Lolo Pass Road Access Alternatives Project
OR CLACK 37005 (1)
Clackamas County, Oregon

Addendum: East Barlow Trail Alternative
June 2016

Prepared for:

Western Federal Lands Highway Division
WFLHD Task Order No. T-14-002, DTFH70-10-D-00019

Prepared by:

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INTRODUCTION AND EXECUTIVE SUMMARY

The Western Federal Lands Highway Division (WFLHD) of the U.S. Department of Transportation, Federal Highway Administration (FHWA) and Clackamas County are evaluating options to provide safe, long-term access to public lands (including the Mount Hood National Forest [MHNF]) and private properties.

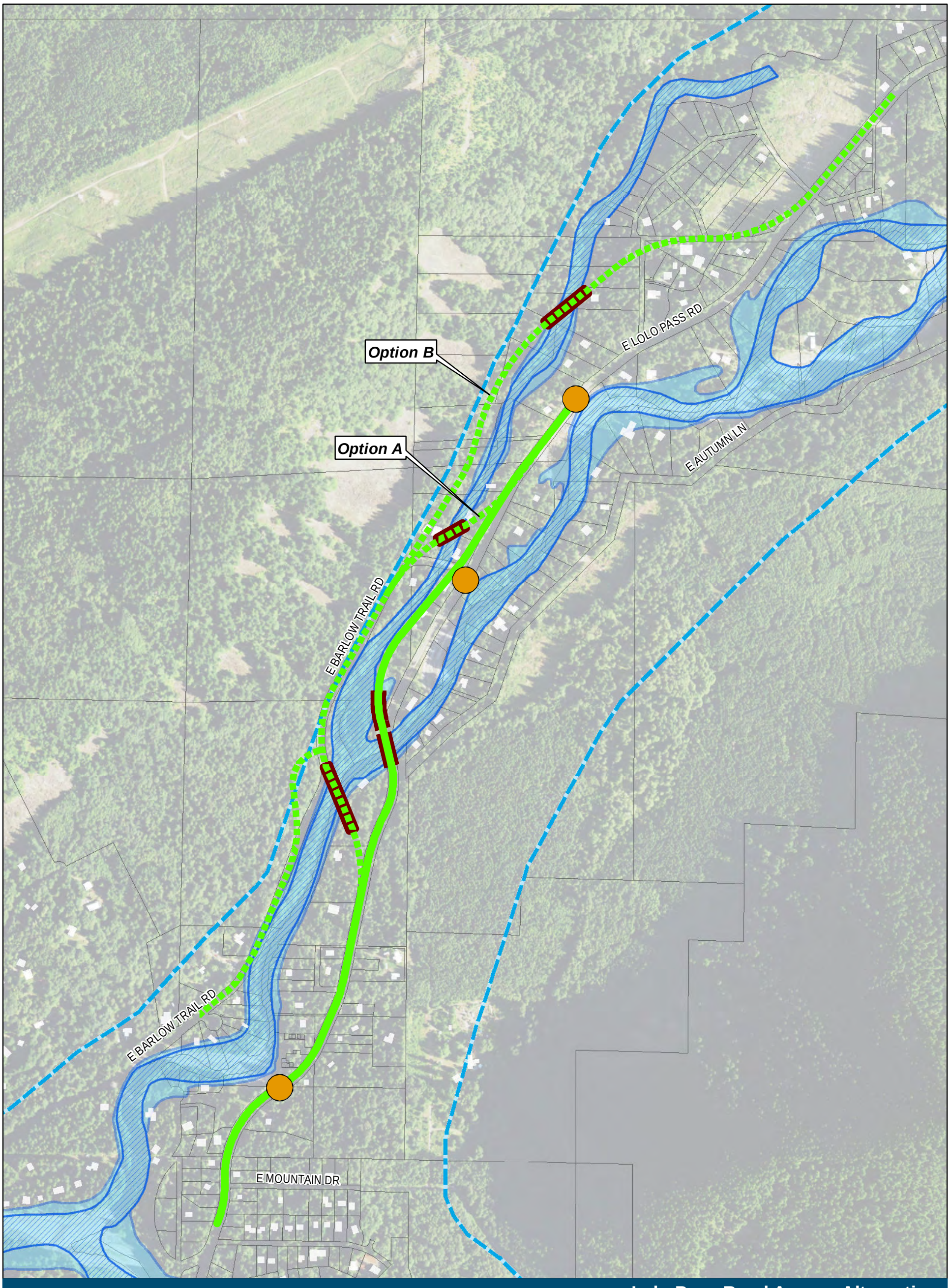
PURPOSE OF MEMORANDUM

This memorandum assesses an alternative that was introduced during the agency and public outreach associated with the Lolo Pass Road Access Alternatives Study in 2015. That alternative, named the East Barlow Trail Road Alternative, would reroute the existing roadway to the east between a point south of the confluence of Clear Creek and the Sandy River and an area between the intersections of Lolo Pass Road with East Barlow Trail Road and Michigan Road. The alternative would avoid several portions of Lolo Pass Road that have been and will continue to be vulnerable to severe damage from major floods and ongoing river channel migration.

The purpose of this memorandum is to document the hydrologic and geomorphic, engineering, cost, and environmental analyses conducted for the new alternative. Two options are considered that vary by the location at which they cross Clear Creek. Additionally, a phasing concept is introduced which could allow staged development of the project.

SUMMARY: EAST BARLOW TRAIL ROAD ALTERNATIVE: A VARIATION ON THE MODIFY EXISTING LOLO PASS ROAD ALTERNATIVE

As described in the Alternatives Analysis Report produced for Clackamas County and FHWA in November 2015, the existing bridge over the Sandy River is a considerable constriction to the river. This constriction causes localized erosion issues and puts the existing bridge, surrounding roadway, and nearby homes at risk in future events. In response to that constriction, a Modify Existing Lolo Pass Road Alternative was developed and presented to the public, agencies, and stakeholders for comment. After public and agency outreach, a variation on the Modify Existing Lolo Pass Road Alternative that would use part of East Barlow Trail Road was developed for evaluation. This East Barlow Trail Road Alternative was refined considering hydromorphic, geologic, environmental, and engineering feasibility, and is presented in this addendum. Figure ES-1 shows the proposed alternative compared to the original Modify Existing Lolo Pass Road alternative.



Lolo Pass Road Access Alternatives

FEMA Floodway
FEMA 100-Year Floodplain
Channel Migration Zone

Revetment Area

Alternatives

Modify Existing Lolo Pass Road
Modify Existing East Barlow Trail Road
Bridge Deck

Sandy River Corridor Study Area

ES-1

Modify Existing Lolo Pass Road and Modify Existing East Barlow Trail Road Alternatives

Data Sources:
ESRI, ArcGIS Online, World Imagery. 2010. Microsoft.
FEMA. 2015.

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As shown in Figure ES-1, the East Barlow Trail Road Alternative includes a new bridge over the Sandy River and two potential locations for the bridge over Clear Creek: Option A for crossing Clear Creek is closer to the confluence of the Sandy River and Clear Creek, and Option B for crossing Clear Creek is farther upstream. Both options would include the same crossing of the Sandy River, a replacement bridge downstream of the existing crossing. The project could be phased, as shown described below.

Options A and B are discussed separately below, though they share many common elements. Additionally, a phasing concept is presented in this memorandum. Phasing would allow the project to be built in two stages, which could bring benefits to the area with only a portion of the overall funding required for the project. Phasing is discussed in more detail at the end of the memorandum.

Table 1 presents the key features of the new alternative, and presents the same information for the other alternatives that were included in the Alternatives Report produced in 2015.

Table 1. Key Features of the East Barlow Trail Road Alternative and Other Potential Build Alternatives

	East Barlow Trail Road Alternative (Options A & B)	Modify Existing Lolo Pass Road	Zigzag Mountain West	Zigzag Mountain East
Bridge Length	Sandy River Bridge: 400 feet Clear Creek Bridge (Option A): 175 feet Clear Creek Bridge (Option B): 300 feet	Two 200-foot bridges at existing crossing	800-foot bridge (four spans)	800-foot bridge (four spans)
Improvements to Existing Lolo Pass Road?	Yes – new Sandy River bridge and 1-3 riverbank reinforcements planned	Yes – new Sandy River bridge and three riverbank reinforcements planned	One riverbank reinforcement planned south of Autumn Lane	No
Length of New/Improved Roadway	Full length: Option A: 0.9 mile Option B: 1.4 miles	0.6 mile	1.6 miles	1.7 miles

	East Barlow Trail Road Alternative (Options A & B)	Modify Existing Lolo Pass Road	Zigzag Mountain West	Zigzag Mountain East
Right-of-way (#parcels, #potential displacements)	17–26 parcels, 2-5 potential displacements	10–18 parcels, 4–5 potential displacements	12–22 parcels, 1–2 potential displacements	25–26 parcels, 1–2 potential displacements
Acres (footprint)	8.6–11.2 acres	5	23	25
Planning-Level Construction Cost	$18.4 - $20.3 M	$12.8 M	$24.7 M	$27.2 M

CONTENTS OF THIS REPORT

The remainder of this report consists of seven sections and attachments. The sections are as follows:

- Description of Alternative – Options and Phases
- Geomorphic and Hydrologic Assessment
- Engineering Issues
- Geological Hazards
- Cost Analysis
- Access to Private Property

The report addresses the analysis of the potential build alternative (and options) in the context of technical and environmental constraints. The cost and property access sections present high-level estimates of construction cost and discuss potential impacts to private properties.

DESCRIPTION OF THE EAST BARLOW TRAIL ROAD ALTERNATIVE

The East Barlow Trail Road Alternative was introduced as an option to the "The Modify Existing Lolo Pass Road Alternative" after agency and public input on the 2015 study. The East Barlow Trail Road concept introduced at the time was refined into an alternative considering hydromorphic, geologic, environmental, and engineering feasibility, and is depicted in Figure 1.

The East Barlow Trail Road Alternative includes the following features:

- A new bridge over the Sandy River downstream of the existing bridge.
- A new bridge over Clear Creek (two potential locations; Option A for crossing Clear Creek is closer to the confluence of the Sandy River and Clear Creek, and Option B for crossing Clear Creek is farther upstream).
- Roadway to divert traffic from the existing Lolo Pass Road in the area of active channel movement.
- A realigned East Barlow Trail Road (to allow a connection to the new roadway).
- Revetments in up to three areas along Lolo Pass Road to armor the roadway against stream migration and damage from flooding events.

In addition to the above features, a phasing concept is presented in this memorandum. Phasing would allow the project to be built in two stages, which could bring benefits to the area with only a portion of the overall funding required for the project. Phasing is labeled on Figure 1; Phase 1 would be the northern part of the alignment with the new crossing of Clear Creek, and Phase 2 would develop the new crossing of the Sandy River and connection back to the existing Lolo Pass Road to the south. Phasing is discussed in more detail below.

OPTION B
Phase 1

OPTION A
Phase 1

Phase 1
Phase 2

Phase 1
Phase 2

BARLOW TRAIL RD
CONNECTION
Phase 2

OPTIONS A & B
Phase 2

Clear Creek
Lolo Pass Rd
Barlow Trail Rd
Sandy River
R1
R2
R3

Lolo Pass Road Access Alternatives

FEMA Floodway
FEMA 100-Year Floodplain
Channel Migration Zone
Buildings
Revetment Area

Retaining Wall
Bridge
Barlow Road Trail Option A - Phase 1
Barlow Road Trail Option B - Phase 1
Barlow Road Trail Options A & B - Phase 2
Barlow Road Connection - Phase 2

Figure 1, Sheet 1
East Barlow Trail Road Alternative Options and Phasing

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Data Sources: *ESRI, ArcGIS Online, World Imagery. 2010. Microsoft; FEMA. 2015.*

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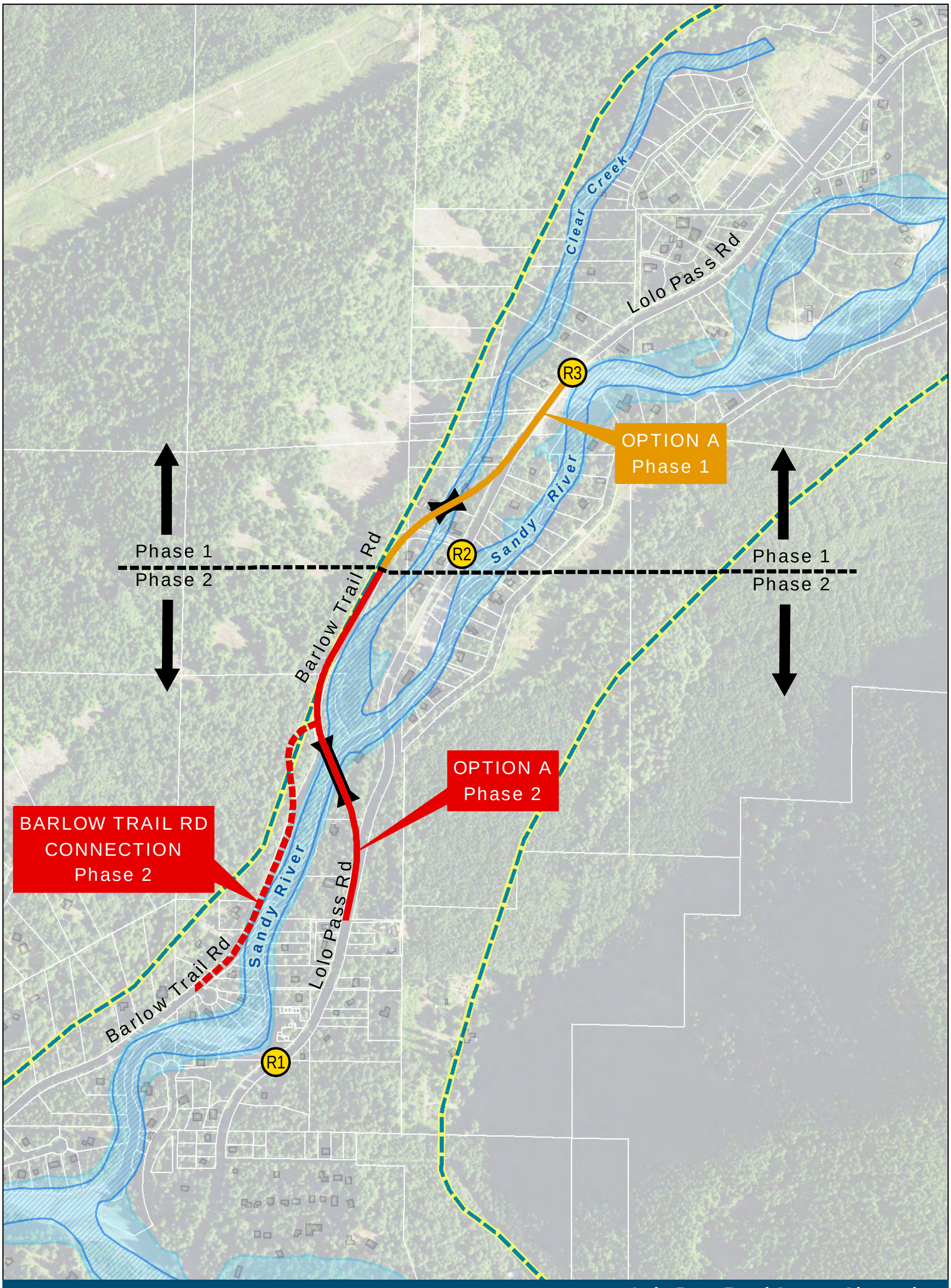
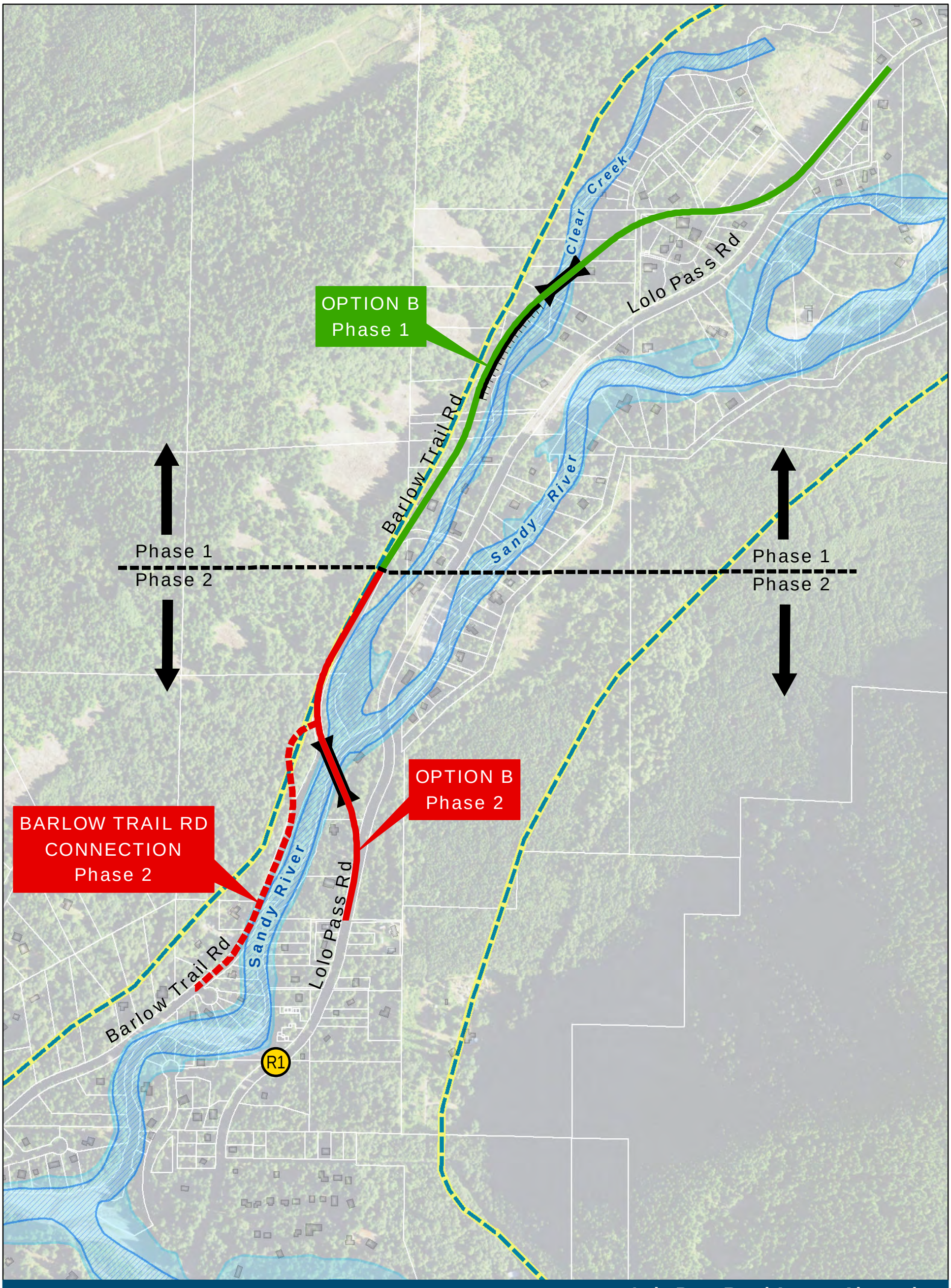


Lolo Pass Road Access Alternatives

Figure 1, Sheet 2
East Barlow Trail Road Alternative
Option A Phasing

Data Sources: *ESRI, ArcGIS Online, World Imagery. 2010. Microsoft; FEMA. 2015.*



Lolo Pass Road Access Alternatives

FEMA Floodway
FEMA 100-Year Floodplain
Channel Migration Zone
Buildings
Revetment Area

Retaining Wall
Bridge
Barlow Road Trail Option B - Phase 1
Barlow Road Trail Option B - Phase 2
Barlow Trail Road Connection - Phase 2

Figure 1, Sheet 3
East Barlow Trail Road Alternative
Option B Phasing

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Data Sources: *ESRI, ArcGIS Online, World Imagery. 2010. Microsoft; FEMA. 2015.*

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PHASED IMPLEMENTATION

The East Barlow Trail Road Alternative elements and cost estimates have been divided into two potential phases for construction:

- Phase 1: The Clear Creek bridge crossing and connections at the north end to existing Lolo Pass Road and at the south end to East Barlow Trail Road west of the current bridge spanning Clear Creek.
- Phase 2: The Sandy River bridge crossing and connection to existing Lolo Pass Road between Autumn Lane and Mountain Drive, and the realignment of East Barlow Trail Road to connect to the west end of the bridge.

Either of these phases could be implemented in an emergency situation if a future flood event occurs and Clackamas County receives Emergency Relief funding. Constructing the Clear Creek bridge as Phase 1 in particular would provide a level of redundancy for accessing private properties and the MHNF from East Barlow Trail Road if the existing Lolo Pass Road bridge over the Sandy River or sections along existing Lolo Pass Road north of the bridge become unusable due to flooding. Phase 1 could also be implemented without significant changes to the alignment, grade, and typical section of the full alternative. The Option B (upstream) crossing of Clear Creek would provide the greater benefit in this scenario because it bypasses a section of East Lolo Pass Road that is also known to be subject to closure from flooding. Construction of Option A could provide some benefit if it were combined with substantial bank stabilization and further realignment of Lolo Pass Road through private parcels to shift it away from the Sandy River.

Separate cost estimates for the East Barlow Trail Road Alternative have been produced for each of the two phases listed, as presented in the cost analysis section below (Tables 3 through 5). The approximate limits of costs for each phase are identified in Figure 1 (detail on Sheets 2 and 3) and in the profile diagrams in Attachment B, although an interim connection point can be selected at any point where the alignment matches the existing East Barlow Trail Road. The Clear Creek Bridge options are identified as Phase 1 (only one of the options would be constructed), and the Sandy River bridge and connection to East Barlow Trail Road are listed as Phase 2. Phase 2 would include removal of the existing bridge over the Sandy River.

GEOMORPHIC AND HYDROLOGIC ASSESSMENT

The East Barlow Trail Road Alternative would introduce two new bridges to the project area: one across the Sandy River downstream of the existing Lolo Pass Road bridge crossing, and

another bridge across Clear Creek. There are two potential locations for the bridge over Clear Creek: Option A is approximately 1,700 feet upstream of the Clear Creek/Sandy River confluence, and Option B is approximately 3,300 feet upstream of the confluence (Figure 1). These options are discussed separately below, though they share many common elements.

The key considerations in evaluating the bridge crossings are:

- Identify geomorphic processes operating at potential bridge sites.
- Assess the potential for existing and future channel migration and avulsion to negatively affect the bridge at both sites.
- Evaluate flood surface elevations associated with the 100-year storm event (1% annual chance) at both sites under both existing and possible future conditions.

As discussed in detail in the September 2015 report by Natural Systems Design, Inc. (NSD), the Sandy River presents a significant risk of channel migration throughout this project reach. The river has moved through past bridge and road alignments in the project area, and is still adjusting to past eruptive episodes from Mt. Hood. No alternatives considered within the project area will be completely outside the Channel Migration Zone (CMZ) as mapped by NSD (the CMZ is shown on Figures 1 and 3).

The magnitude of risk for channel migration generally varies by the type of landform and proximity to the main channel and historical channel alignments. The assessment of geomorphic risk is keyed to the relationship of the road and bridge crossing locations to the landforms present throughout the valley. The primary landforms present within the project reach include (from lowest to highest in elevation relative to the river):

1. Active channels of Sandy River and Clear Creek.
2. Alluvial terraces consisting of sediments reworked by the river. There are multiple elevations associated with the alluvial terrace, but they are generally within 10 vertical feet of the active channel.
3. Lahar terraces composed of Old Maid lahar deposits. This surface lies on the order of 10 to more than 25 feet above the adjacent main channel.
4. Surrounding hillsides typically composed of volcanic rocks.

It is important to note that any of the terraces and the hillsides in this reach can be influenced by channel migration. There is a progressive reduction in risk as you move up onto the higher alluvial terrace and lahar terraces, and give the active channel more space.

A summary of the geomorphic and hydrologic findings is presented below. For documentation of the full analysis, see the attached memorandum authored by NSD, *Lolo Pass Road Access*

Alternatives Study: Additional Geomorphic and Hydraulic Assessment of the Barlow Trail Alignment (Attachment 1).

HYDRAULIC REVIEW

Each of the three potential bridge locations (the two Clear Creek crossing options and the Sandy River crossing) was reviewed to assess the potential influence of the bridge on flood flows, and to consider the general hydraulic characteristics of each crossing. This review is intended to develop preliminary recommendations regarding span width, low chord elevation, and the potential for scour. At each location, the potential for systemic channel aggradation was assessed.

Clear Creek Crossing

It appears feasible to install a bridge for Clear Creek that will span the regulatory floodplain with a low chord elevation that provides some factor of safety in the case of potential channel aggradation. However, the landings on the left (eastern) riverbank will be exposed to potential scour, which should be considered in structure design.

Both crossing options have a relatively confined flow path at higher flow, consistent with the preliminary flood mapping. Both locations are similar hydraulically; the location farther upstream is less confined, with an overbank bench on the left bank of the river that results in lower overall velocity and associated shear stress.

Clear Creek is relatively confined between the valley toe slope and the higher terrace. At the downstream location (Option A), a span width of approximately 100 feet would allow for the structure to span from the toe slope to the terrace. This span width would exceed the regulatory floodplain in this location. The minimum low chord elevation at the downstream crossing to consider would be 1,483 feet (Base Flood Elevation [BFE] + 3 feet). The adjacent higher terrace is at elevation 1,488 feet. Please note that these span lengths were developed using perpendicular alignments; if the structure is skewed, the overall length will need to be increased to preserve the perpendicular span lengths discussed.

The downstream bridge location was also tested to determine the potential impacts of channel aggradation. The existing bed elevation was increased by 4 feet and then reanalyzed with the same 1% annual chance flow. Modeled water levels under the aggraded bed condition were 4.5 feet higher than the unaggraded scenario, indicating that the increase in water level is slightly higher than the simulated rise in the bed. Therefore, an additional 4.5 feet of clearance would be needed to accommodate aggradation. The estimated low chord elevation that would allow for both debris passage and channel aggradation would be BFE + 3 feet [debris passage] + 4.5 feet [aggradation] = 1,487 feet.

At the upstream location (Option B), if the bridge is to span between the toe slope and the high terrace, the minimum span width would be approximately 300 feet. If this option is selected, then the low chord elevation would be near 1,518 feet elevation, approximately 15 feet above the 1% annual chance floodplain. The lowest elevation to consider would be BFE + 3 feet = 1,506 feet.

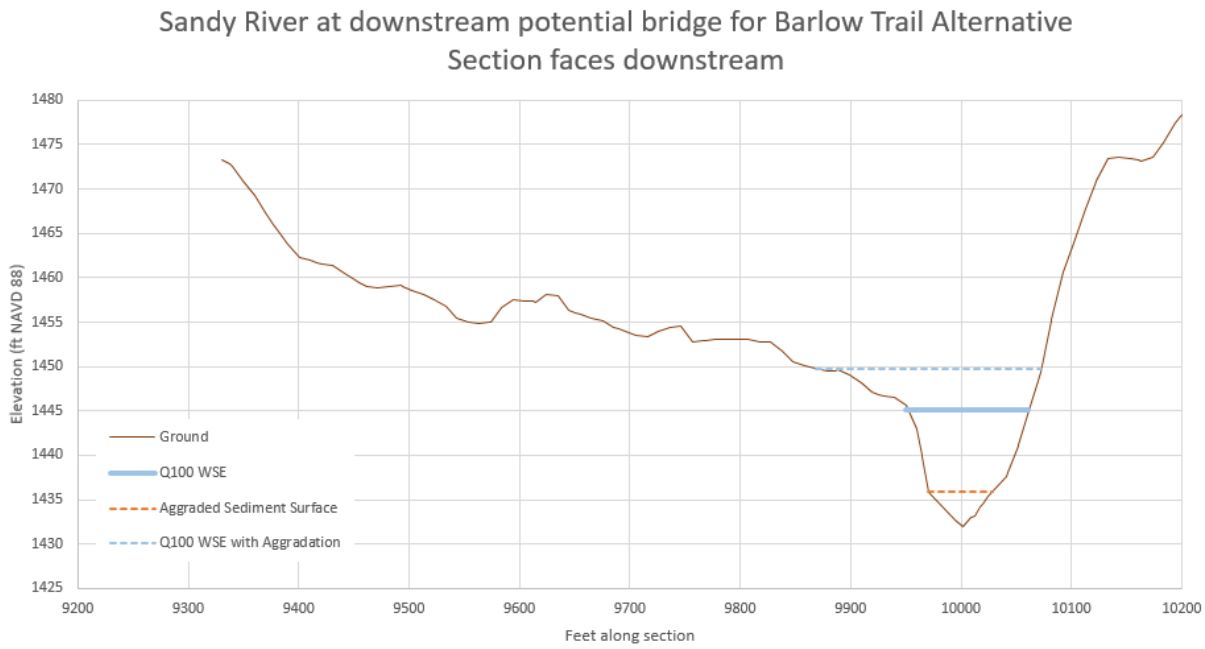
The WinXSPRO upstream section was modified to aggrade the bed by 4 feet to test the response in this reach. The modeled water surface simulating aggraded conditions was 3.2 feet higher than the existing flood elevation; therefore adding 4 feet to account for aggradation should be sufficient in this reach. The estimated low chord elevation that would allow for both debris passage and channel aggradation would be BFE + 3 feet [debris passage] + 4 feet [aggradation]= 1,510 feet elevation.

Sandy River Crossing

For the Sandy River, NSD used the DOGAMI HEC-RAS model, as described in its September 2015 report. A HEC-RAS model has not been developed for Clear Creek. NSD used the 2016 preliminary floodplain mapping (DOGAMI, in prep) as a basis for flood elevation and used WinXSPRO to assess hydraulic conditions at the two potential Clear Creek bridge crossings. Sections were cut at each location using the 2011 LiDAR data as the source of topographic information. The hydraulic review for Clear Creek is substantially less detailed than the review for the Sandy River.

For the East Barlow Trail Road Alternative Sandy River crossing, the existing HEC-RAS was modified to remove the existing Lolo Pass Road bridge and add a new bridge at approximately river mile 43.55. The initial bridge geometry was estimated using the elevations of adjacent terraces to determine how a span that would not interact with the 1% annual chance flow scour would potentially interact with flood flows; this allowed NSD to develop a minimum low chord elevation for the bridge. The initial hydraulic result is shown below in Figure 2 for both aggraded and ungraded conditions.

Figure 2. HEC-RAS Cross Section at the Potential Sandy River Crossing Downstream of the Confluence with Clear Creek



A low chord elevation that both accounts for aggradation and allows for debris passage would be 1,453 feet. This elevation intersects a higher portion of the alluvial terrace than an elevation that does not accommodate aggradation and debris flow, but the elevation is still relatively low and exposed to channel migration. NSD recommends using a similar width to the replacement option (400 feet) to reduce exposure to lateral migration. A sloped structure likely will be required in order to intersect the higher western terrace. Because only minimum elevations were reviewed for this evaluation, higher low chord elevations due to slope are acceptable.

Summary Bridge Parameters

Key bridge parameters for the Sandy River and the two Clear Creek crossing options are included below in Table 2.

Table 2. Bridge Parameters to Meet Hydraulic and Geomorphic Objectives

Parameter	Sandy River at RM 44.55	Clear Creek Option A (Downstream Bridge Location)	Clear Creek Option B (Upstream Bridge Location)
Minimum span width to stay outside of floodplain	230 feet	100 feet	150 feet
Span width that reduces exposure to lateral migration	400 feet	175 feet	300 feet
Minimum low chord elevation (BFE + 3 feet)	1,448.1 feet	1,483 feet	1,506 feet
Low chord elevation that includes aggradation (aggraded BFE + 3 feet)	1,453 feet	1,487.5 feet	1,510 feet

ENGINEERING ISSUES

The East Barlow Trail Road Alternative presents engineering challenges, particularly on the east side of Clear Creek where the roadway needs to balance between the steep and potentially unstable slopes to the west and Clear Creek on the east. In addition, the connection at the west end of the Sandy River bridge to the existing East Barlow Trail Road to the south requires significant excavation of the west slope to create a new intersection. Figure 3 shows critical engineering features of the East Barlow Trail Road Alternative, along with both options to cross Clear Creek. Attachment B contains plan and profiles for the alternative and options, plus an elevation view and cross section for the retaining wall required for Option B.

ROADWAY CLASSIFICATION AND DESIGN SPEED

As noted in the Alternatives Report, the Clackamas County functional class map shows Lolo Pass Road as a minor arterial north of East Barlow Trail Road, and it is assumed to be a rural minor arterial based on the project's location outside an urban area and without urban features, such as curbs or sidewalks. The design volume is 3,000 Average Daily Traffic (ADT).

The design of the existing roadway does not meet the basic rule (55 mph) in all locations, but where possible, the new or replacement roadway would be developed to meet this standard. The East Barlow Trail Road Alternative assumed a design for the proposed roadway that meets AASHTO standards and aims for a 50 mph design speed, and the proposed curves meet this criterion using superelevations up to 8 percent. Design exceptions would be written as needed if these standards were not met. During a future design phase of the project, the applicable design criteria and any design exceptions would need to be finalized.

DESIGN ASSUMPTIONS

Conceptual alignments were laid out for the East Barlow Trail Road Alternative based on the design criteria and findings regarding hydraulics and sensitive resources. Profile drawings and river cross-section data are presented in Attachment 2.

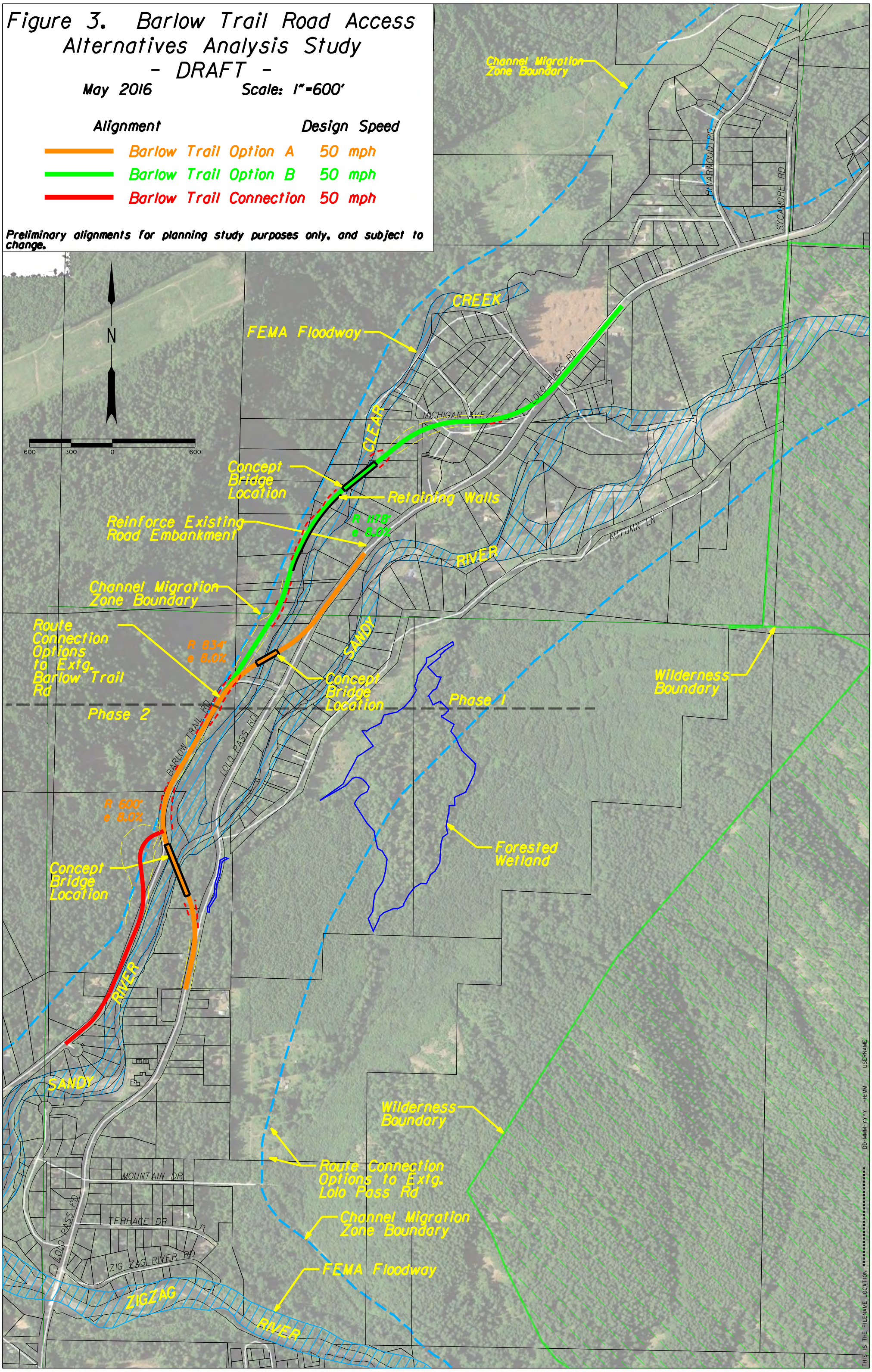
The new roadway would have 11-foot travel lanes and 6-foot paved shoulders, and guardrail on steep embankments and bridge approaches. For a 50 mph design speed, 8-foot shoulders are the standard, so using 6-foot shoulders would require a design exception. The typical section was selected based on the criteria for a rural roadway and the design speed.

Figure 3. Barlow Trail Road Access Alternatives Analysis Study
- DRAFT -

May 2016 Scale: 1"=600'

Alignment	Design Speed
Barlow Trail Option A	50 mph
Barlow Trail Option B	50 mph
Barlow Trail Connection	50 mph

Preliminary alignments for planning study purposes only, and subject to change.



As discussed above in the introduction, the East Barlow Trail Road Alternative was developed with two possible options for crossing Clear Creek and reconnecting to Lolo Pass Road at the north end of the project area. Both options require a significant realignment of the existing East Barlow Trail Road to create a new intersection west of the proposed Sandy River bridge, as the red alignment shows in Figure 3. The profiles in Attachment B show the steep west bank and the excavation required for the intersection. The skewed alignment crossing the river is needed to minimize this impact to the high west bank, while also allowing the new crossing to serve as the continuous alignment turning to extend north. Constructing the intersection with a smaller realignment of East Barlow Trail Road serving as the main through roadway could also be possible; however, that configuration would require a "T" intersection with a right turn for the new roadway at the west end of the Sandy River bridge. Both Clackamas County and WFLHD expressed a preference for the continuous flow of traffic on the primary route.

Clear Creek Option A (Downstream) Crossing Alignment

The new alignment with a crossing of Clear Creek that is downstream from Option B avoids the section where the creek is in proximity to the steep west bank and therefore avoids the long approach retaining wall. The skew across the creek is lessened because of the wider bench on the west bank to fit a longer curve; however, the alignment remains skewed primarily due to the nearness of the road connection east of the creek.

This connection to the existing Lolo Pass Road northeast of the creek crossing is the most significant issue associated with this location—it fails to bypass one of the areas of Lolo Pass Road that is most vulnerable to severe damage from Sandy River flooding. This area of Lolo Pass Road is almost directly across from the narrow west canyon wall along Clear Creek, making it impossible to avoid both areas with a single new alignment.

Clear Creek Option B (Upstream) Crossing Alignment

The new alignment with a bridge across Clear Creek that is farther upstream from the confluence of Clear Creek and the Sandy River (Option B) would extend the alignment north of one of the areas of Lolo Pass Road vulnerable to severe damage from major floods and ongoing river channel migration. This alignment crosses Clear Creek about 1,500 feet beyond the downstream alignment location, in an area where the west bank has a bench above the channel that allows space for the curved bridge approach. The limited space along this bank creates a high skew crossing the creek, but also minimizes the impact to most of the structures in the development along Michigan Avenue. Crossing locations that are not as far upstream are limited by the proximity of the channel to the steep west canyon slope, or would connect to existing Lolo Pass Road where it would still be vulnerable to Sandy River migration.

The proximity of Clear Creek to this steep west bank slope can be seen in an Option B cross section included in Attachment B. The only possibility for a roadway that would avoid the steep 100 percent slope of the canyon is to construct the roadway with a retaining wall that is longer than 600 feet in order to avoid the main channel of Clear Creek. In locations such as the one shown in the cross section, the bottom of the retaining wall could encroach on the BFE and be subject to scour during flood or aggradation events.

BRIDGES AND WALLS

The East Barlow Trail Road Alternative would involve new bridge crossings of Clear Creek and the Sandy River, as outlined above and illustrated in Figures 1 and 3. Specific assumptions about the bridges follow. As noted above, the project could be phased, with the Clear Creek bridge built during phase one and the Sandy River bridge being built during phase two.

Clear Creek Bridge: Option A

The new bridge across Clear Creek under Option A (downstream) would be a 175-foot-long, single-span structure. The bridge type proposed for this crossing location is a 90-inch-deep prestressed concrete girder. Six girders will be required to carry the 36-foot-8-inch–wide bridge section. An 8.5-foot structure depth with allowance for a cast-in-place concrete deck and girder camber is used to set the roadway profile for a minimum of 3 feet of clearance between the water surface elevation of the 100-year flood and the bottom of the bridge structure.

The abutments of this single-span bridge would be small caps founded on small, 30-inch-diameter drilled shafts, similar to the Sandy River bridge described above.

Retaining walls required at the bridges would include standard concrete wingwalls at both abutments. Roadway fills on a 2-to-1 slope (horizontal to vertical) would extend up from the front face of the abutments, resulting in wingwalls approximately 15 feet long.

Clear Creek Bridge: Option B

The new bridge across Clear Creek under Option B would be a 300-foot-long, two-span structure. It would be located upstream of the Option A bridge described above. The relatively long bridge length for crossing Clear Creek is required due to the high skew of this alignment. A 300-foot-long bridge is required to span the 100-year floodway and to allow for channel migration; this length is too long to achieve with the typical, cost-effective bridge types. The bridge type proposed for this crossing location is an 84-inch-deep prestressed concrete girder with each of the two spans being 150 feet long. Six girder lines would be required to carry the 36-foot-8-inch–wide bridge section. An 8-foot structure depth with allowance for a cast-in-place concrete deck and girder camber is used to set the roadway profile for a minimum of 3

feet of clearance between the water surface elevation of the 100-year flood and the bottom of the bridge structure.

Similar to the Sandy River bridge described above, this two-span bridge will require the center pier to be located in the active Clear Creek channel, and similar construction techniques and disadvantages exist for this pier location as well. However, alternative bridge types to achieve a single, 300-foot-long span are likely cost-prohibitive for this low-volume roadway.

The interior bents would be similar to those of the Sandy River Bridge described above, requiring two columns to be supported on large concrete pile caps founded on relatively small-diameter shafts drilled through the alluvial and debris flow sediments that contain large cobbles and boulders, and would be founded in competent rock below. Similarly, the abutments would be small caps founded on small-diameter drilled shafts.

Retaining walls required at the bridges would include standard concrete wingwalls at both abutments. Roadway fills on a 2-to-1 slope (horizontal to vertical) would extend up from the front face of the abutments, resulting in wingwalls approximately 15 feet long. This option would also require a long retaining wall along the roadway approaching the south end of the bridge, as described in the Design Assumptions section of this report.

New Sandy River Bridge

The new bridge across the Sandy River under the East Barlow Trail Road Alternative would be located downstream of the confluence with Clear Creek. The new bridge would be longer, and the profile grade would be raised to provide for a greater hydraulic opening to pass the design flood. The new bridge is proposed to be a two-span structure, with each span being approximately 200 feet long. This two-span structure would require a pier in the active Sandy River channel. Construction of this pier would require a work bridge and cofferdam system to install foundation elements, and construct the pile cap and twin columns. A disadvantage of this two-span configuration is that the substructure elements within the channel areas will restrict stream flow, cause areas of turbulent flows (greatly increasing the potential for scour and channel degradation), and introduce debris catch potentials at the bridges. However, a single-span bridge that is 400 feet long requires a structure type that is likely cost-prohibitive for a roadway with this low traffic volume.

The most appropriate bridge type for a 200-foot-long span is a steel plate girder structure with a cast-in-place concrete deck. Four girder lines will be required to carry the 36-foot-8-inch–wide bridge section. Other structure types, including spliced, precast concrete girders and cast-in-place concrete box girders, are also able to achieve this span length, but those alternatives require temporary falsework bents to be placed in the river for extended periods. These falsework bents are an added project cost and increase the risk of high water flow restrictions

during construction. Given these factors, steel alternatives are a cost-effective bridge type for this application. Bridge costs are further itemized in later sections of this report.

The total structure depth, including steel girder and deck section, would be approximately 7.25 feet. The proposed roadway profile is set to provide for a minimum of 3 feet of clearance between the water surface elevation of the 100-year flood and the bottom of the bridge structure. The 3-foot clearance is recommended for hydraulic openings with a potential for a large amount of debris flow.

The interior bent would require two columns, approximately 6 feet in diameter, to be supported on large concrete pile caps founded on relatively small, 30-inch-diameter shafts. A preliminary estimate is that 12 shafts would be required at each interior bent. These shafts would be drilled through the alluvial and debris flow sediments that contain large cobbles and boulders, and would be founded in competent rock below.

The abutments of the Sandy River bridge under the East Barlow Trail Road Alternative would be relatively small concrete caps founded on small, approximately 30-inch-diameter drilled shafts installed as described above.

Retaining walls required at the bridges would include standard concrete wingwalls at the both abutments. Roadway fills on a 2-to-1 slope (horizontal to vertical) would extend up from the front face of the abutments, resulting in wingwalls approximately 15 feet long.

GEOLOGICAL HAZARDS

GEOLOGIC SETTING

Lolo Pass Road is located along the upper part of the Sandy River drainage, about 10 miles west of Mount Hood. In the project area, the Sandy River occupies a channel about 0.25 to 0.75 mile in width. The river Channel Migration Zone, or CMZ, is bounded by upland areas underlain by Quaternary and Tertiary volcanic rocks. Figure 4 shows the geologic concerns associated with the East Barlow Trail Road Alternative. For reference, the previously considered alternatives are also shown on the map.

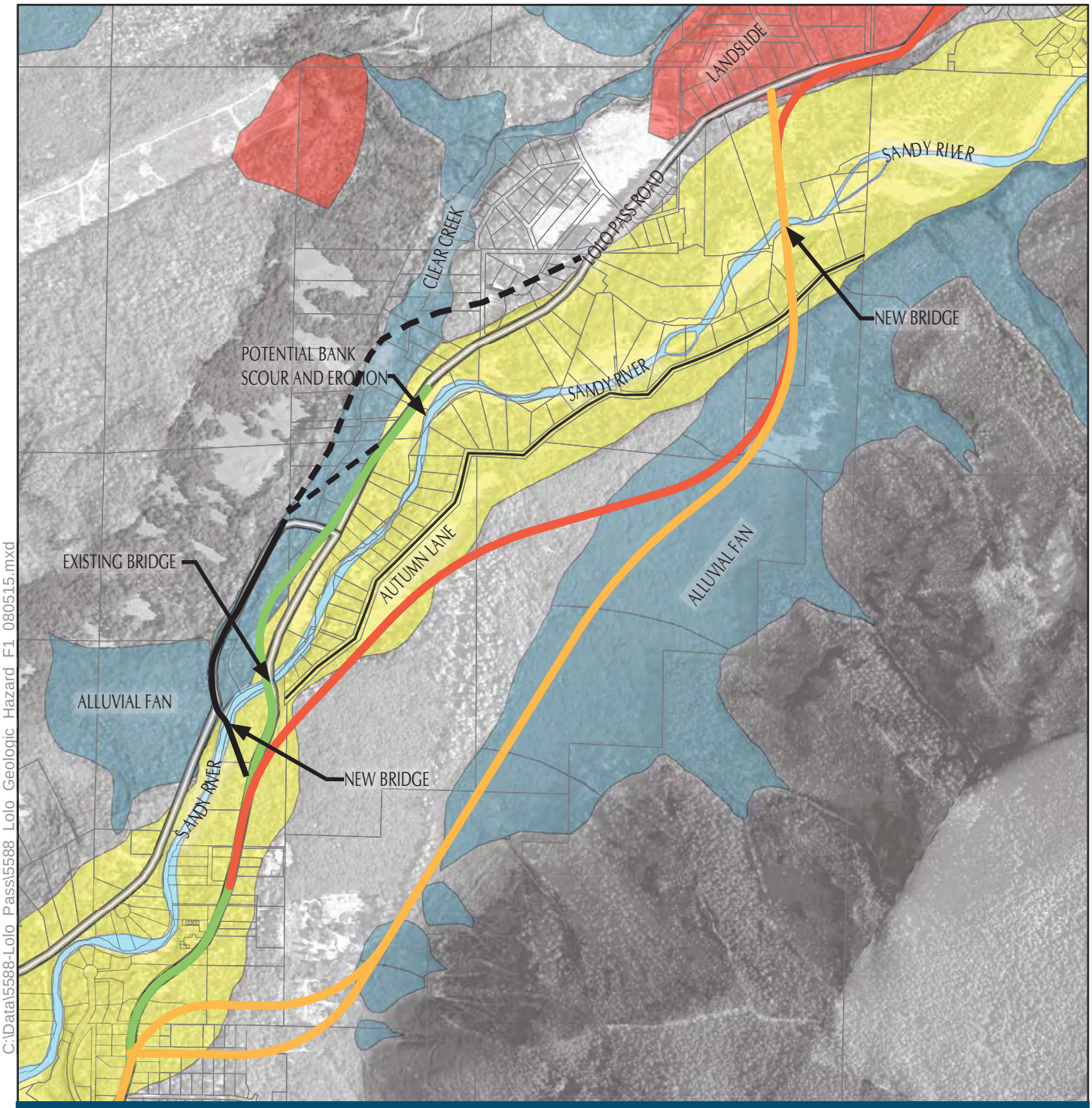
The channel is underlain by granular materials (sand, gravel, cobbles, and boulders) from volcanic debris flow deposits, older consolidated alluvial terrace deposits, and recent alluvial deposits in the active Sandy River channel. The channel for Clear Creek is located along the northwest edge of the CMZ for the Sandy River.

At the location for the new bridge over the Sandy River, weathered siltstone and conglomerate volcaniclastic rock are exposed at the north bank of the Sandy River. Alluvium consisting of sand to boulders is visible on the south bank of the river. To the north of the bridge site, highly weathered to decomposed volcaniclastic rock is exposed in the cut slope along the north side of Barlow Trail Road. The primary geotechnical considerations for design of bridge foundations will be the characteristics of alluvial and debris flow sediments underlying the project alignment, and the depth and quality of the underlying rock.

Northeast of the site for the new bridge over the Sandy River, the alignment for the East Barlow Trail Road Alternative is located along the west edge of an area where alluvium was deposited within the CMZ of Clear Creek. Significant protective measures for the roadway embankment could be needed in some areas to resist erosion from Clear Creek. In addition, there is a risk that the Sandy River could avulse to the Clear Creek channel as a result of flooding. Steep talus-covered slopes ascend northwest from the alignment of this alternative. Locating the alignment on these slopes would require extensive cuts that would have a significant risk of slope instability.

A new bridge over Clear Creek will also be needed. However, the potential bridge locations are not visible from the public roads. This analysis assumes that the geotechnical considerations for the bridge over Clear Creek will be similar to those described above for the Sandy River bridge site.

The point where the alignment of the East Barlow Trail Road Alternative would reconnect with the existing Lolo Pass Road alignment has not yet been determined. The alternative alignment



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Lolo Pass Road Access Alternatives

ALIGNMENT ALTERNATIVES

- MODIFY LOLO PASS ROAD
- ZIG ZAG MOUNTAIN WEST
- ZIG ZAG MOUNTAIN EAST
- BARLOW TRAIL ROAD

GEOLOGIC HAZARD

- ALLUVIAL FAN
- LANDSLIDE
- DEBRIS FLOW

Figure 4
Geologic Hazard Map

North

0 1,000 2,000 FT

GRI

DAVID EVANS AND ASSOCIATES, INC.
LOLO PASS ROAD ACCESS ALTERNATIVES

May 2016 | Job No. 5588-A

could reconnect just northeast of the existing intersection of Barlow Trail Road and Lolo Pass Road. Reconnection at that point will have a significant risk of long-term road closures due to continued scour and erosion of the river bank, especially at the bend in the river just upstream of this location. Another option is to extend the alignment for the new section of Lolo Pass Road northeastward toward the intersection of Michigan Avenue and Lolo Pass Road. The extended realignment would move Lolo Pass Road away from the section of the Sandy River that has been identified as an area of potential riverbank erosion and scour that could damage the road.

FURTHER GEOTECHNICAL INVESTIGATION AND RECOMMENDATIONS

A geotechnical investigation will be needed to design the new bridges over the Sandy River and Clear Creek, and the approach embankments. The primary geotechnical considerations for design of bridge foundations will be the characteristics of alluvial and debris flow sediments underlying the site, and the depth and quality of the underlying rock. The presence of large cobbles and boulders within the sediments are anticipated. Considering the constructability of foundations in this material and the possibility that the foundations will extend into the rock, we recommend considering small-diameter drilled shaft foundations that can be drilled using casing and down-hole hammer equipment, which are typically limited to diameters of about 30 inches. A geotechnical investigation will be needed to evaluate the subsurface conditions for design of bridge foundations, embankment subgrades, and roadway cuts.

A preliminary geotechnical investigation to evaluate the characteristics of the sediments and depth to rock at the proposed bridge location is recommended. The information gathered by the preliminary geotechnical investigation will be useful in conceptual planning, preliminary design, and preliminary cost estimating for the proposed alternatives. GRI recommends using sonic drilling methods for the borings in alluvium and rock coring for the borings into rock. For the East Barlow Trail Road Alternative, four borings are recommended: one at the south Sandy River bridge abutment, one near the north bridge abutment, and two at the location of the new bridge over Clear Creek. The boring located near the north abutment likely can be made in the Barlow Trail Road right-of-way. The borings south of the river and at the Clear Creek bridge site will likely require access onto private property for the exploration to be reasonably close to the proposed bridge location.

The embankment fill for this alternative will be constructed on materials that are relatively loose and potentially susceptible to seismically induced liquefaction. The need for ground improvement methods to reduce the risk of liquefaction should be evaluated as part of the preliminary geotechnical investigation. Ground improvements would most likely be completed before construction of the embankment fills.

COST ANALYSIS

This section provides comparative conceptual-level costs for the East Barlow Trail Road Alternative. The alternatives analysis and cost estimating was conducted at a level of detail sufficient to compare the alternatives with one another. The approach to estimate the costs for the East Barlow Trail Road Alternative was the same as that used for the other alternatives (presented in the Alternatives Report produced in 2015). The analysis is at a greater level of detail than typically used in comprehensive land use and transportation planning, but is a substantially less detailed analysis than expected in analyzing the specific impacts of a proposed project design where more exact right-of-way lines, construction limits, and facility geometry and design features are known.

Table 3 presents a simplified summary of the costs for the alternative.

Table 3. Planning-Level Construction Cost: Summary of Costs by Phase and Option

Project Component	Phase 1 (Includes Clear Creek Bridge)	Phase 2 (Includes new Sandy River Bridge)[a]	Total Estimated Construction Cost
Option A: Full Route	$7.2 million	$11.2 million	$18.4 million
Option B: Full Route	$9.1 million	$11.2 million	$20.3 million

[a] *Phase 2 is the same for both Option A and B. Costs include the removal of the existing Sandy River bridge during Phase 2.*

Tables 4 through 6 present planning-level construction cost estimates for the East Barlow Trail Road Alternative. Tables 4 and 5 present the costs of the two Clear Creek options (Option A and Option B). Table 6 presents cost estimates for the Sandy River bridge and the connection to East Barlow Trail Road, which would be the same with either of the northern options. The northern section could be implemented as a first phase of the work, as discussed at the end of this memorandum.

The costs include the major known construction items using planning-level construction quantity estimates and unit costs. The most significant items are bridge and wall structures, earthwork grading, paving, and drainage and water quality features. The estimates also include costs for bank stabilization in one to two locations along Lolo Pass Road (one location for the Clear Creek crossing farther upstream, and two for the downstream option), as shown on Figures 1 and 3. Note that unit costs used in the 2015 analysis were retained for the calculations below to allow comparable construction costs between all alternatives.

Items not specifically listed are assumed to be included in the contingency percentages. These estimates, however, do not include significant known items such as design and permitting, right-of-way acquisition or utility relocation.

Table 4. Planning-Level Construction Cost: East Barlow Trail Road Alternative: Option A

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL	SECTION TOTALS
Mobilization and Traffic Management					**$ 736,000**
MOBILIZATION (10%)	LS	1	10%	$ 408,000	
TEMPORARY PROTECTION AND DIRECTION OF TRAFFIC (8%)	LS	1	8%	$ 326,000	
Roadwork					**$ 903,010**
GENERAL EXCAVATION	CUYD	1,000	$ 18	$ 18,000	
EMBANKMENT IN PLACE	CUYD	15,000	$ 18	$ 270,000	
CLEARING AND GRUBBING	ACRE	3	$ 4,000	$ 12,000	
AGGREGATE BASE	TON	3,800	$ 24	$ 91,200	
ASPHALT CONCRETE PAVEMENT	TON	2,000	$ 100	$ 200,000	
GUARDRAIL	FOOT	2,766	$ 35	$ 96,810	
STRIPING	LS	1	$10,000	$ 10,000	
SIGNING (3%)	LS	1	3%	$ 123,000	
LANDSCAPING (2%)	LS	1	2%	$ 82,000	
Drainage and Sewers					**$ 195,600**
CULVERT PIPE	FOOT	100	$ 100	$ 10,000	
BIOSLOPES	FOOT	1,560	$ 60	$ 93,600	
BIORETENTION SWALE	FOOT	600	$ 70	$ 42,000	
BIORETENTION POND	EACH	1	$ 50,000	$ 50,000	
Bridges					**$ 1,297,875**
BRIDGE SUPERSTRUCTURE (INCL. RAILS)	SQFT	6,475	$ 125	$ 809,375	
BRIDGE SUBSTRUCTURE (INCL. WINGWALLS)	SQFT	6,475	$ 60	$ 388,500	
REMOVE EXISTING CLEAR CREEK BRIDGE	EACH	1	$100,000	$ 100,000	
Riverbank Protection					**$ 1,980,000**
RIVERBANK PROTECTION (#1)	FOOT	300	$ 3,300	$ 990,000	
RIVERBANK PROTECTION (#2)	FOOT	300	$ 3,300	$ 990,000	
SUBTOTAL					**$ 5,110,485**
CONTINGENCIES (40%)		40%			$ 2,044,194
TOTAL					**$ 7,154,679**

Note: The costs include the major known construction items using planning-level construction quantity estimates and unit costs. Option A would require the removal of the existing Clear Creek bridge. The costs do not include preliminary engineering, permitting, right-of-way, or utility relocation costs.

Table 5. Planning-Level Construction Cost: East Barlow Trail Road Alternative: Option B

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL	SECTION TOTALS
Mobilization and Traffic Management					**$954,000**
MOBILIZATION (10%)	LS	1	10%	$ 557,000	
TEMPORARY PROTECTION AND DIRECTION OF TRAFFIC (8%)	LS	1	8%	$ 446,000	
Roadwork					**$ 1,810,900**
GENERAL EXCAVATION	CUYD	24,000	$ 18	$ 432,000	
EMBANKMENT IN PLACE	CUYD	13,000	$ 18	$ 234,000	
CLEARING AND GRUBBING	ACRE	5	$ 4,000	$ 20,000	
AGGREGATE BASE	TON	9,700	$ 24	$ 232,800	
ASPHALT CONCRETE PAVEMENT	TON	4,500	$ 100	$ 450,000	
GUARDRAIL	FOOT	4,060	$ 35	$ 142,100	
BARRIER	FOOT	500	$ 50	$ 25,000	
STRIPING	LS	1	$ 10,000	$ 10,000	
SIGNING (3%)	LS	1	3%	$ 159,000	
LANDSCAPING (2%)	LS	1	2%	$ 110,000	
Drainage and Sewers					**$ 382,000**
CULVERT PIPE	FOOT	500	$ 100	$ 50,000	
BIOSLOPES	FOOT	4,000	$ 60	$ 240,000	
BIORETENTION SWALE	FOOT	600	$ 70	$ 42,000	
BIORETENTION POND	EACH	1	$ 50,000	$ 50,000	
Bridges					**$ 2,380,500**
BRIDGE SUPERSTRUCTURE (INCL. RAILS)	SQFT	11,100	$ 110	$ 1,221,000	
BRIDGE SUBSTRUCTURE (INCL. WINGWALLS)	SQFT	11,100	$ 75	$ 832,500	
MSE RETAINING WALL	SQFT	6,540	$ 50	$ 327,000	
Riverbank Protection					**$ 990,000**
RIVERBANK PROTECTION (#1)	FOOT	300	$ 3,300	$ 990,000	
SUBTOTAL					**$ 6,517,400**
CONTINGENCIES (40%)		40%		$ 2,606,960	
TOTAL					**$ 9,124,360**

Note: The costs include the major known construction items using planning-level construction quantity estimates and unit costs. The costs do not include preliminary engineering, permitting, right-of-way, or utility relocation costs. Additionally, Option B would not require removal of the existing bridge across Clear Creek. If that bridge is removed, the cost estimate would increase by approximately $140,000 (including contingency).

Table 6. Planning-Level Construction Cost: East Barlow Trail Road Alternative: Southern Section (Sandy River Bridge Crossing and Connection to East Barlow Trail Road)

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL	SECTION TOTALS
Mobilization and Traffic Management					**$ 1,158,000**
MOBILIZATION (10%)	LS	1	10%	$ 643,000	
TEMPORARY PROTECTION AND DIRECTION OF TRAFFIC (8%)	LS	1	8%	$ 515,000	
Roadwork					**$2,939,100**
GENERAL EXCAVATION	CUYD	100,000	$ 18	$ 1,800,000	
EMBANKMENT IN PLACE	CUYD	4,000	$ 18	$ 72,000	
CLEARING AND GRUBBING	ACRE	10	$ 4,000	$ 40,000	
AGGREGATE BASE	TON	7,100	$ 24	$ 170,400	
ASPHALT CONCRETE PAVEMENT	TON	3,700	$ 100	$ 370,000	
GUARDRAIL	FOOT	4,420	$ 35	$ 154,700	
STRIPING	LS	1	$ 10,000	$ 10,000	
SIGNING (3%)	LS	1	3%	$ 193,000	
LANDSCAPING (2%)	LS	1	2%	$ 129,000	
Drainage and Sewers					**$155,000**
CULVERT PIPE	FOOT	150	$ 100	$ 15,000	
BIOSLOPES	FOOT	800	$ 60	$ 48,000	
BIORETENTION SWALE	FOOT	600	$ 70	$ 42,000	
BIORETENTION POND	EACH	1	$ 50,000	$ 50,000	
Bridges					**$ 3,755,600**
BRIDGE SUPERSTRUCTURE (INCL. RAILS)	SQFT	14,800	$ 190	$ 2,812,000	
BRIDGE SUBSTRUCTURE (INCL. WINGWALLS)	SQFT	14,800	$ 57	$ 843,600	
REMOVE EXISTING SANDY RIVER BRIDGE	EACH	1	$ 100,000	$ 100,000	
SUBTOTAL					**$ 8,007,700**
CONTINGENCIES (40%)		40%			$ 3,203,080
TOTAL					**$ 11,210,780**

Note: The costs include the major known construction items using planning-level construction quantity estimates and unit costs. The costs do not include preliminary engineering, permitting, right-of-way, or utility relocation costs. Anticipated costs include the removal of the existing Sandy River bridge.

ACCESS TO PRIVATE PROPERTY

Lolo Pass Road provides public access from US 26 to the west side of the MHNF. The road is the sole winter access to the MHNF and to more than 200 residences, cabins, and campgrounds north of East Barlow Trail Road.

The East Barlow Trail Road Alternative would change access to residences in the vicinity of the project by rerouting their travel to the new roadway. The new roadway would become the primary route, and the existing Lolo Pass Road would be downgraded to a local access road with a reduced maintenance schedule.

Figure 5 shows tax lots and structures in proximity to the East Barlow Trail Road Alternative. People accessing properties north of the confluence of the Sandy River and Clear Creek but south of Mountain Drive would likely encounter out-of-direction travel to locations north and south of Lolo Pass Road. Some of the residences along East Lolo Pass Road that would be bypassed by the new alignment could potentially be cut off from access in a future storm event, if they were unable to reach one of the intact roadways.

27E27CD
500
600
700
800
900
1100
1300
1500
2200
2400
3600
3500
3300
3702
3700
3200
3100
3701
2900
2800
2700
3801
3800
3802
27E34BA
Phase 1
Phase 2
27E34
00400
Barlow Trail Rd
Lolo Pass Rd
Autumn Ln
27E34
00602
27E34
00700
27E34
00603
27E34
00600
27E34 00700
27E34
00601
1300
1301
700
600
800
500
200
100
2500
1302
2600
2700
2800
2900
3200
3100
3000
27E34CB

Lolo Pass Road Access Alternatives

Tax Map Boundary
Buildings
Retaining Wall
Bridge
Barlow Road Trail Option A - Phase 1
Barlow Road Trail Option B - Phase 1
Barlow Road Trail Options A & B - Phase 2
Barlow Road Connection - Phase 2

Figure 5, Sheet 1
East Barlow Trail Road Alternative
Tax Lots

N
0 350 700 Feet

Data Sources: *Metro RLIS, 2016.*

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27E27A
27E27DB
27E27D
27E27CD
27E34BA
Cascade St
Minikahda St
Portland Ave
Michigan Ave
Lolo Pass Rd
Autumn Ln
100
500
600
800
900
1200
4000
1100
3900
3800
3700
1000
3600
3500
3400
1890
1800
2300
2400
2500
1700
2800
900
2700
2601
2501
2503
2000
1900
1800
1700
400
1600
1500
1300
2100
2200
1100
600
700
800
2400
3600
3500
3300
3702
3700
3200
3100
3701
2900
2800
3801
2700
3800
3802
Phase 1
Phase 2
Lolo Pass Road Access Alternatives
Tax Map Boundary
Buildings
Retaining Wall
Bridge
Barlow Road Trail Option A - Phase 1
Barlow Road Trail Option B - Phase 1
Barlow Road Trail Options A & B - Phase 2
Barlow Road Connection - Phase 2
Figure 5, Sheet 2
East Barlow Trail Road Alternative
Tax Lots
N
0
350
700
Feet
Data Sources: *Metro RLIS, 2016.*
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