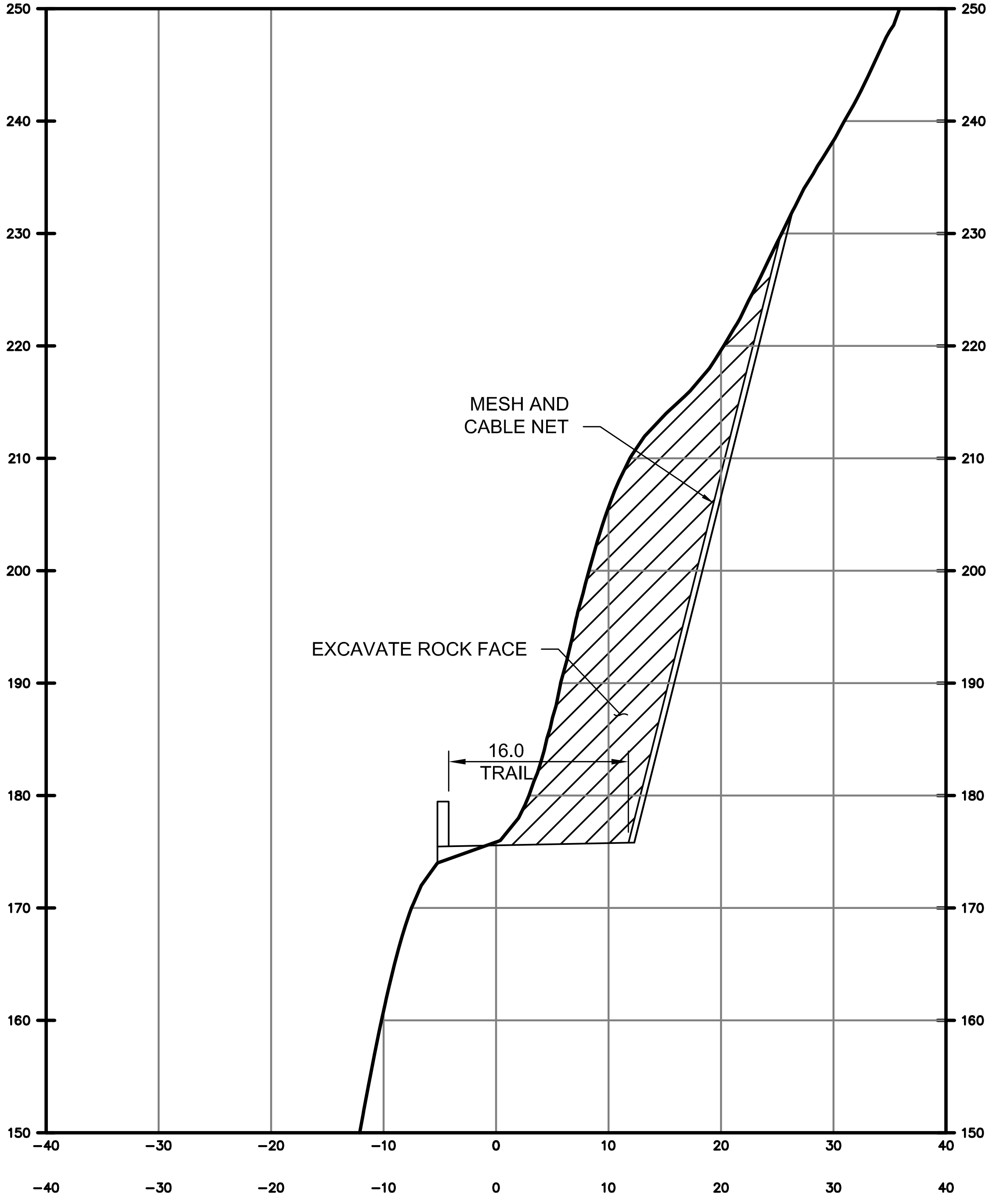
PARSONS BRINCKERHOFF

DETAIL 7



SHELF WIDENING CONCEPTS
CANTILEVERED DECKING

HISTORIC COLUMBIA RIVER HIGHWAY MITCHELL POINT FEASIBILITY AND COST STUDY	Oregon Department of Transportation PARSONS BRINCKERHOFF	DETAIL 8



SHELF WIDENING CONCEPTS
SCALING AND NETTING

HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

PARSONS BRINCKERHOFF

DETAIL
9

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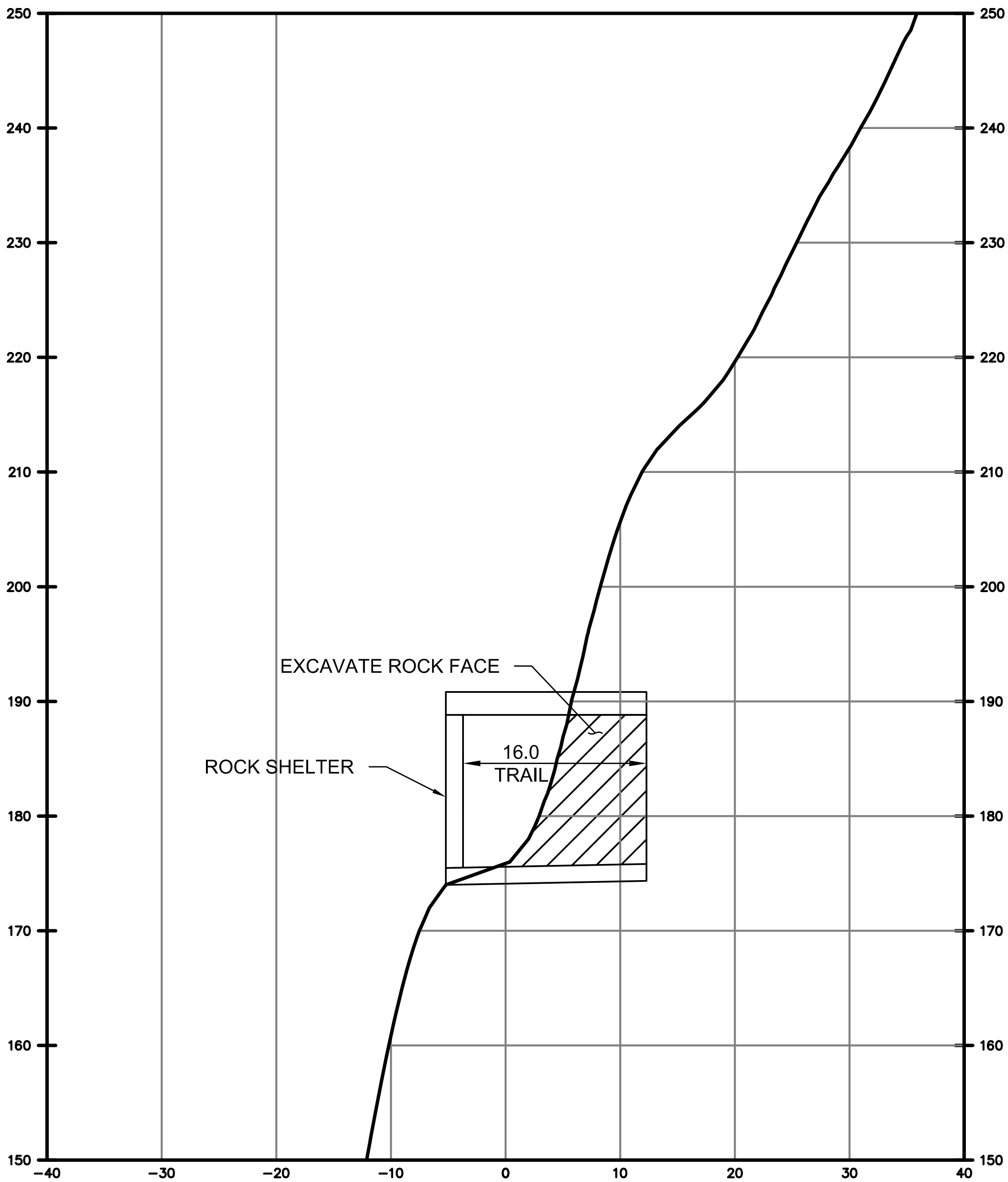

SHELF WIDENING CONCEPTS
ROCK SHELTER

HISTORIC COLUMBIA RIVER HIGHWAY
MITCHELL POINT FEASIBILITY AND COST STUDY

Oregon Department of Transportation

PARSONS BRINCKERHOFF

DETAIL
10

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