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Paleontological Resource Technical Report

Digital 299 Broadband
Humboldt, Trinity, and Shasta Counties, California

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Prepared for:

Transcon Environmental, Inc.
1942 University Avenue, Suite 206
Berkeley, CA 94704

Prepared by:

Department of PaleoServices
San Diego Natural History Museum
P.O. Box 121390
San Diego, California 92112-1390

Katie M. McComas, M.S., Paleontological Report Writer & GIS Specialist
Thomas A. Deméré, Ph.D., Principal Paleontologist

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Executive Summary

This Paleontological Resource Technical Report and accompanying GIS database (with geologic and fossil potential layers) was prepared for the Digital 299 (D299) Broadband project (Proposed Action), a proposed regional telecommunications network that will provide broadband infrastructure to portions of Humboldt, Trinity, and Shasta counties, California.

The Proposed Action is to install approximately 300 miles of fiber optic cable, mostly buried along existing roads. New road construction is not proposed. Construction of the Proposed Action would be in two phases, the first phase including construction of the middle-mile fiber optic facilities and vaults, which would be entirely buried. During the second phase of the project, Vero will partner with last-mile providers to build out last-mile connections, planned to be attached to existing utility poles. Wireless facilities (e.g., cellular towers or equipment) are not proposed as part of this Action. The Proposed Action also includes the construction of up to six prefabricated buildings to support signal regeneration, distribution, and interconnection (also referred to as "node" buildings). These buildings would be installed during the first phase of the project and are sited off public land.

The Proposed Action transects a region of complex geology that encompasses portions of three California geomorphic provinces, including the Coast Ranges Geomorphic Province, the Klamath Mountains Geomorphic Province, and the Great Valley Geomorphic Province. In the Coast Ranges Geomorphic Province, relatively young (late Cenozoic), locally fossil-rich sedimentary rocks in the Eel River Basin overlie faulted and metamorphosed Mesozoic-age rocks of the sparsely fossil-bearing Franciscan Complex and non-fossil-bearing Coast Range Ophiolite. In the Klamath Mountains Geomorphic Province, a complex amalgamation of numerous tectonostratigraphic terranes has been intruded by a patchwork of plutonic rocks. (A tectonostratigraphic terrane is defined as a fault-bounded package of rocks of regional extent characterized by a shared geologic history that differs from that of neighboring terranes.) Individual terranes typically represent tectonic fragments composed of ancient ocean crust, volcanic island arcs, and subduction-accumulated mélange that sequentially (east to west) collided with and accreted to the western edge of North America during early Paleozoic, late Paleozoic, Triassic, and Jurassic time. Several of these terranes also include weakly to strongly metamorphosed marine sedimentary rocks that locally contain age-significant fossils. At a few locations in this province are smaller fault-bounded basins containing erosional remnants of Cretaceous marine and Cenozoic nonmarine fossil-bearing sedimentary rocks. In the Great Valley Geomorphic Province, a localized sequence of fossil-bearing late Cenozoic fluvial and alluvial fan sedimentary rocks overlap the eastern margin of the Klamath Mountains and document regional environmental and biotic changes of the last 5 million years.

Following the Potential Fossil Yield Classification System (PFYC) of the USFS and BLM, PFYC rankings have been assigned to all 29 of the geologic units individually mapped as occurring along the alignment and included in the GIS database. Of these, only six geologic units have been assigned a high potential (PFYC 4): unnamed Pleistocene-age marine and nonmarine overlap deposits, and the Falor, Modesto, Riverbank, Tehama, and Weaverville formations. An additional four geologic units have been assigned a moderate potential (PFYC 3): unnamed Pleistocene-age nonmarine terrace deposits, and the Red Bluff, Galice, and Bragdon formations.

Earthwork that will occur within geologic units with a PFYC ranking of 3 or 4 is typically mitigated for impacts to paleontological resources, with the exception of certain types of earthwork that cannot be feasibly monitored for paleontological resources (e.g., small-diameter augering and jack and bore drilling methods). Recommended mitigation measures are provided to address possible impacts, and include a measure to prepare a paleontological monitoring and discovery plan (PMDP). For the

Proposed Action, the PMDP should be prepared once detailed information is available concerning the location, type, and extent of earthwork, and should include (at a minimum) the following standard elements: description of the earthwork (e.g., specific areas, depths of excavation, and/or project components) to be monitored for paleontological resources; methods of paleontological monitoring; procedures for fossil discoveries and determining the significance of a discovery; field and laboratory methods for fossil collection, preparation, and curation; progress and final reporting requirements; and a curatorial agreement with a regional repository to receive any recovered fossil remains.

Contents

1.0 Introduction

This technical report provides an assessment of paleontological resources for the Digital 299 (D299) Broadband project (Proposed Action), a proposed regional telecommunications network that would provide broadband infrastructure to portions of Humboldt, Trinity, and Shasta counties, California. The following current Proposed Action description was provided by Transcon Environmental, Inc.

1.1 Proposed Action Description

The Proposed Action is to install approximately 300 miles of fiber optic cable, mostly buried along existing roads. New road construction is not proposed. Construction of the Proposed Action would be in two phases, the first phase including construction of the middle-mile fiber optic facilities and vaults, which would be entirely buried. During the second phase of the project, Vero will partner with last-mile providers to build out last-mile connections, planned to be attached to existing utility poles. Wireless facilities (e.g., cellular towers or equipment) are not proposed as part of this Action.

The Proposed Action also includes the construction of up to six prefabricated buildings to support signal regeneration, distribution, and interconnection (also referred to as “node” buildings). These buildings would be installed during the first phase of the project and are sited off public land.

The Proposed Action area extends through three counties in northern California: Humboldt, Trinity, and Shasta. The route has been chosen to include alternative segments in case field conditions prove constructability of the main route difficult. The main route and alternative segments are described below, following the route from west to east.

The main route begins along the coast with terminus points in Samoa and Eureka. The alignment follows two routes north around Humboldt Bay, including a crossing of Samoa Bridge from the Peninsula to Eureka, with the two routes connecting Arcata. From Arcata, the main route heads north to its junction with SR 299. From here, it follows two routes: one north for 16 miles through McKinleyville and Clam Beach to a terminus point in Trinidad, and the other continuing eastward as the main route following SR 299 to Blue Lake where it departs from SR 299 through residential Blue Lake, then for 16 miles following Maple Creek Road, Bald Mountain Road, and Snow Camp Road, connecting back to SR 299 at the intersection of Old Highway 200. The main route follows SR 299 for 5 miles to Saber Tooth Road, with an alternative segment continuing on SR 299 and the main route following the Saber Tooth Road and County Route 7K1000 for 6 miles where it reconnects and continues along SR 299 for about 50 miles through Willow Creek, Salyer, Burnt Ranch, Big Bar, to Junction City. At Willow Creek, an aerial spur breaks off from the main route north to serve Hoopa.

Between Salyer and Junction City, three alternative segments are proposed in case the main route along SR 299 is not able to be constructed. One alternative segment departs SR 299 just west of Salyer following Route 447 and Hennessey Road southeast for 15 miles. Another alternative segment departs the main route from Burnt Ranch and follows Route 16, Forest Route 5N09, 5N25, and Eagle Rock Road for 20 miles, including a 5-mile spur up to Eagle Rock Peak. This alternative reconnects with the main route along SR 299 in Big Bar. The third alternative in this area departs the main route west of Helena, breaking into alternate paths around Junction City, the main route heading south along Wintu Pass Road, Forest Route 33N41, Red Hill Road, and Dutch Creek Road, and the alternative segment running north from Valdor Road, an unnamed Forest Road, PowerHouse Road, and Canyon Creek Road; both alternatives reconvene at SR 299 in Junction City.

From Junction City, the main route follows SR 299 to Slattery Pond with an alternative segment continuing on SR 299 and the main route following La Grange Road and Castle Road for 2 miles back to

SR 299 to Weaverville. In Weaverville, the main route breaks from SR 299 to follow Trinity Lake Boulevard, Lance Gulch Road, and Route 3 for 4 miles. An aerial route continues following Route 3 south to Douglas City, while the main route continues east along Browns Mountain Road for 10 miles into Lewiston. Within Lewiston, it follows Lewiston Road, Trinity Dam Boulevard, and other residential roads. It continues east for 17 miles following Deadwood Road, French Gulch Road, and Trinity Mountain Road before the route connects back to SR 299 south of French Gulch.

Connected again with SR 299 south of French Gulch, the main route continues for 14 miles through Whiskeytown and Shasta, breaking south in Redding to follow Buenaventura Boulevard, Placer Street, and other residential roads. It follows Route 273/South Market Street south for 9 miles to Anderson where it follows Barney Road and Locust Street, with an alternative segment following South Barney Road and Industry Road, and the main route following Locust Road to Trefoil Lane, terminating on Trefoil Lane northeast of Cottonwood.

A Proposed Action overview map is included as Figure 1. Additional detailed location maps are included in Appendix A.

1.1.1 Project Facilities and Construction

The backbone consists of four underground conduits housing the fiber optic cable. Barrel vaults are installed underground adjacent to the line to splice the cable and provide access to the conduit. Aerial attachments would extend from the backbone, attaching to existing utility poles to connect communities. Up to six prefabricated buildings (nodes) would be placed to facilitate signal regeneration. These facilities and associated construction methods are described in further detail below.

1.1.1.1 Buried conduit and vaults

Four 1.25-inch conduits would house the fiber optic cable. Cable would be installed in one conduit, while two others would be left empty for maintenance work or future capacity. The conduit would be placed along the road shoulder or through the roadway if shoulders are narrow. Three construction methods are proposed to account for variations in geology and terrain or environmental sensitivities: horizontal directional drilling (HDD); plowing, and trenching with either a trencher, backhoe, or rock saw, all described below.

- Horizontal directional drilling (HDD) – Most of the project (approximately 90%) will be constructed using the HDD method. HDD is a steerable, trenchless method of installing underground conduits along a prescribed bore path by using a surface drilling rig. HDD causes minimal impacts; ground disturbance occurs only at each entry/exit point, referred to as "bore pits." Bore pits would be sized up to 10 feet by 10 feet, to a maximum depth of 4.5 feet. Bore pits would be sited outside sensitive areas and within the 25-foot-wide temporary construction corridor.

  An HDD bore normally installs conduit in 500- to 700-foot ranges, and in some cases over 2,500-foot ranges can be obtained, depending on the substrate. The bore diameter to house the conduit would 4 inches and would be buried between 36-42 inches deep, with a maximum depth of 10 feet achievable when necessary.

  The HDD process involves drilling a hole with guidance equipment and continuous drill bit position monitoring. Once drilling is complete, the conduit is pulled through the bore hole. HDD uses a clay/water mixture that is pumped down the drill stem to lubricate the drill head and drill pipe, maintain the bore hole opening, and remove bore cuttings.

  Vero will employ a Contingency Plan in case of frac-outs during the HDD operation. The Plan will include overarching best management practices as well as site-specific measures and requirements. Agencies will have an opportunity to review and discuss the Plan with Vero prior to issuing permits. General best management practices include but are not limited to installing temporary sediment barriers and storing spoils away from riparian boundaries when boring under waterways; monitoring fluid pressure and bore paths for the duration of drilling operations; keeping a vacuum and spill kit on-site.

- Plowing and trenching – In areas where HDD is not feasible (terrain, environmentally sensitive areas), the plow or trench construction method would be used. A plow machine has a 2- to 3-inch-wide stationary or vibrating blade that cuts a narrow slit for the conduit to be inserted below ground. As the ground is cut, the conduit is installed at the desired depth by feeding it down a chute located on the back of the blade. As the tractor passes the insertion point, the ground is packed behind it, restoring it to its original condition. This allows soil compaction to simultaneously take place as the conduit is being installed as one single action. After the conduits are installed, the furrow is compacted back in place by the back end of the plow or a following compaction vehicle. Plowing creates minimal temporary disruption to the soil; soil disturbance from the plow blade is anticipated to occur within a 4- to 6-inch width. Equipment for this operation include tracked vehicles 10 to 12 feet long.

  Areas of fractured rock or that are otherwise unsuitable for plowing or HDD would be constructed through using trenching machines, excavators, backhoes, or rock saws. The trenches are opened and material is stacked to the side within the 25-foot-wide construction corridor. Conduit is placed and stacked material is returned to the trench and compacted. Temporary soil disturbance from trenching is anticipated to be approximately 6 feet wide. The typical bucket size on a backhoe used for trenching would be 18 inches, up to a maximum of 24 inches.

  Rock sawing is used to dig trenches in rock or extremely compacted soil conditions. The trenching component of the rock saw consists of a large rotating cutting wheel with blades or teeth that cut up/crush the ground as it rotates, breaking rocks or compacted soil. Rock saws are placed along the trench line with the blade lowered to the desired depth. Then the vehicle cuts along the trench line. Spoils from the trench are fine 0.25-inch to 0.5-inch gravel which is deposited adjacent to the trench for backfill. In shallow trenches, spoils are removed, and a slurry backfill is used. The slurry protects the conduit and cable from inadvertent dig ups or damage.

- Barrel/access vaults – Underground vaults are necessary along the alignment to splice cables and provide access to the buried conduit. Vaults are excavated and placed at the same time as conduit installation; they would be sized 4 feet by 4 feet by 4 feet deep, spaced approximately every 2,500 feet. Specific vault locations are unknown but would be placed along the centerline of the conduit within the proposed temporary disturbance area (i.e., 25-foot-wide corridor). Vaults are covered with metal access lids flush with the ground.

- Fiber optic cable placement – Once the conduit and vaults are installed, the conduit is tested and then the fiber optic cable is placed. Fiber optic cable is placed using two primary methods: 1) pulling cable using Kevlar tape or 2) pneumatically using compressed air, colloquially known as "blowing" or "jetting."

  For both methods, a reel of cable is transported via flat-bed truck to access vaults along the alignment. For cable pulling, Kevlar tape is attached to the fiber line and fed into the conduit. Once the fiber/tape reaches the next vault location, it is retrieved and spliced to the next section of fiber. To use compressed air, a truck- or trailer-based compressor and a 3-foot by 2-

foot “blowing machine” channels the cable and compressed air along a tube and into the conduit. The fiber line flows through the conduit with the compressed air, is retrieved at the next vault location, and is spliced to the next section of cable.

1.1.1.2 Overhead conduit

- Bridge attachments – For perennial and intermittent waterways that have bridges, conduit would be attached to the existing bridge, or the fiber cable would be installed in existing conduit already attached to the bridge, if available. All bridge attachments would be certified by a professional civil engineer registered in the State of California. Conduit would be affixed on the side or underside of the bridge to meet visual needs of the particular structure and location. Bolts, clips, or anchors would be used to secure the conduit to the bridge in such a way that it would not impact the structural integrity of the bridge. Typically, a standard drill is used to install hardware on bridges. Conduit would be housed in a single 6-inch steel pipe installed by crews using a “reach around” boom that operates on a trailer that sits on the roadway, with an extension that reaches out from the railing of the bridge and extends below the bridge surface to the work platform.

  At either end of bridge crossings, an area 3 feet wide by 10 feet long (the same size as a bore pit) would be disturbed to bring the buried conduit above ground to attach to bridges. This area would generally be in line with the bridge alignment and up to 50 feet from where the bridge and conduit attachments begin. These areas would be sited outside sensitive areas.

  For water crossings that do not have bridges suitable for conduit attachment but do have culverts, the conduit would be installed using HDD under the waterway or culvert.

- Pole attachments – Fiber cable would be attached to existing utility poles during the second phase of the project. Pole attachments would be utilized only for last-mile attachments to serve communities and CAIs. Additionally, Digital 299 would support the provision of last-mile services in the community of Lewiston, which would be delivered via aerial utility poles within Lewiston. This Proposed Action includes building out the fiber line to strategic pole locations for future connections to homes and businesses within Lewiston; specific connections in Lewiston would be determined between Vero Networks and interested parties.

  Aerial attachments would be installed on existing poles using existing access. New poles or access roads are not proposed as part of this Proposed Action. Although unlikely, it is possible that existing poles would have to be replaced if loading calculations indicate pole structures need to be reinforced to handle increased loads. Vero Networks would coordinate with the pole and landowners regarding any needed pole replacements.

  Existing poles would be accessed using bucket trucks, or crew members would climb the poles to manually attach the cable. Cable would be pulled through rollers from the uphill end of the route. Once the cable is pulled through the rollers, the linemen would return to the poles, detach the rollers, and permanently affix the cable to the pole.

1.1.1.3 Node buildings

The Proposed Action includes installation of up to six prefabricated buildings (nodes) to regenerate transmission signals and serve as points of interconnection to other service providers. Node buildings measure up to 20 feet by 25 feet, depending on location, and would be enclosed in 50-foot by 50-foot secured compounds and secured by locked gates.

The prefabricated buildings would have finished concrete walls, composite or metal roofs, metal doors, and no windows. They are manufactured off-site and placed on-site with equipment. The buildings are secured to concrete slabs, which would likely require grading to create a level surface prior to installation. The proposed node locations are in the communities of Eureka, Arcata, Willow Creek, Big Bar, Weaverville, Redding, Anderson, and Cottonwood. The buildings require electricity, which would be provided primarily by existing commercial power. Each building's commercial power system would be backed up by battery (a minimum of 8-hour capacity) and a 75-kilowatt or 125-kilowatt propane- or natural gas-powered generator. These buildings also may be supported by solar power, and all buildings would have an air conditioning system, similar to large, window-mounted units. These buildings would not be occupied but can accommodate one to two persons to work on equipment. Typically, visits to check on equipment would occur monthly.

Node buildings will be located off public land. Specific locations have not been determined.

1.1.1.4 Construction operations

Equipment needed to construct the Proposed Action would include a Caterpillar D8, backhoe, 10-wheeler truck, semi-trailer truck, three-quarter-ton pickup truck, excavator, trencher, dozer/plow, loader, cable reel trailer, air blower device, air compressor, mechanical pusher/puller, and water truck. All equipment would stay within the 25-foot construction area or staging areas. Multiple crews would be working concurrently along the route, all in a generally linear fashion. Construction pace is between 500 feet and 2 miles per day, depending on construction method and terrain. Access and egress to and from construction sites would occur along existing roadways.

Staging and laydown areas are used to store vehicles, equipment, and materials during construction. Temporary parking of vehicles overnight would occur within these areas or as permitted along remote unpaved back roads. Areas potentially used for staging or laydown have been pre-determined, included in this environmental analysis, and are depicted on maps in Appendix A. It is expected that more staging/laydown areas are identified than will be needed.

Staging/laydown areas have been previously disturbed, and grading is not anticipated prior to use.

- <u>Construction schedule</u> – The total duration of construction for the Proposed Action is estimated up to 24 months, estimated to begin in the fourth quarter of 2020. Construction crews generally work 8 to 10 hours a day, 5 days a week, during daylight hours. Saturday work may be required in some areas as needed; approval from the proper agency would be obtained prior to construction on weekends. No work is anticipated to occur on major holidays.

  Digital 299 would avoid lane closures during times of inclement weather, including but not limited to rain, snow, and ice.

  Phase 2 of the project (last-mile connections) would begin construction as soon as last-mile providers and Vero finalize interconnection points and locations of service drops.

- <u>Traffic control</u> – This Proposed Action would follow federal, state, and local guidelines for temporary traffic control in construction zones. Guidelines include signage, cones, barricades, flagging, and pilot cars. Traffic control plans would be submitted for encroachment approval from state and local agencies, based on the specific conditions of the roadways and construction sites involved. Active flagging and the use of pilot cars would likely be used along SR 299 and on city streets, while a combination of signage and flagging would be used in more remote areas. Advanced notification of traffic control measures would be given to the community under certain conditions. The Proponent will develop Traffic Control Plans prior to the start of construction and as required by city and county agencies.

- Subsurface warning tape and cable locating technology – A continuous ribbon of warning tape would be placed along and above the new conduit during construction. The warning tape would be imprinted with a warning message to excavators that fiber optic cable is buried below. The subsurface tape may be magnetic, which would allow engineers to locate the fiber optic cable conduit.
- Fiber optic cable marker posts – Aboveground warning marker posts would be placed along the entire cable route at intervals of approximately 700 feet. The posts would be contained within the ROW directly above or offset of the conduit. These 4-foot-tall metal, poly-vinyl, or fiberglass posts are installed to provide visible evidence of the presence of buried cable, identify the owner of the cable, and provide a telephone number for emergency notifications. The location of the marker post may be adjusted to accommodate sensitive environments (e.g., sensitive vegetation communities) or physical limitations (e.g., rocks). Land management agencies would be consulted on preference for marker posts regarding color, placement, or other features.

1.1.1.5 Operation and maintenance

Operation and maintenance needs for fiber optic networks are generally minimal, but they are required when a risk is identified or damage to the cable is discovered. The fiber line would be electronically monitored continuously for such risk or damage. Surveyors may also drive along the existing roads to inspect the line after a significant weather or seismic event; existing roads would be utilized for operation and maintenance activities. If the conduit requires access, the barrel vaults installed as part of the Proposed Action would be utilized to inspect or repair the line. Ground-disturbing activities associated with on-going operation and maintenance procedures are typically minor and would only occur as a result of erosion control repair in the event of storm damage, landslides, or other emergencies. The scope of this analysis assumes maintenance activities would be confined to the existing roadway and the 10-foot fiber optic ROW.

1.2 Scope of Work

The Proposed Action crosses a region of complex geology that includes a variety of geologic units, including some that are known to contain paleontological resources. This technical report provides baseline data on the nature, distribution, and concentration of paleontological resources along the Proposed Action alignment, examines construction-related potential impacts to paleontological resources, and suggests mitigation measures to reduce potential impacts to paleontological resources to less than significant levels. Also provided is a Geographic Information System (GIS) database containing geologic mapping of the area encompassing a one-mile buffer of the Proposed Action alignment and a paleontological resource potential map of the Proposed Action alignment (also provided in map book format as an appendix to the report). This report was written by Katie M. McComas and Thomas A. Deméré of the Department of PaleoServices, SDNHM. The GIS database was compiled by Katie M. McComas.

1.3 Definition of Paleontological Resources

As defined here, paleontological resources (i.e., fossils) are the buried remains and/or traces of prehistoric organisms (i.e., animals, plants, and microbes). Body fossils such as bones, teeth, shells, leaves, and wood, as well as trace fossils such as tracks, trails, burrows, and footprints, are found in the geologic units/formations within which they were originally buried. The primary factor determining whether an object is a fossil or not is not how the organic remain or trace is preserved (e.g., "petrified"), but rather the age of the organic remain or trace. Although typically it is assumed that fossils must be older than ~11,700 years (i.e., the generally accepted end of the last glacial period of the Pleistocene

Epoch), organic remains older than recorded human history and/or older than middle Holocene (about 5,000 radiocarbon years) can also be considered to represent fossils (Society of Vertebrate Paleontology [SVP], 2010).

Fossils are considered important scientific and educational resources because they serve as direct and indirect evidence of prehistoric life and are used to understand the history of life on Earth, the nature of past environments and climates, the membership and structure of ancient ecosystems, and the pattern and process of organic evolution and extinction. In addition, fossils are considered to be non-renewable resources because typically the organisms they represent no longer exist. Thus, once destroyed, a particular fossil can never be replaced.

Finally, paleontological resources can be thought of as including not only the actual fossil remains and traces, but also the fossil collection localities and the geologic units containing those localities. The collection locality includes both the geographic and stratigraphic context of fossils—the place on the earth and the stratum (deposited during a particular time in earth's history) from which the fossils were collected. Localities themselves may persist for decades, in the case of a fossil-bearing outcrop that is protected from natural or human impacts, or may be temporarily exposed and ultimately destroyed, as in the case of fossil-bearing strata uncovered by erosion or construction. Localities are documented with a set of coordinates and a measured stratigraphic section tied to elevation detailing the lithology of the fossil-bearing stratum as well as overlying and underlying strata. This information provides essential context to enable any future scientific study of the recovered fossils.

1.3.1 Definition of Significant Paleontological Resources

The California Environmental Quality Act (CEQA, Public Resources Code Section 21000 et seq.) dictates that a paleontological resource is considered significant if it "has yielded, or may be likely to yield, information important in prehistory or history" (Section 15064.5, [a][3][D]). The Society of Vertebrate Paleontology (SVP) has further defined significant paleontological resources as consisting of "fossils and fossiliferous deposits[…]consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant, and trace fossils, and other data that provide taphonomic, taxonomic, phylogenetic, paleoecologic, stratigraphic, and/or biochronologic information" (SVP, 2010).

1.4 Regulatory Framework

Paleontological resources are considered scientifically and educationally significant nonrenewable resources; they are protected under a variety of laws, regulations, and ordinances. The Project site is located within Humboldt, Shasta, and Trinity counties, California, and crosses land managed by the Bureau of Land Management (BLM), United States Forest Service (USFS), National Park Service (NPS), and the State of California, as well as tribal and private land. Pertinent laws, regulations, and ordinances are summarized below.

1.4.1 Federal

Notable Federal legislative protection for paleontological resources includes the Antiquities Act of 1906, the National Environmental Policy Act of 1969, the Federal Land Policy Management Act of 1976, and, most directly, the Paleontological Resources Preservation Act of 2009.

The American Antiquities Act of 1906 (6 U.S.C. 431-433). Establishes a penalty for disturbing or excavating any historic or prehistoric ruin or monument or object of antiquity on federal lands. The act also establishes a permit requirement for collection of antiquities on federal lands. Although not specifically addressing paleontological resources, the act is considered relevant to such resources by number of federal agencies that consider fossils to be objects of antiquity.

The National Environmental Policy Act (NEPA) of 1969, (P.L. 91-190; 42 U.S.C. 4321-4347), recognizes the continuing responsibility of the Federal Government to "preserve important historic, cultural, and natural aspects of our national heritage . . ." (Sec. 101 [42 U.S.C. § 4321]) (#382). As with the American Antiquities Act, NEPA does not specifically address paleontological resources but is interpreted by many federal agencies to be applicable to such resources. For example, the BLM and the USFS both view NEPA as one of the major laws protecting paleontological resources on public lands.

The Federal Land Policy and Management Act (FLPMA) of 1976 (P.L. 94-579; 43 U.S.C. 1701-1782) defines significant fossils as: unique, rare or particularly well-preserved; an unusual assemblage of common fossils; being of high scientific interest; or providing important new data concerning [1] evolutionary trends, [2] development of biological communities, [3] interaction between or among organisms, [4] unusual or spectacular circumstances in the history of life, [5] or anatomical structure.

The Paleontological Resources Preservation Act (PRPA) of March 2009 (P.L. 111-011) is the first statute to directly address management and protection of paleontological resources on USFS, BLM, and U.S Department of the Interior, Bureau of Reclamation (BOR) lands. This law essentially codifies collecting polices of federal land management agencies. It allows reasonable amounts of common invertebrate and plant fossils to be casually collected with negligible disturbance. In addition, it requires protection and preservation of uncommon invertebrate and plants and all vertebrate fossils, including imprints, molds, casts, etc. The PRPA further describes requirements for permitting collection on federal lands, stipulations regarding the use of paleontological resources in education, continued federal ownership of recovered paleontological resources, and standards for acceptable repositories of collected specimens and associated data. The PRPA also provides for criminal and civil penalties for unauthorized removal of paleontological resources from federal lands.

To implement the policies of the PRPA, the United States Department of Agriculture (USDA) adopted regulations (Title 36 C.F.R. Part 291) in April 2015 to manage, protect, and preserve paleontological resources on National Forest System lands. These regulations provide for management of paleontological resources by establishing fossil collection permitting procedures, setting curation standards, establishing civil and criminal penalties, prohibiting fossil collection for commercial purposes, and developing procedures for allowing the casual collection of some of these resources on certain lands and under specific conditions.

The Department of the Interior (DOI) proposed its own set of regulations (81 F.R. 88173) in December 2016 for the implementation of PRPA on lands administered by the Bureau of Land Management, the Bureau of Reclamation, the National Park Service, and the U.S. Fish and Wildlife Service. While not yet adopted, these proposed regulations address the management, collection, and curation of paleontological resources—including fossil collection permitting procedures, curation and repository standards, and confidentiality of paleontological locality data—and details civil penalty procedures for illegal collecting, damaging, altering or defacing, or selling of paleontological resources from DOI-administered lands.

1.4.2 Tribal

The Bureau of Indian Affairs (BIA) provides guidance (Indian Affairs Manual Part 59, Chapter 7) regarding the protection and management of paleontological resources, which are considered to be trust resources on tribal lands. As trust resources, the landowner has the right to determine the fate of any discovered fossils, including retaining ownership and/or determining if fossils should be preserved in place. Prior to the excavation of any "imbedded" fossils, written consent to excavate must be received from the landowner and/or tribe. If the landowner and/or tribe consents to fossil excavation, a permit may be required from the BIA, operating under the authority of the Secretary of the Interior, which adheres to the above listed federal legislative protection. The permitting process allows the BIA to ensure that applicants are qualified to complete the excavation, have written consent to salvage the fossils, and have developed a plan for the eventual fate of salvaged fossils.

No permit is required for exploration or surface collecting of "non-imbedded" fossils, but these activites are subject to tribal jurisdiction and/or landowner consent.

1.4.3 State

Notable State legislative protection includes the California Environmental Quality Act and the Public Resources Code.

The California Environmental Quality Act (CEQA, Public Resources Code Section 21000 et seq.) protects paleontological resources on both state and private lands in California. This act requires the identification of environmental impacts of a proposed project, the determination of significance of the impacts, and the identification of alternative and/or mitigation measures to reduce adverse environmental impacts. The Guidelines for the Implementation of CEQA (Title 14, Chapter 3, California Code of Regulations: 15000 et seq.) outlines these necessary procedures for complying with CEQA. Paleontological resources are specifically included as a question in the CEQA Environmental Checklist (Section 15023, Appendix G): "Will the proposed project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature." Also applicable to paleontological resources is the checklist question: "Does the project have the potential to… eliminate important examples of major periods of California history or pre-history." For the proposed project, implementation of APM CUL-08 protects paleontological resources in compliance with CEQA.

Other state requirements for paleontological resource management are included in the Public Resources Code (Chapter 1.7), Section 5097.5 and 30244. These statutes prohibit the removal of any paleontological site or feature on public lands without permission of the jurisdictional agency, defines the removal of paleontological sites or features as a misdemeanor, and requires reasonable mitigation of adverse impacts to paleontological resources from developments on public (state) lands.

Sections within the California Code of Regulations (Title 14, Division 3, Chapter 1), are applicable to paleontological resources on lands administered by the California Department of Parks and Recreation (DPR). Section 4307 includes indicates a person shall not destroy, disturb, or remove a geological feature, and defines a geological feature as including paleontological resources. Section 4309 indicates that a person must require a special permit from the DPR in order to collect paleontological resources in order to not be liable for violating Section 4307.

Section 0309 within the California Department of Parks and Recreation Operations Manual specifically outlines policies for site development and the protection of paleontological resources on DPR-managed land (DPR, 2004). Policy 0309.1 Site Development Policy states that planning for site development will include an evaluation of paleontological resources and stabilization of existing paleontological sites. Policy 0309.2 Paleontological Resource Protection Policy states that "paleontological resources will be protected, preserved, and managed for public education, interpretation, and scientific research," through the following steps: a. inventory and systematically monitor for exposed paleontological resources, and protection of fossils through site stabilization, physical protection, collection, or documentation; b. encourage academic field research and scientific study under approved permits (DPR 412P); c. interpret paleontological resources for park visitors; d. prohibit general classroom collection activities; and e. protect known fossil localities and prevent damage to and unauthorized collection of fossils, including by keeping the locations of significant fossil localities confidential.

1.4.4 Local: Humboldt, Trinity, and Shasta Counties

The Humboldt County General Plan (adopted October 2017) does not specify any requirements for paleontological resources. Paleontological resources, however, are often considered a sub-category of cultural resources. The Conservation and Open Space Element of the General Plan contains requirements for cultural resources that involve the identification and documentation of significant historic and prehistoric resources and the mitigation of impacts to significant cultural resources.

Trinity County last updated the Open Space and Conservation Element of its General Plan in 1973, and it does not contain any reference to paleontological or “prehistoric” resources.

The Shasta County General Plan (amended through September 2004) briefly discusses paleontological resources in the mineral resources group. While the General Plan notes the presence of scientifically significant paleontological resources in the county that are protected under Federal, State, and local environmental laws, it does not specifically outline any requirements for the protection of paleontological resources.

Sources: County boundaries, California Department of Forestry and Fire Protection, 2015; World Topographic Map, Esri et al., 2021

PALEOSERVICES
SAN DIEGO NATURAL HISTORY MUSEUM

FIGURE
1

Overview Map
Digital 299 Broadband
Humboldt, Shasta, and Trinity counties, California

2.0 Methods

2.1 Paleontological Records Search and Literature Review

A paleontological records search of the paleontological collections at the SDNHM was conducted in order to identify any known SDNHM fossil collection localities in the vicinity of the Proposed Action alignment. Online searches of paleontological collections databases were also conducted for the University of California Museum of Paleontology (UCMP; https://ucmp.berkeley.edu/collections/) and the Department of Invertebrate Paleontology-Natural History Museum of Los Angeles County (LACMIP; http://ip.nhm.org/ipdatabase/locality_show).

In addition, a literature review was conducted to gain a greater understanding of the geologic history of the area surrounding the Proposed Action, as well as to determine the types of fossils that specific geologic units underlying the alignment have produced. The literature review included examination of relevant published geologic maps and reports, peer-reviewed papers, and other relevant literature (e.g., field trip guidebooks, unpublished theses and dissertations, archived paleontological mitigation reports). This approach was followed in recognition of the direct relationship between paleontological resources and the geologic units within which they are entombed. Knowing the geologic history of a particular area and the fossil productivity of geologic units that occur in that area, it is possible to predict where fossils may or may not be encountered.

2.2 GIS Database

Paleontological and geological information (primarily composited from a series of published digital geologic maps: Fraticelli, et al., 2012; Irwin, 2009; McLaughlin et al., 2000) was compiled into a GIS database focused on a one-mile radius buffer along the alignment. Additional geologic mapping of the Weed quadrangle (Wagner and Saucedo, 1987) was hand digitized, as no digital geologic map of this area was available. Data fields in the GIS attribute table include the geologic unit name, geologic unit age, fossils known from the geologic unit, and the assigned paleontological resource potential of the geologic unit (see criteria outlined in Section 2.3).

A static version of this dataset showing the paleontological resource potential of geologic units exposed along the Proposed Action route is presented in map book format in Appendix A.

All of the maps presented in this report were prepared using Esri's ArcGIS software.

2.3 Paleontological Resource Assessment Criteria

Several different systems have been devised to assign paleontological sensitivity/potential to geologic units, including the three-level classification of Caltrans (https://dot.ca.gov/programs/environmental-analysis/standard-environmental-reference-ser/volume-1-guidance-for-compliance/ch-8-paleontology) that recognizes High Potential, Low Potential, and No Potential geologic units; the four-level classification of the Society of Vertebrate Paleontology (http://vertpaleo.org/Membership/Member-Ethics/SVP_Impact_Mitigation_Guidelines.aspx) that recognizes High Potential, Undetermined Potential, Low Potential, and No Potential (SVP, 2010); and the multiple-level classification used by the United States Forest Service (USFS) and Bureau of Land Management (BLM). As with the other systems, this system (USFS, 1996; BLM, 2007, 2016) recognizes the fact that paleontological resources are considered to include not only actual fossil remains and traces, but also the fossil collecting localities and the geologic units containing those fossils and localities. This procedure utilizes the Potential Fossil Yield Classification (PFYC) system to assign ranks to geologic units based on the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils (USFS, 1996; BLM, 2007, 2016). Under this system, geologic units with a higher potential are assigned a higher class number. The PFYC system is described below.

2.3.1 PFYC Class 5 – Very High Potential

Very high potential (PFYC Class 5) is assigned to highly fossiliferous geologic units that consistently and predictably produce significant paleontological resources. Units assigned to Class 5 have some or all of the following characteristics:

- Significant paleontological resources have been documented and occur consistently.
- Paleontological resources are highly susceptible to adverse impacts from surface disturbing activities.
- Unit is frequently the focus of illegal collecting activities.

2.3.2 PFYC Class 4 – High Potential

High potential (PFYC Class 4) is assigned to geologic units that are known to contain a high occurrence of paleontological resources. Units assigned to Class 4 typically have the following characteristics:

- Significant paleontological resources have been documented, but may vary in occurrence and predictability.
- Surface disturbing activities may adversely affect paleontological resources.
- Rare or uncommon fossils, including nonvertebrate (such as soft body preservation) or unusual plant fossils, may be present.
- Illegal collecting activities may impact some areas.

2.3.3 PFYC Class 3 – Moderate Potential

Moderate potential (PFYC Class 3) is assigned to geologic units where fossil content varies in significance, abundance, and predictable occurrence. Units assigned to Class 3 have some of the following characteristics:

- Marine in origin with sporadic known occurrences of paleontological resources.
- Paleontological resources may occur intermittently, but abundance is known to be low.
- Units may contain significant paleontological resources, but these occurrences are widely scattered.
- The potential for an authorized land use to impact a significant paleontological resource is known to be low-to-moderate.

2.3.4 PFYC Class 2 – Low Potential

Low potential (PFYC Class 2) is assigned to geologic units that are not likely to contain paleontological resources. Units assigned to Class 2 typically have one or more of the following characteristics:

- Field surveys have verified that significant paleontological resources are not present or are very rare.
- Units are generally younger than 10,000 years before present.
- Units that consist of Recent aeolian deposits.
- Sediments that exhibit significant physical and chemical changes (i.e., diagenetic alteration) that make fossil preservation unlikely.

2.3.5 PFYC Class 1 – Very Low Potential

Very Low potential (PFYC Class 1) is assigned to geologic units that are not likely to contain recognizable paleontological resources. Units assigned to Class 1 typically have one or more of the following characteristics:

- Geologic units are igneous or metamorphic, excluding air-fall and reworked volcanic ash.
- Geologic units are Precambrian in age.

2.3.6 PFYC Class U – Unknown Potential

Unknown potential (PFYC Class U) is assigned to geologic units that cannot receive an informed PFYC assignment. Characteristics of Class U may include:

- Geologic units may exhibit features or preservational conditions that suggest significant paleontological resources could be present, but little information about the actual paleontological resources of the unit or area is known.
- Geologic units represented on a map are based on lithologic character or basis of origin, but have not been studied in detail.
- Scientific literature does not exist or does not reveal the nature of paleontological resources.
- Reports of paleontological resources are anecdotal or have not been verified.
- Area or geologic unit is poorly or under-studied.
- BLM staff has not yet been able to assess the nature of the geologic unit.

2.3.7 PFYC Class W – Water

PFYC Class W includes any surface area that is mapped as water. Most bodies of water do not normally contain paleontological resources. However, shorelines should be carefully considered for uncovered or transported paleontological resources. Reservoirs are a special concern because important paleontological resources are often exposed during low water intervals. In karst areas sinkholes and cenotes may trap animals and contain paleontological resources. Dredging river systems may result in the disturbance of sediments that contain paleontological resources.

2.3.8 PFYC Class I – Ice

PFYC Class I includes any area that is mapped as ice or snow. Receding glaciers, including exposed lateral and terminal moraines should be considered for their potential to reveal recently exposed paleontological resources. Other considerations include melting snow fields that may contain paleontological resources with possible soft-tissue preservation.

2.4 Paleontological Impact Analysis

Direct impacts to paleontological resources occur when earthwork operations cut into the geologic units within which fossils are buried and physically destroy the fossil remains. As such, only earthwork (e.g., mass grading, trenching, large diameter boreholes, etc.) that will disturb potentially fossil-bearing geologic units have the potential to result in significant impacts to paleontological resources. As described above, geologic units with significant paleontological resources are those rated as PFYC 3, 4, or 5. Using a conservative approach, geologic units rated as PFYC U are also considered to potentially contain significant paleontological resources until proven otherwise. Although impact avoidance is possible through relocation of a proposed action, paleontological monitoring during construction is typically recommended to reduce any negative impacts to paleontological resources to less than significant levels.

Typically, the purpose of an impact analysis is to determine which (if any) of the construction-related earthwork activities for the Proposed Action may disturb potentially fossil-bearing geologic units, and where and at what depths these impacts are likely to occur. However, because the the specific locations of the various construction elements are currently unspecified, it is not possible to effectively evaluate the location, extent, and likelihood of impacts to paleontological resources. Given this situation, only a general discussion of standard types of impacts are provided in Section 3.3.

3.0 Results

3.1 Geologic Setting

The Proposed Action traverses a geologically complex region that encompasses portions of three California geomorphic provinces, each characterized by its distinctive landforms, rock types, style of tectonic deformation, and fossil content. These include, from west to east: the Coast Ranges Geomorphic Province, the Klamath Mountains Geomorphic Province, and the Great Valley Geomorphic Province. Each of these provinces contains sequences of geologic units that document distinct, but temporally overlapping, geologic histories. Many of the geologic units that preserve the physical record of regional geologic events also preserve the biological record of the organisms, communities, and ecosystems that existed as these events unfolded. Documenting this biological record, as contained in fossils and the rocks that preserve them, can provide important understanding of the history of life, and underscores the value to society of paleontological resources.

The oldest geologic units in the region occur in the Klamath Mountains Geomorphic Province, which, broadly speaking, represents an assemblage of at least seven primary tectonostratigraphic terranes that became sutured to one another over a period of some 300 million years starting in the Ordovician (~470 million years ago) and ending in the early Jurassic (~195 million years ago). (A tectonostratigraphic terrane is defined as a fault-bounded package of rocks of regional extent characterized by a shared geologic history that differs from that of neighboring terranes.) Many of the Klamath terranes originated as volcanic island archipelagos (island arcs) far out in the proto-Pacific Ocean and were carried eastward on oceanic crust via sea floor spreading to eventually encounter subduction zones or collide with other volcanic island arcs. When they reached a subduction zone, the island arcs were too large or thick to be subducted and were instead accreted or welded to the edge of the adjacent island arc or ocean basin. Not only were remnants of the volcanic island arcs accreted, but also portions of the adjacent oceanic crust and its thin veneer of sea floor sediments (with fossils). The assembly of these terranes occurred in sequence from east to west until eventually they were accreted (most likely as a single amalgamated landmass) to the North American continent along an eastward dipping subduction zone, probably during the latest Jurassic or early Cretaceous (~150–140 million years ago).

The tectonstratigraphic terranes of the southern Klamath Mountains consist of varying combinations of ultramafic (mantle) and mafic (lithospheric) oceanic crustal rocks, oceanic hemipelagic sedimentary rocks, shallow marine sedimentary rocks, island arc volcaniclastic rocks, subduction zone mélange rocks, and subduction-fed intrusive plutonic rocks. Boundary faults separating one terrane from another are regional-scale thrust faults, some of which likely represent ancient subduction zones. A census of the principal southern Klamath terranes includes (from east to west) the Eastern Klamath Terrane, the Central Metamorphic Terrane, the Fort Jones Terrane, the North Fork Terrane, the Hayfork Terrane, the Rattlesnake Creek Terrane, and the Western Klamath Terrane (Irwin, 1989, 1994; Snoke and Barnes, 2006). Paleontologically sensitive geologic units occur in several of the Klamath terranes, but along the Proposed Action route are limited to the Bragdon Formation in the Eastern Klamath Terrane and the

Galice Formation in the Western Klamath Terrane. Much younger paleontologically sensitive geologic units unrelated to the Paleozoic and Mesozoic terrane rocks also occur along the Proposed Action route, and include the Weaverville Formation and unnamed nonmarine river terrace deposits.

Broadly speaking, the Great Valley Geomorphic Province represents a Mesozoic forearc basin that developed above subduction zones involved in accretion of the amalgamated Klamath terranes to continental margin of North America and subduction of the Farallon oceanic plate beneath the North American plate. To the east a magmatic arc was forming fed at depth by subduction-generated plutons that were coalescing as the Sierra Nevada Batholith. Emplacement of these plutons was associated with formation of an Andes-style mountain range, which was shedding sediments to the west into the marine waters of the forearc basin. These Cretaceous-age sediments overlapped the accreted Klamath terranes, eventually covering them with an unknown thickness of sedimentary rocks. Although close to the Proposed Action route, these sedimentary rocks (with fossils), do not occur along the alignment. However, a series of much younger paleontologically sensitive geologic units in this area represent coalesced alluvial fans and outwash streams related to late Cenozoic erosion of the eastern foothills of the Coast Ranges and Klamath Mountains (Tehama Formation, Red Bluff Formation, Riverbank Formation, and Modesto Formation).

The Coast Ranges Geomorphic Province, broadly speaking, represents another amalgamated sequence of volcanc island arc, ocean basin, and subduction zone terranes that were accreted to North America beginning shortly after accretion of the Klamath terranes. Characteristic Mesozoic rocks of this province include the Jurassic-age Coast Range Ophiolite, representing upper mantle and oceanic crustal rocks produced at a spreading center, and the Jurassic-Cretaceous-age Franciscan Complex, representing a jumbled mixture of oceanic crustal rocks and ocean floor sediments metamorphosed in a subduction zone.

Subduction of oceanic crust and sea floor sediments and continental accretion has continued in this region since the Mesozoic, and today is reflected in the eastward spreading remnants of the Farallon Plate (Juan de Fuca and Gorda plates) that are being subducted beneath the northwestward drifting North American Plate at the Cascadia Trench. The nearby Mendocino Triple Junction, which marks the intersection of a spreading center (Juan de Fuca Ridge), subduction zone (Cascadia Trench), and transform fault (San Andreas Fault), is continuing its northward migration that began during the Oligocene (~30 million years ago) as the ancestral San Andreas Fault began accommodating movement formerly confined to the East Pacific Rise spreading center (the precursor of the Juan de Fuca Ridge and Cocos Ridge). In this complex geologic setting, the Eel River Basin was formed during the late Miocene (~7 million years ago) and since then has received thick sequences of marine and nonmarine sediments, many of which are paleontologically sensitive. Of these, however, only the Pleistocene-age Falor Formation and unnamed marine and nonmarine terrace deposits occur along the Proposed Action route. Inland during the late Miocene and Pliocene, the ancestral Klamath Moutains were deeply eroded to produce a planar peneplain surface that subsequently has been tectonically tilted to the west and deeply dissected by westward and southward flowing streams and rivers.

3.2 Geologic Units with PFYC Rankings of 3 or 4

Published geologic mapping of the region crossed by the Proposed Action identifies 29 distinct geologic units directly underlying the proposed route (Table 1). However, only 10 of these are here assigned PFYC rankings of Moderate (PFYC 3) or High (PFYC 4). Because the focus of this report is to determine whether construction of the Proposed Action will impact significant paleontological resources, it was decided to provide detailed geologic and paleontological background only for geologic units of Moderate to High potential. Minimal information (i.e., unit name, geologic age, PFYC rank, and PFYC rank justification) is provided for the remaining geologic units in Table 1 and the attributes table in the GIS database.

3.2.1 Nonmarine terrace deposits (Qt)

General Information: Nonmarine terrace deposits of Pleistocene age (approximately 2.58 million to 11,700 years old) occur in the Weaverville-Lewiston area and the Eureka-Arcata area. In the Weaverville-Lewiston area, these deposits are generally elevated relative to present-day streams, and consist of alluvial sand and gravel (Irwin, 2009). In the Eureka-Arcata area, this unit may also include minor intertongues of shallow marine sediments and the late Pleistocene-age Hookton and Rohnerville formations, in addition to younger late Pleistocene and early Holocene river terraces elevated relative to modern streams (McLaughlin et al., 2000; Ogle, 1953).

Paleontology: Fossil remains of Rancholabrean mammals, including deer, mammoth, and ground sloth, have been recovered from similar Pleistocene-age nonmarine sedimentary deposits in the Douglas City area (south of Weaverville) in Trinity County (Jefferson, 2010). Additional Rancholabrean mammals known from the Humboldt Bay area include bison, American mastodon, and Columbian mammoth (Jefferson, 2010). Partially carbonized wood and poorly preserved internal molds of marine clams have been recovered from possible Hookton Formation sediments in the Henderson Gulch area, located just south of Eureka (Ogle, 1953).

Distribution: Nonmarine terrace deposits underlie portions of Segments 01A, 01A1, 08, and 20–22.

Potential Fossil Yield Classification: Nonmarine terrace deposits are assigned a moderate potential (PFYC 3) based on the scattered occurrence of scientifically significant terrestrial vertebrate fossils recovered from these deposits.

3.2.2 Marine and nonmarine overlap deposits (Qo)

General Information: Marine and nonmarine overlap deposits of early to late Pleistocene age (approximately 900,000 to 11,700 years old) occur in the Eureka-Arcata-Trinidad area. This undifferentiated unit includes a discontinuous series of offshore marine, nearshore marine, estuarine, shallow bay, and tidal flat deposits, and also includes nearshore marine deposits of the Falor Formation (see Section 3.2.3) in some areas to the northeast of Eureka (Harvey, 1994; Kelley, 1984; McLaughlin et al., 2000). Also included in this unit are the overlying marine terrace deposits (McLaughlin et al., 2000; Wagner & Saucedo, 1987).

Paleontology: Harvey (1994) summarized the fossil-bearing Pleistocene deposits along the coast from north of Arcata to Trinidad. The middle Pleistocene-age (approximately 800,000 to 700,000 years old) bioclastic sand deposits at Moonstone Beach, located just north of the mouth of Little River, have produced fossil remains of marine invertebrates and a mammoth. Between Trinidad Head and Little Head, sand deposits of middle Pleistocene-age (approximately 575,000 to 425,000 years old) have yielded an intertidal to subtidal marine invertebrate fauna. Middle Pleistocene-age (approximately 500,000 years old) shallow marine deposits in the Crannell Junction area, meanwhile, have produced a particularly diverse molluscan fauna, along with foraminifers, bryozoans, sponges, annelid worms, barnacles, crabs, mantis shrimp, sand dollars, sea urchins, land plants, and marine vertebrates (bony fish, sea birds, Steller sea lion, and sea otter) (Kohl, 1974). The exposures at Crannell Junction are, in fact, the type locality (the locality from which the specimens on which the species is defined were collected) for the extinct sea otter *Enhydra macrodonta* (Kilmer, 1972). Slightly younger fossil-bearing marine terrace deposits exposed at Elk Head, to the north of Trinidad, have yielded remains of marine invertebrates that inhabited a sublittoral rocky shoreline environment during the middle Pleistocene (approximately 450,000 to 350,000 years ago). Finally, late middle Pleistocene-age (approximately

209,000 to 143,000 years old) nearshore marine and shallow bay deposits exposed near the mouth of Mad River have yielded fossil remains of mollusks, crustaceans, and plants (Harvey, 1994). The approximate locations of these fossil localities are shown in Appendix A.

Distribution: Marine and nonmarine overlap deposits underlie portions of Segments 01A, 01A1, 02A, and 02 Glendale Alt.

Potential Fossil Yield Classification: Marine and nonmarine overlap deposits are assigned a high potential (PFYC 4) based on the documented recovery of marine invertebrates and marine vertebrates from these deposits.

3.2.3 Falor Formation (Qf)

General Information: The early to middle Pleistocene-age (approximately 2.1 million to 700,000 years old) Falor Formation is dominantly composed of cobble and pebble conglomerate and sandstone deposited in a nearshore marine setting, but also includes some continental or fluvial sediments in eastern outcrops (Harvey, 1994; Kelley, 1984; Manning and Ogle, 1950). The Falor Formation is included in the "Wildcat Group" in the Blue Lake-Korbel area (Fraticelli et al., 2012), and in "marine and nonmarine overlap deposits" in the Eureka-Arcata area (McLaughlin et al., 2000). In the Eureka-Arcata area, this map unit also includes fossil-bearing marine and estuarine deposits that are younger than the Falor Formation. Because the actual extent of the Falor Formation is poorly defined in the available digital geologic mapping, it is assumed that this formation is present in areas mapped as the "Wildcat Group" in the Blue Lake-Korbel area, and is likely also present in more limited outcrops in the Eureka-Arcata area where "marine and nonmarine overlap deposits" are depicted (see Kelley, 1984).

Paleontology: A fossil marine invertebrate fauna has been documented from the Falor Formation in the Maple Creek, Boulder Creek, and Canon Creek areas along Mad River, to the southeast of Blue Lake. Included are gastropods (snails), bivalves (clams, mussels, scallops), barnacles, and echinoids (sand dollars) that are indicative of a cool water, shallow, open marine paleoenvironment (Manning and Ogle, 1950). Manning and Ogle (1950) also report small conifer cone fossils recovered from near benchmark (BM) 999 along Maple Creek Road, "fairly well preserved leaves in poorly fissile clayey shales" located east of the Korbel post office, and large chunks of carbonized wood in gray clay beds located along Mad River. Fossil remains of marine mammals, including the partial skull of a dwarf baleen whale (*Herpetocetus* sp.), have also been reported from sandstone cobbles derived from the Falor Formation in the Boulder Creek area (Boessenecker, 2013).

Distribution: The Falor Formation underlies portions of Segments 02 and 03.

Potential Fossil Yield Classification: The Falor Formation is assigned a high potential (PFYC 4) based on the documented scientifically significant marine vertebrate, marine invertebrate, and plant fossils recovered from these deposits.

3.2.4 Modesto Formation (Qm)

General Information: The Modesto Formation was named for late Pleistocene- to early Holocene-age (approximately 75,000 to 9,000 years old) fluvial and alluvial fan sediments exposed on the south bluff of the Tuolumne River south of the city of Modesto. Marchand and Allwardt (1981) suggested that these sediments were deposited as a continuous series of coalescing alluvial fans along the eastern flanks of the Sierra Nevada between the Kern River in the south and the Sacramento River in the north. More recently, the formation name has been widely applied to young Pleistocene fluvial terrace deposits in other parts of the Great Valley, including the area around Red Bluff and Redding, where the formation is divisible into at least two units, primarily distinguished on the basis of topographic expression (i.e., degree of dissection of terrace and alluvial fan surfaces) and position (characteristic elevation of surfaces), as well as degree of soil development (Blake et al., 1999). As such, the upper unit typically consists of poorly consolidated clays, silts, sands, and gravels that form the topographically higher of the two Modesto Formation terraces. The lower unit is also poorly consolidated, but sediments are more weathered than those in the upper unit and contain better developed paleosol horizons. Lower unit terraces topographically are a few meters lower than upper unit terraces (Helley and Harwood, 1985).

Paleontology: The Modesto Formation has produced significant vertebrate fossils (e.g., large-bodied land mammals) from a selection of sites in San Joaquin, Fresno, Merced, Stanislaus, Yolo, and Sutter counties (Dundas et al., 2009; Jefferson, 2010; UCMP online database). Certainly the most significant discoveries to date have been those associated with paleontological mitigation work related to construction of the Arboleda Drive overcrossing project along SR 99 southeast of Merced. Over 1,000 vertebrate fossils were collected from 39 localities discovered at varying depths of 2 to 27 feet below original ground surface. Recovered fossils include skeletal elements of bony fishes, frogs, lizards, snakes, birds, and mammals. The latter group includes specimens of mice, gopher, pack rat, kangaroo rat, ground squirrel, rabbits, puma, coyote, dire wolf, mule deer, horses, ancient bison, American llama, western camel, giant ground sloth, and Columbian mammoth (Gust et al., 2012).

Distribution: The Modesto Formation underlies portions of Segments 27–29.

Potential Fossil Yield Classification: The Modesto Formation is assigned a high potential (PFYC 4) based on the documented terrestrial vertebrate fossils recovered from these deposits.

3.2.5 Riverbank Formation (Qr)

General Information: The middle to late Pleistocene-age (approximately 450,000 to 97,000 years old) Riverbank Formation consists of paleosols (ancient soil horizons) and alluvial-fan and stream-laid gravel, sand, silt, and clay sediments derived from the surrounding mountain ranges—the Sierra Nevada to the east and the Klamath Mountains to the north (Marchand and Allwardt, 1981). In the Redding area, the formation rests on an upper and lower terrace, both cut into the surface of the Tehama Formation (Blake et al., 1999). While lithologically very similar to the Modesto Formation, the Riverbank Formation can be distinguished by its elevated position relative to the Modesto Formation and by its greater degree of soil development (Blake et al., 1999).

Paleontology: While not yet documented in the Redding area, fossils of terrestrial vertebrates, fish, and plants have been recovered from the Riverbank Formation where exposed in Sacramento County and the northern portion of the San Joaquin Valley. The majority of fossils were recovered from just a few sites: during construction of the ARCO sports arena in Sacramento, and from the Teichert and Davis gravel pits in Sacramento. These collection localities yielded remains of cyprinid fish, frog, colubrid snake, western pond turtle, duck, mole, coyote, dire wolf, squirrel, pocket gopher, pocket mouse, harvest mouse, pack rat, meadow vole, cottontail rabbit, deer, bison, camel, horse, mammoth, and Harlan's ground sloth, as well as an unidentified leaf impression and seed of a holly-leafed cherry (Hansen and Begg, 1970; Hilton, et al., 2000; Jefferson, 2010). The presence of *Bison* indicates a Rancholabrean age for this assemblage (approximately 240,000 to 11,700 years old). Additional documented vertebrate fossil localities are located in Stanislaus and Merced counties (Jefferson, 2010).

Distribution: The Riverbank Formation underlies portions of Segments 27–29 and 29 Alt.

Potential Fossil Yield Classification: The Riverbank Formation is assigned a high potential (PFYC 4) based on the documented terrestrial vertebrate fossils recovered from these deposits.

3.2.6 Red Bluff Formation (Qrb)

General Information: The early to middle Pleistocene-age (approximately 1.08 million to 450,000 years old) Red Bluff Formation occurs as elevated remnants of a thin pediment cover composed of bright red sandy gravel (Helley and Jaworowski, 1985). In the Redding area, the Red Bluff Formation contains clasts derived from granitic and metamorphic rocks of the Klamath Mountains, and truncates the underlying Tehama Formation (Blake et al., 1999; Helley and Jaworowski, 1985).

Paleontology: Fossil remains of horse (*Equus* sp.)—a humerus and partial lower jaw—are reported from the Red Bluff Formation in the Woodland area (approximately 15 miles northwest of Sacramento) (Jefferson, 2010; UCMP online collections database).

Distribution: The Red Bluff Formation underlies portions of Segments 27 and 29.

Potential Fossil Yield Classification: The Red Bluff Formation is assigned a moderate potential (PFYC 3) based on the scarce occurrence of vertebrate fossils in this geologic unit.

3.2.7 Tehama Formation (Tte)

General Information: The Tehama Formation was named for late Pliocene-age (approximately 3.4 million years old) nonmarine sedimentary rocks exposed in the eastern foothills of the Coast Ranges in Tehama County (Russell and VanderHoof, 1931). These rocks were deposited as a coalesced series of alluvial fans and outwash streams along the western and northwestern margins of the Sacramento Valley, and typically consist of pale yellow to greenish-gray claystones, siltstones, and sandstones with interbedded cross-stratified cobble conglomerates (Helley and Harwood, 1985). A distinctive massive pumice tuff (Nomlaki tuff) occurs in the lower part of the Tehama Formation and has been radiometrically dated at ~3.4 million years old (Sarna-Wojcicki et al., 1991). Although originally described for deposits in Tehama County, the formation name has also been applied to coeval alluvial and fluvial sedimentary rocks around Red Bluff and Redding. On the eastern and northeastern margins of the Sacramento Valley, similar age nonmarine sedimentary rocks have been assigned to the Tuscan Formation.

Paleontology: The Tehama Formation has produced a wealth of late Pliocene land mammal fossils from a number of sites in Butte, Colusa, Contra Costa, Napa, Solano, Tehama, and Yolo counties, with the most diverse assemblages found in Tehama and Yolo counties. The most common fossils are isolated teeth and foot bones of horse, but also include isolated teeth and/or bones of fish, turtle, tortoise, shrew, gopher, pack rat, deer mouse, dog, coyote, peccary, deer, mastodon, and ground sloth. The occurrence of this diverse land mammal assemblage in well-dated sedimentary deposits is significant.

Distribution: The Tehama Formation underlies portions of Segments 27 and 29.

Potential Fossil Yield Classification: The Tehama Formation is assigned a high potential (PFYC 4) based on the documented terrestrial vertebrate fossils recovered from these deposits.

3.2.8 Weaverville Formation (Tw)

General Information: The Weaverville Formation was named for early to middle Miocene-age (approximately 23 to 16 million years old) sedimentary rocks exposed near the community of Weaverville in the southeastern Klamath Mountains. MacGinitie (1937) and Barnett (1989) proposed that these sediments were deposited in fluvial (braided river) and lacustrine (lake and swamp) paleoenvironments in a now-separated series of fault-bounded basins. As described by Barnett (1989), the lithologies vary from basin to basin, but in general consist of a thick sequences of blue, fossil-bearing and organic-rich shales, laminated siltstones, lignites, and water-laid tuffs that locally are overlain by cross-bedded sandstones and clast-supported pebble to cobble conglomerates. The combined factors of interbedded tuffs (volcanic ash deposits), bounding faults, and tilted strata suggest that the Weaverville Formation accumulated during a time of regional extensional tectonics involving volcanism, faulting, uplift.

Paleontology: The Weaverville Formation has produced significant plant macro- and micro-fossils from a series of localities in the Klamath Mountains (MacGinitie, 1937; Barnett, 1989). The macro-fossils consist of extremely well-preserved compressions of leaves and flowers, as well as flattened carbonized branches and logs, while the micro-fossils consist of well-preserved pollen grains. The overall flora totals 84 taxa referable to modern genera and families of herbs, vines, shrubs, and trees, and consists of lichens, ferns, grasses, cattails, sumac, water chestnut, legumes, swamp cypress, oak, walnut, laurel, dogwood, sycamore, willow, elm, fig, tupelo, and pine. Ecologically, the Weaverville fossil flora is reflective of a series of plant paleo-communities, including mixed broad-leaf evergreen and deciduous forest, mixed coniferous forest, and cypress-tupelo swamp forest. Paleoclimate indicators suggest a subtropical to warm temperate climate during the transition from the tropical-subtropical floras of the Eocene to the temperate floras of the Miocene.

Other fossils known from the Weaverville Formation include remains of freshwater diatoms, sponges, and mollusks, as well as rare skeletal remains of bony fishes (MacGinitie, 1937).

Distribution: The Weaverville Formation underlies portions of Segments 18–21.

Potential Fossil Yield Classification: The Weaverville Formation is assigned a high potential (PFYC 4) based on its well-preserved and diverse fossil flora, which is arguably the best early Miocene floral record in California.

3.2.9 Galice Formation (Jg)

General Information: The Galice Formation was named for late Jurassic-age (approximately 160 million years old) sedimentary rocks exposed near the community of Galice, Oregon in the northern Klamath Mountains. MacDonald et al. (2006) considered these rocks to have been deposited as a stacked sequence of siliceous hemipelagic sediments and turbidites that conformably overlie ocean crustal rocks represented by the Josephine ophiolite. The hemipelagic sediments of the Galice Formation typically consist of green to black, thinly-bedded radiolarian argillites with lesser green to black radiolarian cherts, both commonly with slaty cleavage. The turbidites primarily consist of dark gray to black slates and thinly-bedded to massive metasandstones and coarse-grained greywackes, along with rare beds of pebble conglomerates containing rounded clasts of black shale. In some areas the formation is interbedded with volcanic tuffs, suggesting deposition in close proximity to an active island arc. Low temperature-low pressure metamorphism of the sedimentary and ocean crustal rocks occurred during late Jurassic accretion of the island arc and intra-arc basin to North America (Nevadan Orogeny) (Saleeby and Harper, 1993).

Paleontology: The Galice Formation is sparsely fossiliferous, but has produced biochronologically significant late Jurassic (Oxfordian-Kimmerigian) marine mollusks (e.g., *Buchia concentrica*) and radiolarians, as well as paleoenvironmentally important trace fossils (Imlay, 1980; Pessagno et al., 1993). Fragmentary plant fossils have also been reported from the Galice Formation.

Distribution: The Galice Formation underlies portions of Segments 07–09 and 11–14.

Potential Fossil Yield Classification: The Galice Formation is assigned a moderate potential (PFYC 3) because of the geochronologically important marine molluscan and radiolarian fossils recovered from this geologic unit.

3.2.10 Bragdon Formation (Mbr)

General Information: The Bragdon Formation was named for early Mississippian-age (approximately 358 to 340 million years old) sedimentary rocks exposed near the town of Bragdon (now covered by Trinity Lake) in the southeastern Klamath Mountains. Watkins (1990) proposed that these rocks were deposited as marine turbidities in an island arc-related ocean basin that formed as a result of Devonian extensional tectonics. Lithologically, the Bragdon Formation typically consists of blue-gray, thinly-bedded, unfossiliferous argillites and thickly-bedded greywackes, but also includes locally fossiliferous lenses of limestones, as well as siltstones, calcareous mudstones, and conglomerates (Watkins, 1974). The latter are characterized by the presence of abundant clasts of chert, white quartz, and limestone (Irwin, 1989).

Paleontology: Fossils reported from the Bragdon Formation include remains of sponges; solitary and colonial corals; fenestrate bryozoans; productid, chonetid, and pedunculate brachiopods; infaunal and epifaunal bivalves; gastropods; scaphopods; trilobites; and crinoids (Watkins, 1974). The majority of these fossils are derived from limestone lenses within the formation, and likely lived on submerged carbonate banks that were subject to limited wave action. This interpretation is based in part on the common occurrence of pedunculate brachiopods in these ancient reef-forming deposits (Watkins, 1993).

Distribution: The Bragdon Formation underlies portions of Segments 22–25.

Potential Fossil Yield Classification: The Bragdon Formation is assigned a moderate potential (PFYC 3) because of the important marine invertebrate fossils recovered from this geologic unit. These fossils provide biochronological and paleoenvironmental data that has been critical to understanding the geologic history of the eastern Klamath Mountains.

3.3 Results of the Paleontological Impact Analysis

In the Eureka-Arcata-Trinidad area, paleontologically sensitive geologic units are widespread, and include unnamed Pleistocene-age nonmarine terrace deposits (PFYC 3), unnamed Pleistocene-age marine and nonmarine overlap deposits (PFYC 4), and the Falor Formation (PFYC 4). In the Redding area, paleontologically sensitive geologic units occur along the northwestern margin of the Sacramento Valley, and include the Modesto Formation (PFYC 4), Riverbank Formation (PFYC 4), Red Bluff Formation (PFYC 3), and Tehama Formation (PFYC 4). In the Weaverville-Lewiston area, paleontologically sensitivity geologic units include nonmarine terrace deposits (PFYC 3), the Weaverville Formation (PFYC 4), and the Bragdon Formation (PFYC 3). The paleontologically sensitive Galice Formation (PFYC 3) occurs in the vicinity of the Trinity River, from Hoopa south to Burnt Ranch. In addition, it should be noted that varying amounts of artificial fill are likely present along previously developed portions of the alignment (especially paved roadways), and may overlie the PFYC 3 and 4 geologic units. If the thickness of artificial fill is greater than the depth of proposed earthwork in a given area, the likelihood of impacts to paleontological resources is diminished accordingly.

As currently understood, approximately 90% of the buried optic cable and conduit will be installed using the horizontal directional drilling (HDD) method. This hydraulic drilling method typically produces spoils of pulverized sedimentary rock in a slurry of lubricant and water, and thus destroys most, if not all, macrofossil remains that may have been present. In addition, the precise stratigraphic context of any encountered fossils (including microfossils) is impossible to document with this construction method, eliminating their research value. Therefore, sections where the HDD method will be used are not recommended for paleontological monitoring. However, excavation of the sending and receiving bore pits (measuring 10 feet by 10 feet, excavated to a maximum depth of 4.5 feet) at either end of HDD segments can be successfully monitored for paleontological resources.

In areas where HDD methods cannot be used, plowing or trenching construction methods are proposed. The plowing method uses a 2- to 3-inch wide stationary or vibrating blade to cut a narrow slit for the installation of conduit to a desired depth, resulting in disturbance measuring 4 to 6 inches wide. Backfill of the slit occurs as the plow machine passes, eliminating the ability for monitors to view any of the minimal spoils expected to be produced by this method. Therefore, sections where the plowing method will be used are not recommended for paleontological monitoring. The cut-and-cover trenching method uses trenching machines, excavators, backhoes, or rock saws to excavate an open trench measuring approximately 6 feet wide. Spoils are placed alongside the trench before being used as backfill, and can result in the successful discovery and recovery of paleontological resources. Therefore, trenching construction methods can be successfully monitored for paleontological resources.

Barrel/access vaults will be placed approximately every 2,500 feet along the alignment, and will measure 4 feet by 4 feet, excavated to a depth of 4 feet. Excavation of access vaults is typically accomplished using excavators or backhoes, which produce spoils often consisting of large blocks of rock or sedimentary matrix that can contain relatively intact fossil remains. Therefore, excavation of access vaults can be successfully monitored for paleontological resources.

The placement of fiber optic cable is achieved by pulling or “blowing”/”jetting” the cable through the conduit between adjacent vault locations. This work does not require any additional excavations, as it utilizes the existing vaults and installed conduit and, therefore, is not recommended for paleontological monitoring.

Bridge attachments may be necessary where the alignment crosses waterways. Conduit will either be attached to the existing bridge or the fiber optic cable will be installed in existing conduit already attached to the bridge, where available. The only anticipated earthwork related to bridge attachments will occur at either end of the bridge crossing, where excavations measuring 3 feet wide by 10 feet long will be required to bring buried conduit above ground to attach to the bridge. Where bridge attachment is not possible, HDD methods will be used to install conduit under the waterway. Both the excavation of pits for bridge crossings and HDD sending and receiving bore pits can be successfully monitored for paleontological resources. In contrast, the actual bridge attachment work does not require earthwork and the HDD drilling cannot be successfully monitored.

The installation of last-mile fiber cable using pole attachments will utilize existing utility poles. This method does not require any ground disturbance and, therefore, is not recommended for paleontological monitoring.

The installation of up to six prefabricated node buildings will require grading of a level building pad prior to pouring of a concrete slab on which to site each structure. Grading typically produces spoils that can contain intact fossils remains and, therefore, can be successfully monitored for paleontological resources.

Construction operations, including the use of laydown/staging areas, placement of subsurface warning tape with the buried conduit, and installation of fiber optic cable marker posts, are not anticipated to require significant excavations into previously undisturbed strata. The proposed laydown/staging areas are located along existing roads in previously disturbed areas, and further grading is not anticipated prior to their use. Placement of subsurface warning tape and marker posts is anticipated to occur within strata that were disturbed during installation of the buried cable and conduit, and therefore will not result in additional impacts to paleontological resources and will not require paleontological monitoring.

Operations and maintenance activities associated with the installed fiber optic network are generally not anticipated to require ground disturbance (i.e., use of existing access roads, and access to buried fiber optic cable via existing barrel vaults). Some minor earthwork may be associated with erosion control repairs that result from storm damage or landslides, but this work is anticipated to be superficial and unlikely to impact previous undisturbed strata. Therefore, work associated with operations and maintenance is not recommended for paleontological monitoring.

Although specific details concerning the locations of the various construction earthwork components for the Proposed Action are not currently available, it is almost certain that earthwork along certain segments of the alignment will disturb geologic units assigned a PFYC ranking of 3 or 4, as outlined in Section 3.2 and Table 1 (also see Appendix A), and thus may negatively impact paleontological resources. As construction details are made available (e.g., locations of access vaults, segments of buried conduit to be installed by the trenching method, HDD sending and receiving bore pits, bridge crossing end points, and node buildings), the included GIS database may be used to determine whether impacts to paleontological resources are likely at a given location along the alignment.

Table 1. Summary of PFYC ratings of geologic units underlying the Proposed Action, listed in approximate stratigraphic order from youngest to oldest.

Geologic Unit	Age	PFYC	PFYC Justification
marine beach and dune deposits	Holocene	PFYC 2: Low	Younger than 10,000 years
surficial deposits, undivided	Holocene	PFYC 2: Low	Younger than 10,000 years
landslide deposits	Quaternary	PFYC 2: Low	Diagenetic alteration
nonmarine terrace deposits	Pleistocene-early Holocene	PFYC 3: Moderate	Significant fossils widely scattered; common invertebrates/plants intermittent
marine and nonmarine overlap deposits	Pleistocene	PFYC 4: High	Significant fossils documented
Falor Formation	early-middle Pleistocene	PFYC 4: High	Significant fossils documented
Modesto Formation	late Pleistocene-early Holocene	PFYC 4: High	Significant fossils documented
Riverbank Formation	middle-late Pleistocene	PFYC 4: High	Significant fossils documented
Red Bluff Formation	early-middle Pleistocene	PFYC 3: Moderate	Significant fossils widely scattered
Tehama Formation	Pliocene	PFYC 4: High	Significant fossils documented
Weaverville Formation	Oligocene-Miocene	PFYC 4: High	Significant fossils documented
Franciscan complex	Cretaceous	PFYC 2: Low	Diagenetic alteration
Coast Range ophiolite	middle-late Jurassic	PFYC 1: Very Low	Igneous rock; metamorphic rock
Galice Formation	late Jurassic	PFYC 3: Moderate	Significant fossils widely scattered

Geologic Unit	Age	PFYC	PFYC Justification
Rogue Formation?	Jurassic	PFYC 1: Very Low	Igneous rock
Western Jurassic terrane	Jurassic	PFYC 2: Low	Diagenetic alteration
Rattlesnake Creek terrane	Permian-Jurassic	PFYC 2: Low	Diagenetic alteration
Hayfork terrane	Permian-Triassic	PFYC 2: Low	Diagenetic alteration
Eastern Hayfork subterrane	Permian-Triassic	PFYC 2: Low	Diagenetic alteration
North Fork terrane	Permian-Jurassic	PFYC 2: Low	Diagenetic alteration
Bragdon Formation	early Mississippian	PFYC 3: Moderate	Significant fossils widely scattered
Abrams Mica Schist	Devonian	PFYC 2: Low	Diagenetic alteration
Balaklala rhyolite	Devonian	PFYC 2: Low	Fossils very rare
Copley Greenstone	Devonian	PFYC 1: Very Low	Igneous rock; metamorphic rock
Central terrane	Paleozoic	PFYC 2: Low	Diagenetic alteration
igneous rocks, undivided	various	PFYC 1: Very Low	Igneous rock
metaigneous rocks, undivided	various	PFYC 1: Very Low	Metamorphic rock
metasedimentary rocks, undivided	various	PFYC 2: Low	Diagenetic alteration
metavolcanic rocks, undivided	various	PFYC 1: Very Low	Metamorphic rock

4.0 Recommendations

4.1 General Strategies for Paleontological Mitigation

Mitigation of significant impacts to paleontological resources along the Proposed Action alignment may be accomplished through avoidance or paleontological monitoring, as summarized below.

4.1.1 Avoidance/Establishment of an Environmentally Sensitive Area

Avoidance of project impacts to paleontological resources can, in some instances, be achieved by project redesign so that the project's impact areas are no longer sited in areas with the potential to contain significant paleontological resources. Avoidance can also involve developing a construction approach that does not involve excavations into potentially fossil-bearing geologic units.

Establishment of environmentally sensitive areas (ESAs) may be employed in conjunction with avoidance in order to protect paleontological resources within or immediately adjacent to certain parts of a project site while concurrently allowing the project to proceed. Generally, ESAs involve some combination of avoidance, exclusionary fencing (or other physical protective barrier), and administrative protection measures as an alternative to excavation.

4.1.2 Paleontological Monitoring

Development and implementation of a paleontological mitigation plan involving paleontological monitoring of earthwork can minimize impacts through recovery and conservation of fossils unearthed during construction, and is the most commonly employed mitigation strategy for paleontological resources. Development of a paleontological mitigation plan commonly involves establishing pre-construction, during-construction, and post-construction procedures and methods designed for the specific conditions of a given project. Pre-construction measures generally address professional qualifications, fossil repository selection, and acquiring relevant permits. During-construction measures generally address construction monitoring, data recovery, safety considerations, fossil discovery and recovery, and inadvertent discoveries. Post-construction measures generally address fossil preparation, fossil curation, fossil storage, and final reporting.

Implementation of the paleontological mitigation plan generally involves paleontological monitoring, and the recovery and conservation of fossils that may be unearthed during a construction project. Most commonly, the paleontological mitigation program is implemented during construction (e.g., active monitoring of excavations), but in rare cases, surveys and fossil salvage can occur prior to construction (e.g., fossils are readily visible in surficial sediments within the project site, and are collected prior to the start of earthwork). Fossils recovered as a result of monitoring are generally prepared and then curated into a regional fossil repository for permanent care and storage.

4.2 Impact Summary and Recommendations

For the Proposed Action, paleontological monitoring is recommended for proposed construction components that will be located in areas underlain by paleontologically sensitive geologic units (i.e., nonmarine terrace deposits, marine and nonmarine overlap deposits, and the Falor, Modesto, Riverbank, Red Bluff, Tehama, Weaverville, Galice, and Bragdon formations; see Appendix A) and will involve earthwork that can be feasibly mitigated (e.g., trenching for underground fiber optic line, excavation of access vaults, excavation of HDD sending and receiving pits, excavations at either end of bridge attachments, grading for node buildings).

The following mitigation measures are recommended to reduce potential project-related impacts to paleontological resources to less than significant levels, and are formulated in accordance with industry standards (e.g., BLM, 2016; Murphey et al., 2019; SVP, 2010).

4.2.1 Suggested Mitigation Measures:

1. Prior to the start of construction, qualified Project Paleontologist should be retained to prepare and implement a paleontological monitoring and discovery plan (PMDP). The PMDP should include (at a minimum) the following standard elements: description of the earthwork (e.g., specific areas, depths of excavation, and/or project components) to be monitored for paleontological resources (based on the mapping included in the PFYC GIS database); methods of paleontological monitoring; procedures for fossil discoveries and determining the significance of a discovery; field and laboratory methods for fossil collection, preparation, and curation; progress and final reporting requirements; and a curatorial agreement with a regional repository to receive any recovered fossil remains.
    - The Project Paleontologist should have a graduate degree in paleontology, paleobiology, or geobiology, and proven experience in supervising paleontological assessment and paleontological mitigation programs. The Project Paleontologist should also have all necessary agency permits as required by the BLM, NPS, USBR, USFS, and California DPR.
    - The repository should be a recognized paleontological specimen repository (e.g., an AAM-accredited museum or university) with a permanent curator, and be capable of storing fossils in a facility with adequate security against theft, loss, damage, fire, pests, and adverse climate conditions.
2. A paleontological monitor, under the supervision of the Project Paleontologist, should be on-site to inspect all relevant earthwork into previously undisturbed deposits of nonmarine terrace deposits, marine and nonmarine overlap deposits, and the Falor, Modesto, Riverbank, Red Bluff, Tehama, Weaverville, Galice, and Bragdon formations. The monitor should take appropriate field notes and photographs to collect and document stratigraphic and paleontological data.
3. If fossils are discovered, they should be salvaged by the paleontological monitor and/or the Project Paleontologist. In most cases this fossil salvage can be completed in a short period of time (e.g., minutes to hours). Because of the potential for the recovery of microvertebrate fossil remains, such as isolated mammal teeth, it may be necessary to collect bulk sedimentary matrix samples.
4. In the event that fossils are discovered during a period when a paleontological monitor is not on site (an inadvertent discovery), earthwork within the vicinity of the discovery site should temporarily halt and the Project Paleontologist contacted to evaluate the significance of the discovery. If the inadvertent discovery is determined to be significant, the fossils should be recovered, as per mitigation measure 3.
5. Fossil remains collected during monitoring and salvage should be cleaned, repaired, sorted, identified, and cataloged as part of the mitigation program. Fossil preparation may also include screen washing for microvertebrate fossils or other laboratory analyses, if applicable. Fossil preparation and curation activities may be conducted at the laboratory of the contracted Project

Paleontologist (if so equipped), at an appropriate outside agency, and/or at the designated fossil repository, and should follow the standards of the designated repository.

6. Prepared fossils, along with copies of all pertinent field notes, photos, and maps, should be housed in the designated repository. Curation of the fossils should be accompanied by financial support for initial specimen storage (e.g., purchase of storage cabinets).
7. A final summary report should be completed that outlines the results of the mitigation program. This report will include discussions of the methods used, stratigraphic section(s) exposed, fossils collected, and significance of recovered fossils. This report should be submitted to the appropriate agencies, as well as to the designated repository (if fossils are recovered).

5.0 References

*indicates source geologic map used in GIS database compilation

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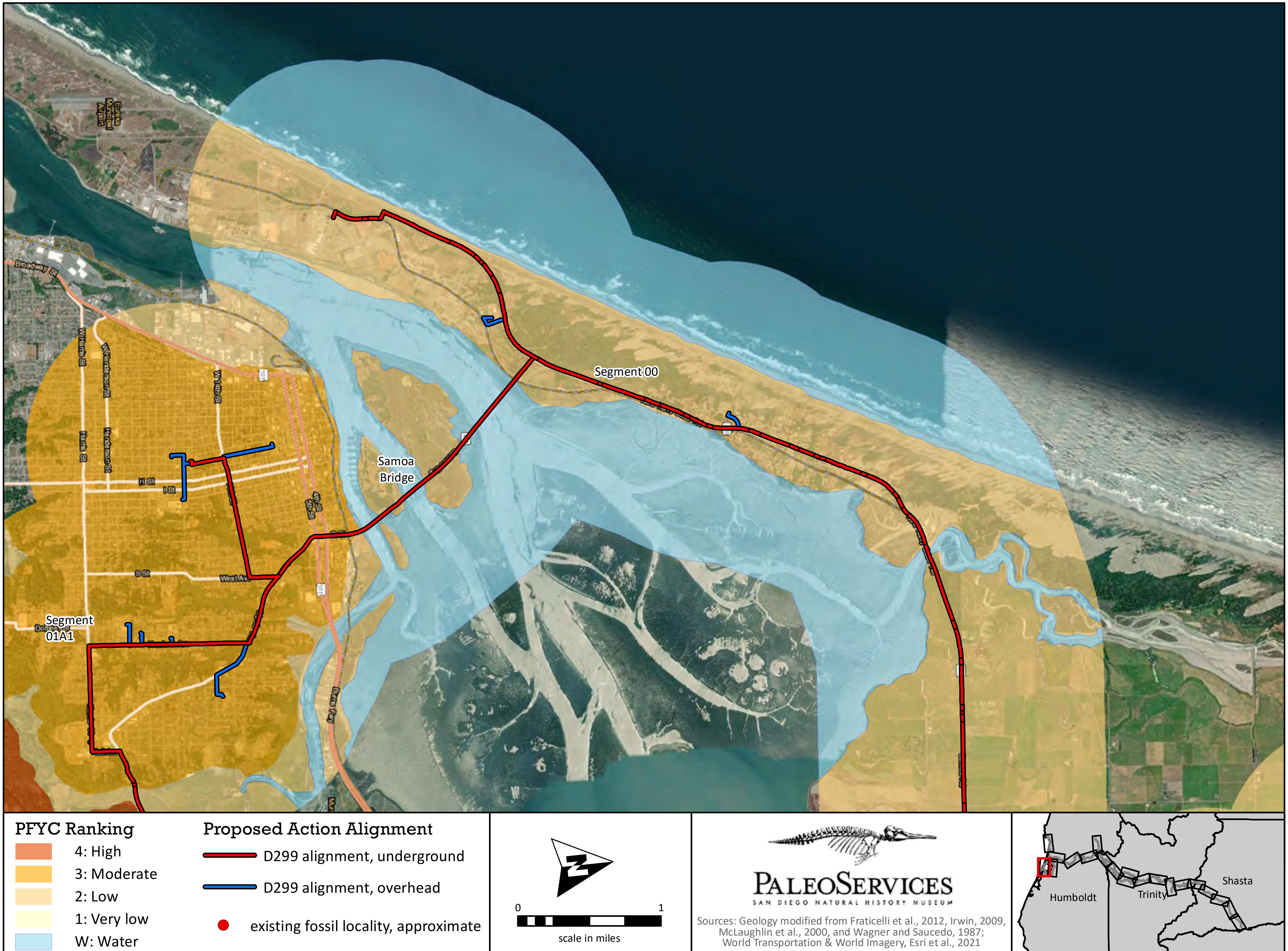
Appendix A

PFYC map of the Proposed Action alignment.



Appendix A: Paleontological Potential Map, Digital 299 Broadband, Humboldt, Trinity, and Shasta Counties, California

PFYC Ranking

- 4: High
- 3: Moderate
- 2: Low
- 1: Very low
- W: Water

Proposed Action Alignment

- D299 alignment, underground
- D299 alignment, overhead
- existing fossil locality, approximate

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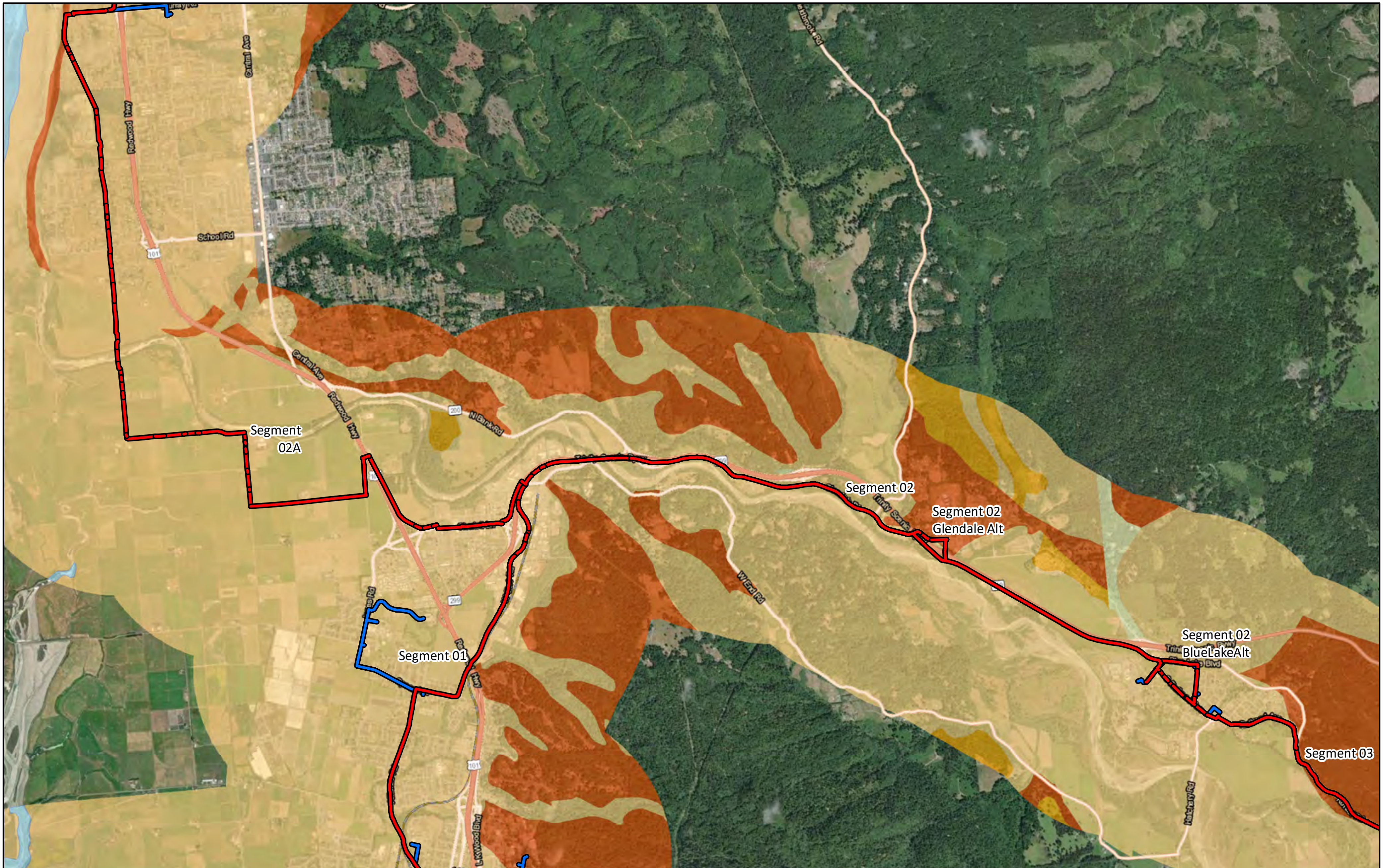

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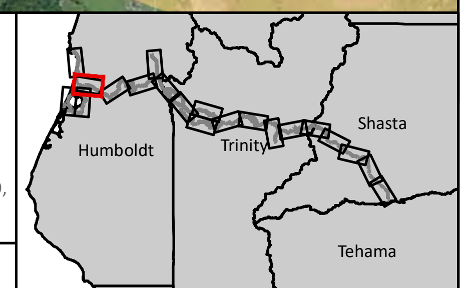

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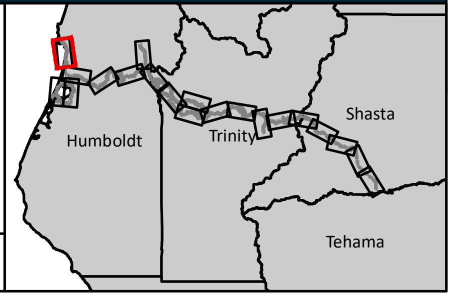

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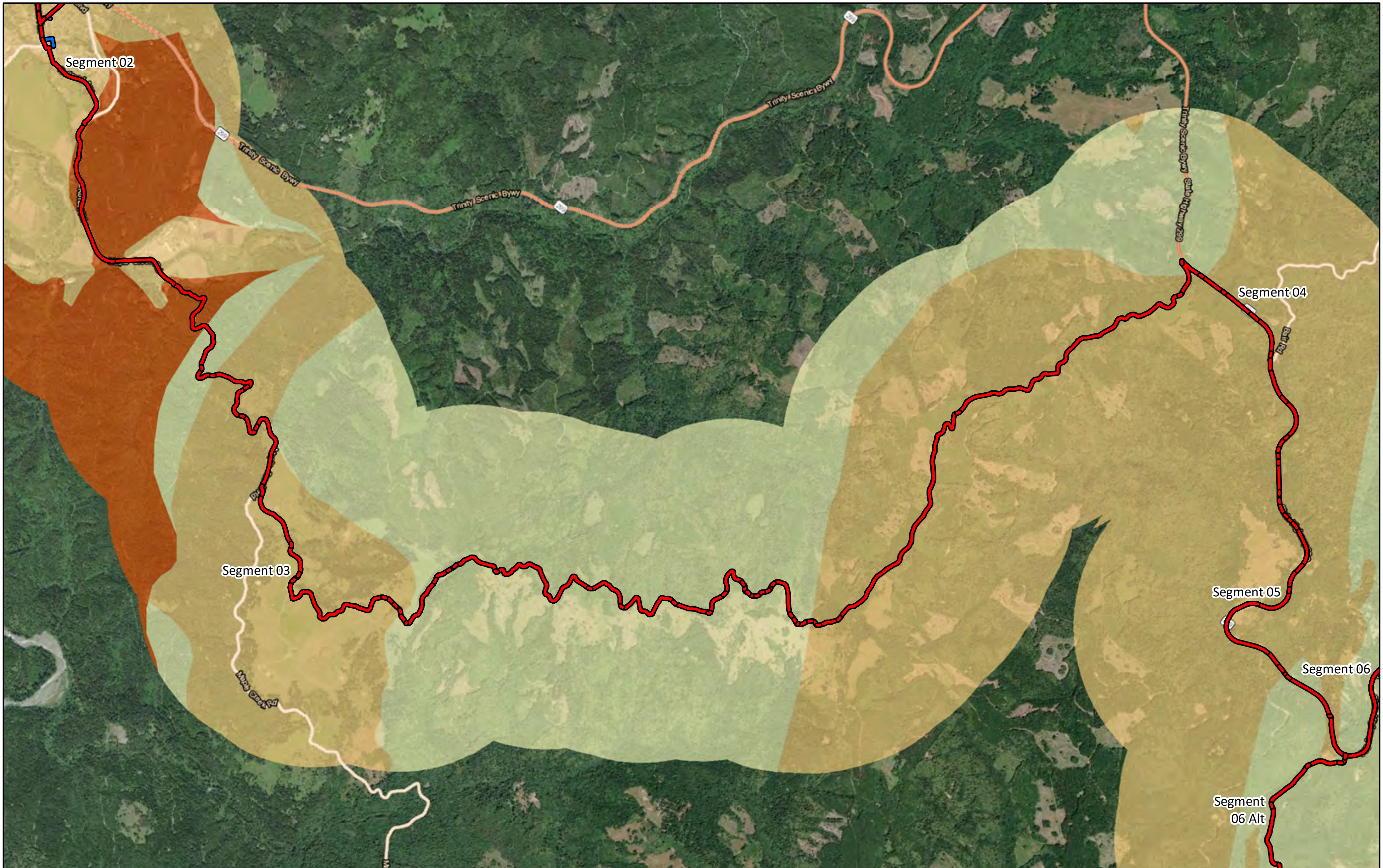

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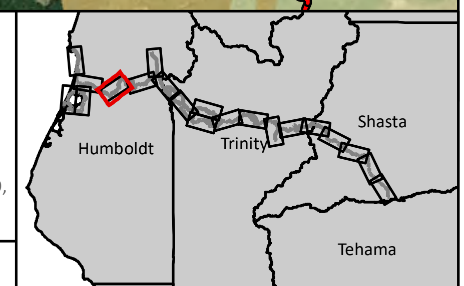

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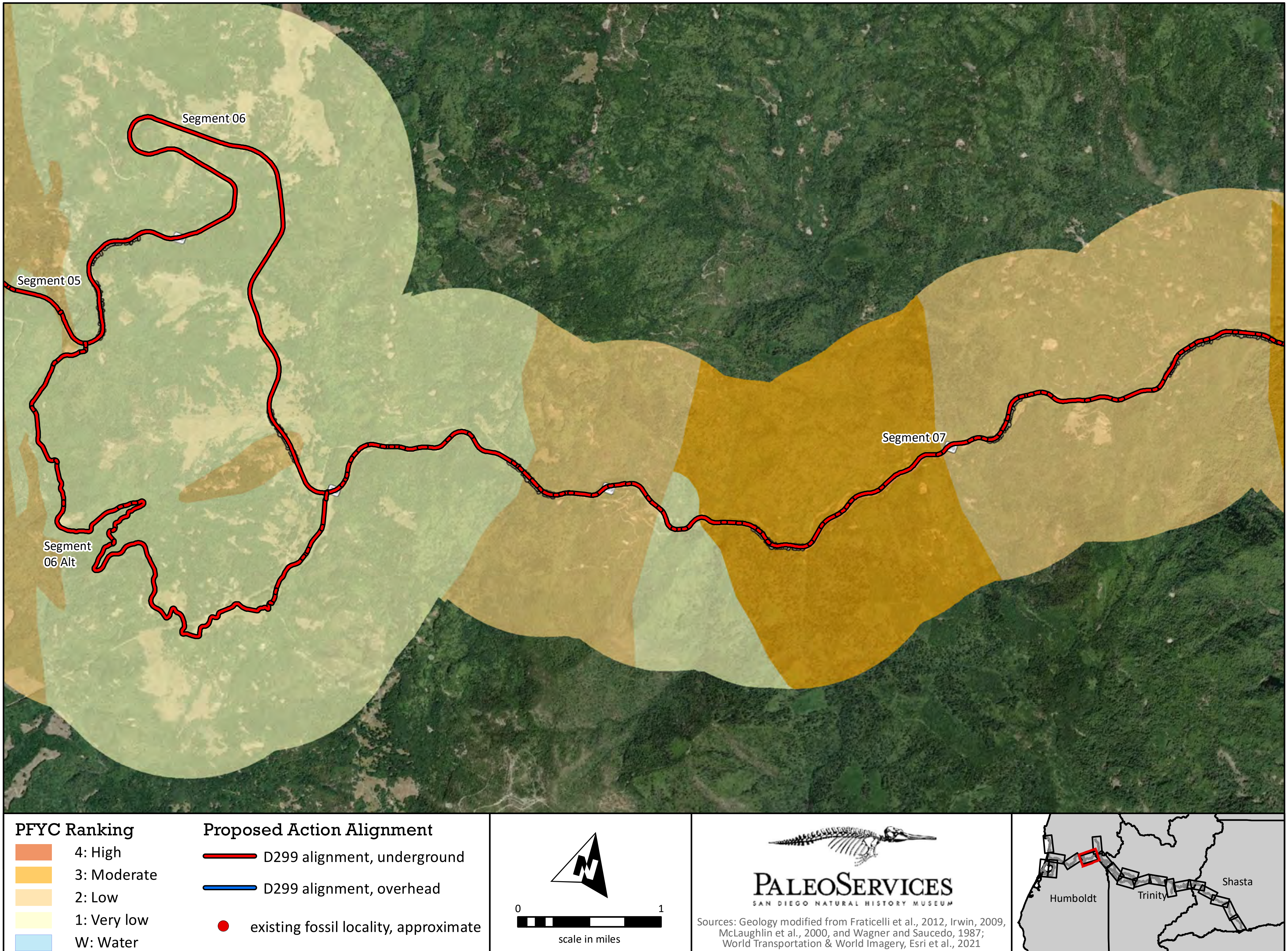

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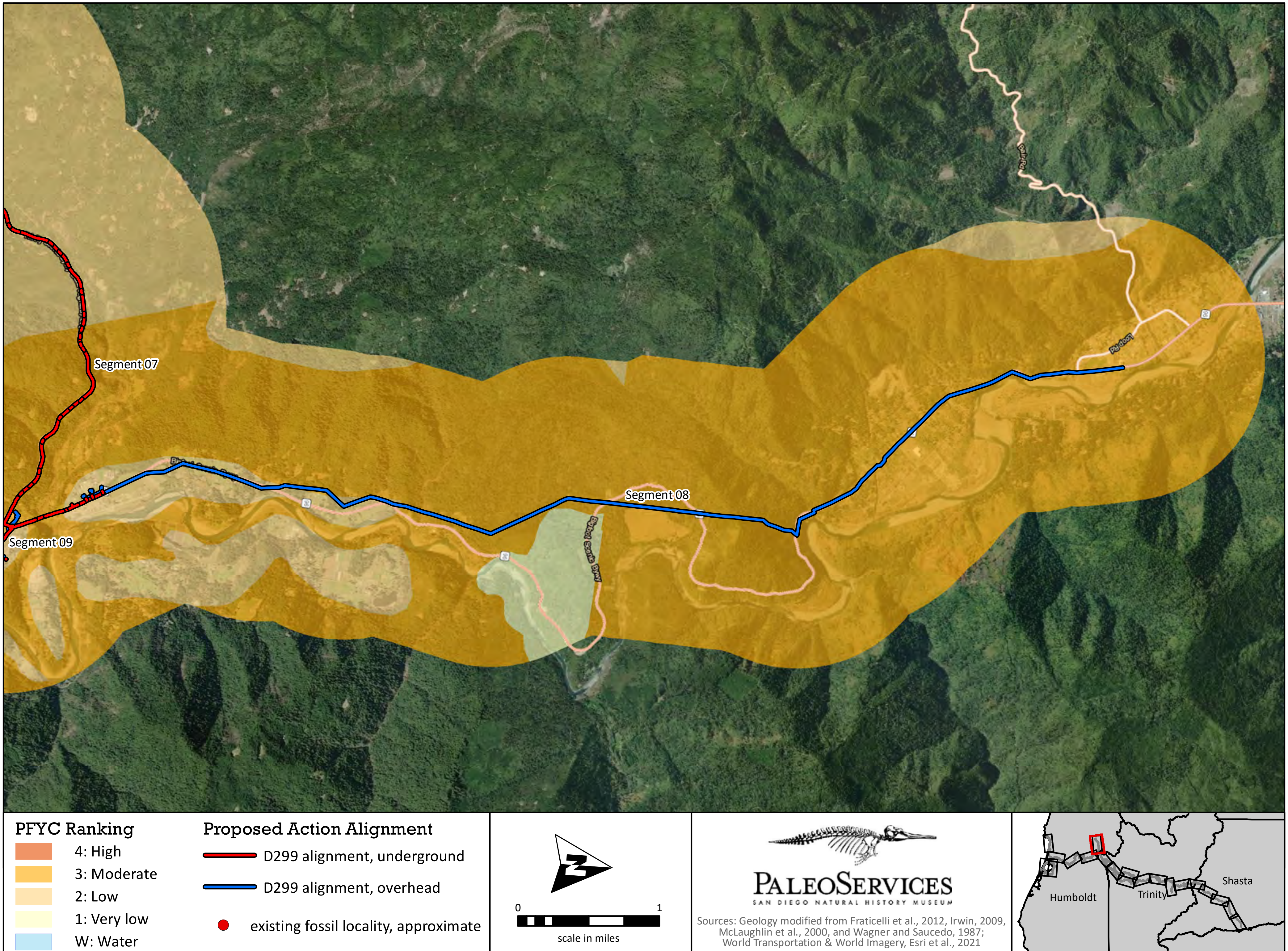

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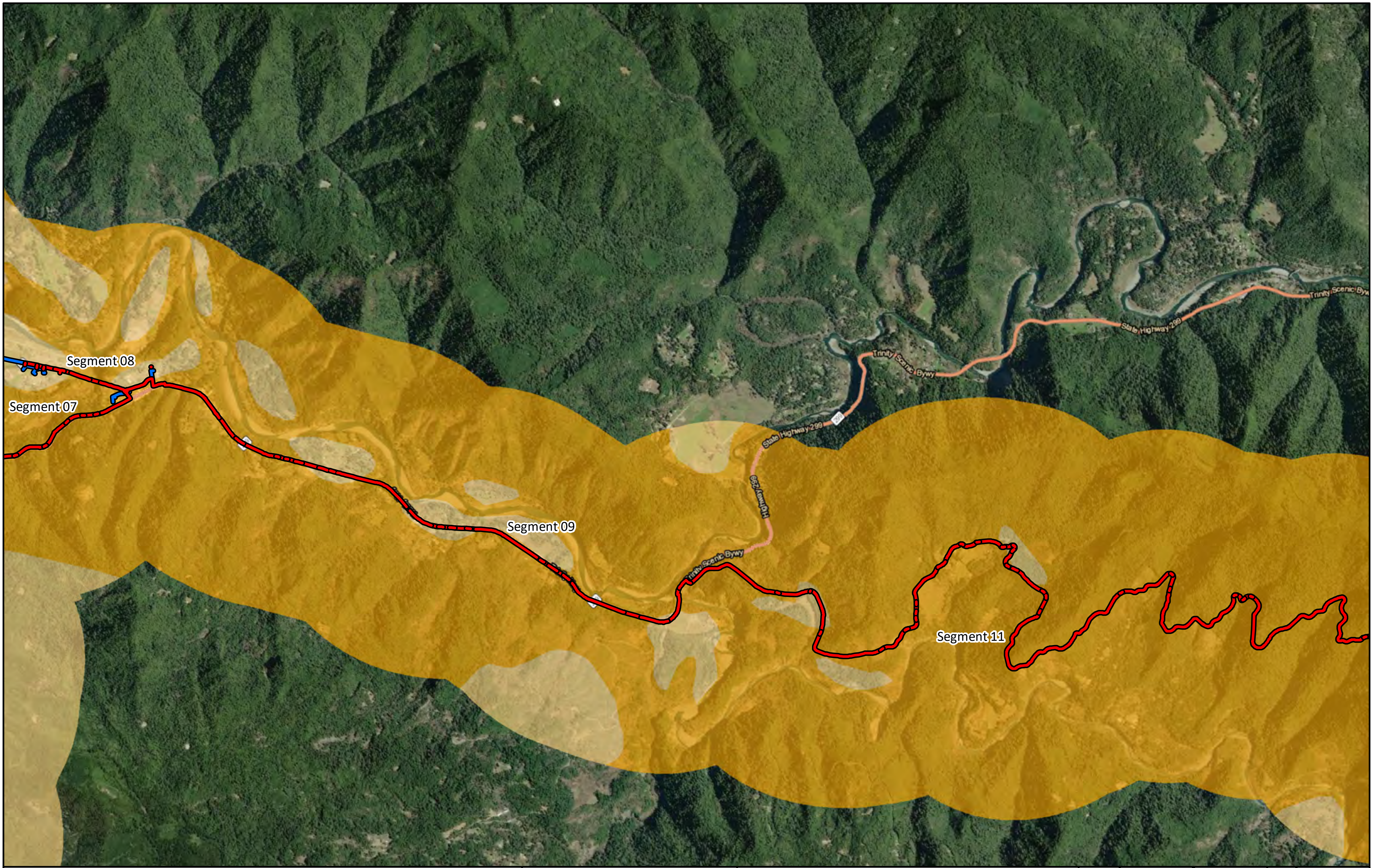

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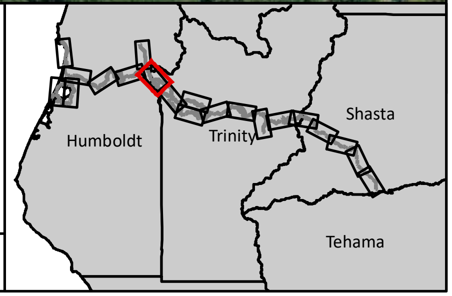

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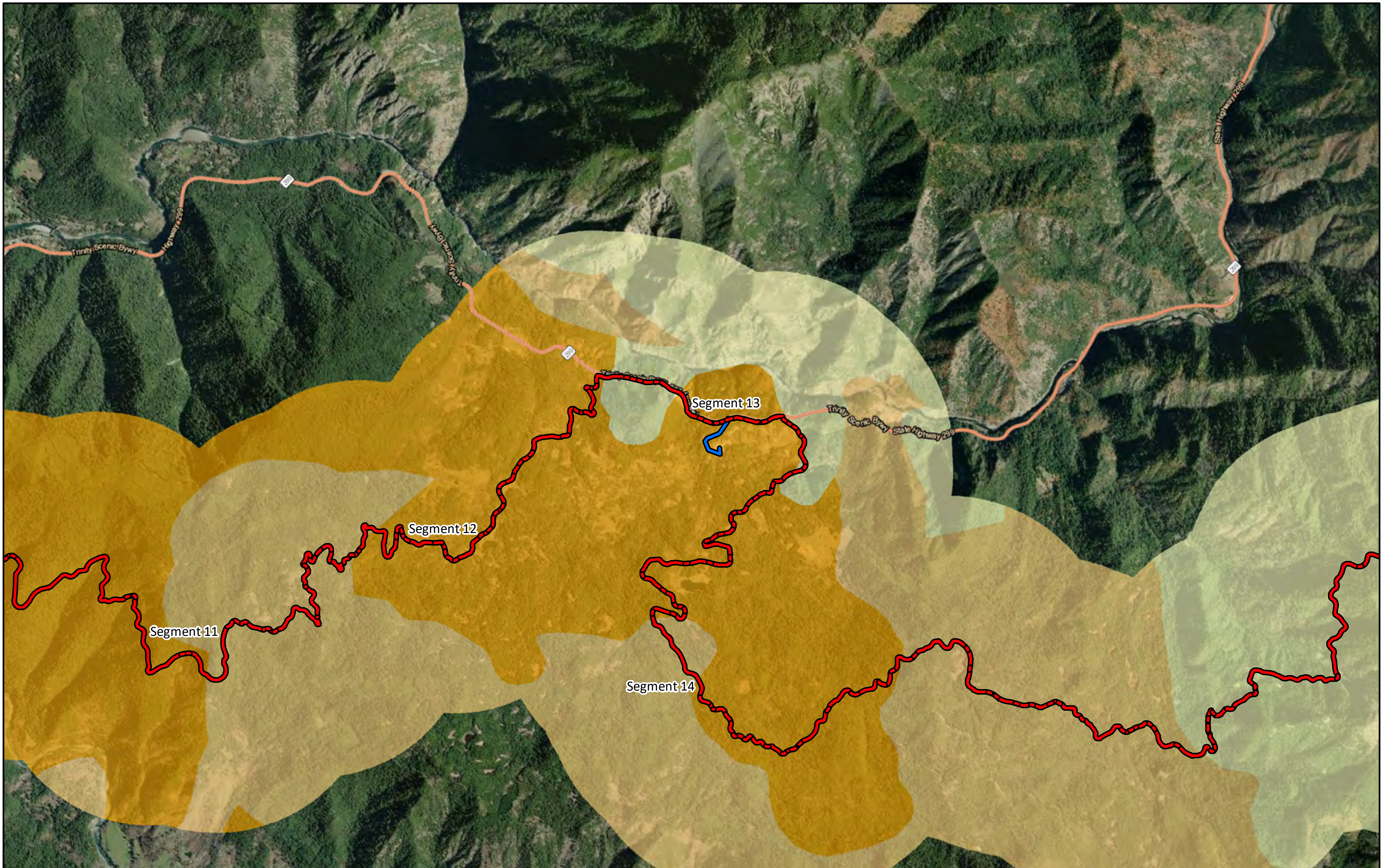

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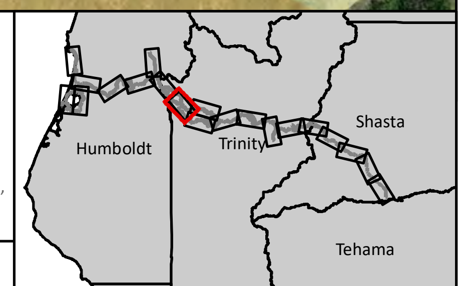

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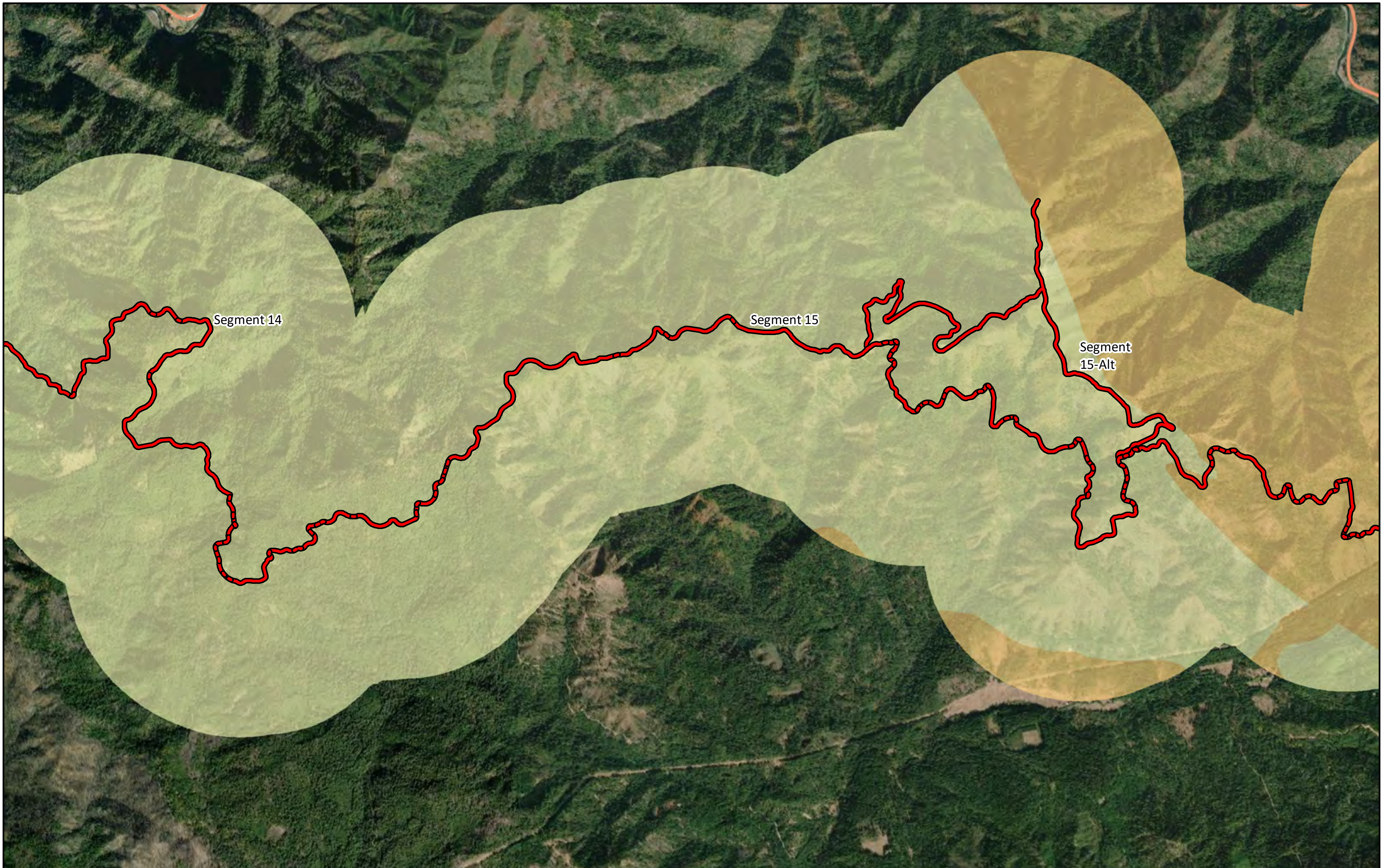

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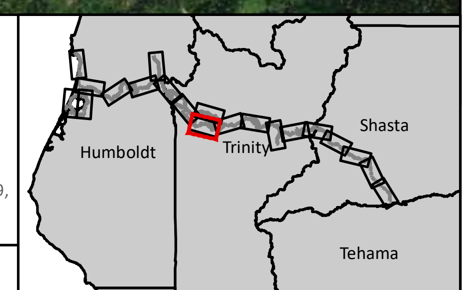

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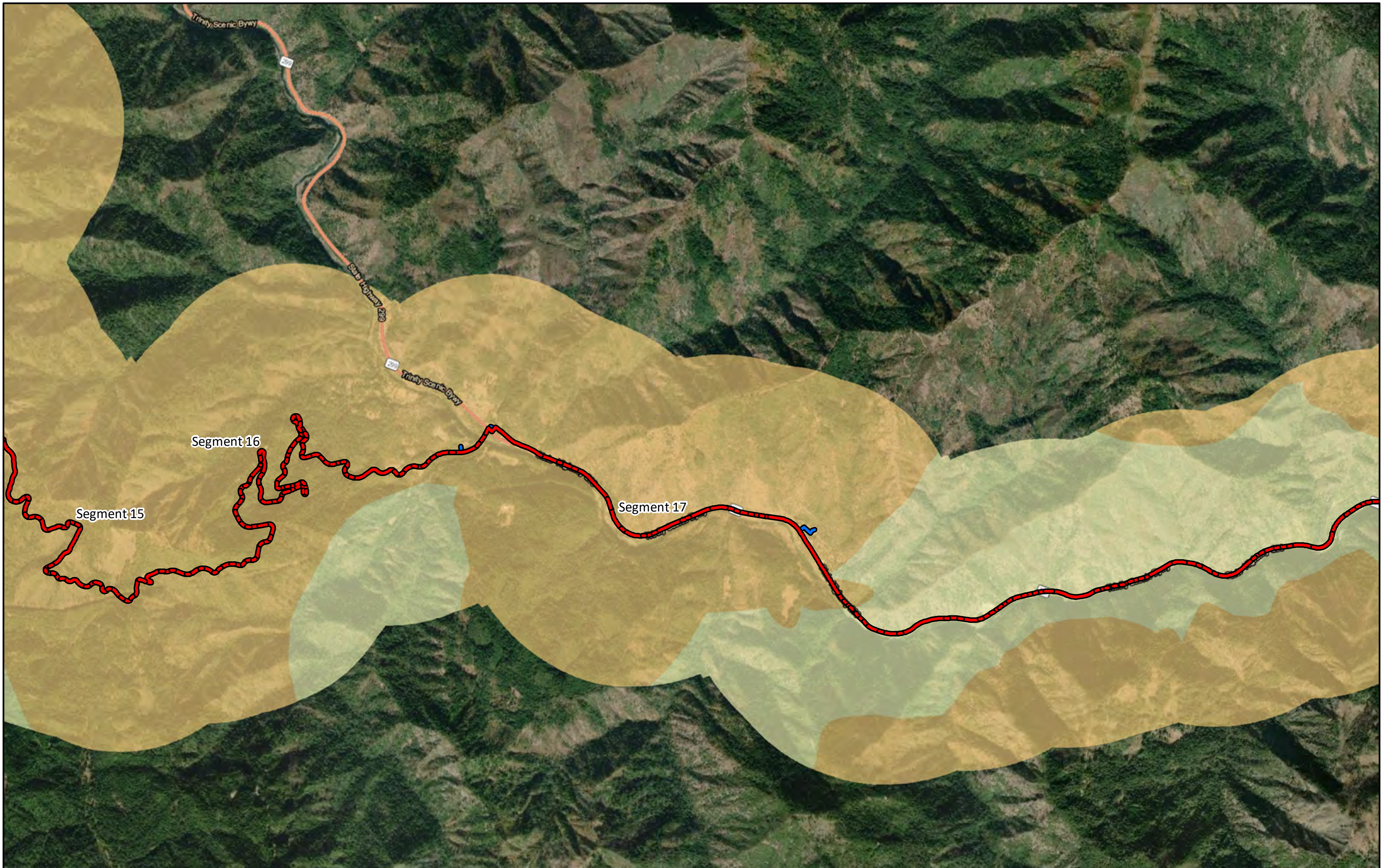

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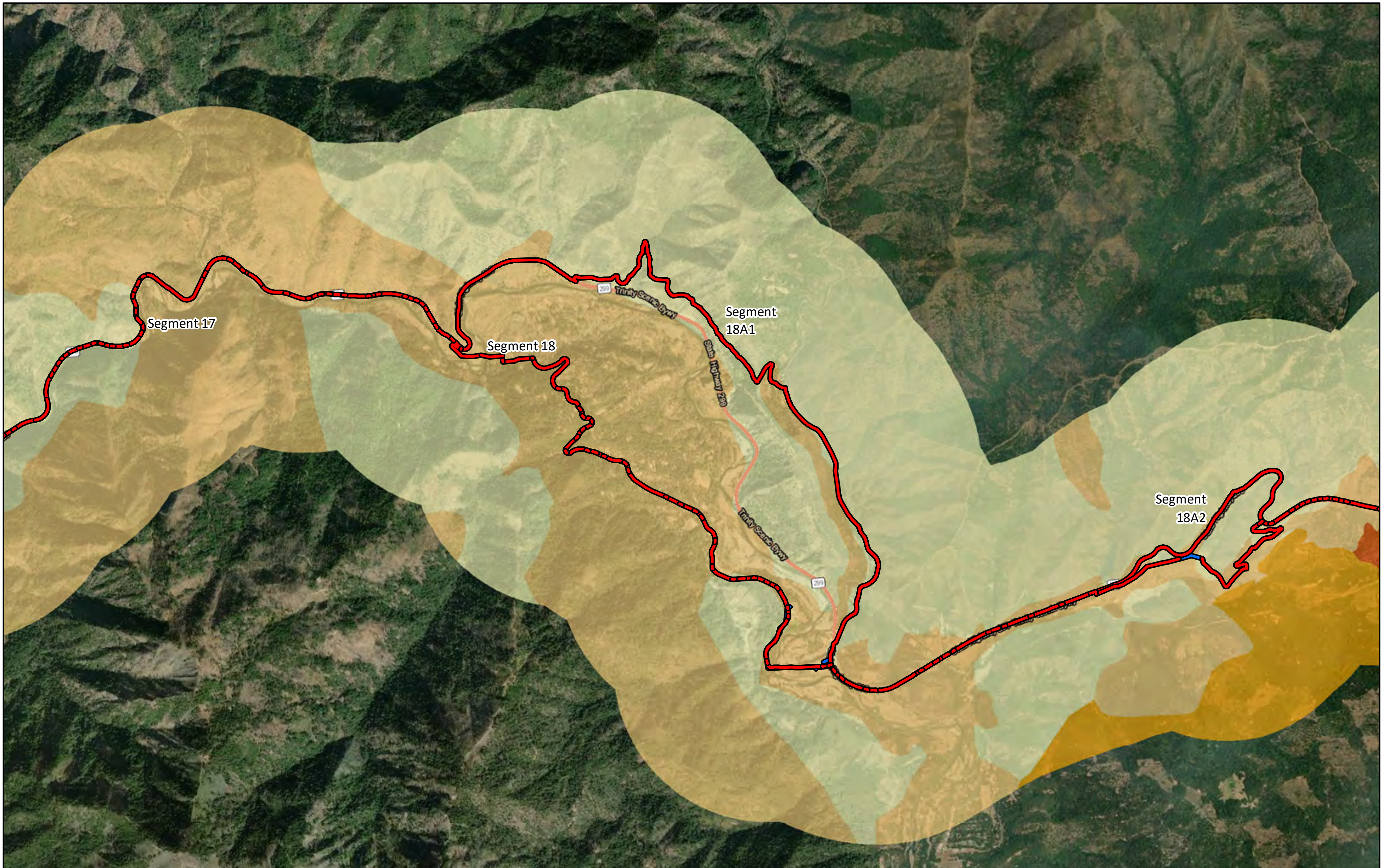

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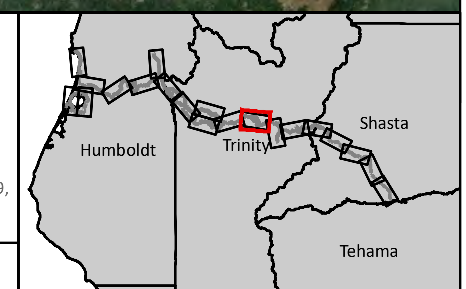

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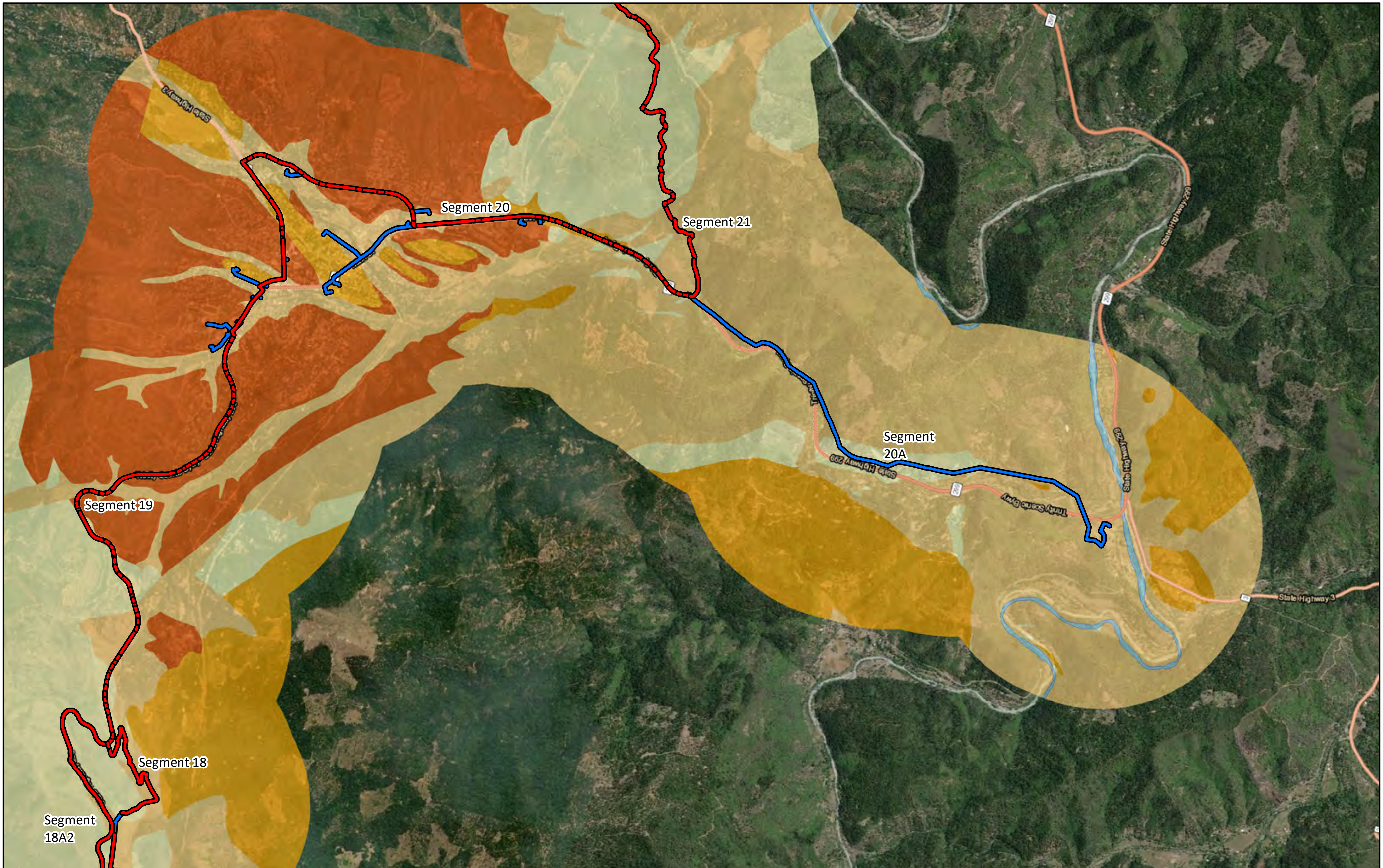

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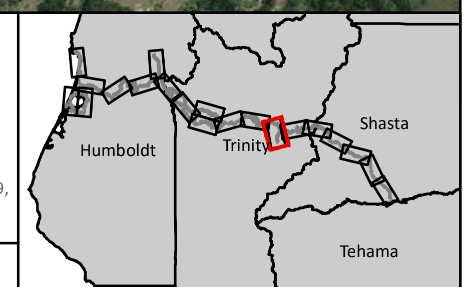

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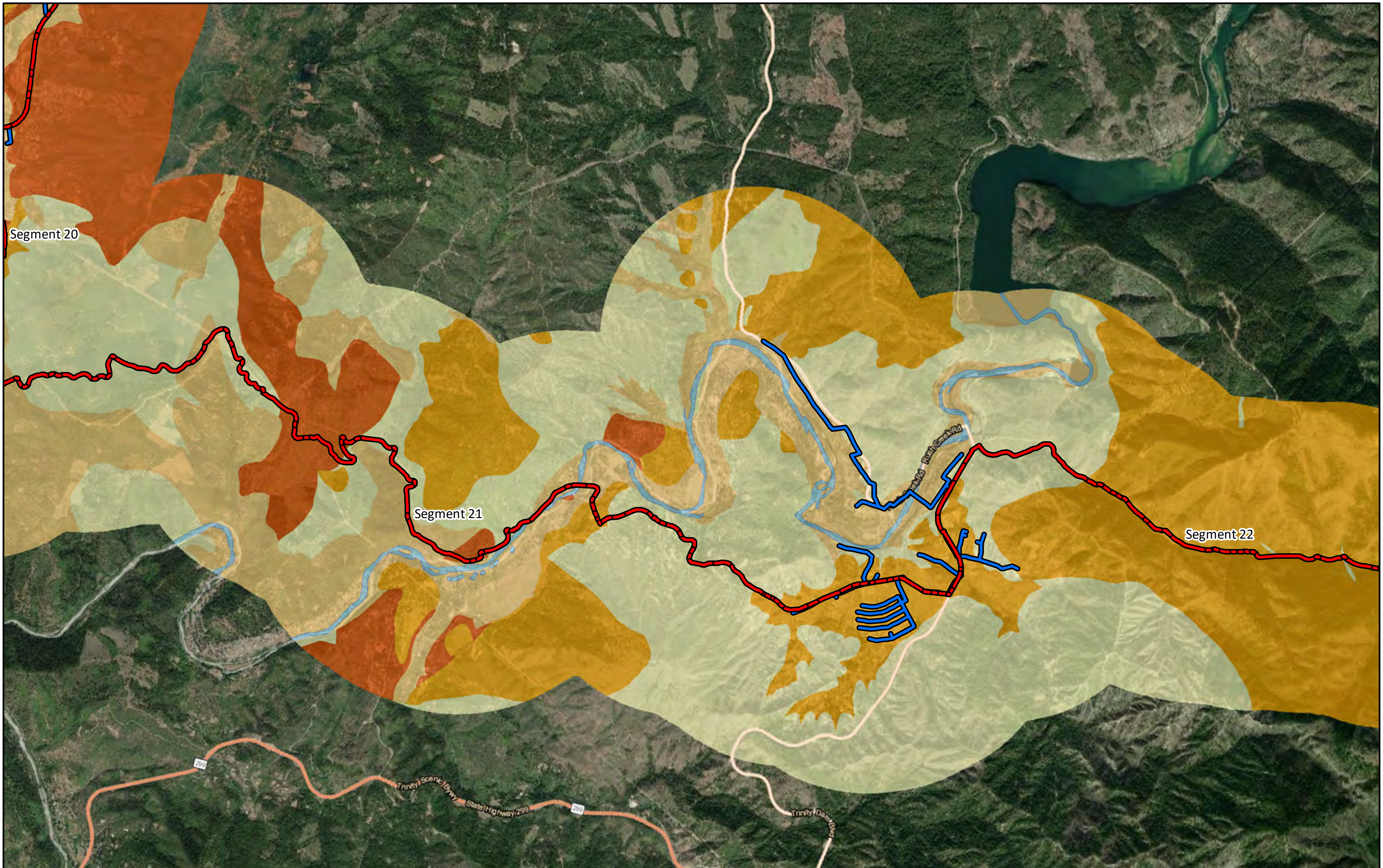

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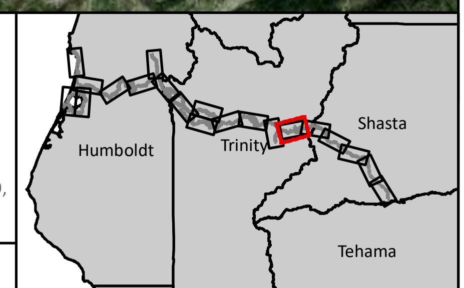

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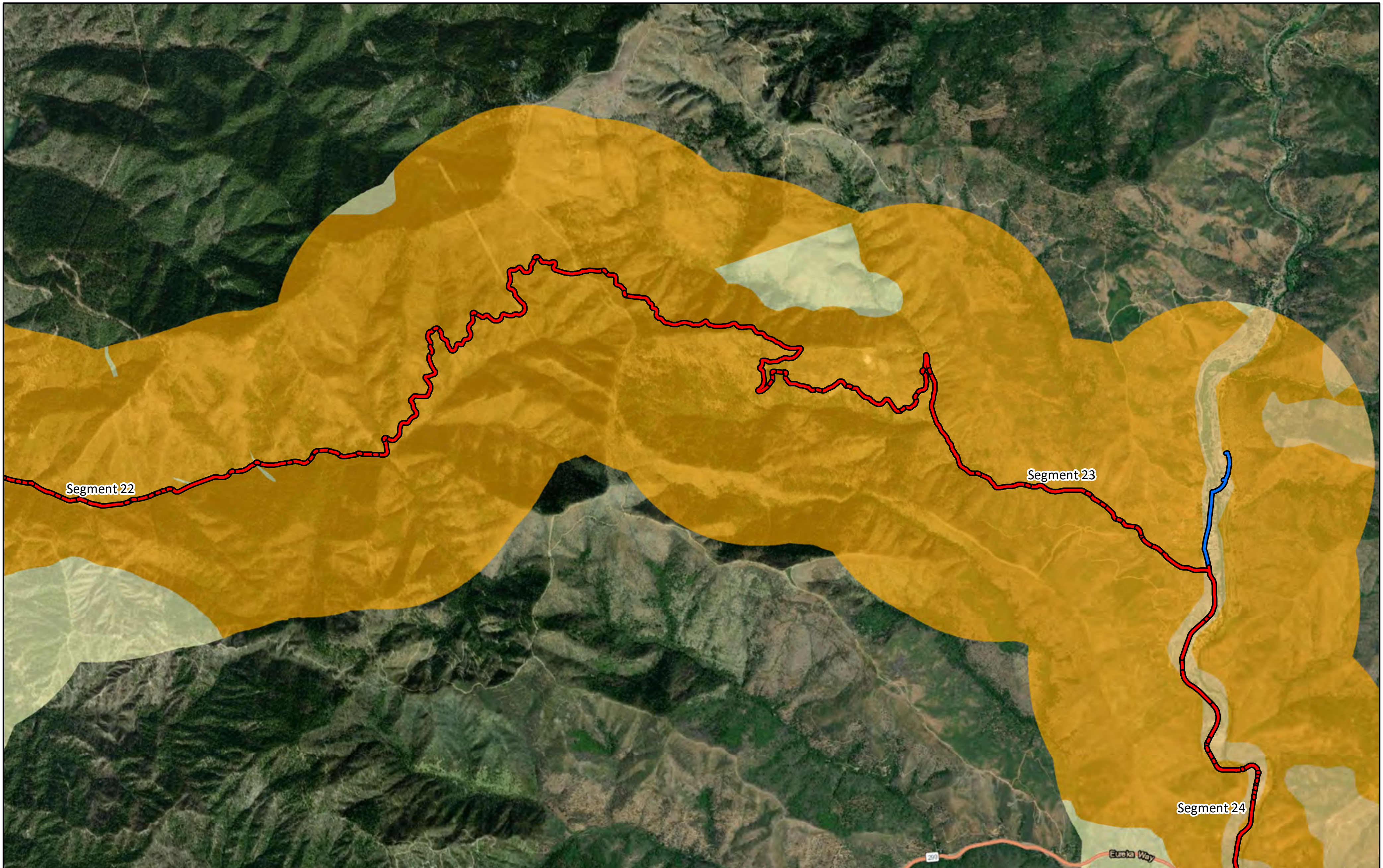

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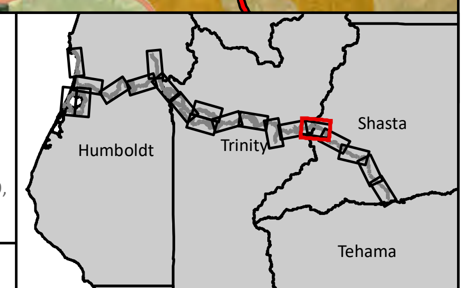

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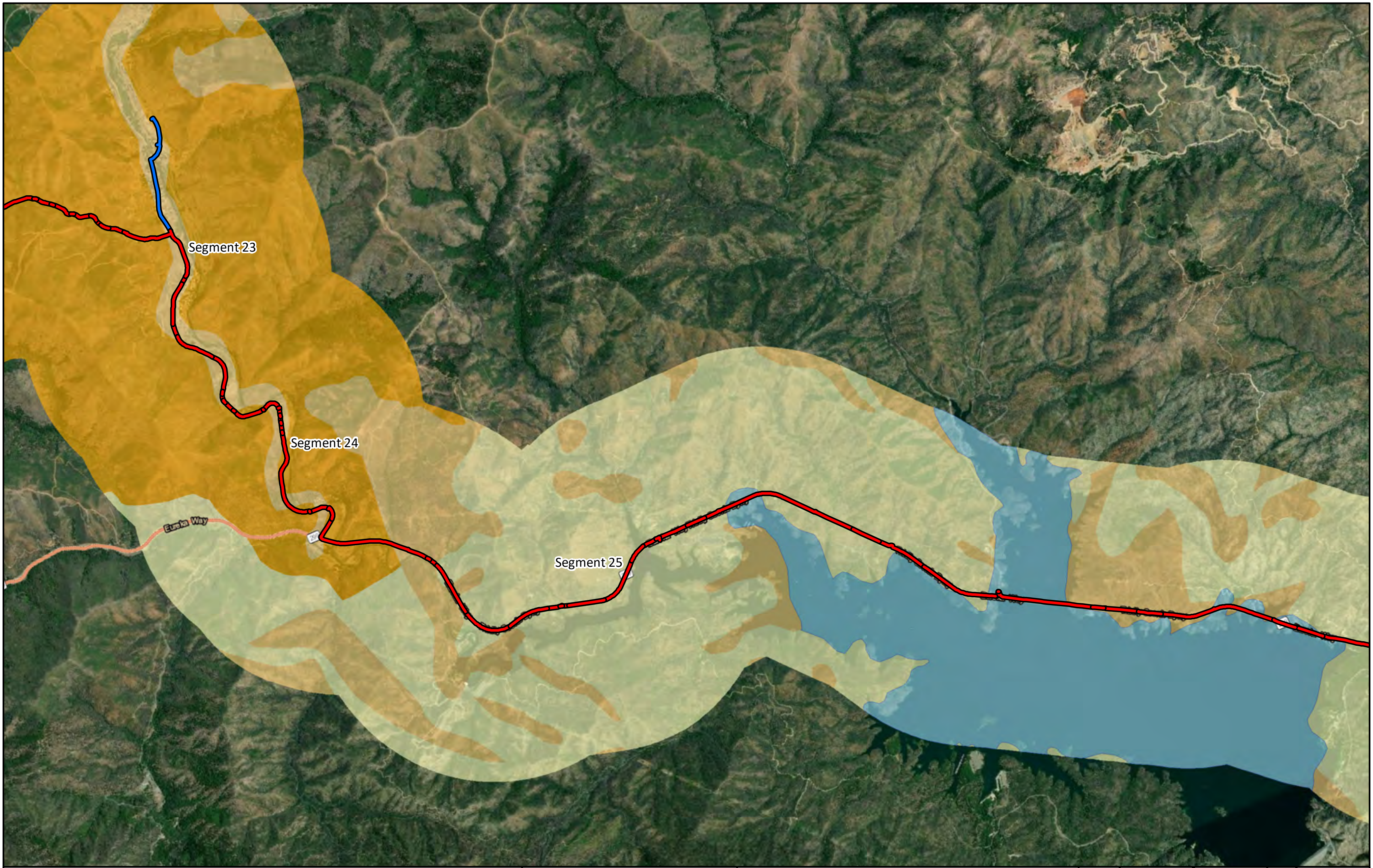

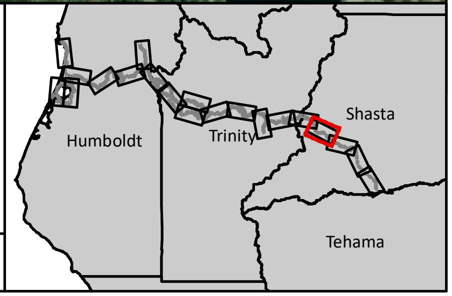

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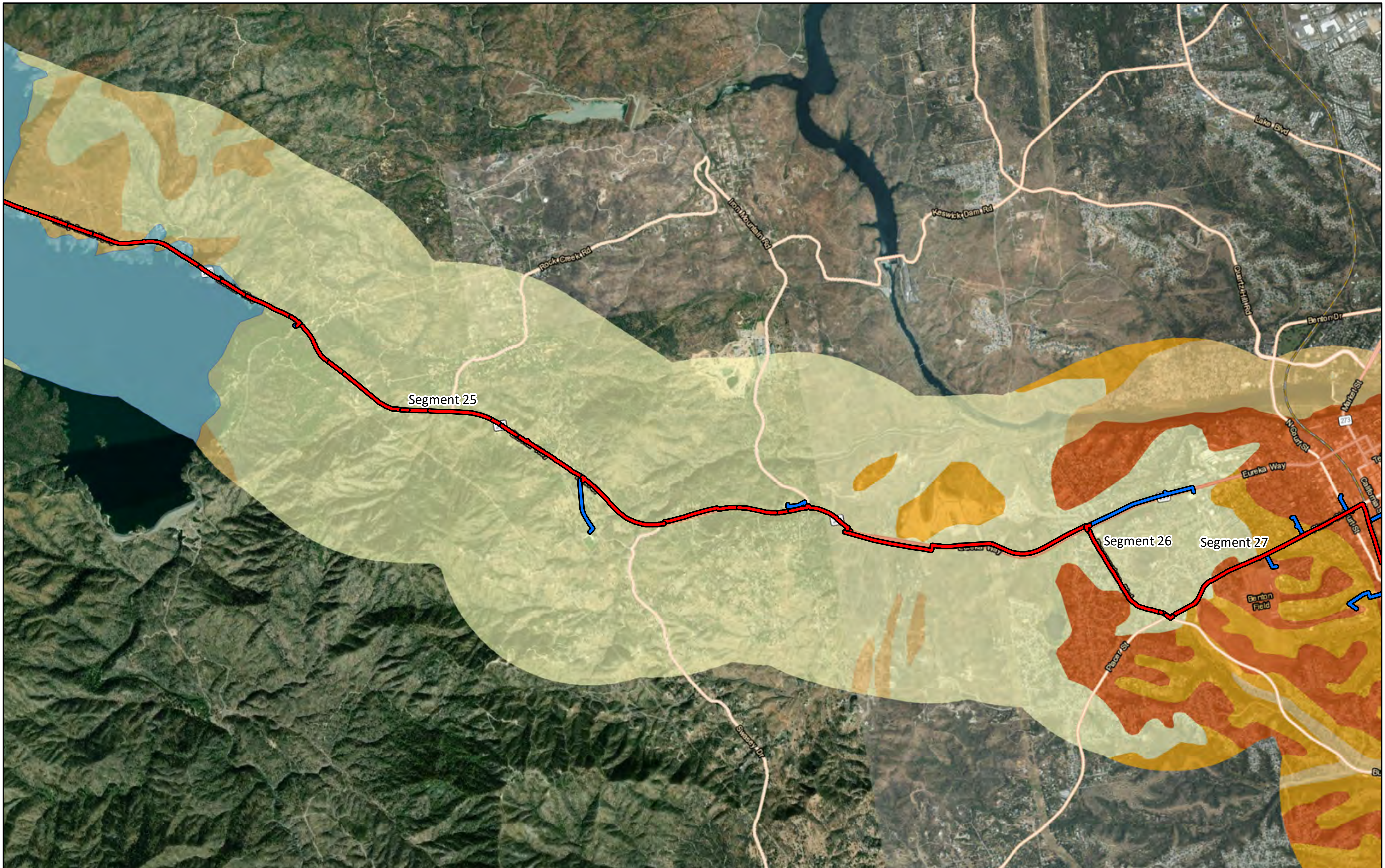

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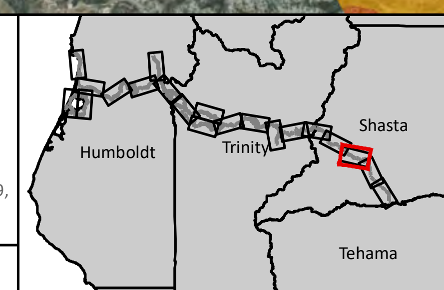

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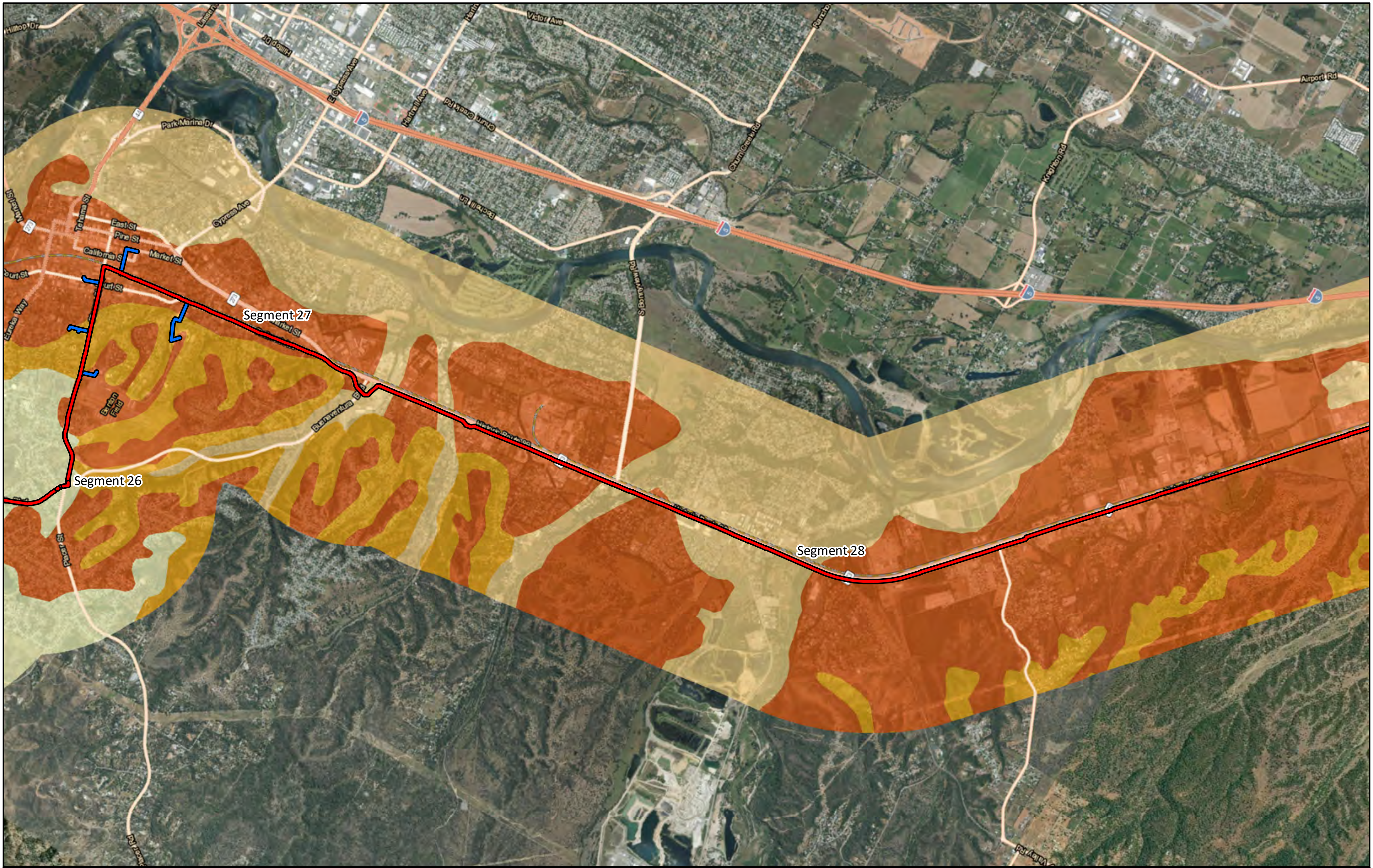

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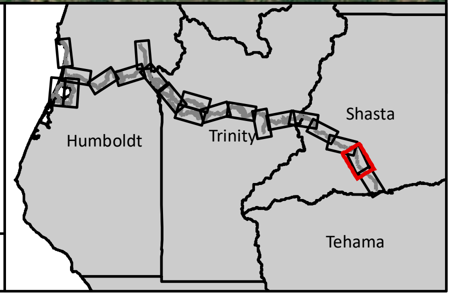

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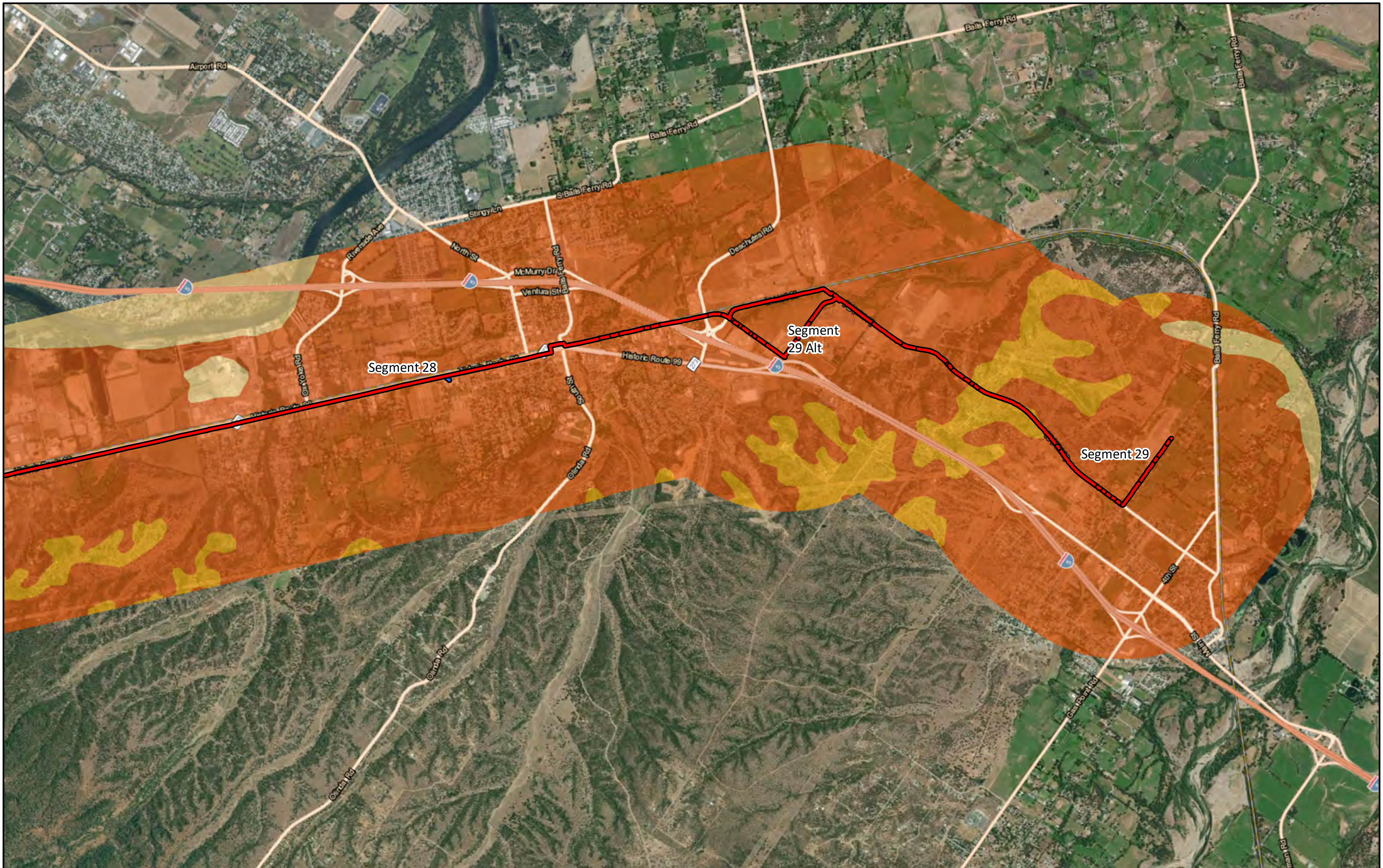

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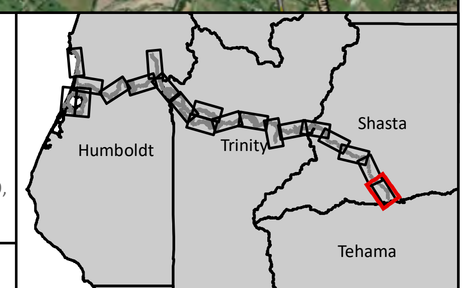

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