Appendix A
Geologic Maps and Rock Unit Descriptions

APPENDIX A

GEOLOGIC MAPS

This appendix presents geologic maps that cover the IPC Proposed Route, IPC Alternate, and the NEPA Flagstaff Alternate project alignments. Geologic maps of the alignments were originally created by Shaw Environmental & Infrastructure, Inc., and were first presented in their Desktop Geotechnical Report, dated January 19, 2012. Subsequent new alignments, such as the IPC Willow Creek Alternate and Flagstaff NEPA Alternate alignments, as well as changes to the previous alignments, were investigated by Shannon & Wilson, Inc. Maps from the new IPC and the NEPA Flagstaff Alternate alignments and alignment changes are integrated with the IPC Proposed Route in this appendix. The following sections describe how the maps were generated and the general characteristics of geologic units. Table A-1 presents a Geologic Time Scale, for reference. Table A-2 summarizes all surficial geologic units encountered within a 0.5-mile radius of the proposed alignments. Sheet 1 presents an index map for the geologic maps, and Sheets 2 through 143 present the geologic maps themselves.

Surficial Geologic Mapping

GIS base files obtained for this study were compiled in the Oregon Geologic Data Compilation (OGDC) by the Oregon Department of Geology and Mineral Industries (DOGAMI) and the Idaho Department of Water Resources (IDWR). The GIS data was then compared with geologic maps for those areas of Oregon and Idaho where the IPC Proposed Route and IPC and NEPA Flagstaff Alternates are proposed. The mapped geologic units and formations along these routes were generalized by this study into five lithologic categories and landslides (which frequently include many different lithologies). The lithologic categories are divided based on similarities in geotechnical engineering properties for subsequent foundation design and construction.

The lithologic categories are:

- Unconsolidated sediments
- Landslide complexes
- Sedimentary rocks
- Volcaniclastic rocks
- Igneous rocks
- Metamorphic rocks

The lithologic categories also help account for variations in formation names and descriptions that may vary between different maps of the same area.[1] The generalized lithologic categories and the major geologic groups included in each category are described below. All surficial geologic formation and mapped subunits encountered within a 0.5-mile radius of the proposed alignments are summarized in Table A-2.

Site-specific geologic reconnaissance and geotechnical drilling will be performed to confirm the geology and engineering properties at specific locations during geotechnical explorations prior to final design.

Unconsolidated Sediments

Unconsolidated sediments consist primarily of water- and wind-deposited sediments including clay, silt, sand, gravel, cobbles and boulders, and minor ash. Included in this unit are alluvium, fan, terrace, and flood deposits. For reference, a geologic time scale has been included below, following the text.

Missoula Flood Deposits (Qmf)

Missoula Flood deposits (Qmf) are fluvial deposits found within the Umatilla basin, which is bounded to the east and south by the Blue Mountains and to the north by the Columbia River. This unit consists primarily of Pleistocene unconsolidated silt, sand, gravel, and boulders deposited by the catastrophic floods of Lake Missoula as recent as 15,500 to 13,000 years BP. Thickness generally ranges from 15 to 50 feet with a maximum thickness of 150 feet (Madin, 2007).

Eolian Sand and Ash (Qe)

Eolian deposits (Qe) are windblown deposits of the quaternary age generally mapped within the Umatilla basin. This unit consists primarily of unconsolidated sands and silt from older Missoula Flood deposits and airfall volcanic ash deposits. Thickness ranges from a thin veneer just outside of the Missoula Flood deposits to approximately 3 feet thick in the highlands (Madin, 2007).

Alluvium (Qa, Qal)

Sediments in this subdivision consist generally of quaternary age unconsolidated sediments deposited on active stream channels and floodplains, including clay, silt, sand, gravel, cobbles, boulders, and in some areas abundant organic material with thin peat beds.

[1] Geologic maps of a given area are often re-mapped and published by different authors, occasionally this leads to revisions in the geologic nomenclature and refinement of map unit descriptions.

Fine-grained deposits are generally located along low terraces along river banks. Playa-lake deposits exist near the southern portion of the alignment, within the Vale quadrangle. Loess and overbank silt deposits exist within the floodplains of the Owyhee, Malheur, and Snake Rivers (Ferns, 1993a). Thicknesses vary from approximately 10 feet to over 30 feet.

Fan Deposits (Qf, Qas, Qtg)

Fan deposits include alluvial fans (Qf), terrace gravel with alluvium fans (Qas), and terrace gravel (Qtg) deposited by streams, typically at the mouth of a canyon. Alluvial fans (Qf) consist of poorly sorted, partly unconsolidated boulder- to clay-size sediments. Along the proposed alignment, this unit is found primarily in the Umatilla Valley, between Little Juniper Canyon and Sand Hollow Creek. This area is also identified on the geologic maps with green hatching. Thicknesses of this unit along the mouth of Sand Hollow Creek are estimated to be 15 to 85 feet (Madin, 2007). Terrace gravels with alluvium fans (Qas) are mapped between Harper, Oregon, and the Idaho-Oregon border, with significant coverage near the Malheur River. These sediments are typically unconsolidated to poorly consolidated fan, pediment deposits of sand and coarse terrace gravels (Ferns, 1993a, 1993b). Terrace and bench gravels (Qtg) are typically unconsolidated to poorly consolidated, poorly sorted gravels and bouldery soil above modern stream channels.

Landslide Deposits (Qls)

Landslide deposits include unconsolidated, unsorted, chaotically mixed colluvium and rock debris formed as a result of bedrock failure. This includes rock-fall, mudflow, debris flow, scree, and talus deposits. These deposits can be identified by their hummocky surfaces and closed depressions, scarps, springs, wet seeps, cracks, and crevices. If the landslide is active, or recently active, it may be identified by tilted trees and landslide scarps. Typically, failure occurs where basalt or coherent lava flows over tuffaceous sedimentary rocks.

Mapped landslide deposits within 0.5 miles of the IPC Proposed alignment were encountered intermittently between the south side of Blue Mountains to approximately 10 miles north of North Powder, northwest of Huntington, north and south of the Malheur River, and north of Lake Owyhee. The nature of these landslide deposits is discussed in further detail in Appendix D.

Sedimentary Rocks

Sedimentary rocks form through consolidation and cementation of loose sediments, and are generally found in layers. The layers are formed by the sequential deposition of weathered rock fragments by processes such as streams and lakes. The following sections describe sedimentary rock formations within the terrane groups that may be encountered along the proposed alignments.

Sedimentary Rocks of the Baker Terrane Group

Formations of the Baker Terrane Group that fall within the category of sedimentary rocks include the Elkhorn Ridge Argillite (MZPZa, Pe, TRPbe) from the Paleozoic/Mesozoic era. These sedimentary and volcanic rocks are located southeast of Baker City, and consist mainly of fine-grained argillite and highly contorted chert and tuffaceous sediments believed to be deepwater ocean basin sediment (OGDC, 2009). These layers of argillite, chert and tuff are interlayered with thin andesitic and basaltic lavas, conglomerate beds, and pod-like limestone lenses which range from a few inches to many hundreds of feet (Prostka 1967).

The Dalles Group

Sedimentary rocks of the Dalles group consist of primarily late Miocene and Pliocene sedimentary rocks located in the Umatilla Valley, including the Alkali Canyon Formation (Tac) and the McKay Formation (Tmm). The Alkali Canyon Formation (Tac) is typically interbedded fluvial and lacustrine (lake-deposited) deposits. The lower portion of this formation is generally interbedded, laminated to bedded clay, silt, and conglomerate. The upper portion of the Tac is generally fine-grained deposits over conglomerate. Maximum thickness of the Tac is approximately 360 feet. The McKay Formation (Tmm) consists of basaltic, fluvial sedimentary rocks near the western edge of the Blue Mountains. This unit mainly consists of weak, indurated basalt cobble conglomerate, pebbly sandstone, and tuffaceous siltstone, with coarse-grained sandstone and sandy siltstone interbeds. Maximum thickness of the Tmm is approximately 330 feet (Madin, 2007).

Idaho Group

The Idaho Group is mainly from the late Miocene and Pliocene (11.2 million to 1.8 million years old) and is comprised of lacustrine sedimentary rocks associated with the large lake systems of western Idaho. Along the proposed alignment, these units are mapped from east of Harper, Oregon, to just west of the Oregon-Idaho Border. The sedimentary rocks in this group consist mainly of well to poorly consolidated siltstone, fine-grained sandstone, mudstone, tuffaceous siltstone, limestone, with thin beds of siltstone, pebble conglomerate, tuff and tuffaceous sandstone. Exposed thicknesses are approximately 350 feet west of Cow Hollow (approximately 10-15 miles east of the proposed alignment) and the thickness increases to the north and east from Deer Butte to Cow Hollow, where over 400 feet of thickness has been encountered (Fern, 1993a).

Neogene Sedimentary Rocks

Neogene sedimentary rocks consist mainly of tuffaceous lacustrine and stream deposits of Miocene to late Miocene-Pliocene age, mapped along the alignment from Baker City to just south of Cottonwood Creek. This unit consists mainly of poorly to moderately well

consolidated, bedded deposits of clay, siltstone and sandstone with intermixed ash and pumice and minor rhyolite flows, basalt flows, and mudflow deposits. It mainly overlies basalt flows, but interfingers with basalt in some locations. Lacustrine sediments in the Durkee area are up to 500 feet thick (Prostka, 1967; Brooks, 1976; Brooks, 2006).

Sedimentary Rocks of the Olds Ferry Terrane

The Olds Ferry Terrane, which is composed of island arc volcanic and fore-arc marine deposits associated with the southernmost-northeast Oregon terranes, is mainly from the Jurassic age (290 to 140 million years old). The Weatherby Formation can be found along the proposed alignments in south Baker and north Malheur counties. Exposures of the contact form a northeasterly trending arc extending from Juniper Mountain, crossing the Snake River, and into Idaho. This unit consists mainly of volcanic greywacke, siltstone, argillite, pebble and cobble conglomerate, sandstone, tuff and massive and thinly bedded limestone, and gray phyllite (TRg). Exposures of the TRg are estimated to be more than 500 feet thick, and perhaps up to 1000 feet near Weatherby Mountain (Prostka, 1967; Brooks, 1976; Brooks, 1979).

Sedimentary Rocks of the Oregon-Idaho Graben

The Oregon-Idaho Graben contains interbedded basalt, andesite, and dacite lava flows with small ash–flow tuffs, mafic hydrovolcanic deposits, tuffaceous sedimentary rocks, sandstone, and conglomerate from the Miocene age. Sedimentary rock portions of this group exist primarily along the southernmost part of the proposed alignment, through eastern Oregon and into western Idaho. Mapped units within this group consist mainly of massive, well-indurated, moderately to well sorted, fine to medium-grained sandstone, medium to coarse-grained conglomerate, tuffaceous siltstone, and claystone. Some isolated exposures of nonwelded tuff and claystone exist near Lake Owyhee, Oregon. Thicknesses range from 300 to greater than 650 feet, and maximum thickness of the Tuff of Kern Basin (Tktb) is estimated to be approximately 400 feet (Ferns, 1993a).

Igneous (Intrusive and Volcanic) and Volcaniclastic Rocks

Igneous rocks are the result of the solidification of magma or lava after cooling. Igneous rocks can either be intrusive (plutonic) formed as a result of the magma cooling very slowly below the surface, or extrusive (volcanic) formed above the ground surface as a result of a volcanic eruption. Volcaniclastic rocks include all clastic volcanic materials (volcanic rock fragments) formed by any process of fragmentation, dispersion, and transporting agent that are deposited in an environment and re-lithify to form a new rock. Volcaniclastic rocks may become mixed with any portion of non-volcanic rock fragments of any kind and, depending on geologic processes and depositional environment may be classified as an igneous or sedimentary rock.

Lake Owyhee Volcanic Field

The Lake Owyhee Volcanic Field consists of rhyolite and andesite lava flows, welded and non-welded tuff of the Littlefields Rhyolite (Tr); welded tuff (Tt); and welded rhyolite tuff (Twt). These ash-flow tuffs and tuffaceous sedimentary rocks are primarily from the Miocene age and extend from Mahogany Mountain in eastern Oregon to Dooley Mountain south of Baker City, Oregon. The unit contains small, isolated patches of welded tuff, and is conformably overlain by lake and stream sediments of lower Pliocene (Prostka, 1967, Brooks, 1976, Brooks 2006).

Columbia River Basalt Group

The Columbia River Basalt Group (CRBG) is the most widespread geologic unit in the Pacific Northwest. This unit includes all mafic lava flows of middle Miocene and is encountered along the entire length of the proposed alignment. Major CRBG formations exposed along or near the alignment include Grande Ronde Basalt, Imnaha Basalt, Saddle Mountain Basalt, and Wanapum Basalt. These individual units have been defined on the basis of stratigraphic position, geochemistry, magnetic polarity, and petrography (Madin, 2007). CRBG's are mainly sequential flow on flow basalt, some with thin interbeds of sediment. Formations thought to be part of CRBG, but not generally included in the CRB Group, are found near the sections of the proposed transmission alignments and are listed below. These include basalt (Tb) in the vicinity of Huntington, Oregon, and tholoeiitic lavas (Tbtv) mapped near Vale, Oregon.

The Grande Ronde Basalt consists of fine-grained flow-on-flow sequence mainly from the middle Miocene age and it comprises the thickest and most voluminous portion of the CRBG. This unit is described as "bluish-black aphyric to sparsely plagioclase phyric lava flows" (Madin, 2007). Although this unit is exposed intermittently from Sand Hollow in the Umatilla Basin to Bully Creek located just west of Vale, exposures are prominent from Slusher Canyon in the Umatilla Basin to east of La Grande and from Cavanaugh Creek to the Cottonwood Fault System located along the east flank of the Cottonwood Mountains (Ferns, 2001, Madin, 2007).

Saddle Mountains Basalt is exposed along the Columbia River between Boardman and Hemingway, specifically parallel to the alignment along the Columbia River west of Boardman and into Eightmile Canyon. This unit consists mainly of fine-grained basalt flows. Thickness of the Saddle Mountain Basalt, derived from well logs, ranges from 20 to 180 feet (Madin, 2007).

The Frenchman Springs member of the Wanapum basalts is a thick and widely distributed unit. Individual flows typically range from 3 to 100 feet, and the total thickness of rock encountered in wells ranges from 150 to 620 feet. Flows typically have rubbly flow tops, solid, jointed interiors,

and are typically flow-on-flow basalts with little or no intervening sediments. This unit is exposed mainly within the Umatilla Basin (Madin, 2007).

High Lava Plains Volcanic Province

The High Lava Plains Volcanic Province is comprised of late Miocene and Pliocene upper olivine basalt flows. These flows are mainly black to greenish- and grayish black basalt flows, breccia, and interbedded tuffaceous siltstones and claystones. These basalt flows are exposed near sagebrush gulch, south of Vale. Thickness varies from 50 feet west of the alignment to more than 400 feet near Mitchell Butte, east of the proposed alignment (Ferns, 1993a).

Igneous Rocks of the Olds Ferry Terrane

Igneous rocks of the Olds Ferry Terrane, specifically those of the Huntington Formation (TRh), underlie approximately 0.75-miles of the proposed alignment southwest of Huntington, Oregon. This region consists primarily of basalt, rhyolite, and, most abundantly, andesite (Brooks, 1979).

Igneous Rocks of the Oregon-Idaho Graben

The Oregon-Idaho Graben is comprised of a series of interbedded olivine basalt, andesite, and dacite lava flows of Miocene age. Exposures of Oregon-Idaho Graben occur along the alignment from west of Vale to just west of the Oregon-Idaho border. Lower alkaline lava flows (Tbcl) are comprised mainly of dark gray to black, fine-grained platy lava flows and breccias that typically weather to brown. Upper alkaline lava flows (Tbcu) are comprised mainly of grayish black olivine basalt, basaltic andesite and andesite flows. Middle lava flows (Tbcm) consist of gray, vesicular, mainly basaltic andesite, and individual flow thickness has been estimated to be more than 300 feet. Lower olivine-rich basalt flows (Tbol) are mainly black to dark-gray, vesicular, and are estimated to be more than 330 feet thick near Succor Creek. Upper calc-alkaline rhyolite and dacite flows and domes (Trcu) are dark-gray and gray rhyolite, rhyodacite, and dacite, which weather to various shades of red. Unit thickness is estimated to be over 300 feet thick north of Grassy Mountain. (Ferns, 1993a).

Powder River Volcanic Field

The Powder River Volcanic Field is comprised of a series of andesite, dacite, olivine-rich basalt, and basaltic lava flows resulting from multiple small volcanoes located between La Grande and Baker City of middle Miocene and Pliocene age. Olivine basalt flows overlying ash-flows are from the earliest of eruptions. Exposures occur along the alignment starting east of La Grande and continue into Idaho, beyond the extents of the Proposed alignment. Major formations of the Powder River Volcanic Field include Andesite of Sawtooth Crater (Ta, Tan,

Tpa, Tpga, Tpgf, Tpgs), Basalt of Little Catherine Creek (Tb, Tgo, Tob, Tpa, Tpb, Tpgb, Tyb), and Dacite of Mt. Emily (Tpd, Tpgd). The Andesite of Sawtooth Crater is typically fine-grained, plated andesite erupted from locations such as Sawtooth Ridge, located northeast of Baker (Swanson, 1981). Basalt of Little Catherine Creek is commonly olivine basalt flows. Dacite of Mt. Emily consists of a single lava flow with matrix–supported basal breccias and an upper massive, locally vesicular flow top. Individual dacite flows near Mt. Emily (Tpgd) are estimated to be more than 400 feet thick (Ferns, 2001). Olivine basalt flows in the Baker Valley to Lower Powder Valley area are often severely faulted.

Igneous Rocks of the Wallowa Terrane

The Wallowa Terrane consists of Island arc volcanic and shallow marine deposits associated with the northernmost of the northeast Oregon accreted terranes from the Permian/Triassic age. Dark, coarse-grained gabbro (gb) of the Sparta Complex is encountered just northwest of Weatherby, Oregon. Exposures of Clover Creek Greenstone (TRcc, TRPu, TRPv, TRPwc, TRv), coarse to fine-grained volcanic and volcaniclastic rocks, can be found north and south of North Powder, Oregon, and along the northern portion of the Timber Canyon NEPA Alternative route. The Clover Creek Greenstone consists primarily of volcanic and metavolcanic rocks comprised of quartz diorite and diorite flow breccias, with some coarse volcaniclastic sandstone, tuff, sandstone, siltstone, chert, conglomerate and minor limestone (Walker, 1979).

Metamorphic Rocks

Metamorphic rocks are those that have been transformed through geologic processes into a different type of rock from that which it started as. The original rock undergoing metamorphism can be sedimentary, igneous, or an older metamorphic rock. These rocks are metamorphosed by means of extreme temperature, pressure, or hydrothermal alteration which causes physical and/or chemical changes from the original form.

Metamorphic Rocks of the Baker Terrane

Metamorphic rocks of the Baker Terrane include Burnt River Schist (TRBi, Pg), which consists mainly of fine-grained greenschist of the Paleozoic/Mesozoic age and gabbro (gb). Minor sections of Burnt River Schist exist for approximately 2 miles along the proposed alignment, near Interstate 84, north and south of Durkee (Prostka, 1967).

Metamorphic Rocks of the Olds Ferry Terrane

Metamorphic rocks of the Olds Ferry Terrane consist of gray phyllite (TRg) and metamorphosed sedimentary rocks (Jw, JTRs) of the Weatherby Formation. This unit exists

along Sisley Creek, near Weatherby, Oregon. Exposures of more than 5,000 feet thick have been found in the vicinity of Morgan Creek (Prostka, 1967).

Metamorphic Rocks of the Wallowa Terrane

Metamorphic rocks of the Wallowa Terrane consist of albite granite (metamorphosed plutonic rocks), of the Sparta Complex (agr). This unit exists for nearly 10 miles along the central portion of the NEPA Timber Canyon Alternate route, just west of Halfway, Oregon. This unit consists of coarse to fine-grained granitic rock, composed primarily of quartz and albite (Prostka, 1962).

GEOLOGIC TIME SCALE

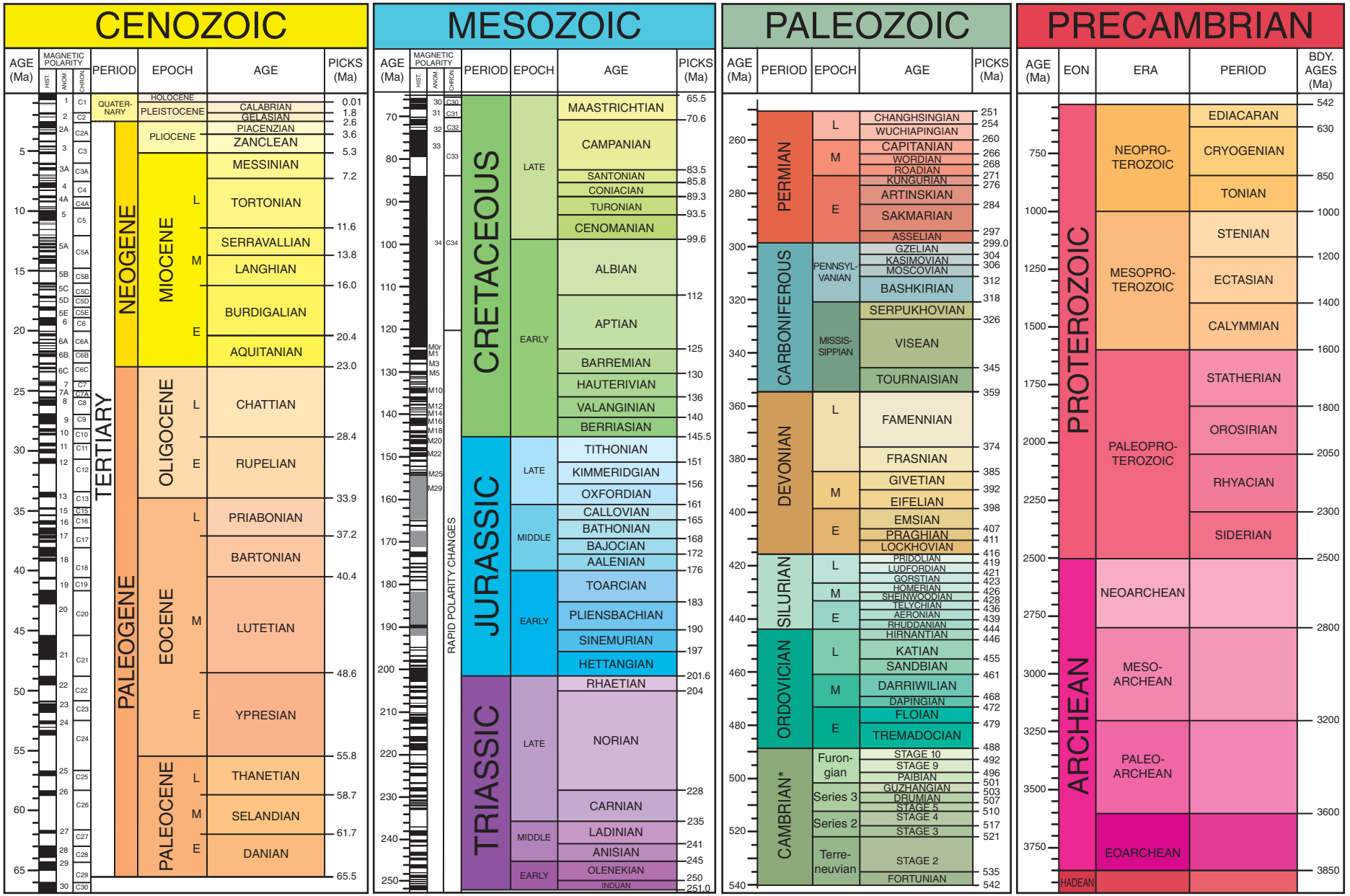

TABLE A-1

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*International ages have not been fully established. These are current names as reported by the International Commission on Stratigraphy.

Sources for nomenclature and ages are primarily from Gradstein, F., Ogg, J., Smith, A., et al., 2004, A Geologic Time Scale 2004: Cambridge University Press, 589 p. Modifications to the Triassic after: Furin, S., Preto, N., Rigo, M., Roghi, G., Gianolla, P., Crowley, J.L., and Bowring, S.A., 2006, High-precision U-Pb zircon age from the Triassic of Italy: Implications for the Triassic time scale and the Carnian origin of calcareous nannoplankton and dinosaurs: Geology, v. 34, p. 1009–1012, doi: 10.1130/G22967A.1; and Kent, D.V., and Olsen, P.E., 2008, Early Jurassic magnetostratigraphy and paleolatitudes from the Hartford continental rift basin (eastern North America): Testing for polarity bias and abrupt polar wander in association with the central Atlantic magmatic province: Journal of Geophysical Research, v. 113, B06105, doi: 10.1029/2007JB005407.

Table A-1 - Summary of Surficial Geologic Map Units

Map Unit Label	Category	Map Unit Name	Age	Terrane Group	Formation	Member	Geologic Rock Type
agr	Metamorphic Rock	Albite granite	Triassic	Wallowa Terrane	Sparta Complex	No data	felsic composition lithologies
dike	Igneous Rock	Dike complex	Miocene	Columbia River Basalt Group	No data	No data	basalt
g	Metamorphic Rock	Greenstones and greenschists	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	greenstone
gb	Igneous Rock	Gabbro	Triassic	Wallowa Terrane	Sparta Complex	No data	mafic composition lithologies
gb	Igneous Rock	Gabbro and meta-gabbro	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	greenstone
gb1	Igneous Rock	Gabbro and meta-gabbro	Triassic	Wallowa Terrane	Sparta Complex	No data	mafic composition lithologies
gb2	Igneous Rock	Gabbro and meta-gabbro	Paleozoic/Mesozoic	Baker Terrane	No data	No data	greenstone
hqd	Metamorphic Rock	Hornblende quartz diorite	Triassic	Wallowa Terrane	Sparta Complex	No data	intermediate composition lithologies
JKi	Igneous Rock	Quartz diorite	Jurassic/Cretaceous	Nevadan Intrusives	No data	No data	intermediate composition lithologies
JTRi	Igneous Rock	Intrusive rocks	Permian/Triassic	Olds Ferry Terrane	Huntington Volcanics	No data	felsic composition lithologies
JTRl	Unconsolidated sediments	Limestone	Jurassic	Olds Ferry Terrane	Weatherby Formation	Jet Creek member	limestone
JTRs	Sedimentary Rock	Sedimentary rocks	Jurassic	Olds Ferry Terrane	Weatherby Formation	Jet Creek member	mixed grained sediments
JTRs	Sedimentary Rock	Marine sedimentary rocks	Triassic	Wallowa Terrane	Hurwal Formation	No data	fine grained sediments
Jw	Sedimentary Rock	Weatherby Formation	Jurassic	Olds Ferry Terrane	Weatherby Formation	Jet Creek member	mixed grained sediments
Jwj	Sedimentary Rock	Jet Creek member	Jurassic	Olds Ferry Terrane	Weatherby Formation	Jet Creek member	mixed grained sediments
Jwjl	Sedimentary Rock	Jet Creek member limestone	Jurassic	Olds Ferry Terrane	Weatherby Formation	Jet Creek member	limestone
kgd	Igneous Rock	Quartz diorite and granodiorite	Jurassic/Cretaceous	Nevadan Intrusives	No data	No data	intermediate composition lithologies
kgd1	Igneous Rock	Quartz diorite and granodiorite	Jurassic/Cretaceous	Nevadan Intrusives	Lookout Mountain Formation	No data	intermediate composition lithologies
Ki?	Igneous Rock	Cretaceous plutons	Cretaceous				igneous rock
Kii	Igneous Rock	Cretaceous plutons - intermediate	Cretaceous				intrusions
KJi	Igneous Rock	Upper Jurassic-lower Cretaceous plutons	Jurassic/Cretaceous	Nevadan Intrusives	No data	No data	intermediate composition lithologies
KJi	Igneous Rock	Quartz diorite and granodiorite	Jurassic/Cretaceous	Nevadan Intrusives	Lookout Mountain Formation	No data	intermediate composition lithologies
KJi	Igneous Rock	Intrusive rocks	Cretaceous	Nevadan Intrusives	Wallowa Batholith	No data	intermediate composition lithologies
KJi1	Igneous Rock	Upper Jurassic-lower Cretaceous plutons	Jurassic/Cretaceous	Nevadan Intrusives	Bald Mountain Batholith	No data	intermediate composition lithologies
KJwt	Igneous Rock	Tonalite of Wallowa Batholith	Cretaceous	Nevadan Intrusives	Wallowa Batholith	No data	intermediate composition lithologies
Kqd	Igneous Rock	Quartz diorite	Jurassic/Cretaceous	Nevadan Intrusives	Lookout Mountain Formation	No data	intermediate composition lithologies
Kqd	Igneous Rock	Quartz diorite	Jurassic/Cretaceous	Nevadan Intrusives	No data	No data	intermediate composition lithologies
Kwt	Igneous Rock	Tonalite and granodiorite of the Wallowa Batholith	Cretaceous	Nevadan Intrusives	Wallowa Batholith	No data	intermediate composition lithologies
ls	Unconsolidated sediments	Limestone	Paleozoic/Mesozoic	Baker Terrane	No data	No data	limestone
ls	Metamorphic Rock	marble	Paleozoic/Mesozoic	Baker Terrane	No data	No data	limestone
ls1	Unconsolidated sediments	Limestone	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	marble
m	Metamorphic Rock	Marble	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	marble
mg/md	Metamorphic Rock	Metamorphosed intrusions	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	greenstone
mqbd	Metamorphic Rock	Metamorphosed intrusions	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	greenstone
mqd	Metamorphic Rock	Metamorphosed intrusions	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	greenstone
mr	Metamorphic Rock	Mixed sedimentary, volcanic and intrusive rocks	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	serpentinite
mvc	Metamorphic Rock	Metavolcaniclastic rocks and greenstones	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	volcaniclastic rocks
MZPZa	Sedimentary Rock	Sedimentary and volcanic rocks	Paleozoic/Mesozoic	Baker Terrane	Elkhorn Ridge Argillite	No data	fine grained sediments
MZPZm3	Metamorphic Rock	Metamorphic rocks	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	mixed lithologies
MZPZn	Metamorphic Rock	Nelson Marble	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	marble
MZPZsv	Metamorphic Rock	Foliated sedimentary and volcanic rocks	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	mixed lithologies
MZPZsv	Metamorphic Rock	Sedimentary, volcanic and intrusive rocks	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	mixed lithologies
p	Metamorphic Rock	Phyllitic rocks	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	sedimentary rocks
Pe	Sedimentary Rock	Elkhorn Ridge Argillite	Paleozoic/Mesozoic	Baker Terrane	Elkhorn Ridge Argillite	No data	fine grained sediments
Per	Sedimentary Rock	Marine sedimentary and volcanic rocks	Paleozoic/Mesozoic	Baker Terrane	Elkhorn Ridge Argillite	No data	fine grained sediments
Per	Sedimentary Rock	Elkhorn Ridge Argillite	Paleozoic/Mesozoic	Baker Terrane	Elkhorn Ridge Argillite	No data	fine grained sediments
Pg	Metamorphic Rock	Greenschist	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	greenstone
Pg1	Metamorphic Rock	Greenschist	Paleozoic/Mesozoic	Baker Terrane	No data	No data	greenstone
Pn	Metamorphic Rock	Nelson marble	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	marble
Ppq	Metamorphic Rock	Phyllitic quartzite	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	sedimentary rocks
PTRg	Metamorphic Rock	Greenschist	Paleozoic/Mesozoic	Baker Terrane	No data	No data	greenstone
px	Igneous Rock	Pyroxenite and peridotite	Triassic	Wallowa Terrane	Sparta Complex	No data	ultramafic composition lithologies
px	Igneous Rock	Peridotite	Triassic	Wallowa Terrane	Sparta Complex	No data	ultramafic composition lithologies

Table A-1 - Summary of Surficial Geologic Map Units

Map Unit Label	Category	Map Unit Name	Age	Terrane Group	Formation	Member	Geologic Rock Type
Qa	Unconsolidated sediments	Alluvium	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
Qa	Unconsolidated sediments	Stream alluvium	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
Qa	Unconsolidated sediments	Quaternary alluvium	Quaternary				continental deposits
Qal	Unconsolidated sediments	Stream alluvium and alluvial fans	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
Qal	Unconsolidated sediments	Alluvium	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
Qal	Unconsolidated sediments	Lacustrine and alluvial plain deposits	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	fine grained sediments
Qal	Unconsolidated sediments	Recent alluvium	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
Qal	Unconsolidated sediments	Alluvium and colluvium	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
Qas	Unconsolidated sediments	Terrace gravels and alluvial fan deposits	Quaternary	Quaternary surficial deposits	Alluvial fan deposits	No data	mixed grained sediments
Qas	Igneous Rock	Terrace gravels and alluvial-fan deposits	Quaternary	Quaternary surficial deposits	Alluvial fan deposits	No data	mixed grained sediments
Qas1	Unconsolidated sediments	Terrace gravels and alluvial fan deposits	Quaternary	Quaternary surficial deposits	Terrace deposits	No data	mixed grained sediments
Qcf	Unconsolidated sediments	Colluvium and talus deposits	Quaternary	Quaternary surficial deposits	Colluvial deposits	No data	mixed grained sediments
Qdf	Sedimentary Rock	Debris-avalanche and debris-flow deposits	Quaternary	Quaternary surficial deposits	Landslide deposits	No data	mixed grained sediments
Qe	Unconsolidated sediments	Eolian sand and ash	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
Qe1	Unconsolidated sediments	Ash, sand, and loess	Quaternary	Quaternary surficial deposits	Eolian deposits	No data	fine grained sediments
Qe1	Unconsolidated sediments	Eolian sand and ash	Quaternary	Quaternary surficial deposits	Eolian deposits	No data	fine grained sediments
Qf	Unconsolidated sediments	Alluvial fill	Quaternary	Quaternary surficial deposits	Terrace deposits	No data	mixed grained sediments
Qf	Unconsolidated sediments	Alluvial fan deposits	Quaternary	Quaternary surficial deposits	Alluvial fan deposits	No data	mixed grained sediments
Qfd	Unconsolidated sediments	Fluvial fan delta deposits	Quaternary	Quaternary surficial deposits	Fan delta deposits	No data	coarse grained sediments
Qg	Unconsolidated sediments	Quaternary colluvium, fanglomerate, and talus	Quaternary				continental deposits
Qgm	Unconsolidated sediments	Glacial moraine	Quaternary	Quaternary surficial deposits	Glacial deposits	No data	mixed grained sediments
Ql	Unconsolidated sediments	Windblown silt and sand	Quaternary	Quaternary surficial deposits	Eolian deposits	No data	fine grained sediments
Qls	Landslide	Landslide debris	Quaternary	Quaternary surficial deposits	Landslide deposits	No data	mixed grained sediments
Qls	Landslide	Landslides	Quaternary	Quaternary surficial deposits	Landslide deposits	No data	mixed grained sediments
Qls	Landslide	Landslide deposits	Quaternary	Quaternary surficial deposits	Landslide deposits	No data	mixed grained sediments
Qls	Landslide	Landslide debris	Quaternary	Quaternary surficial deposits	Alluvial fan deposits	No data	mixed grained sediments
Qls	Landslide	Landslide deposits	Quaternary	Quaternary surficial deposits	Landslide deposits	No data	mixed grained sediments
Qls	Landslide	Landslide debris	Quaternary	Quaternary surficial deposits	Alluvial fan deposits	No data	mixed grained sediments
Qmf	Unconsolidated sediments	Missoula Flood deposits	Quaternary	Quaternary surficial deposits	Missoula Flood deposits	No data	mixed grained sediments
Qp?g	Unconsolidated sediments	Outwash, fanglomverate, flood, and terrace gravels	Quaternary				continental deposits
Qpa	Unconsolidated sediments	Pleistocene waterlaid detritus	Quaternary				continental deposits
Qpmb	Unconsolidated sediments	Plateau and canyon-filling basalt	Quaternary				igneous extrusive rocks - basalt
Qpug	Unconsolidated sediments	Upper Pleistocene deposits	Quaternary				continental deposits
Qsbf	Unconsolidated sediments	Fluviatile sand, gravel, and silt	Quaternary	Quaternary surficial deposits	Bonneville Flood deposits	No data	fine grained sediments
Qt	Unconsolidated sediments	Travertine	Miocene	Neogene sedimentary rocks	No data	No data	limestone
QTal	Sedimentary Rock	Lacustrine and fluvial sediments	Miocene/Quaternary	Neogene sedimentary rocks	No data	No data	fine grained sediments
Qtg	Unconsolidated sediments	Terrace and fan deposits	Quaternary	Quaternary surficial deposits	Terrace deposits	No data	mixed grained sediments
Qtg	Unconsolidated sediments	Terrace and bench gravels	Quaternary	Quaternary surficial deposits	Terrace deposits	No data	mixed grained sediments
Qtg	Sedimentary Rock	Terrace deposits	Quaternary	Quaternary surficial deposits	Terrace deposits	No data	mixed grained sediments
QTg	Sedimentary Rock	Gravel and conglomerate	Miocene/Pliocene	Dalles Group	Alkali Canyon Formation	No data	mixed lithologies
QTg	Sedimentary Rock	Gravel and conglomerate	Miocene/Pliocene	Neogene sedimentary rocks	No data	No data	mixed grained sediments
QTg1	Sedimentary Rock	Gravel and conglomerate	Quaternary	Quaternary surficial deposits	Missoula Flood deposits	No data	coarse grained sediments
QTs	Sedimentary Rock	Fluviatile and lacustrine deposits	Miocene/Quaternary	Neogene sedimentary rocks	No data	No data	fine grained sediments
QTs	Unconsolidated sediments	Pleistocene and Pliocene stream and lake deposits	Quaternary-Tertiary				continental deposits
QTt	Sedimentary Rock	Terrace deposits	Tertiary/Quaternary	Neogene sedimentary rocks	Terrace deposits	No data	mixed grained sediments
Qu	Unconsolidated sediments	Undifferentiated surficial deposits	Quaternary	Quaternary surficial deposits	Alluvial deposits	No data	mixed grained sediments
slide	Landslide	1984 landslide	Quaternary	Quaternary surficial deposits	Landslide deposits	No data	mixed grained sediments
sp	Metamorphic Rock	Mafic and ultramafic rocks	Paleozoic/Mesozoic	Baker Terrane	Burnt River Schist	No data	serpentinite
sp	Metamorphic Rock	Serpentine	Triassic	Wallowa Terrane	Sparta Complex	No data	serpentinite
Ta	Igneous Rock	Andesite flows and domes	Miocene	Powder River Volcanic Field	Andesite of Sawtooth Crater	No data	andesite
Ta	Igneous Rock	Andesite of Sawtooth Crater	Miocene	Powder River Volcanic Field	Andesite of Sawtooth Crater	No data	andesite
Tab	Igneous Rock	Alkali-rich basalts and basaltic trachyandesites	Miocene	Powder River Volcanic Field	Basanite of Horseshoe Basin	No data	alkali basalt
Tac	Sedimentary Rock	Alkali Canyon Formation	Miocene/Pliocene	Dalles Group	Alkali Canyon Formation	No data	mixed grained sediments
Tan	Igneous Rock	Andesite	Miocene	Powder River Volcanic Field	Andesite of Sawtooth Crater	No data	andesite
Tat	Sedimentary Rock	Ash flow tuffs and tuffaceous sedimentary rocks	Miocene	Lake Owyhee Volcanic Field	No data	No data	welded tuff

Table A-1 - Summary of Surficial Geologic Map Units

Map Unit Label	Category	Map Unit Name	Age	Terrane Group	Formation	Member	Geologic Rock Type
Tb	Igneous Rock	Porphyritic olivine basalt	Miocene	Powder River Volcanic Field	No data	Little Catherine Creek member	basalt
Tb	Igneous Rock	Basalt and andesite	Miocene	Columbia River Basalt Group	No data	No data	basalt
Tb	Igneous Rock	Basalt	Miocene	Powder River Volcanic Field	No data	Little Catherine Creek member	basalt
Tb	Igneous Rock	Basalt	Miocene	Columbia River Basalt Group	No data	No data	basalt
Tb	Igneous Rock	Olivine basalt	Miocene	Columbia River Basalt Group	No data	No data	basalt
Tb1	Igneous Rock	Basalt and andesite	Miocene	Powder River Volcanic Field	No data	Little Catherine Creek member	basalt
Tb2	Igneous Rock	Basalt and andesite	Miocene	Neogene volcanic rocks	No data	No data	mixed lithologies
Tba	Igneous Rock	Basalt and andesite	Miocene	Powder River Volcanic Field	No data	Little Catherine Creek member	basalt
Tbcl	Igneous Rock	Lower calc-alkaline lava flows	Miocene	Oregon-Idaho Graben	No data	No data	basalt
Tbcm	Igneous Rock	Middle calc-alkaline lava flows	Miocene	Oregon-Idaho Graben	No data	No data	basalt
Tbcu	Igneous Rock	Upper calc-alkaline lava flows	Miocene	Oregon-Idaho Graben	No data	No data	basalt
Tbf	Igneous Rock	Basalt	Miocene	Columbia River Basalt Group	Wanapum Basalt	No data	basalt
Tbf1	Igneous Rock	Basalt	Miocene	Powder River Volcanic Field	Dacite of Mt. Emily	No data	dacite
Tbhc	Igneous Rock	Hunter Creek Basalt	Miocene	Columbia River Basalt Group	Hunter Creek Basalt	No data	andesite
Tbi	Igneous Rock	Basalt intrusions	Miocene	Oregon-Idaho Graben	No data	No data	basalt
Tbol	Igneous Rock	Lower olivine basalt flows	Miocene	Oregon-Idaho Graben	No data	No data	basalt
Tbou	Igneous Rock	Upper olivine basalt flows	Miocene	High Lava Plains Volcanic Provinc	No data	No data	basalt
Tbt	Igneous Rock	Basaltic tuff	Miocene	Columbia River Basalt Group	No data	No data	basalt
Tbt	Igneous Rock	Lower tholeiitic lava flows	Miocene	Columbia River Basalt Group	No data	No data	mixed lithologies
Tbtv	Igneous Rock	Eastern tholeiitic lavas	Miocene	Columbia River Basalt Group	No data	No data	mixed lithologies
Tcd	Igneous Rock	Columbia River Basalt dikes	Miocene	Columbia River Basalt Group	No data	No data	basalt
Tcg	Igneous Rock	Grande Ronde Basalt	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	No data	basalt
Tcg	Igneous Rock	Grande Ronde Basalt Formation, undifferentiated	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	No data	basalt
Tcg1	Igneous Rock	Grande Ronde Basalt	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	Andesite of Fiddlers Hell	andesite
Tcgf	Igneous Rock	Ferroandesite of Fiddlers Hell	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	Andesite of Fiddlers Hell	andesite
Tcgn1	Igneous Rock	N1 Grande Ronde Basalt	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	Normal magnetostratigraphic unit 1	basalt
Tcgn2	Igneous Rock	N2 Grande Ronde Basalt	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	Normal magnetostratigraphic unit 2	basalt
Tcgn2	Igneous Rock	N2 magnetostratigraphic unit	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	Normal magnetostratigraphic unit 2	basalt
Tcgr1	Igneous Rock	R1 Grande Ronde Basalt	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	Reversed magnetostratigraphic unit 1	basalt
Tcgr2	Igneous Rock	R2 Grande Ronde Basalt	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	Reversed magnetostratigraphic unit 2	basalt
Tcgv	Igneous Rock	Palagonite tuff of Grande Ronde Basalt	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	No data	basalt
Tci	Igneous Rock	Imnaha Basalt	Miocene	Columbia River Basalt Group	Imnaha Basalt	No data	basalt
Tci	Igneous Rock	Imnaha Basalt Formation	Miocene	Columbia River Basalt Group	Imnaha Basalt	No data	basalt
Tcr	Igneous Rock	Columbia River basalts	Miocene	Columbia River Basalt Group	Imnaha Basalt	No data	basalt
Tcr	Igneous Rock	Columbia River Basalt	Miocene	Columbia River Basalt Group	No data	No data	basalt
Tcrb	Igneous Rock	Columbia River Basalt Group flows	Miocene	Columbia River Basalt Group	Grande Ronde Basalt	No data	basalt
Td	Igneous Rock	Dacite flows and domes	Miocene	Powder River Volcanic Field	Dacite of Mt. Emily	No data	dacite
Td	Igneous Rock	Dacite flows	Miocene	Powder River Volcanic Field	Dacite of Mt. Emily	No data	dacite
Tdr	Igneous Rock	Dooley rhyolite breccia	Miocene	Lake Owyhee Volcanic Field	Dooley Mountain Complex	No data	felsic composition lithologies
Tem	Igneous Rock	Elephant Mountain member	Miocene	Columbia River Basalt Group	Saddle Mountain Basalt	Elephant Mountain Member	basalt
Tf	Igneous Rock	Undifferentiated Frenchman Springs flows	Miocene	Columbia River Basalt Group	Wanapum Basalt	Frenchman Springs Member	basalt
Tfls	Sedimentary Rock	Fluvial and lacustrine basinal sediments	Miocene	Neogene sedimentary rocks	No data	No data	fine grained sediments
Tm?b	Igneous Rock	Miocene plateau basalt flows of western Idaho	Quaternary				igneous extrusive rocks - basalt
Tmb	Sedimentary Rock	Miocene plateau basalt flows of western Idaho	Quaternary				igneous extrusive rocks - basalt
Tmd	Sedimentary Rock	Miocene stream and lake deposits	Tertiary				continental deposits
Tmf	Igneous Rock	Miocene silicic flows, tuffs	Tertiary				igneous extrusive rocks - rhyolite, tuff, andesite
Tpb	Igneous Rock	Olivine basalt flows and associated tuff and detritus	Quaternary				igneous extrusive rocks - basalt
Tpd	Igneous Rock	Pliocene stream and lake deposits	Tertiary				continental deposits
Tpf	Igneous Rock	Pliocene silicic welded tuff, ash, and flow rocks	Tertiary				igneous extrusive rocks - rhyolite, tuff, andesite
TRv	Igneous Rock	Metabasalt and submarine volcaniclastics	Triassic				deep marine-to-transitional deposits

LEGEND

- IPC Proposed Route
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- NEPA Alternative
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N W E S

0 20 40 Miles

Boardman - Hemingway
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GEOLOGY INDEX MAP

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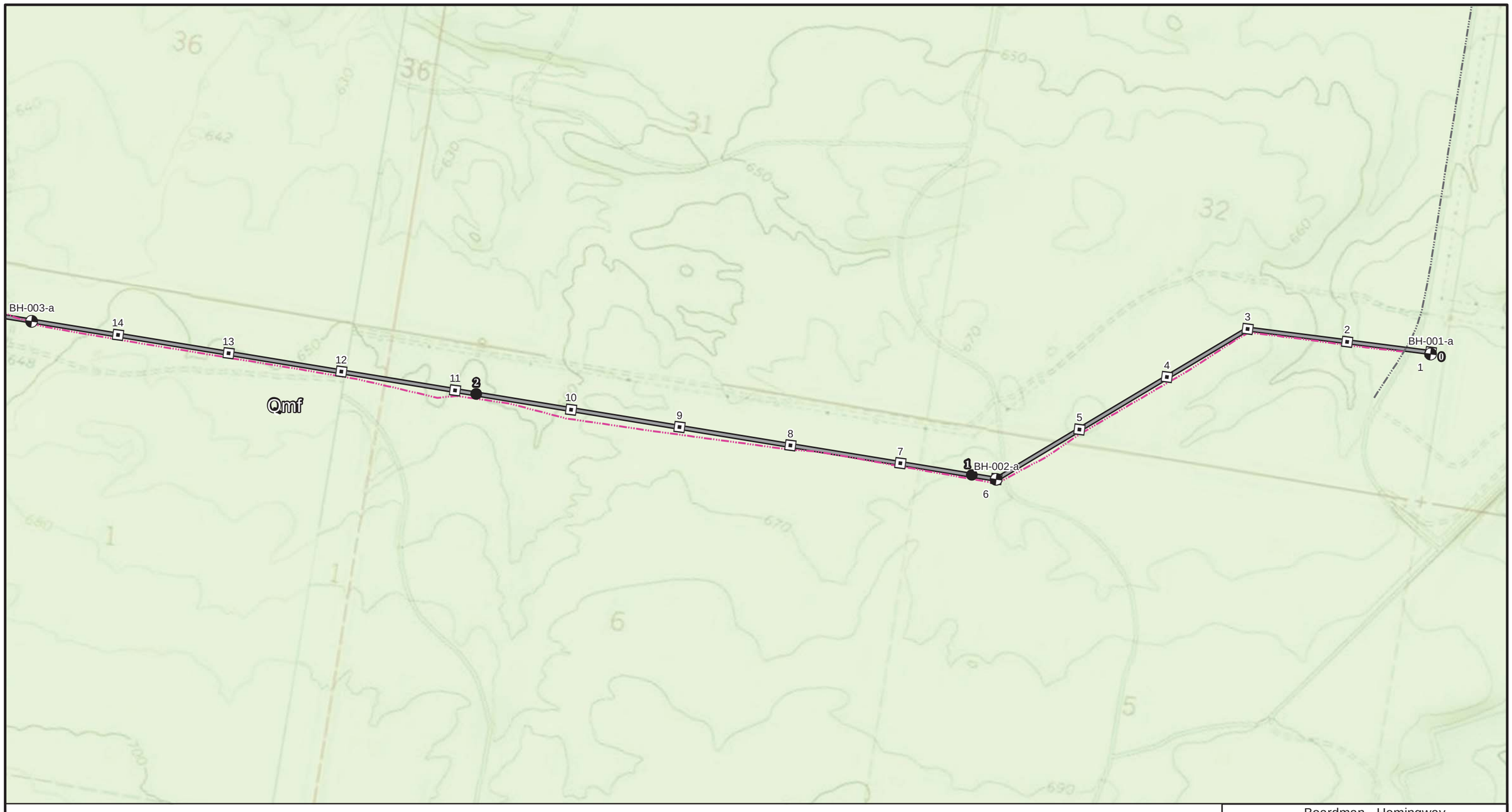

LEGEND

TRANSMISSION FEATURES
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- Landslide (SLIDO)
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- Inferred
- Inferred and queried

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- Overland with Clearing
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EXISITING TRANSPORATION ROADS
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N W E S

NOTE
For geologic unit descriptions see Table A-2

0 1,000 Feet

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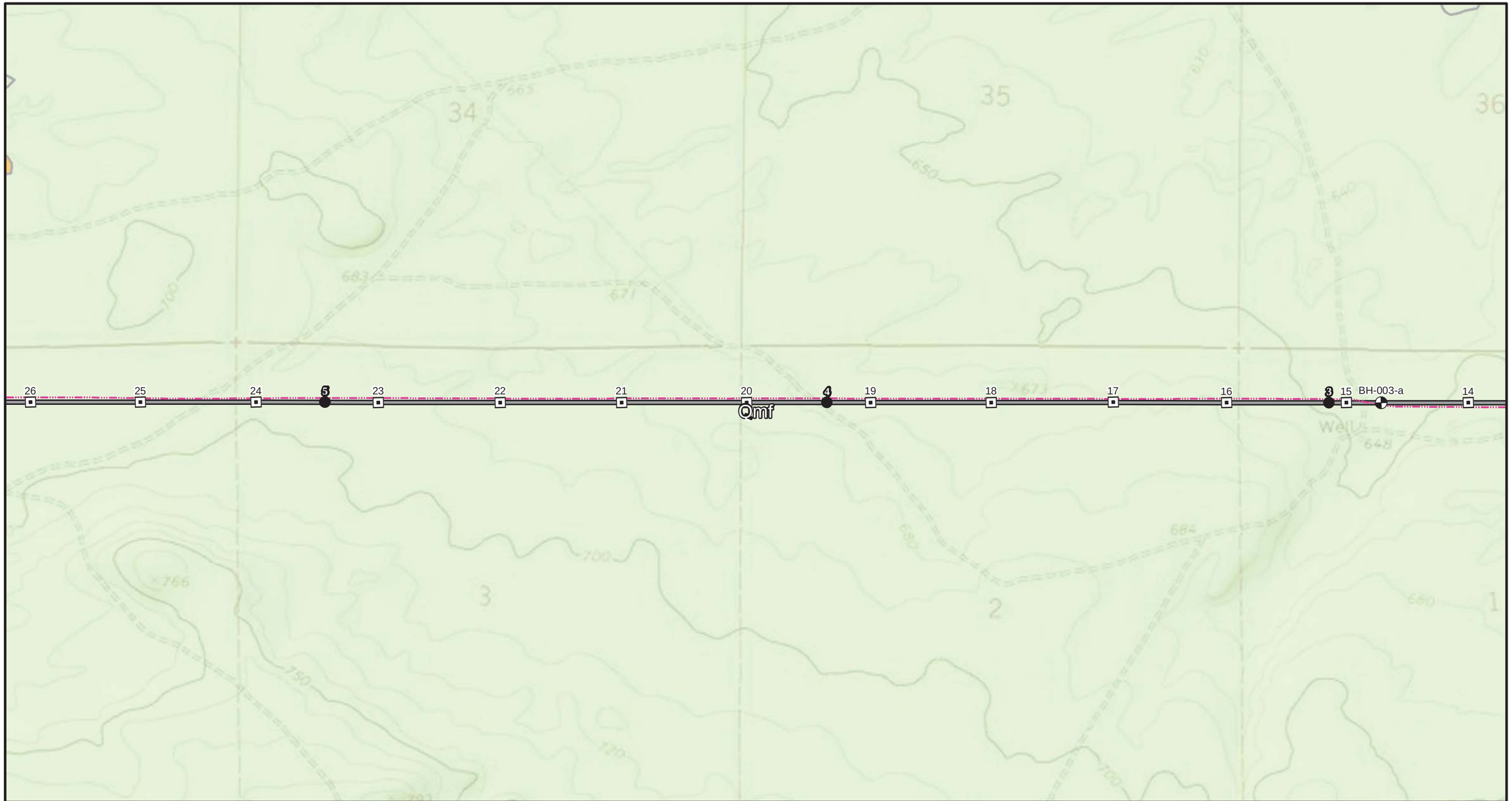

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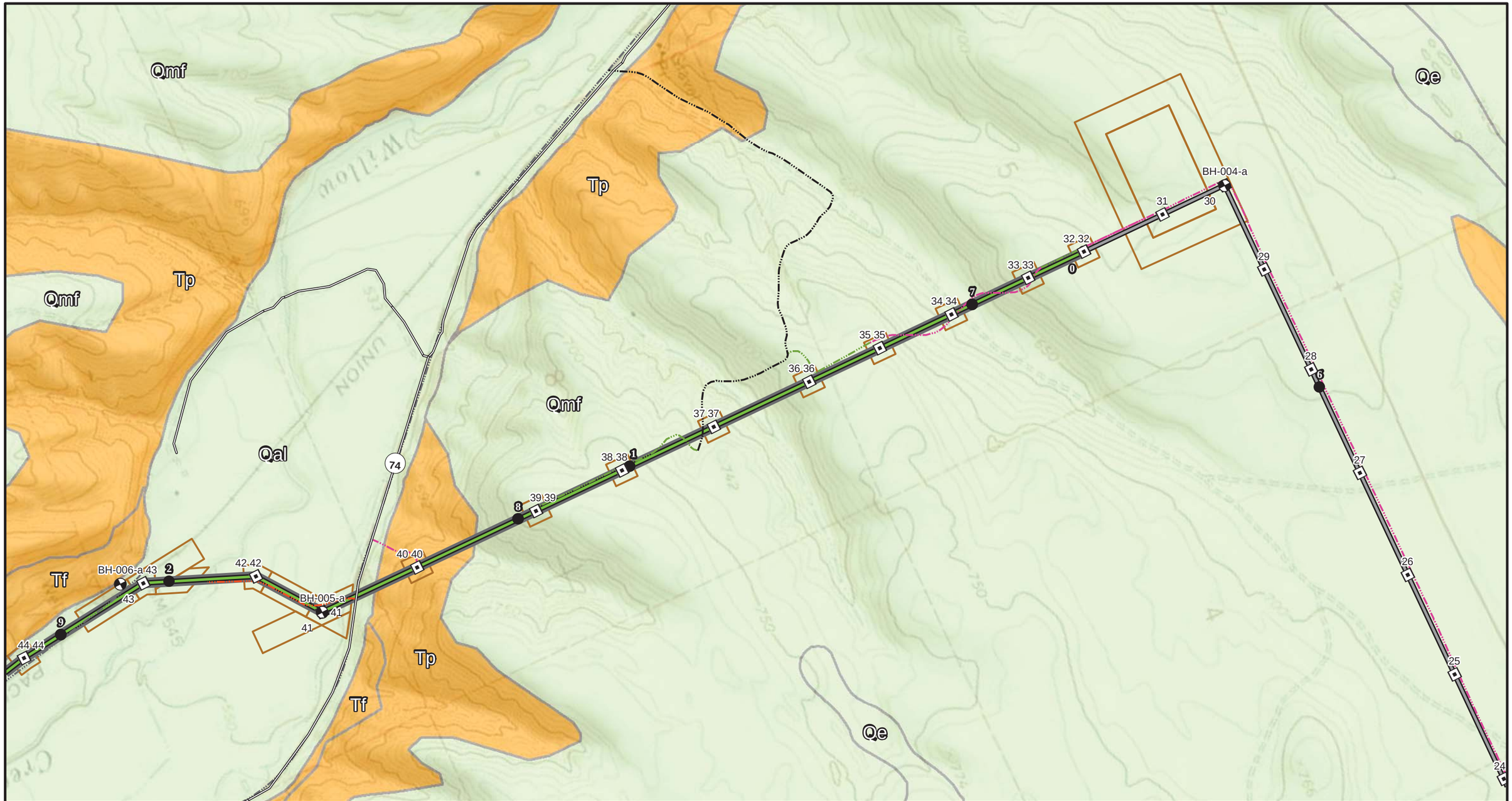

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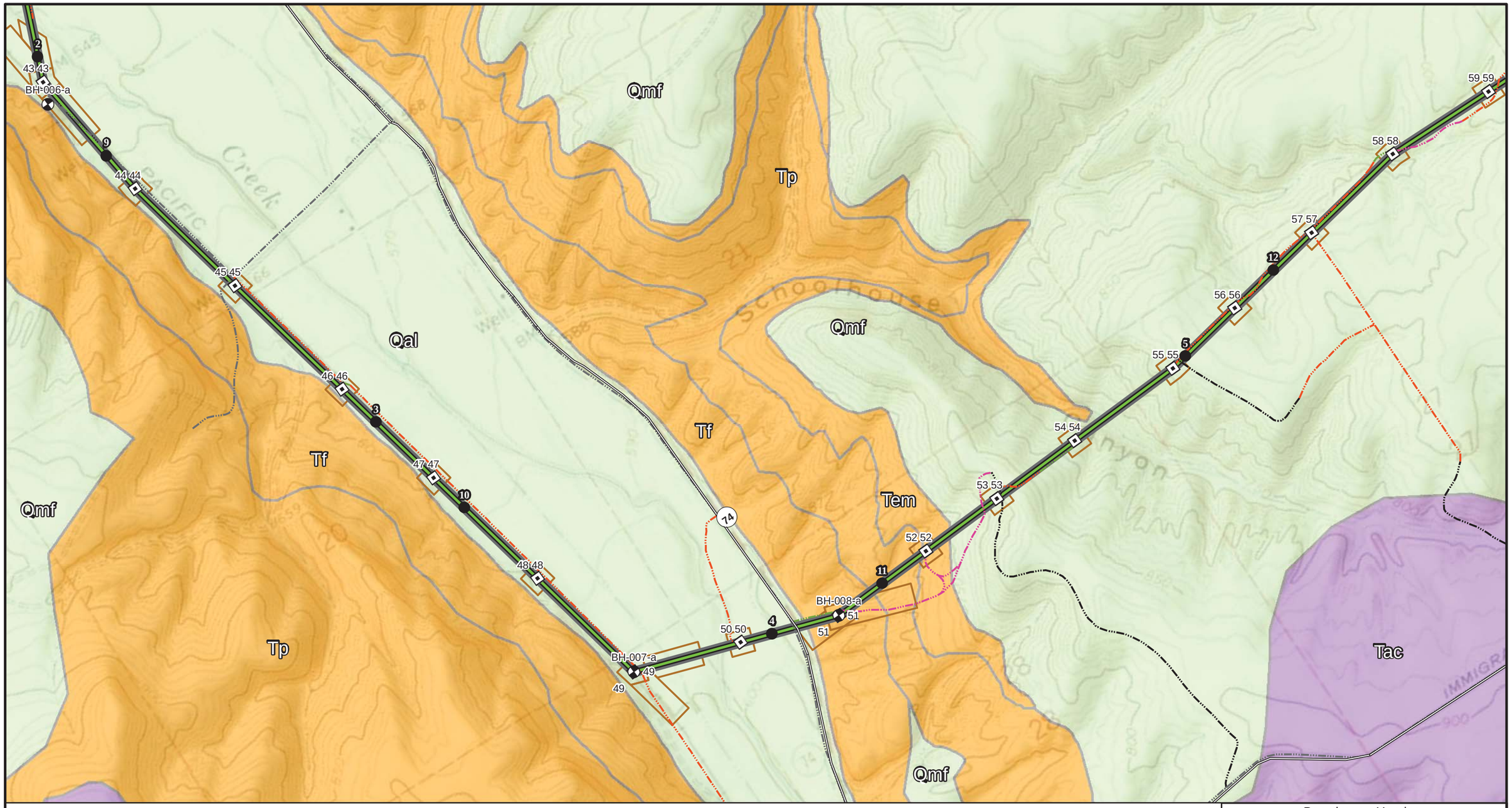

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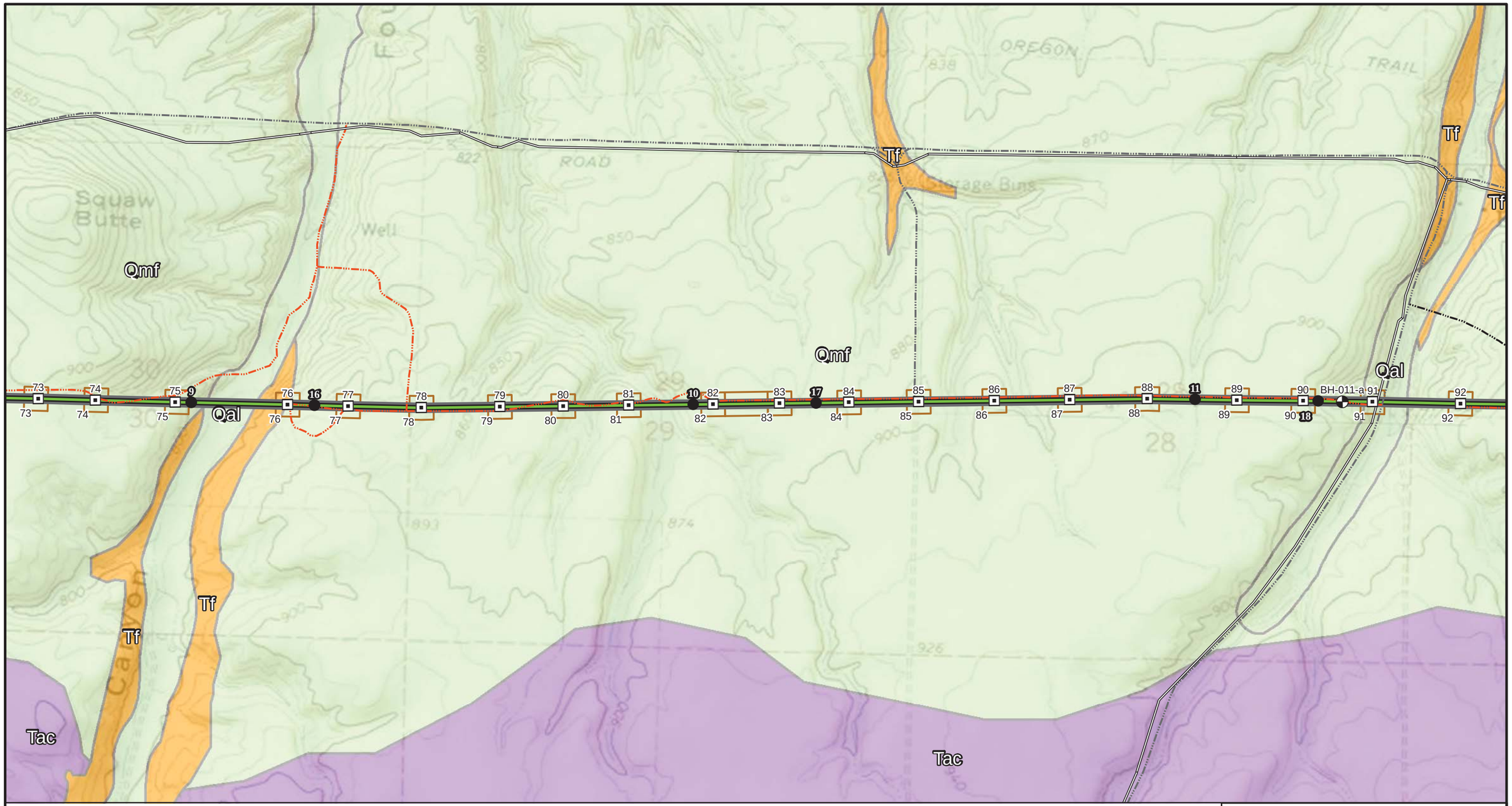

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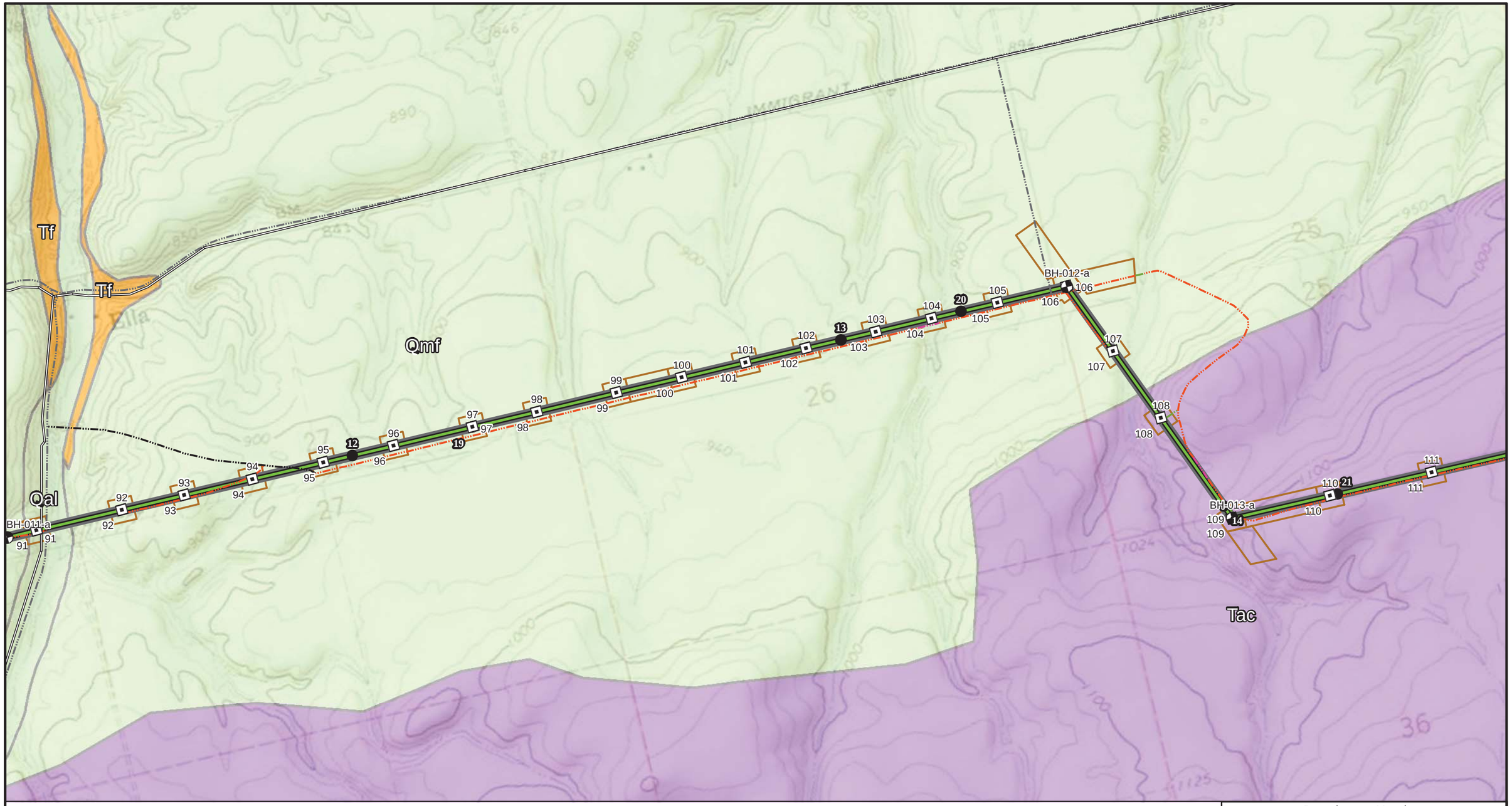

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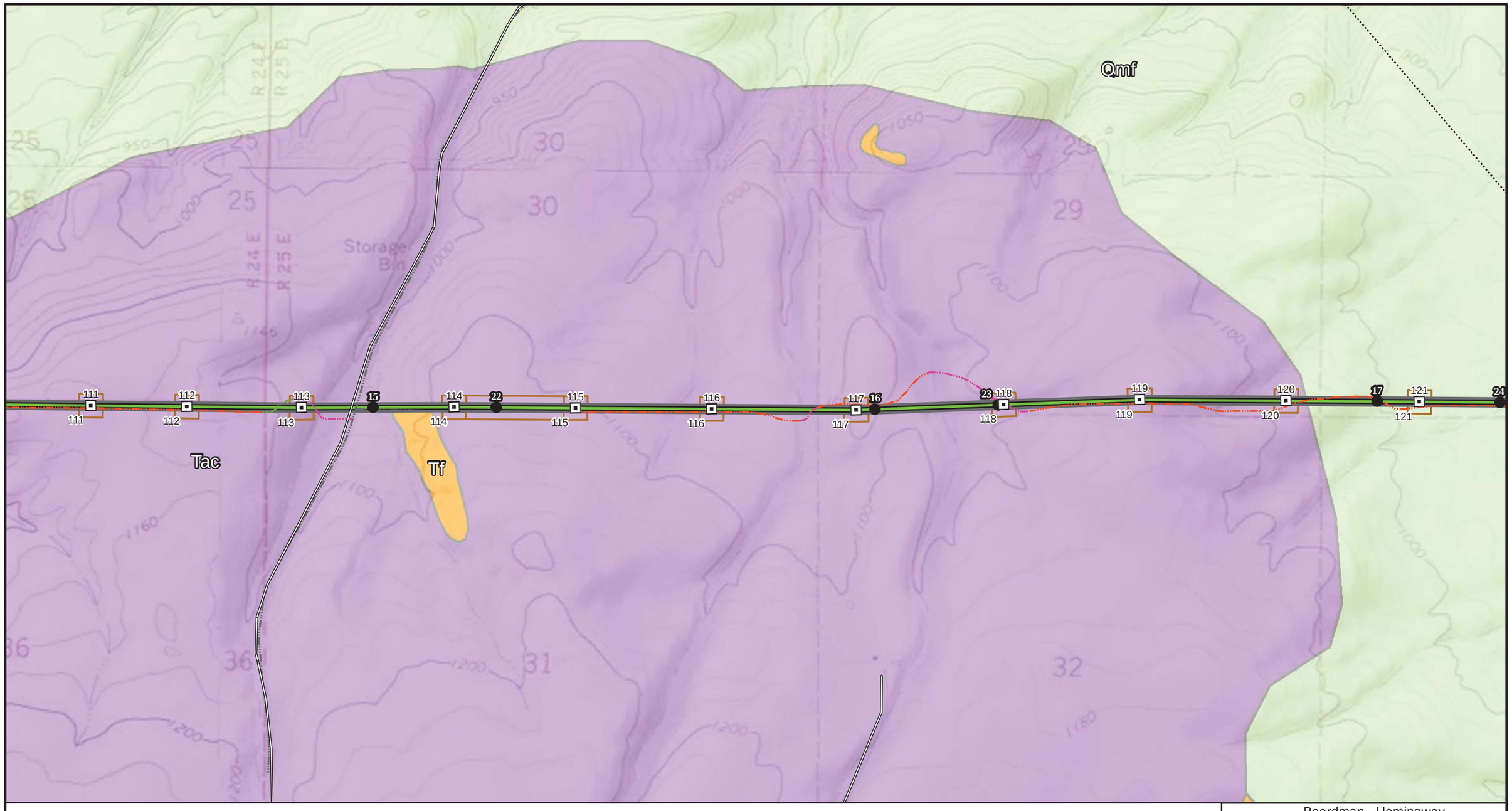

LEGEND

TRANSMISSION FEATURES
- IPC Proposed Route
- IPC Alternative
- NEPA Alternative
- Work Area
- Mileposts
- Towers
- Proposed Borehole

SURFICIAL GEOLOGY
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- Metamorphic Rocks
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- Unconsolidated Rocks
- Volcaniclastic Rocks

LANDSLIDES
- Fan
- Landslide (SLIDO)
- Talus - Colluvium

FAULTS
- Approximate
- Approximate and queried
- Certain
- Concealed
- Inferred
- Inferred and queried

COMMUNICATION
- Communication Power
- Communication Fiber

PRELIMINARY ACCESS PATHS
- Bladed
- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
- Existing Access, To Be Improved
- Existing Access, May Need Repairs
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EXISITING TRANSPORATION ROADS
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- Primary US and State Highways
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N W E S

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0 1,000 Feet

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Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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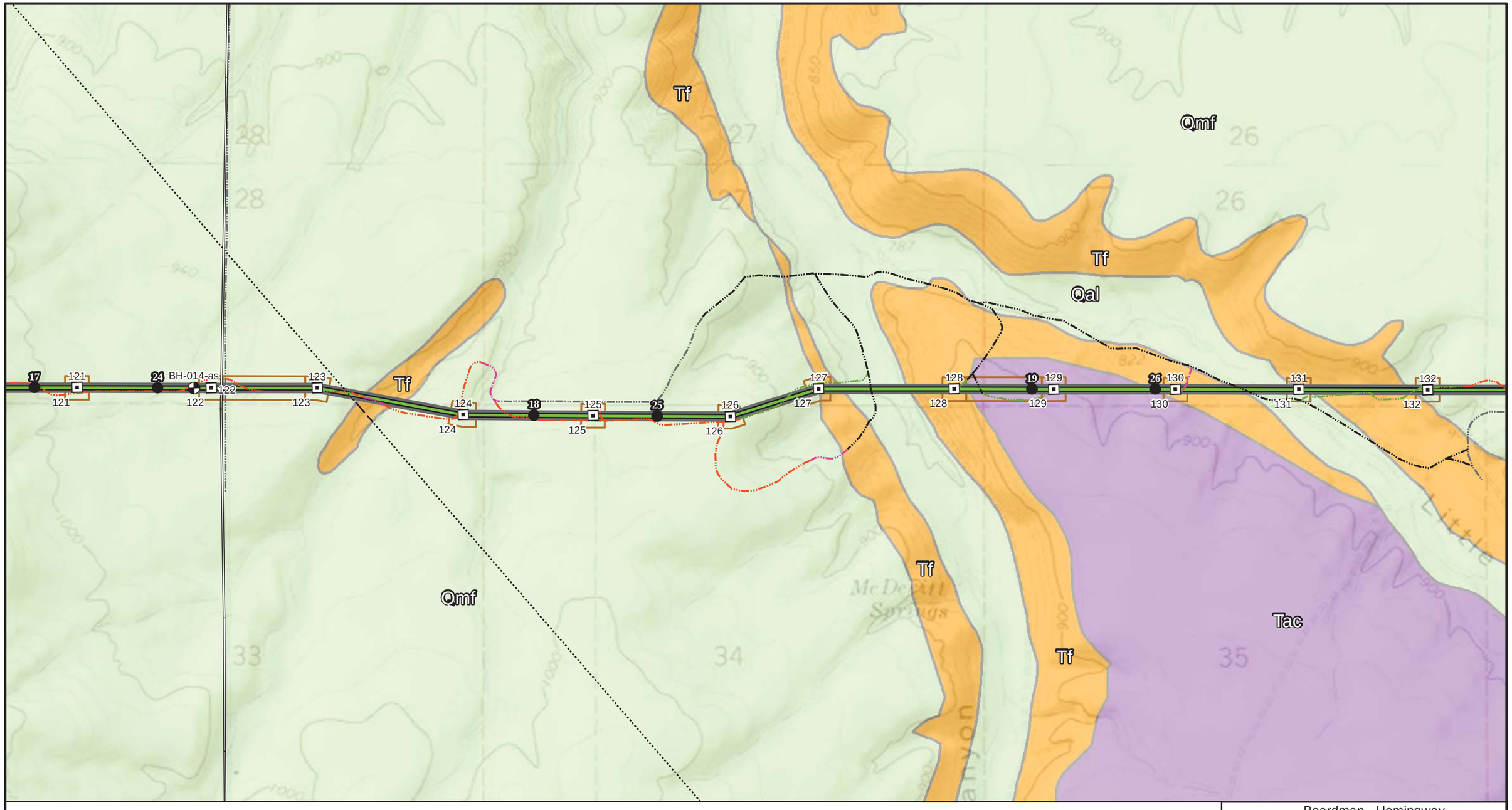

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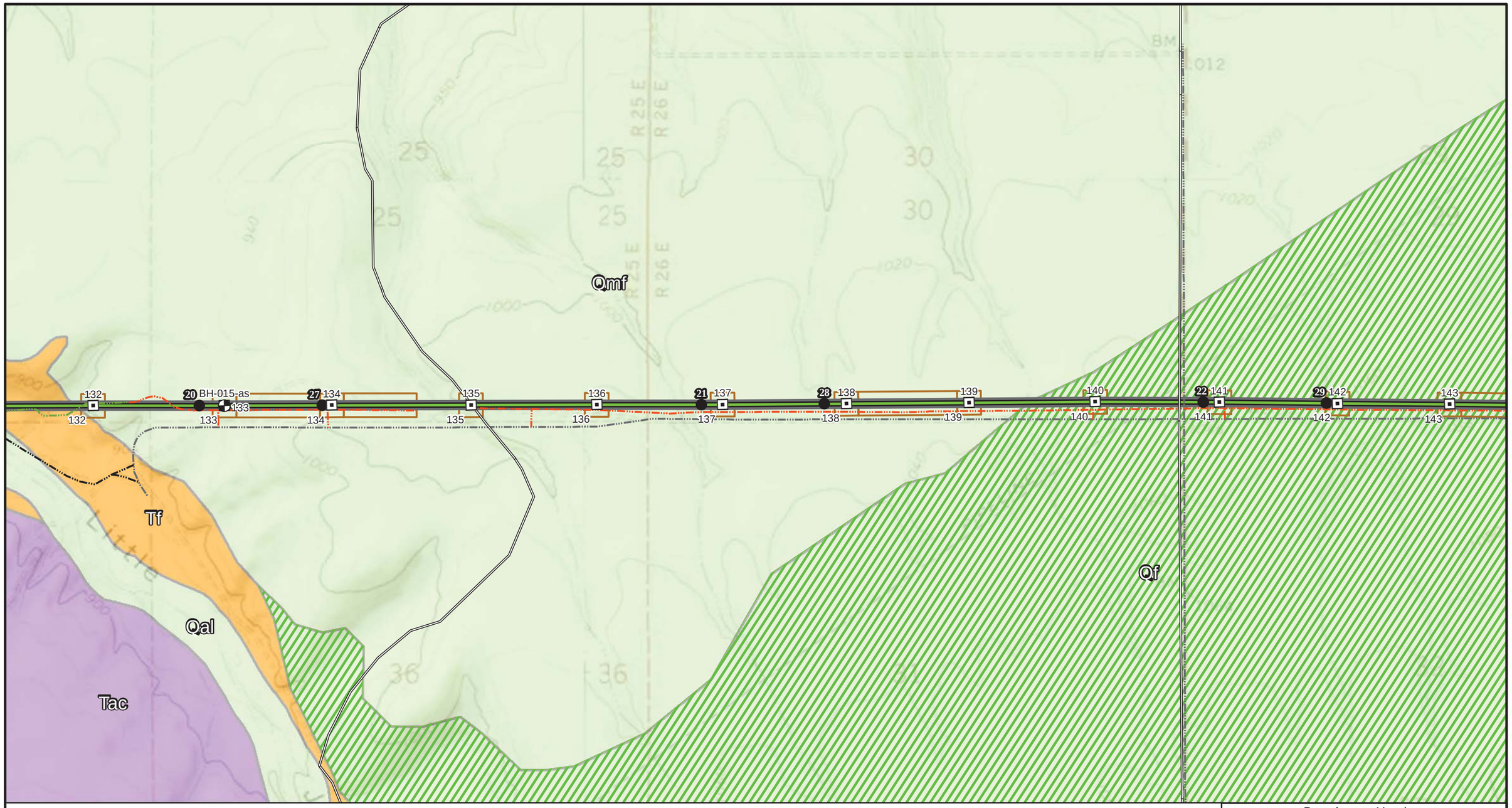

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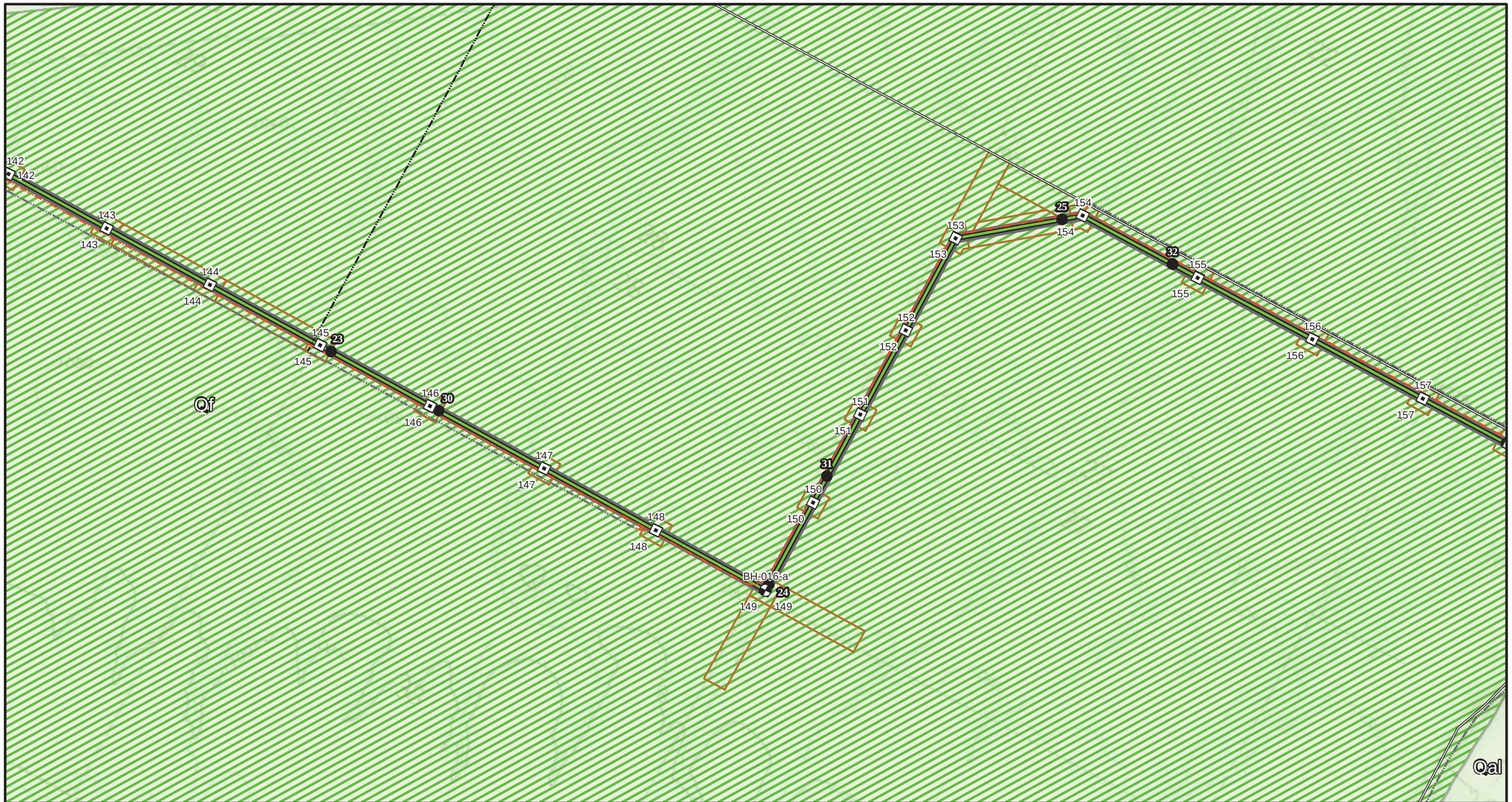

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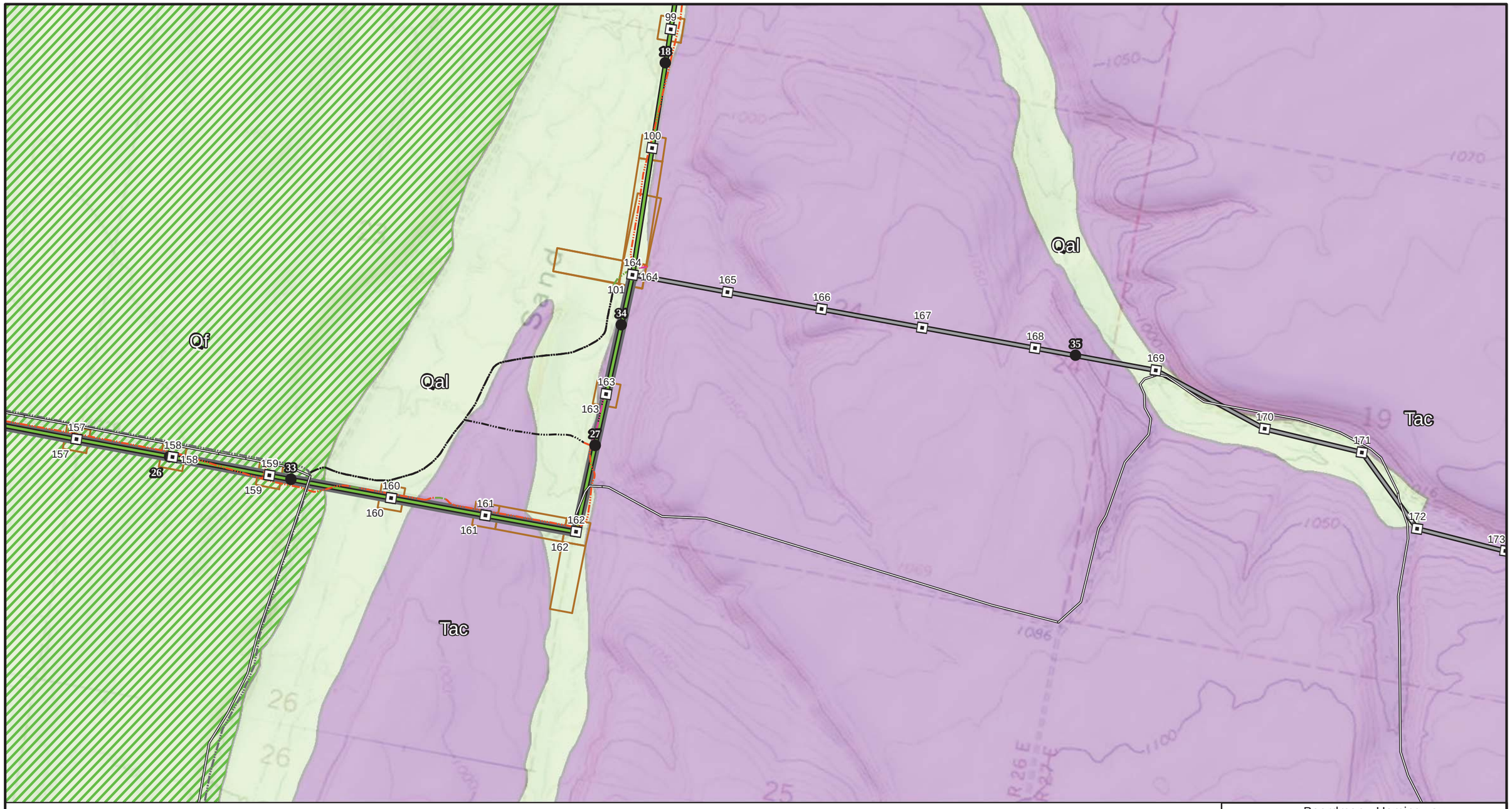

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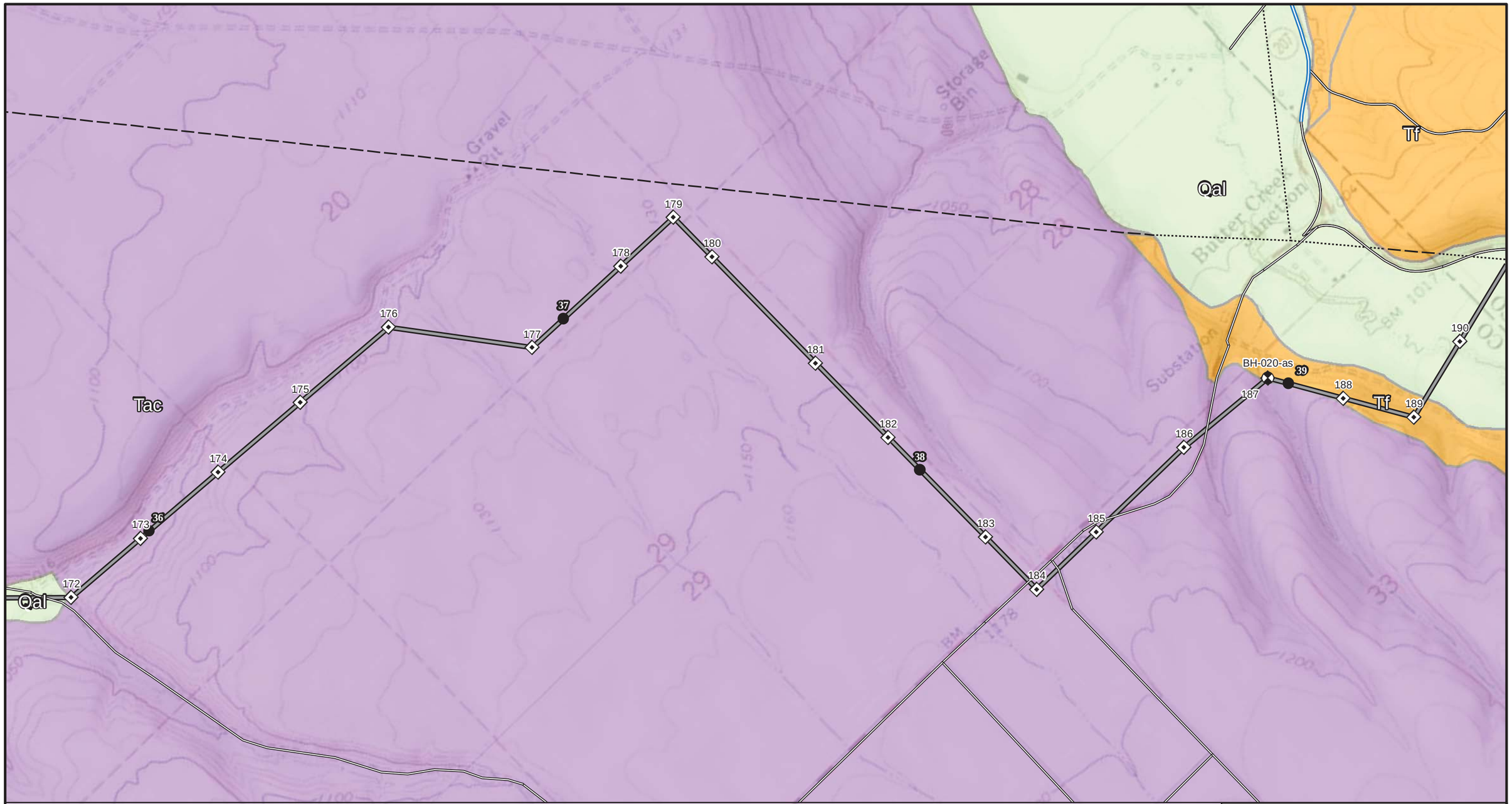

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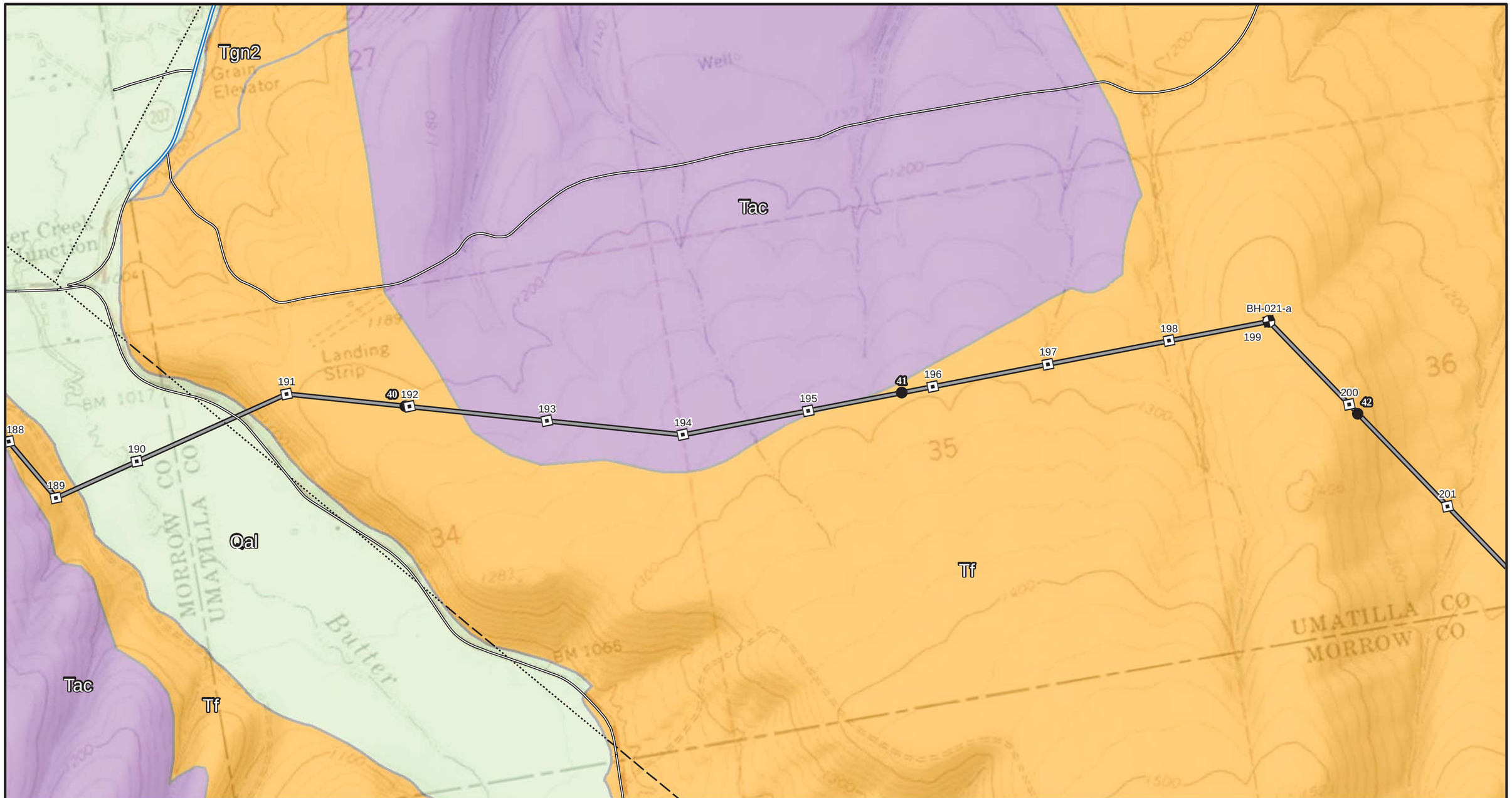

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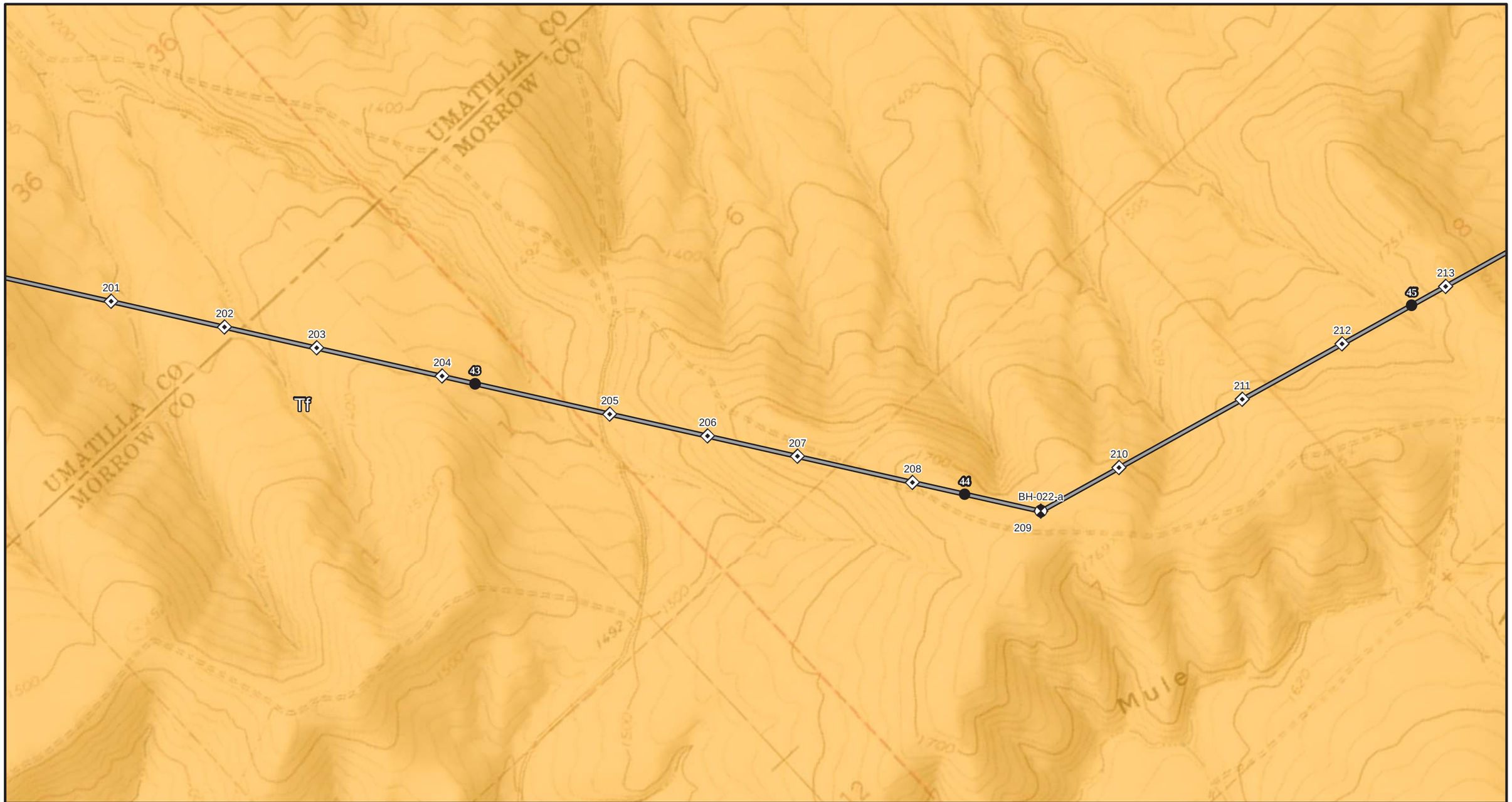

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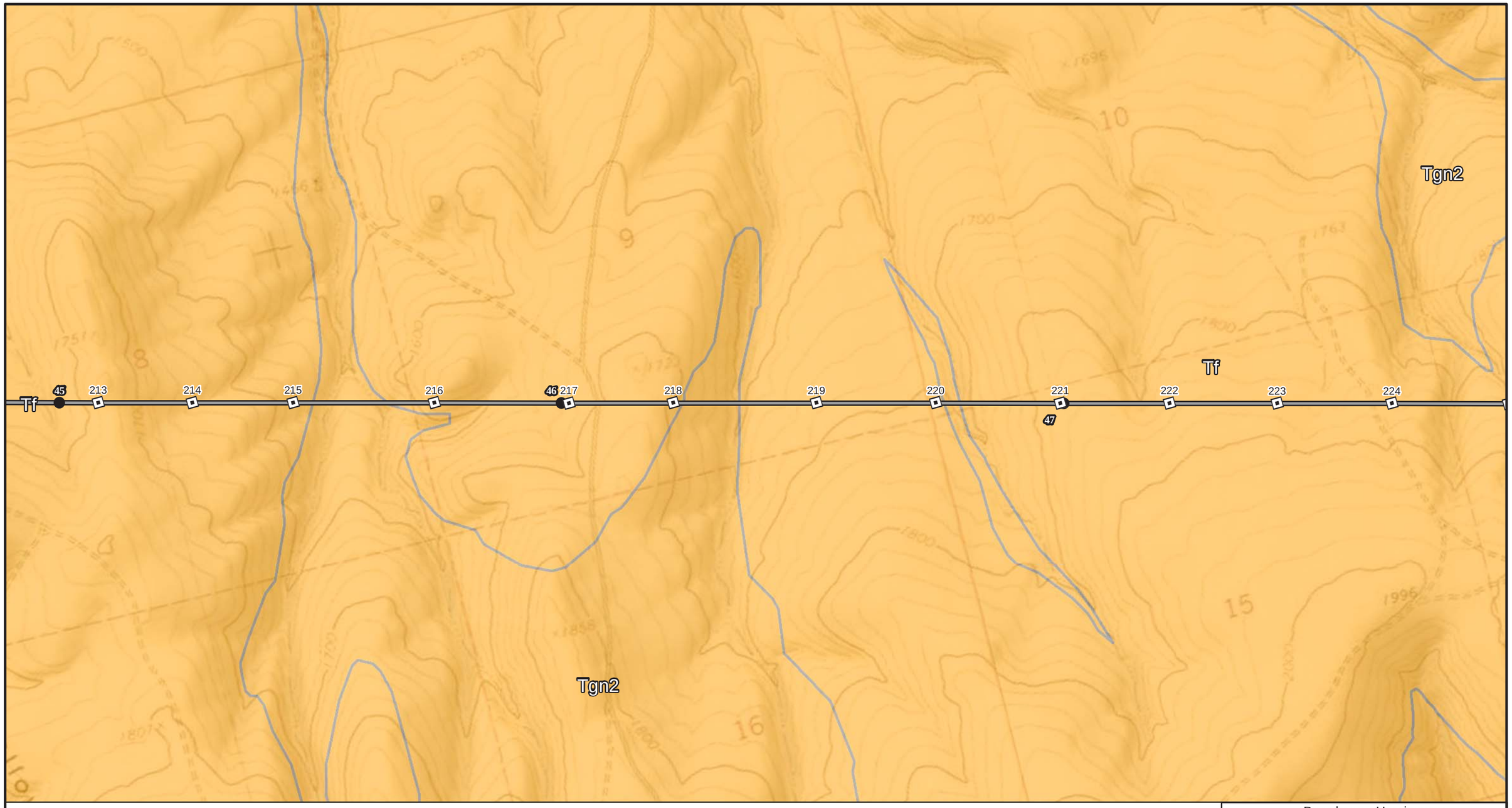

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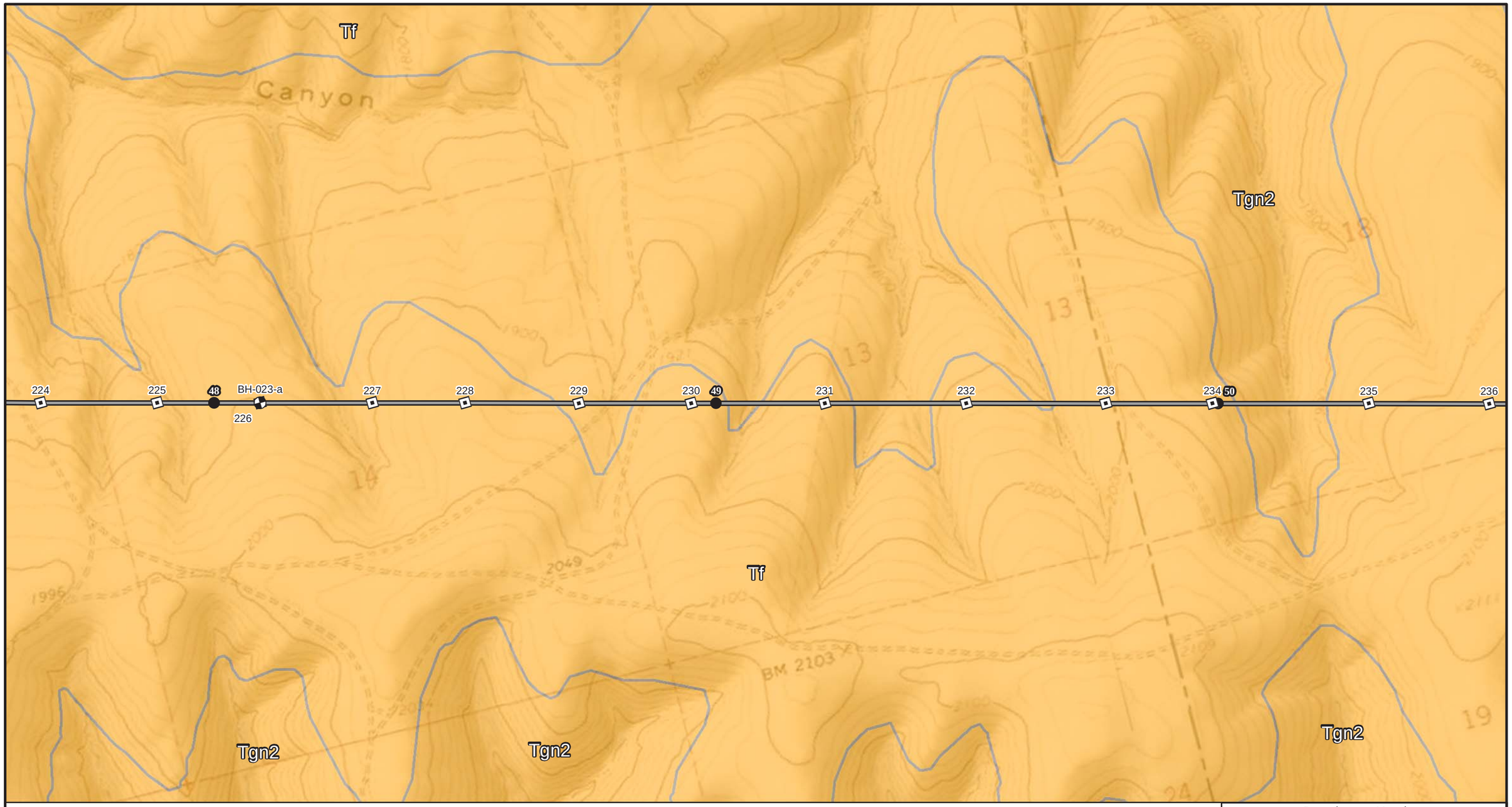

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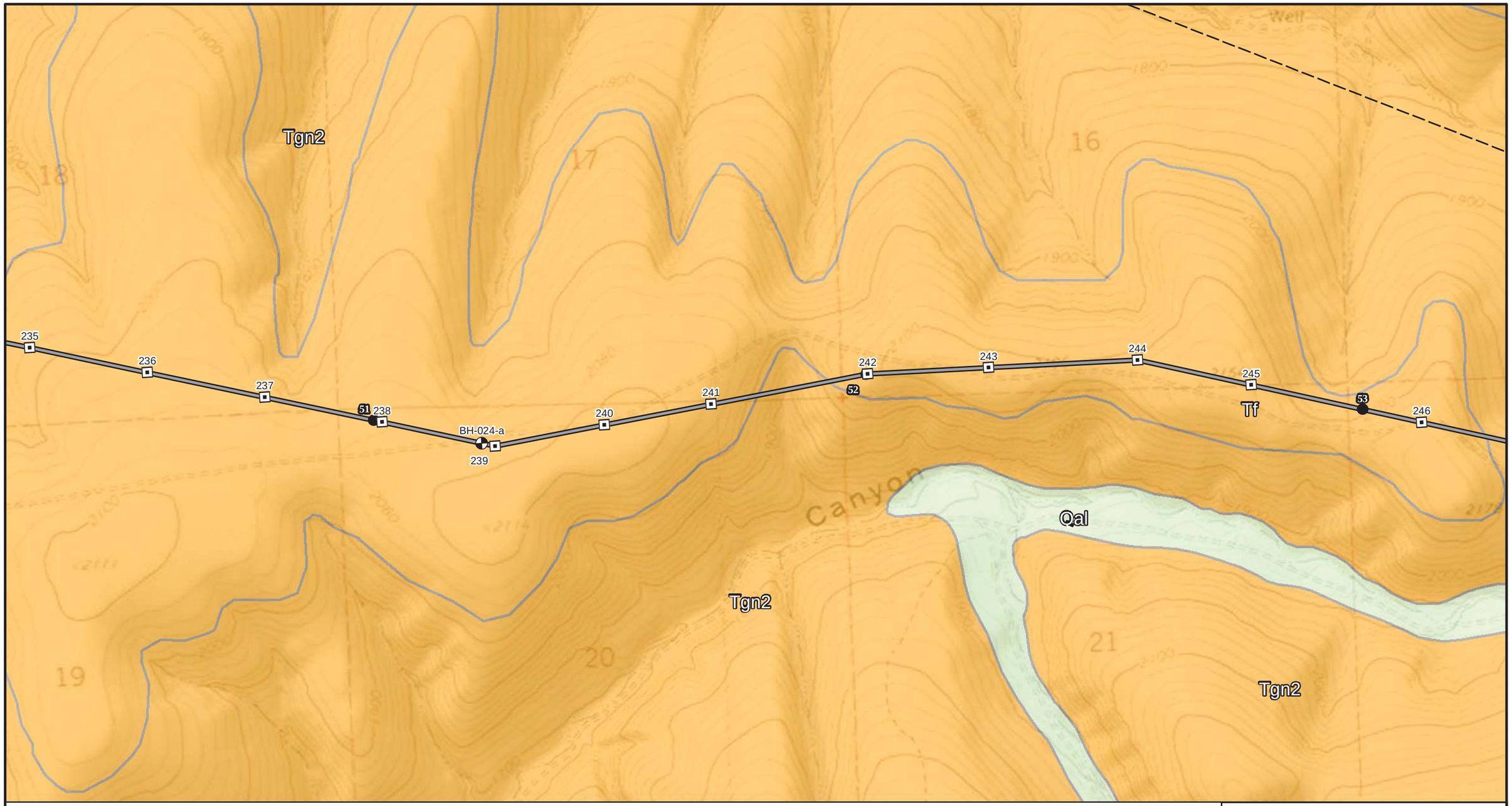

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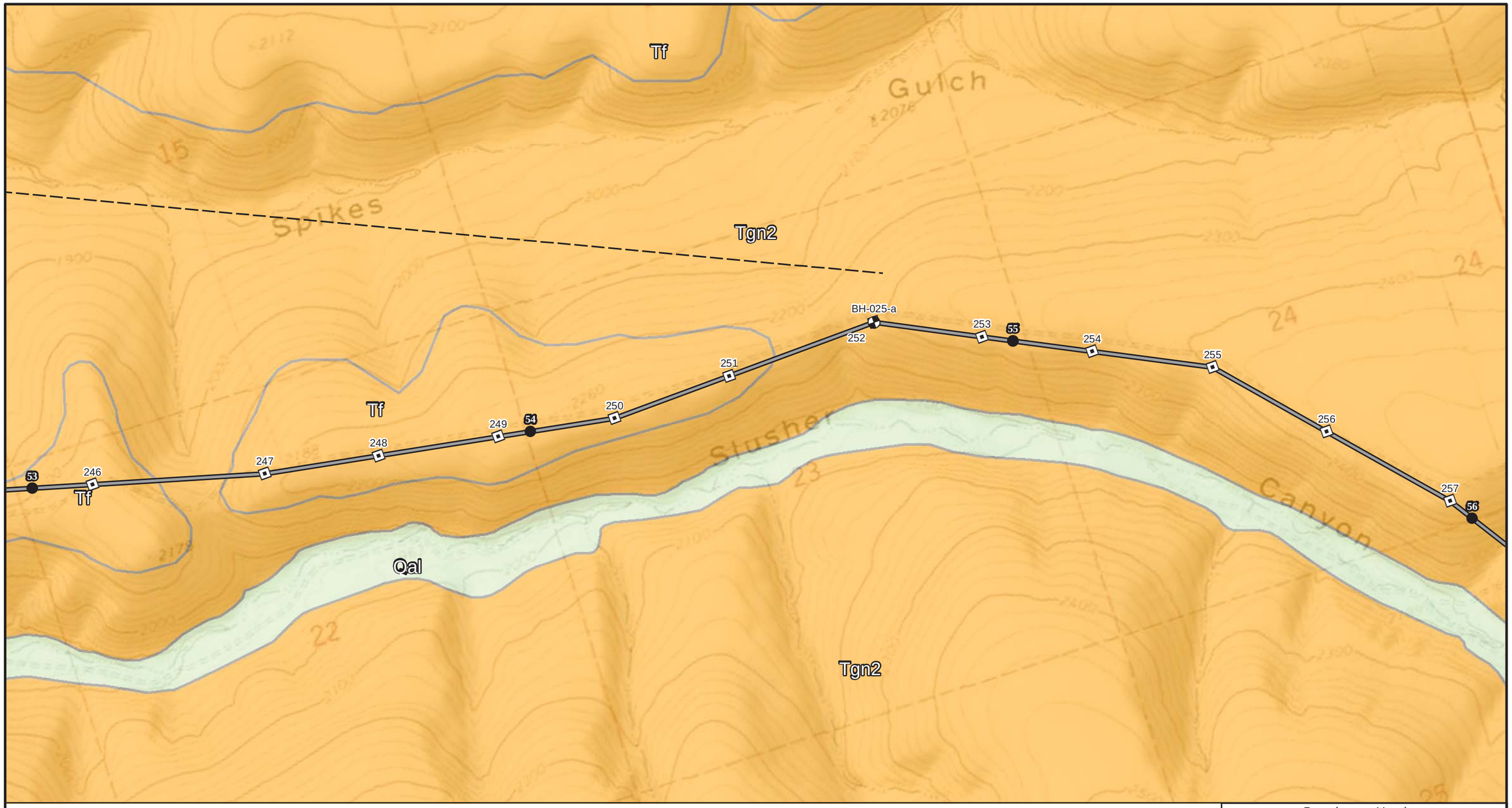

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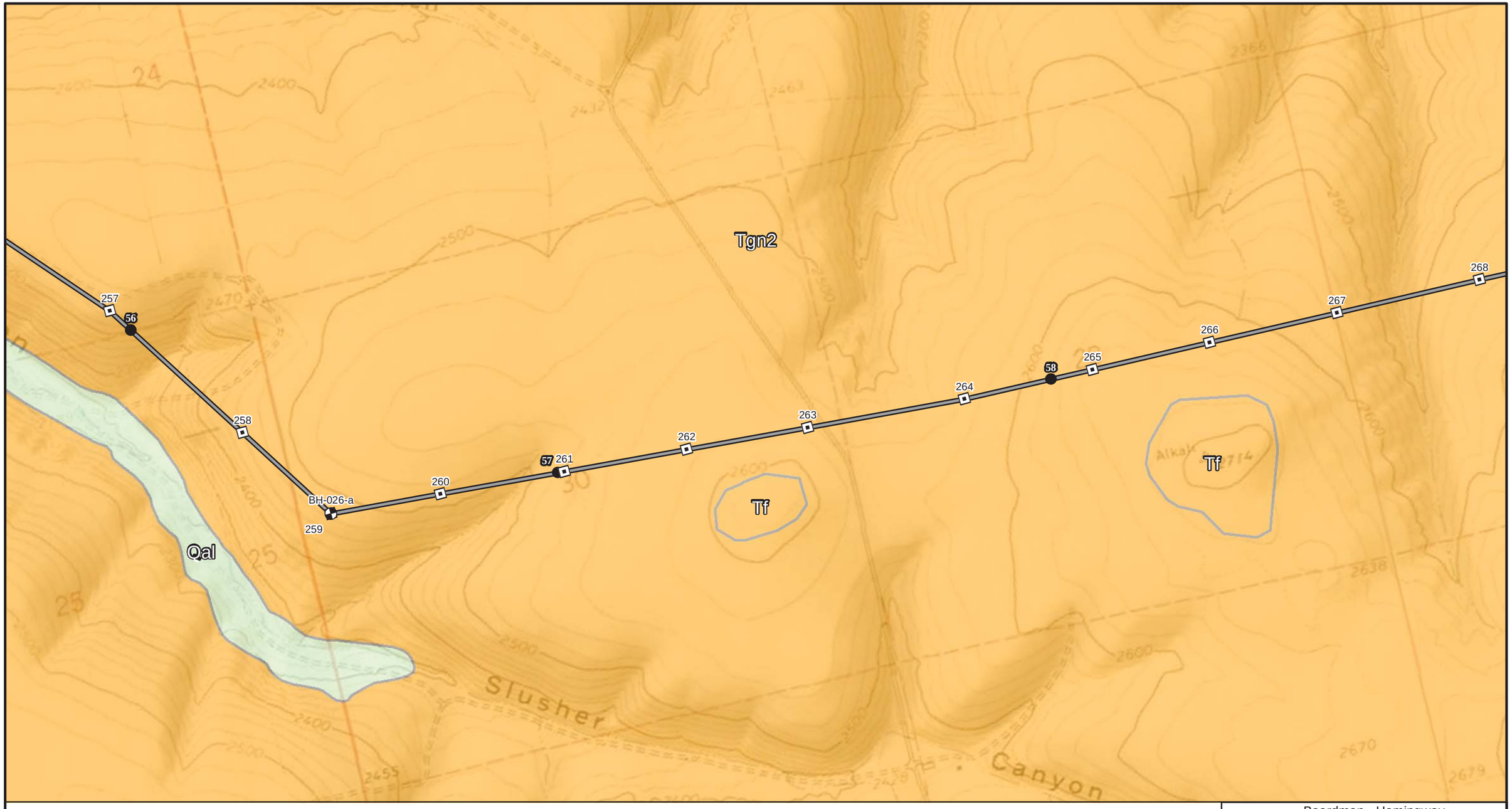

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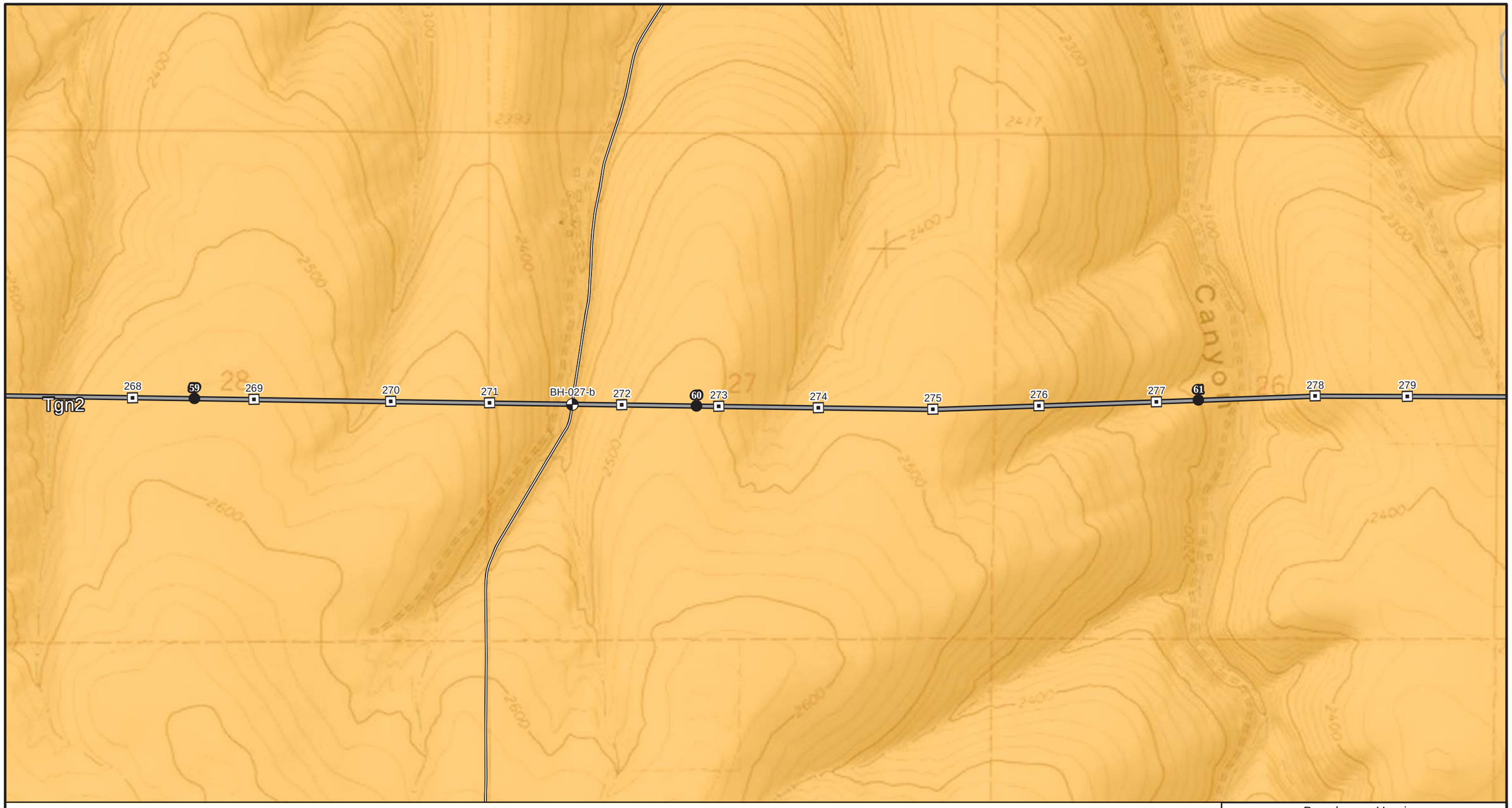

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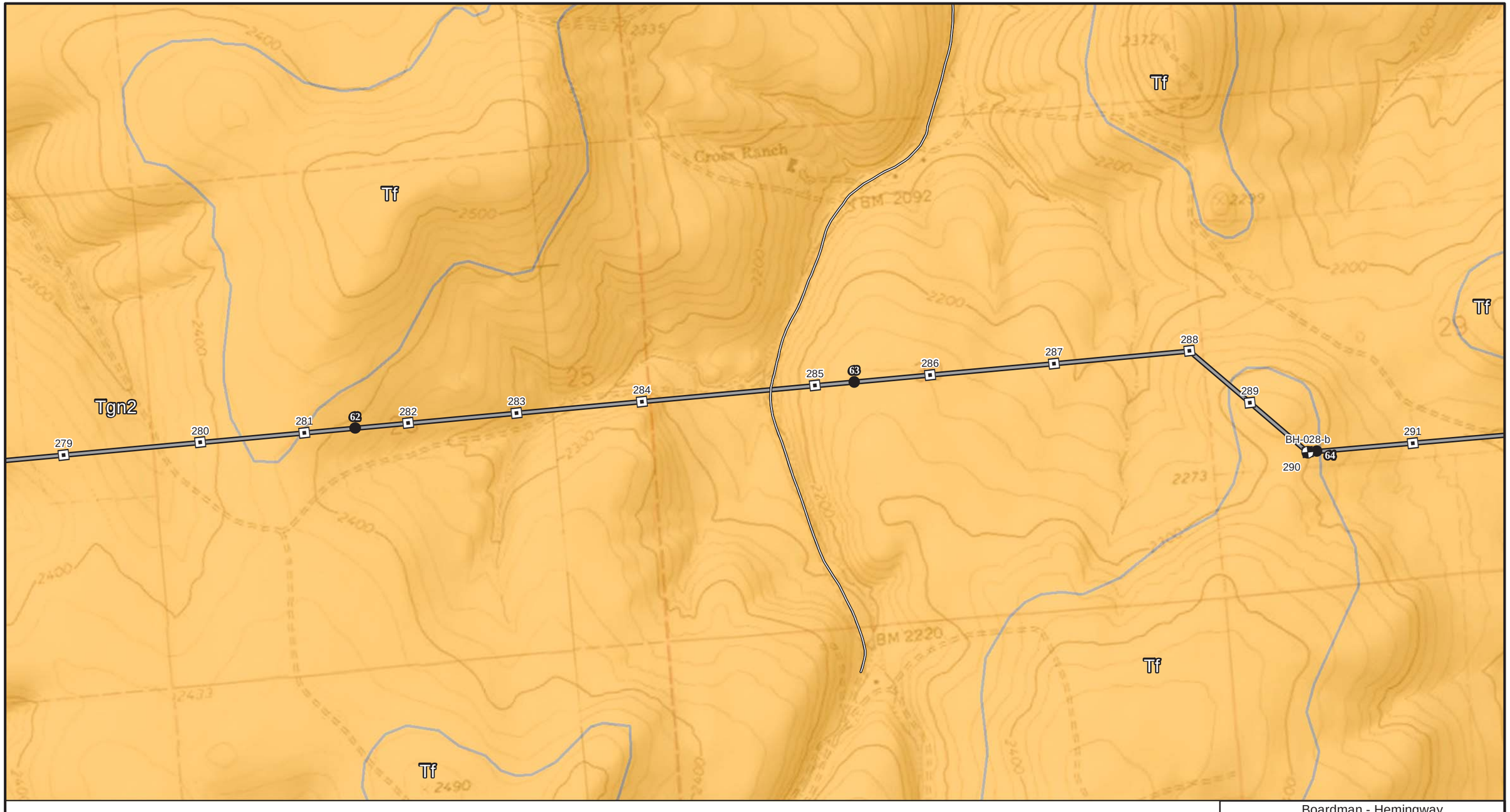

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FAULTS
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COMMUNICATION
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- Overland Travel
- Overland with Clearing
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- Primary Limited Access Road
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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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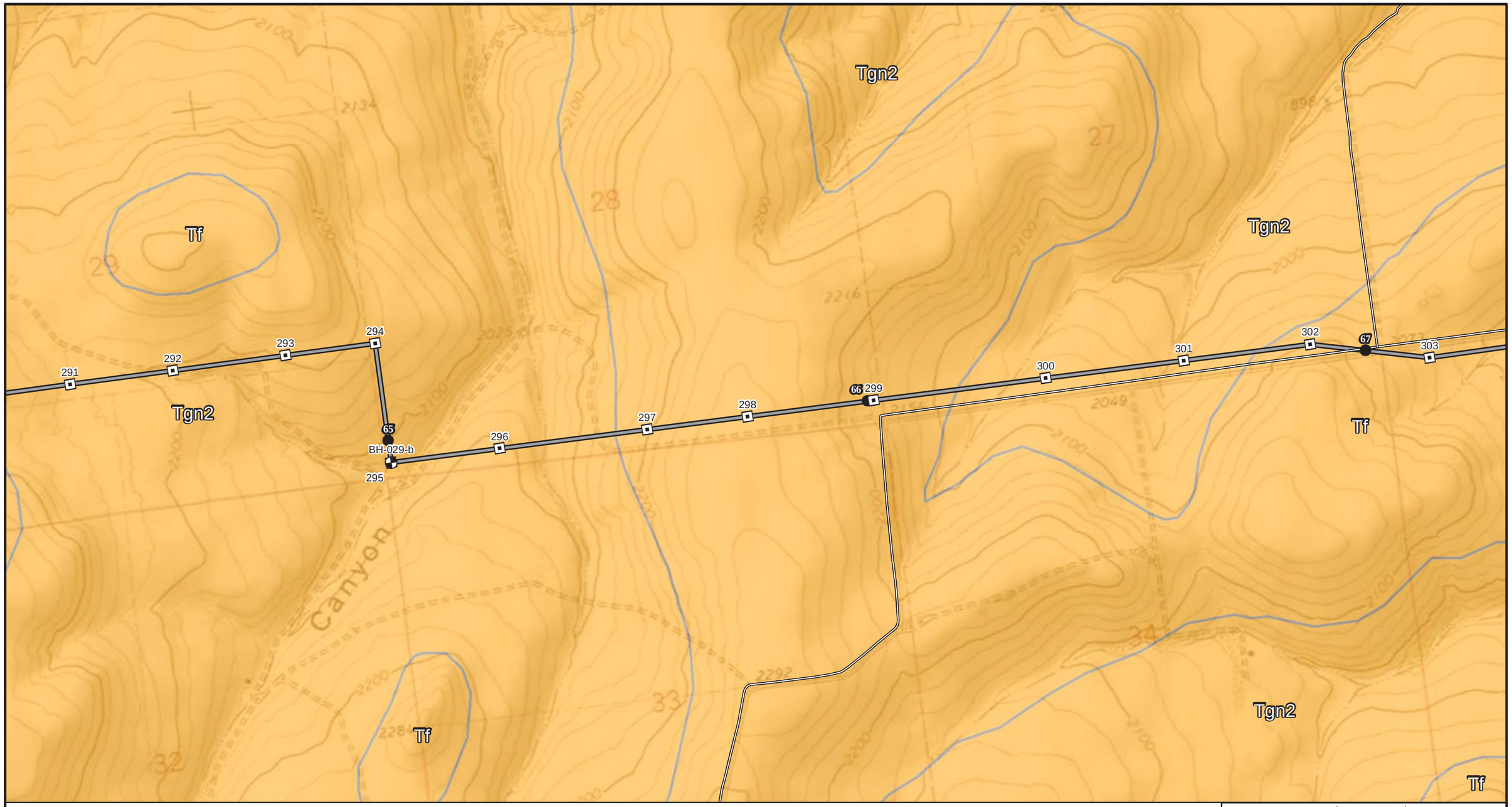

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TRANSMISSION FEATURES
- IPC Proposed Route
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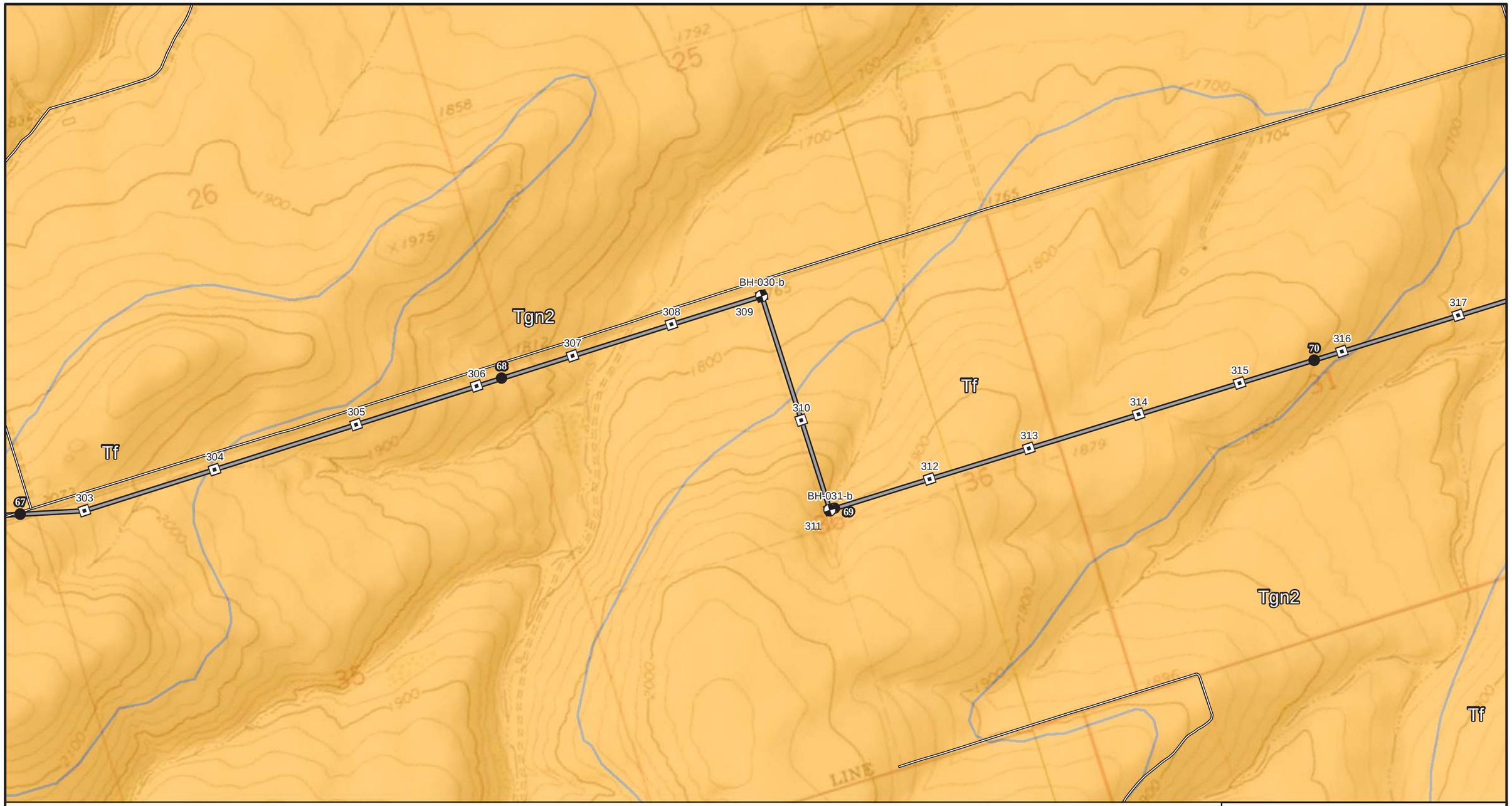

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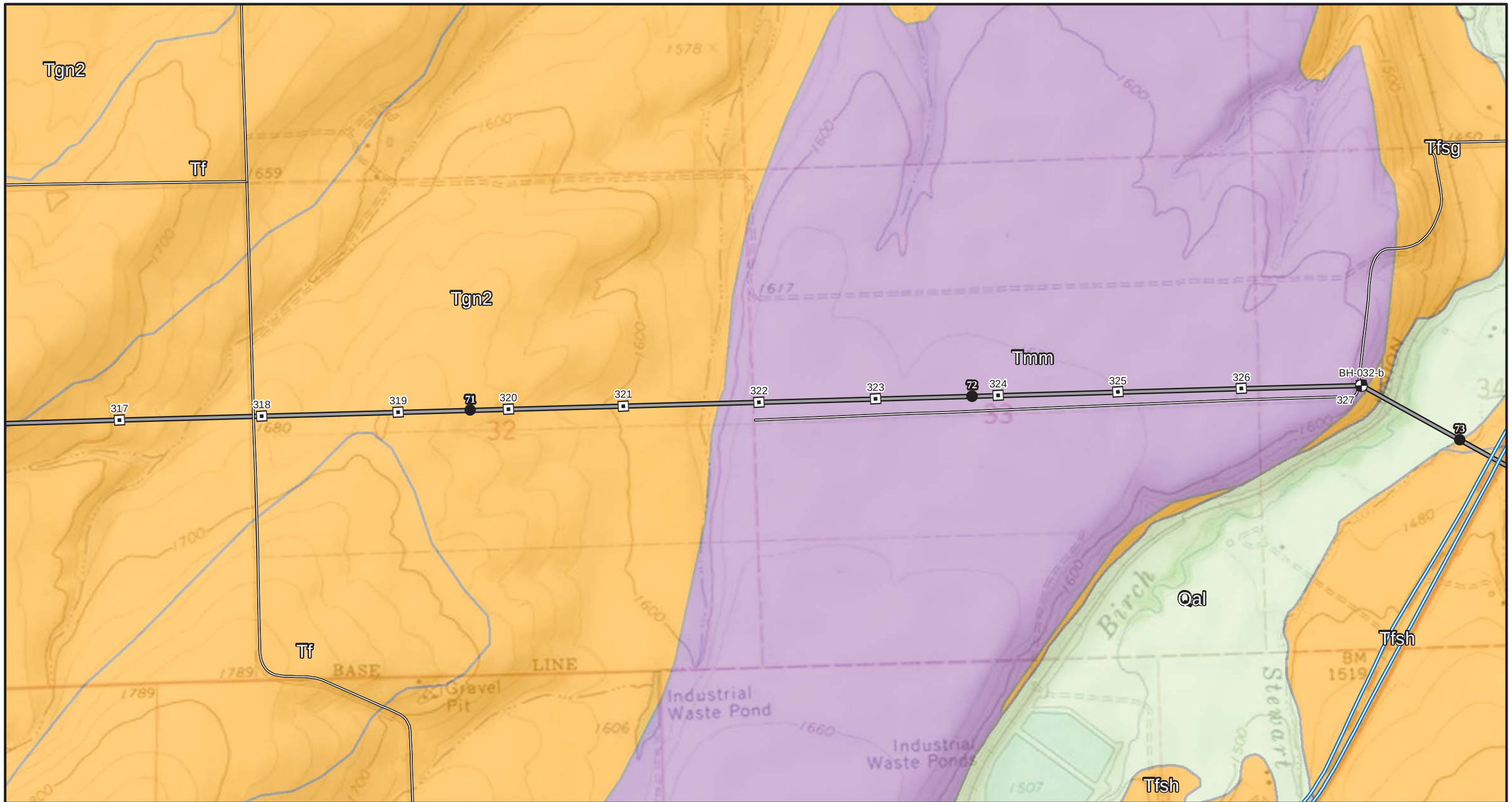

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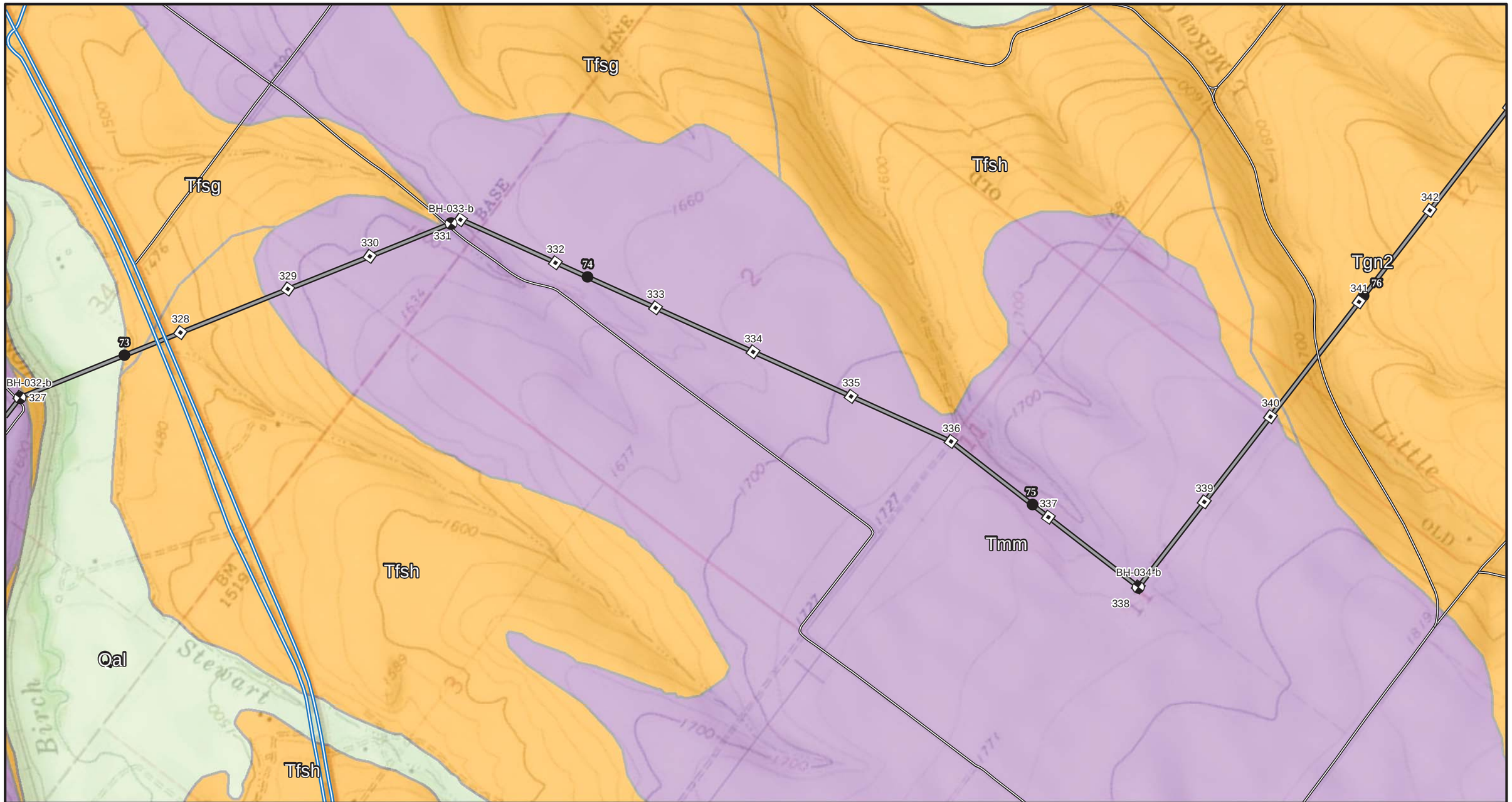

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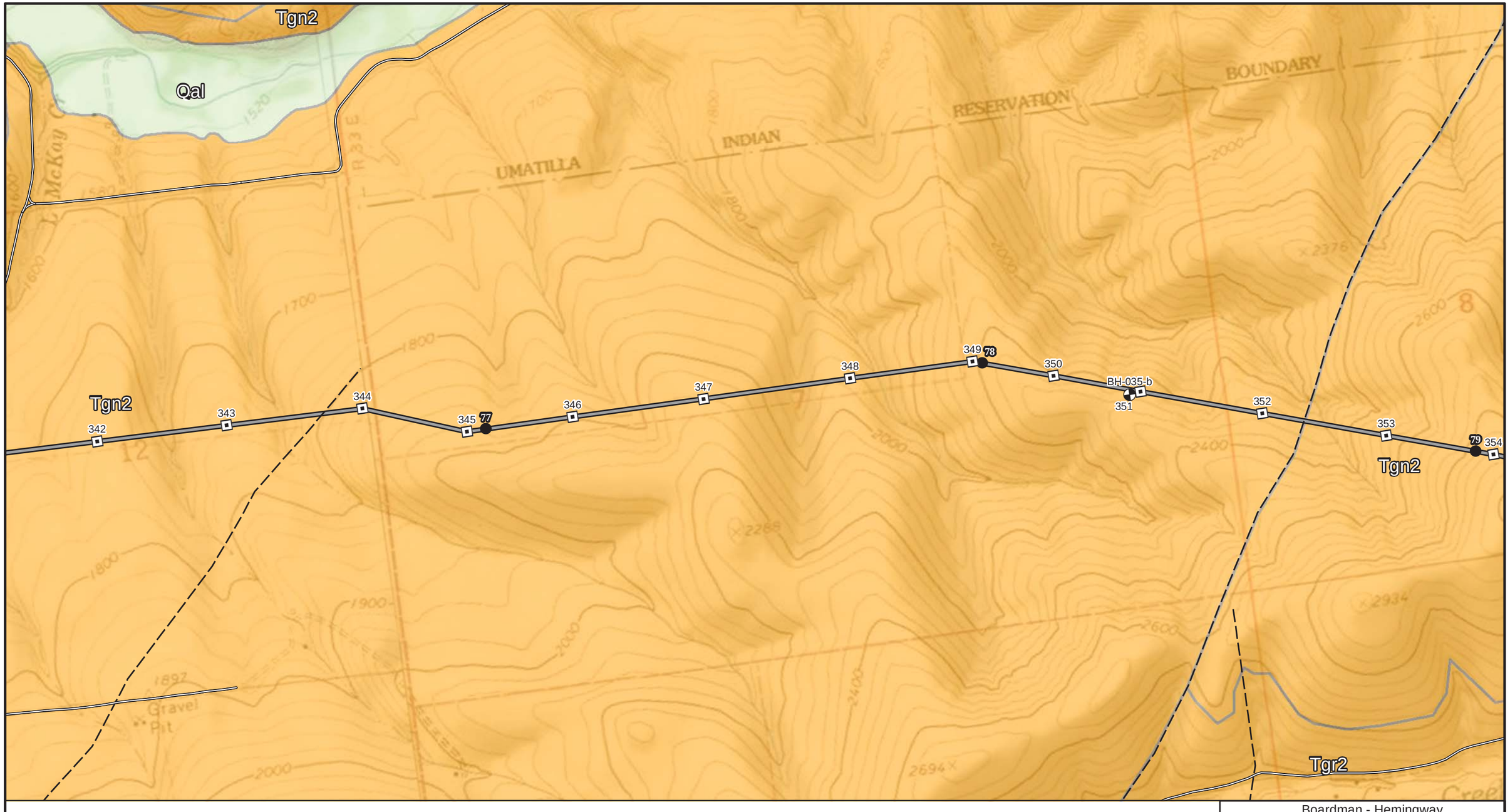

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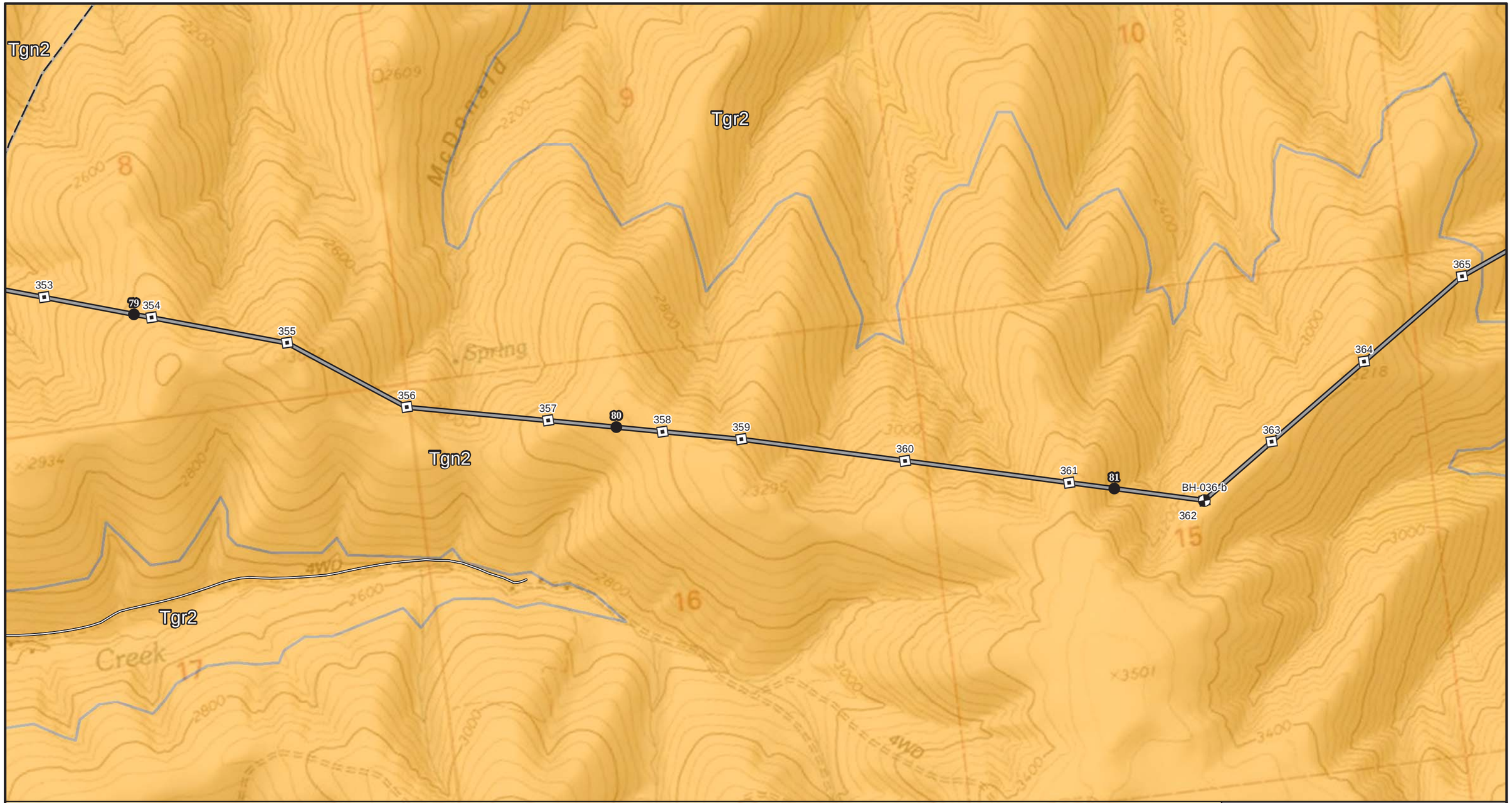

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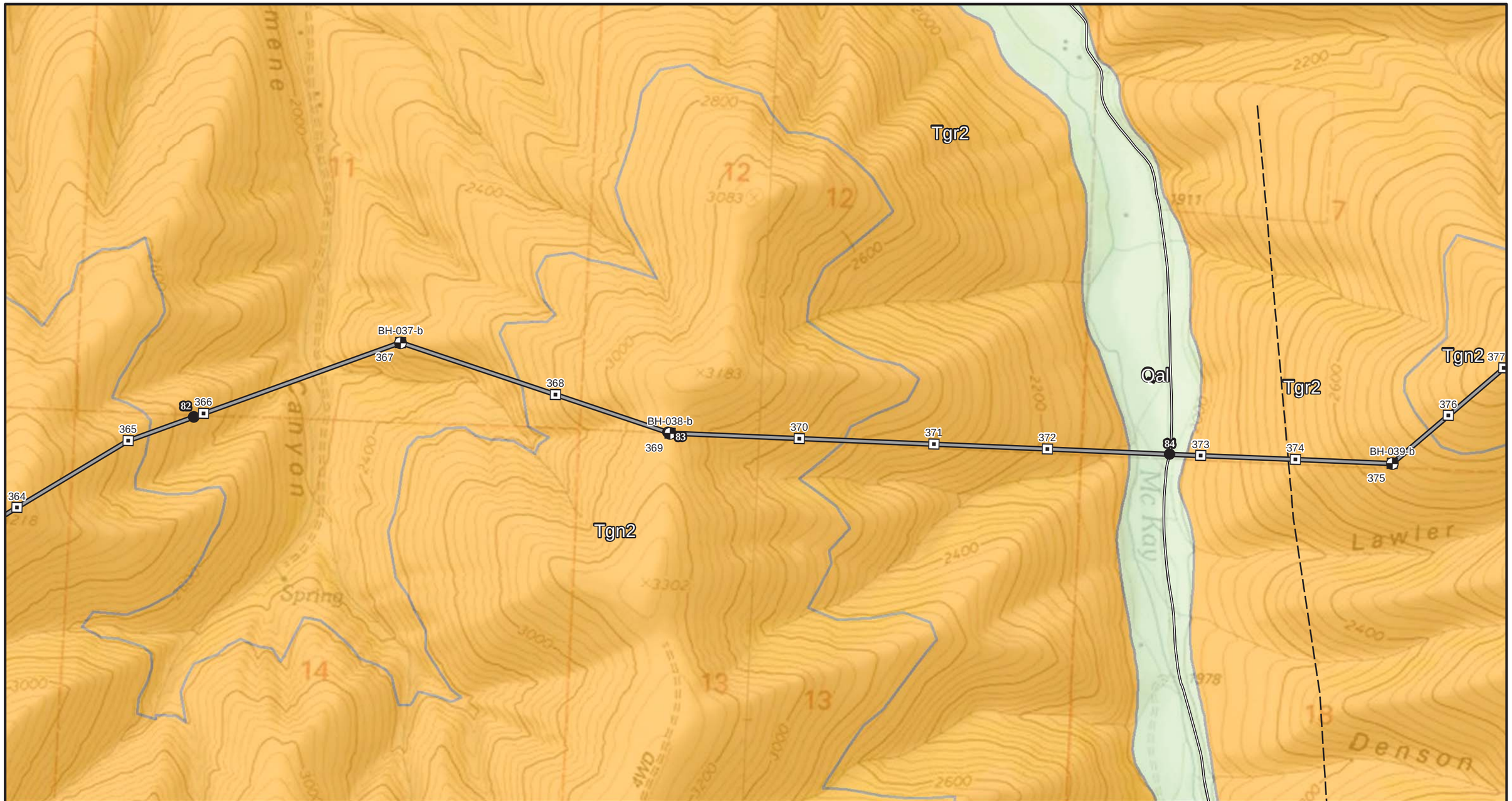

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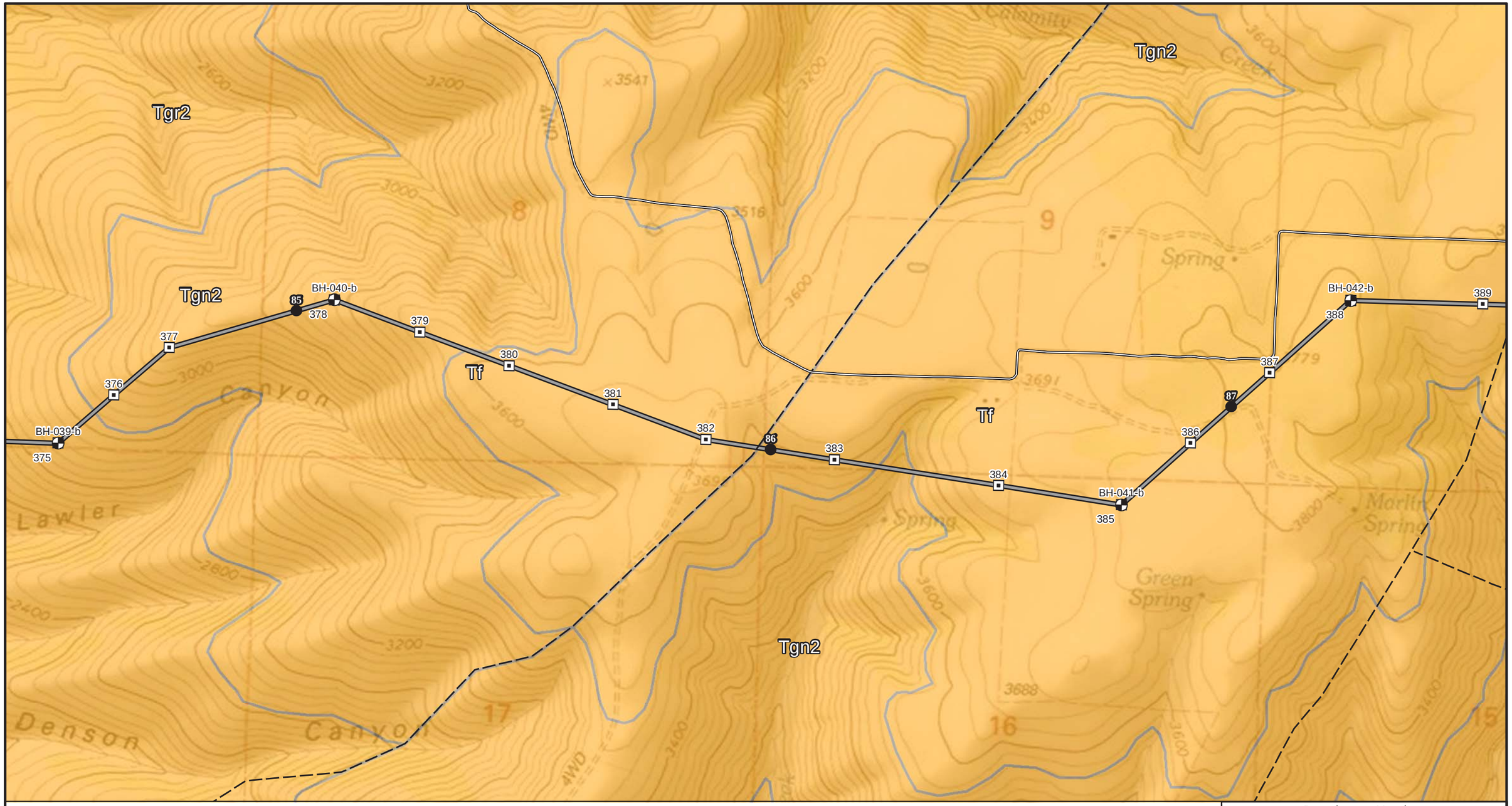

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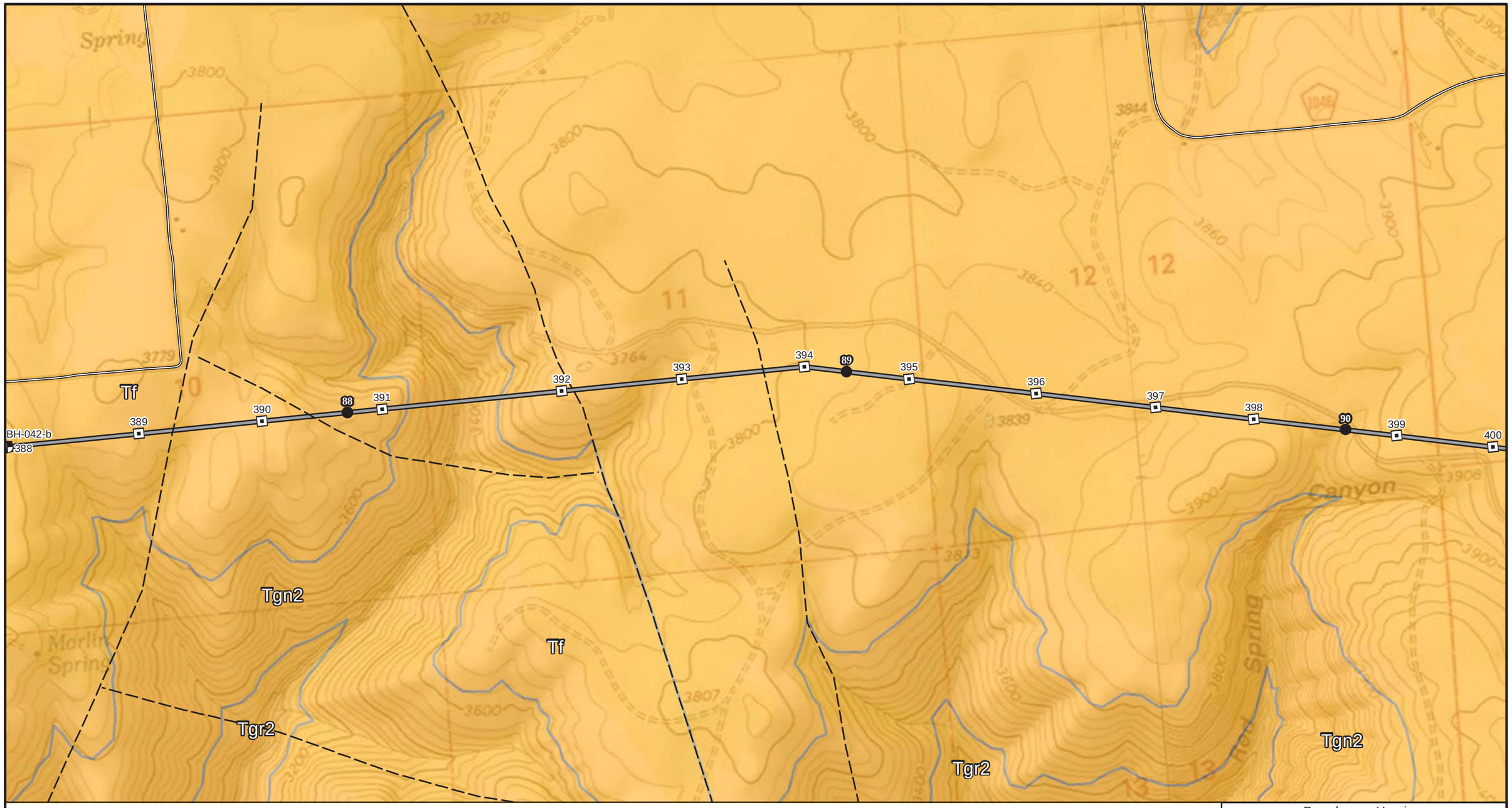

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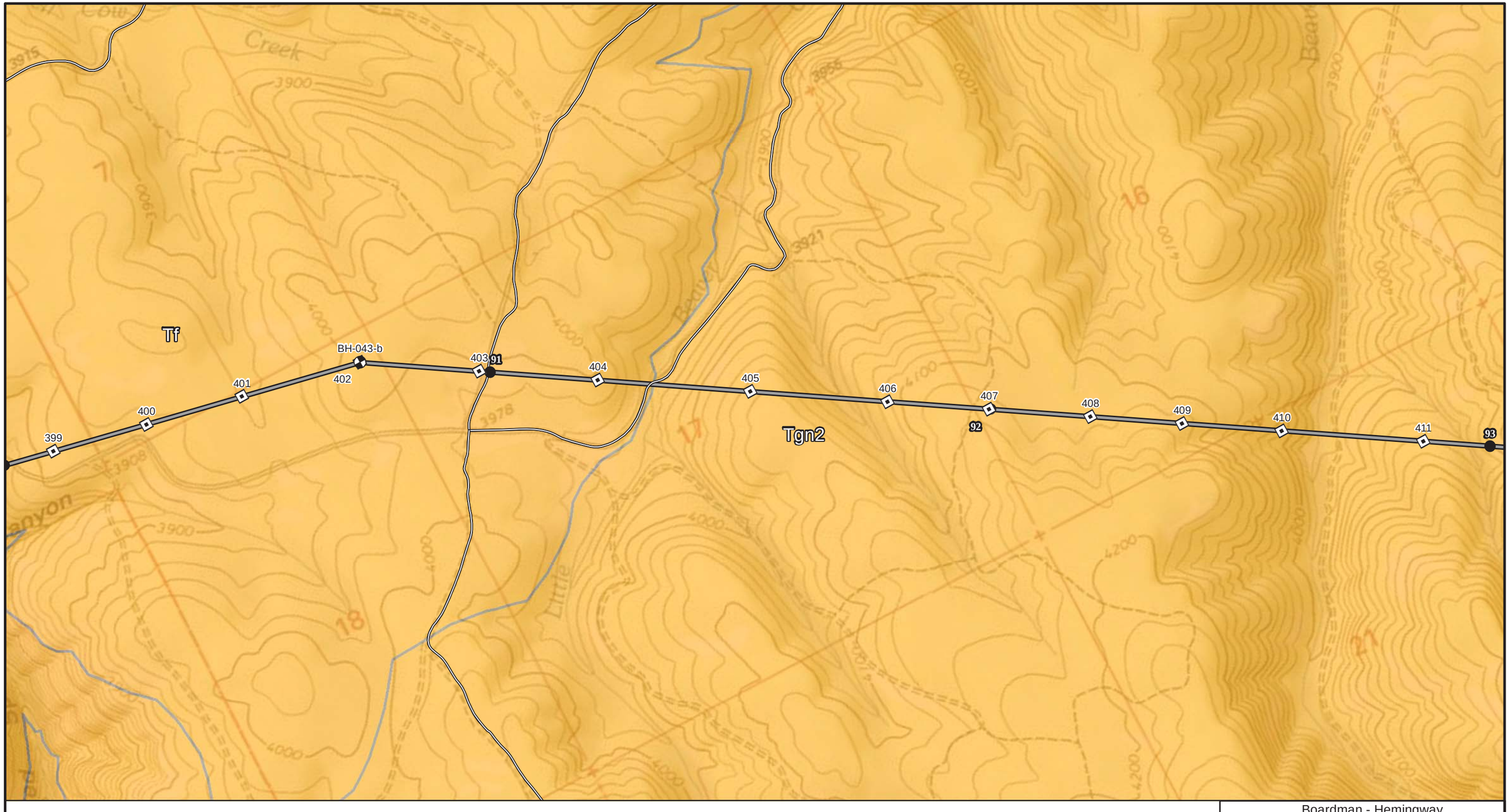

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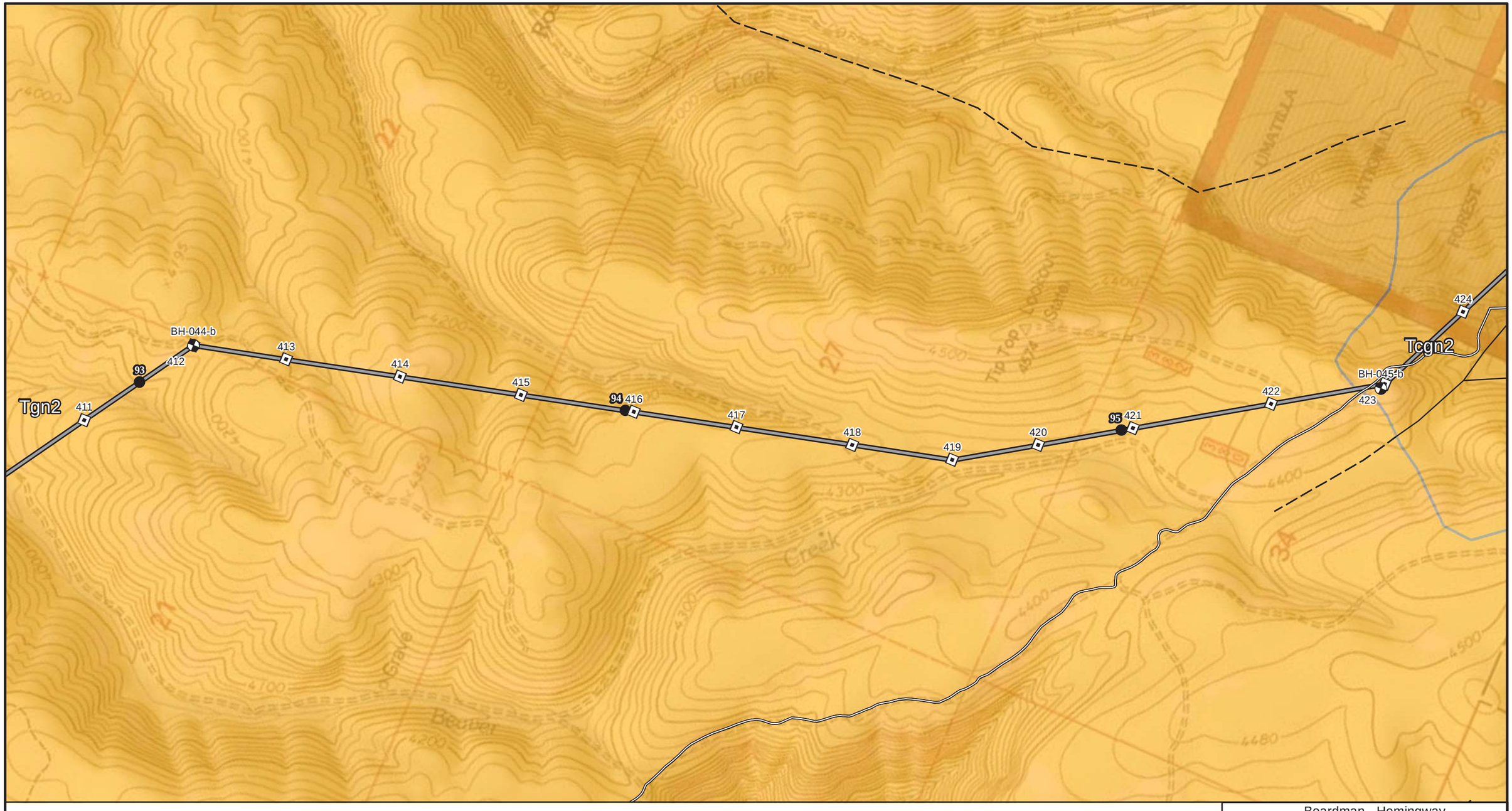

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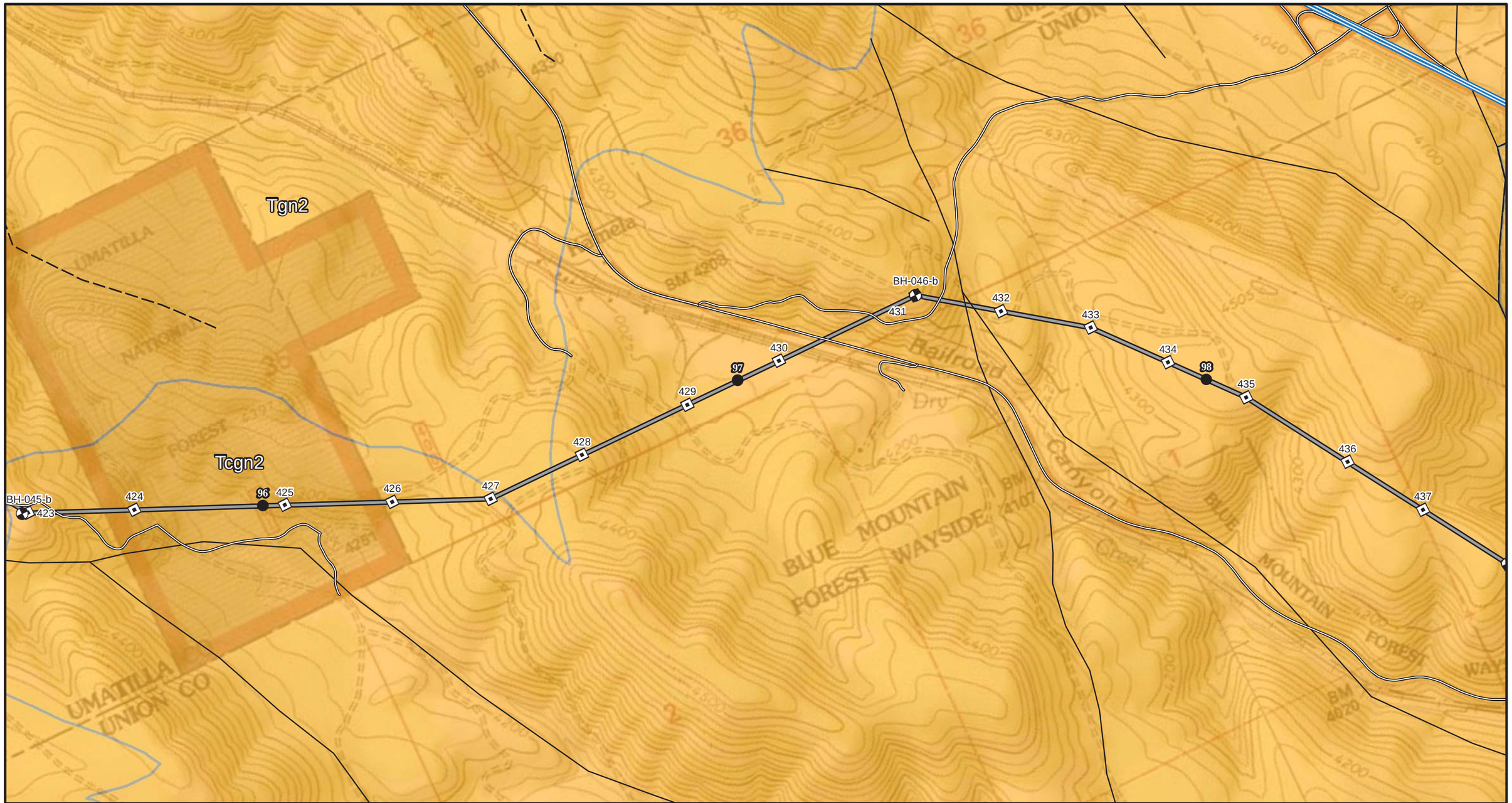

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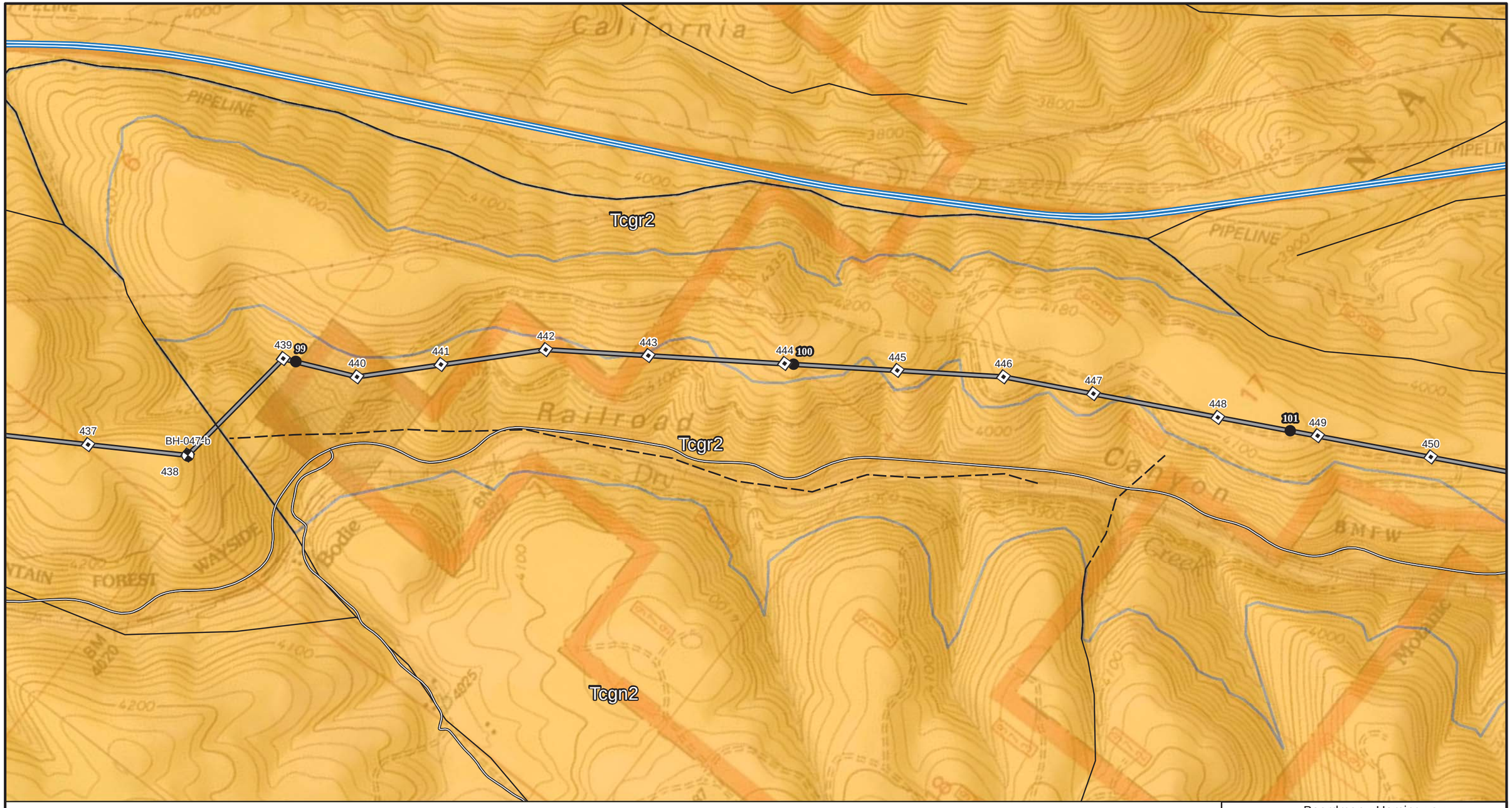

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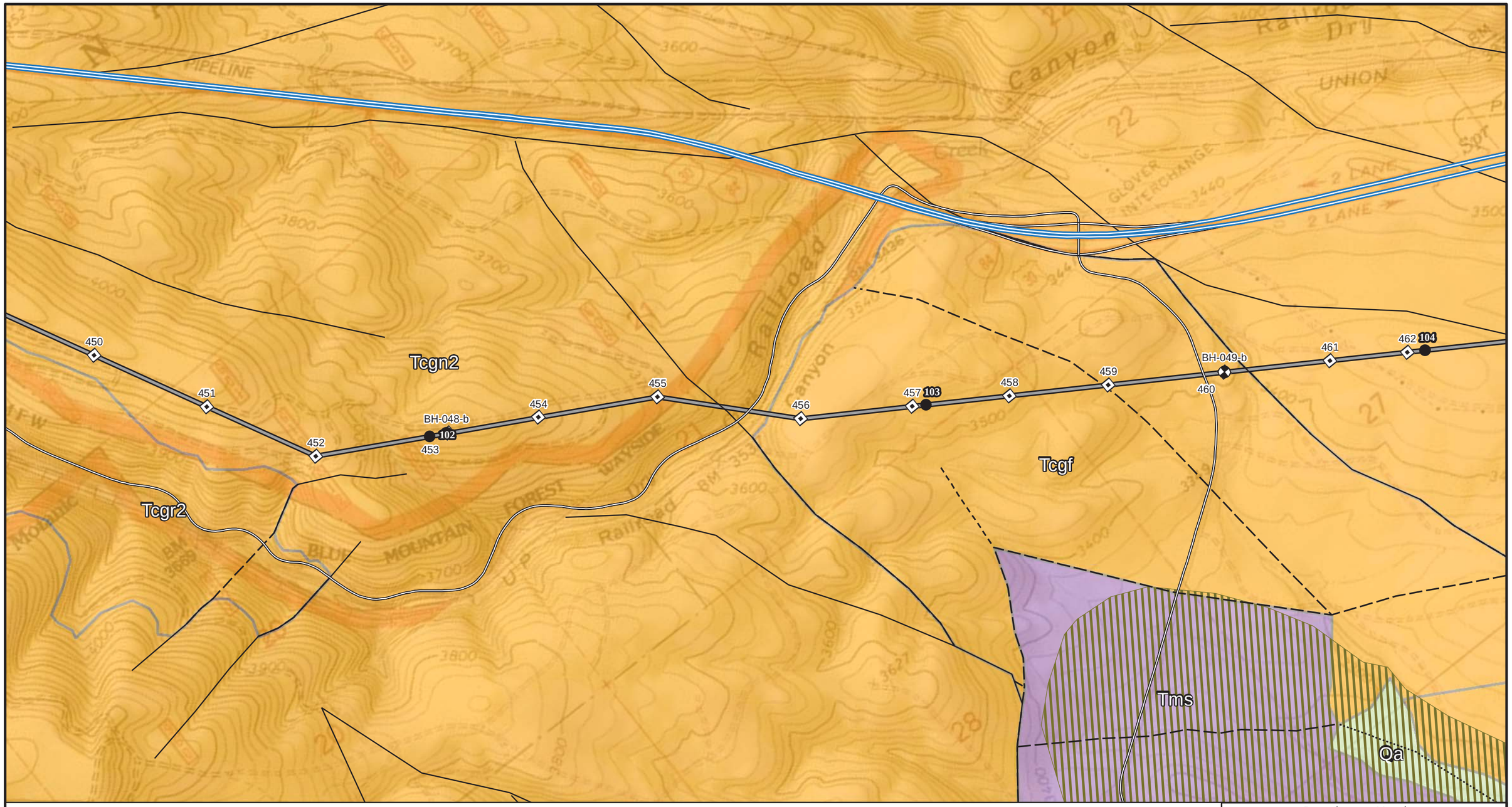

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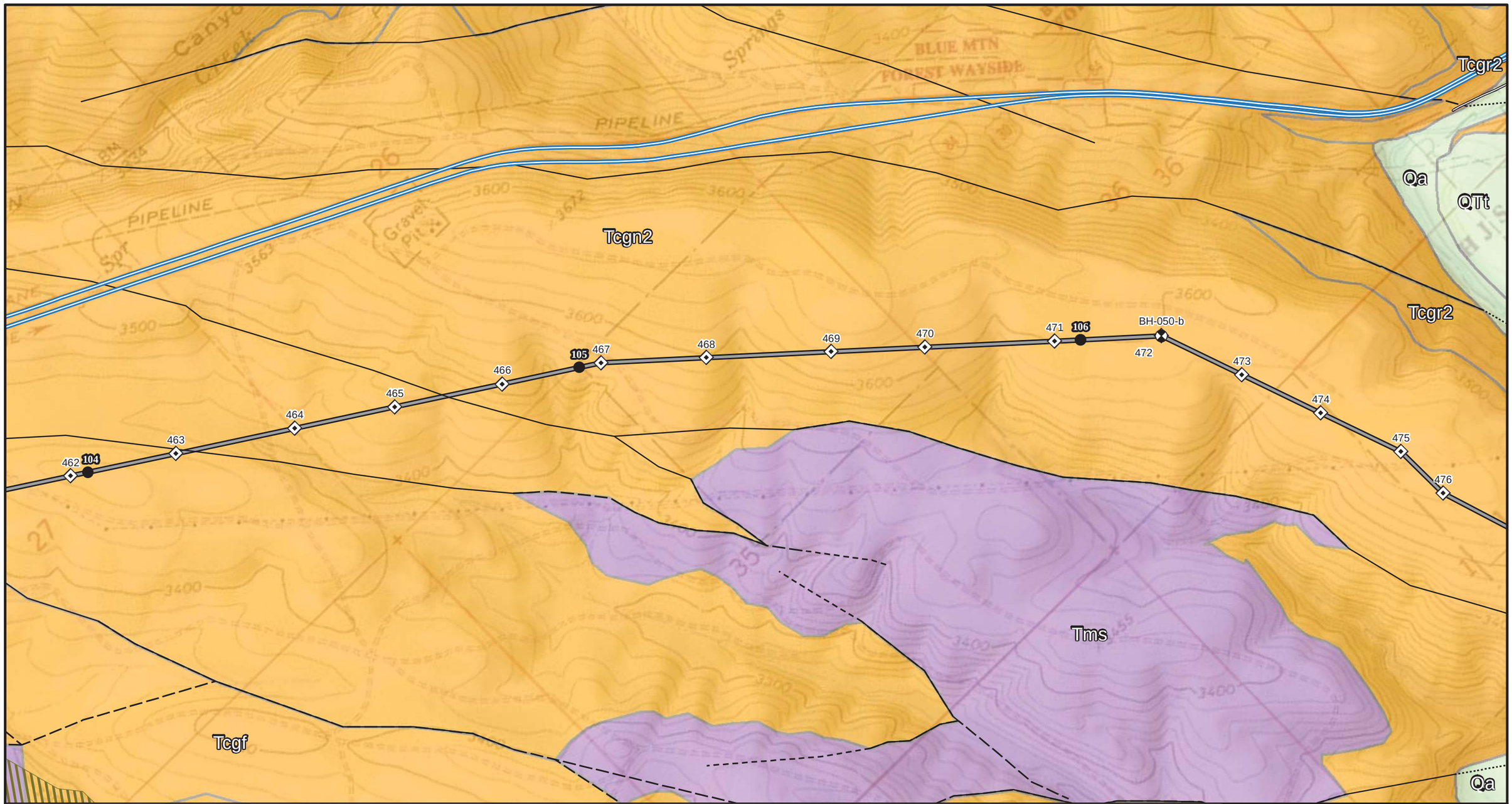

LEGEND

TRANSMISSION FEATURES
- IPC Proposed Route
- IPC Alternative
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- Work Area
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- Towers
- Proposed Borehole

SURFICIAL GEOLOGY
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- Unconsolidated Rocks
- Volcaniclastic Rocks

LANDSLIDES
- Fan
- Landslide (SLIDO)
- Talus - Colluvium

FAULTS
- Approximate
- Approximate and queried
- Certain
- Concealed
- Inferred
- Inferred and queried

COMMUNICATION
- Communication Power
- Communication Fiber

PRELIMINARY ACCESS PATHS
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- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
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- Existing Access, May Need Repairs
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EXISITING TRANSPORATION ROADS
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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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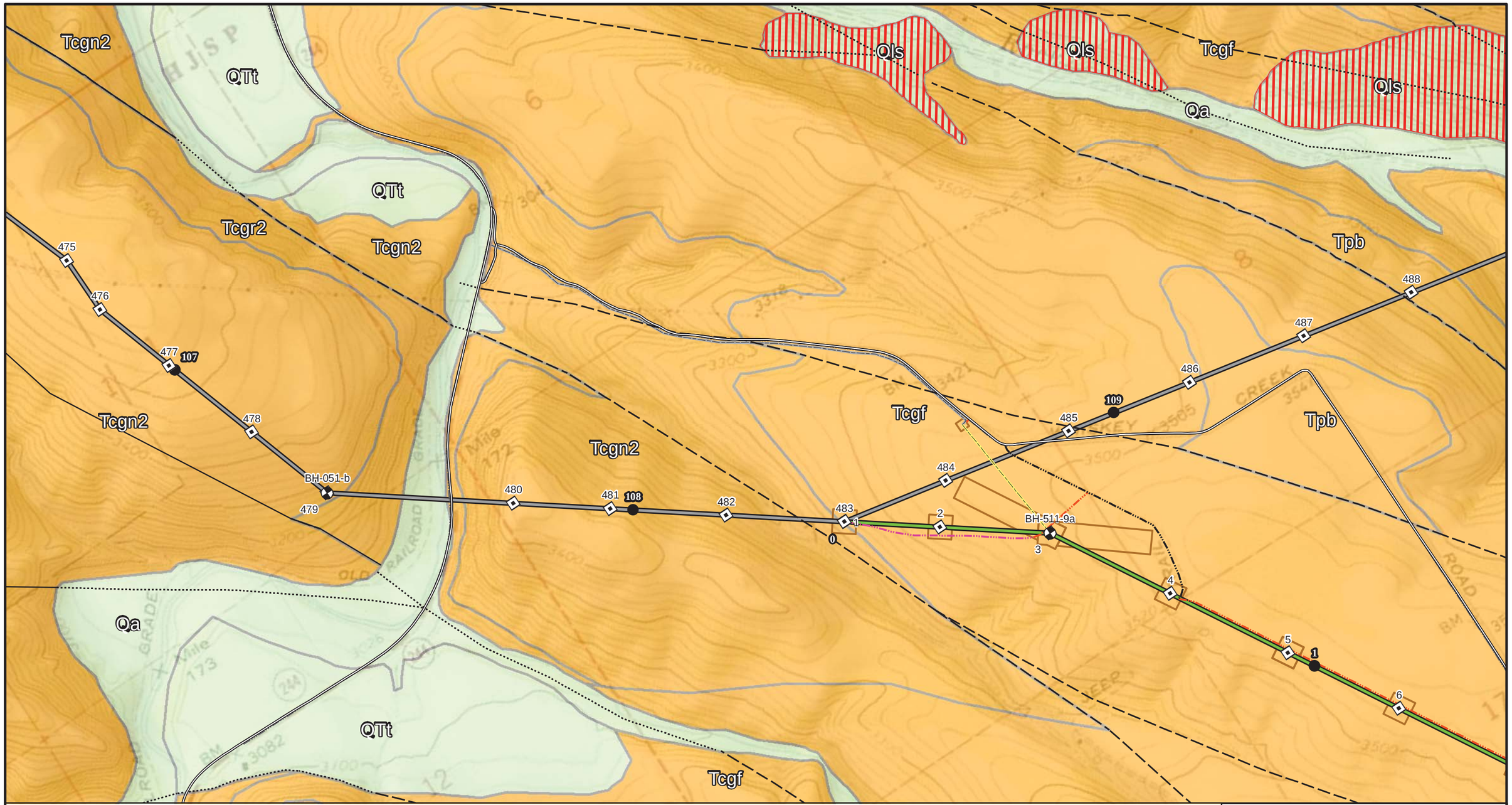

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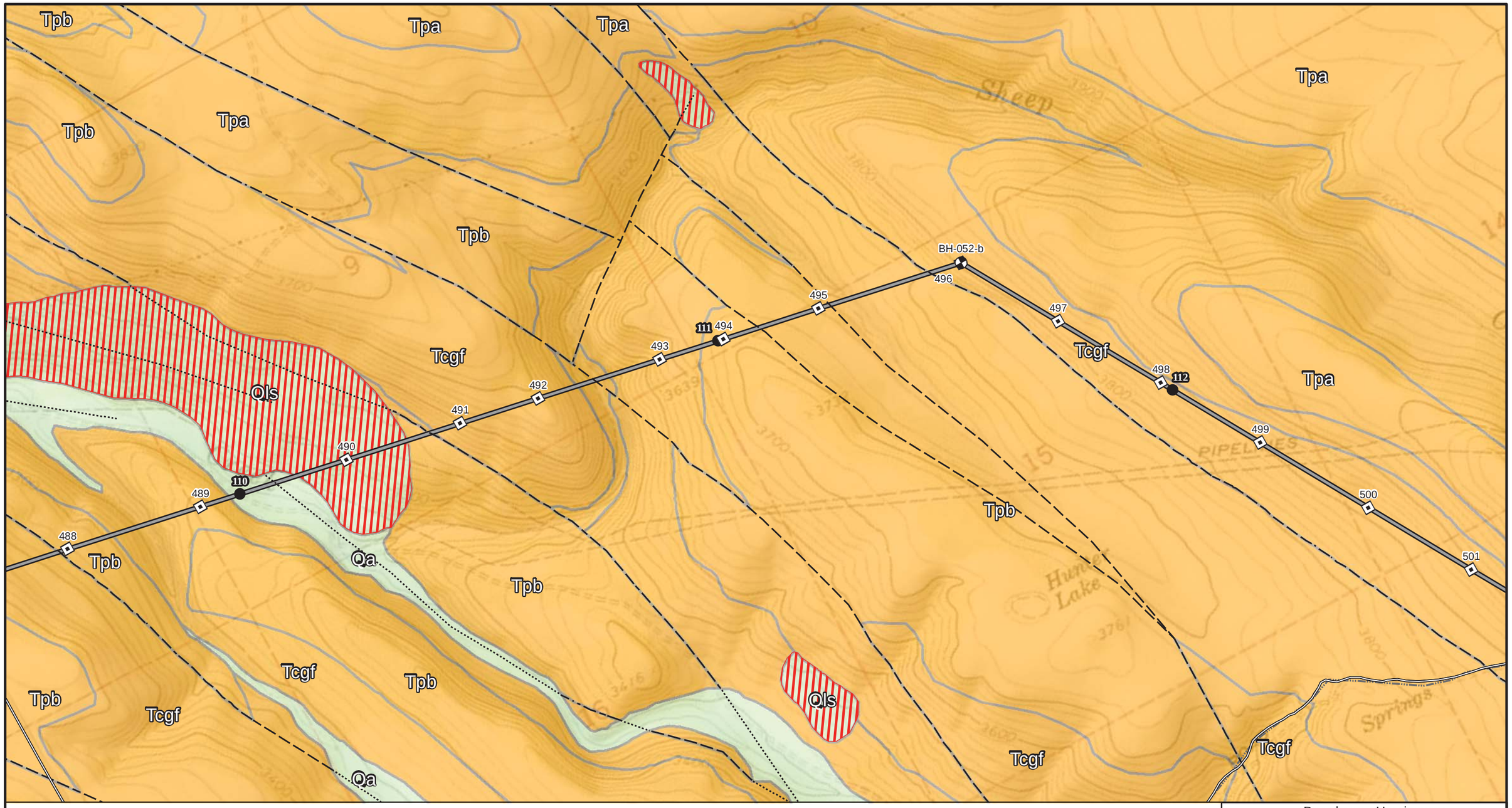

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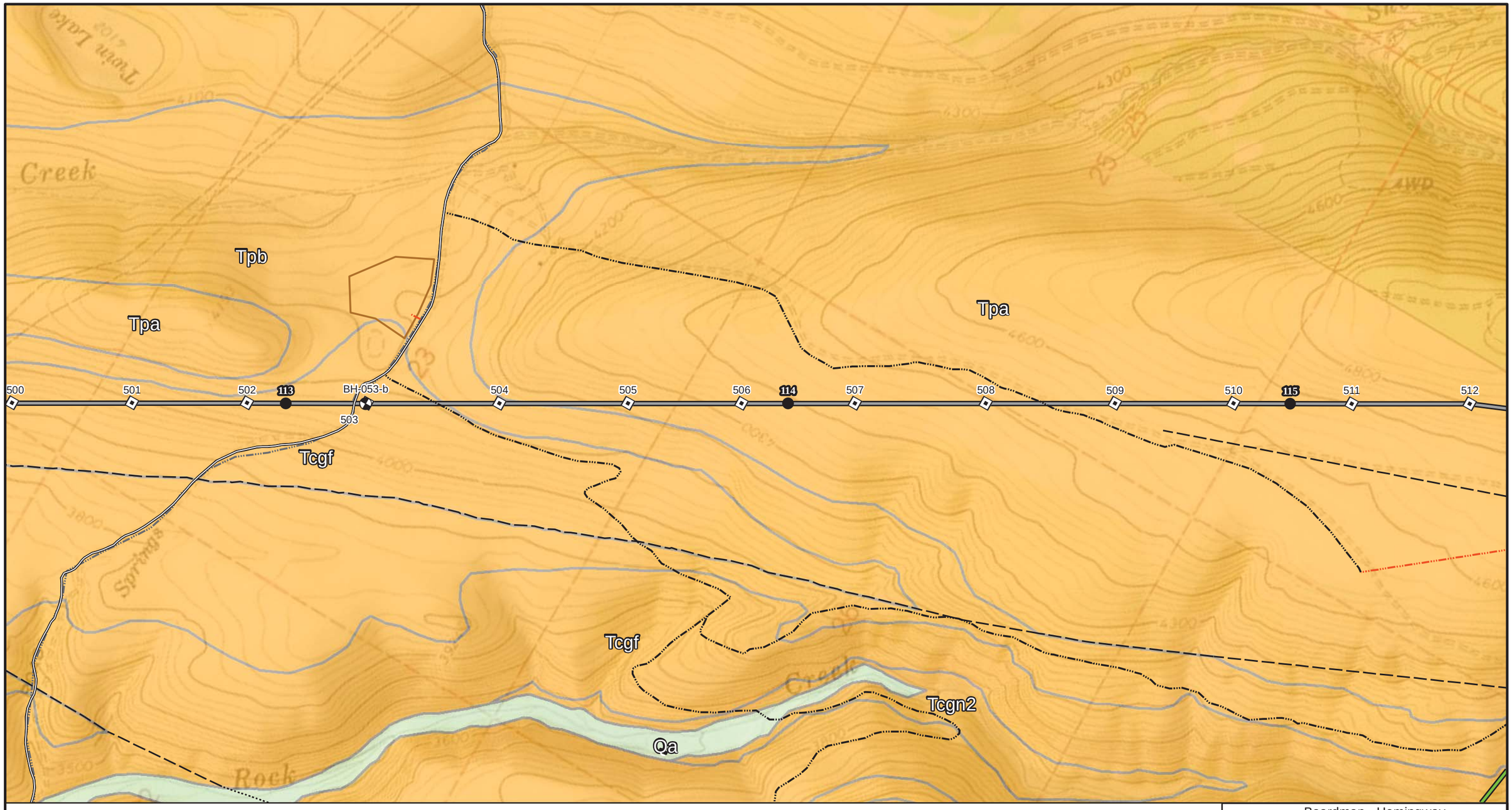

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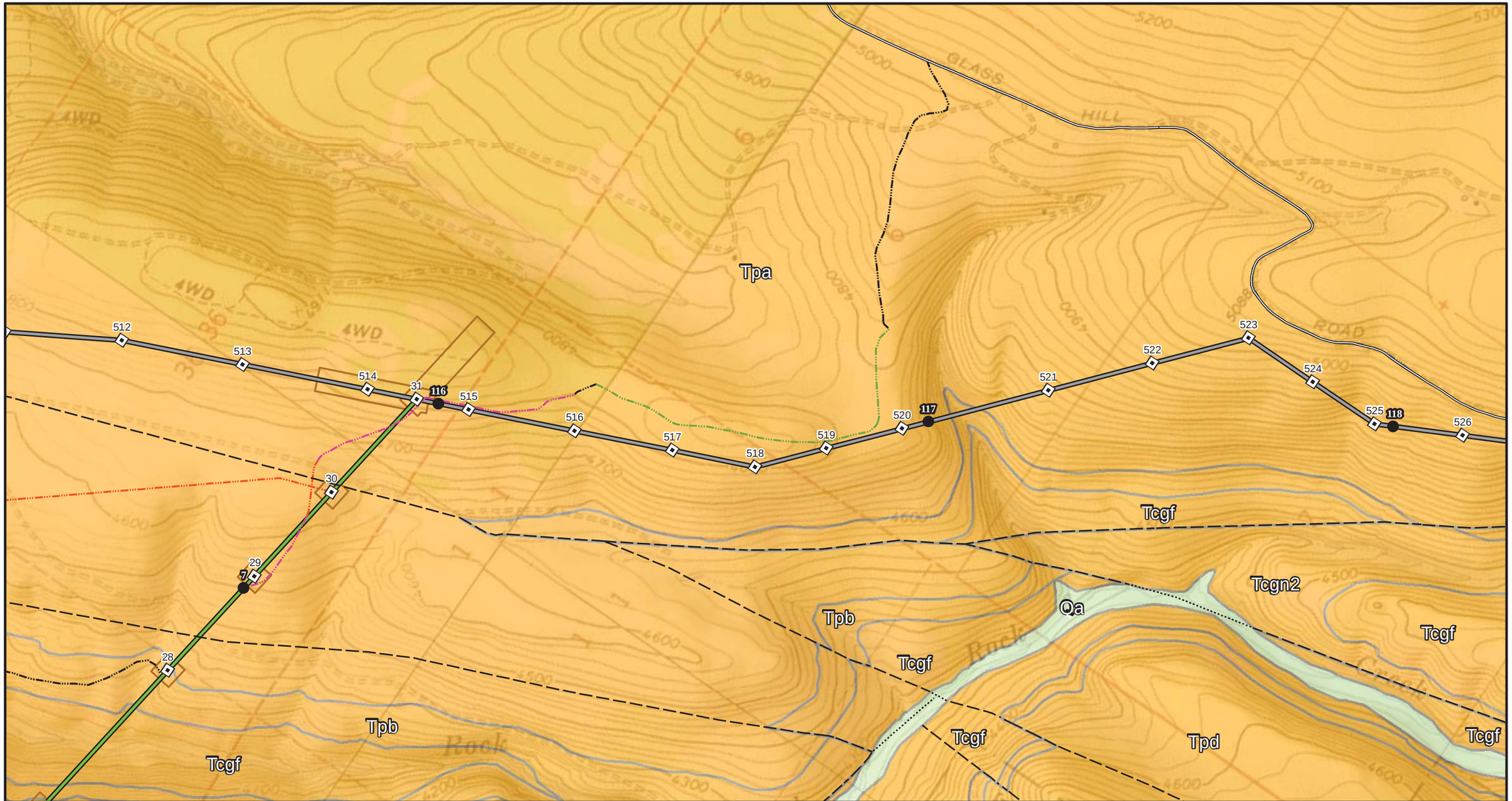

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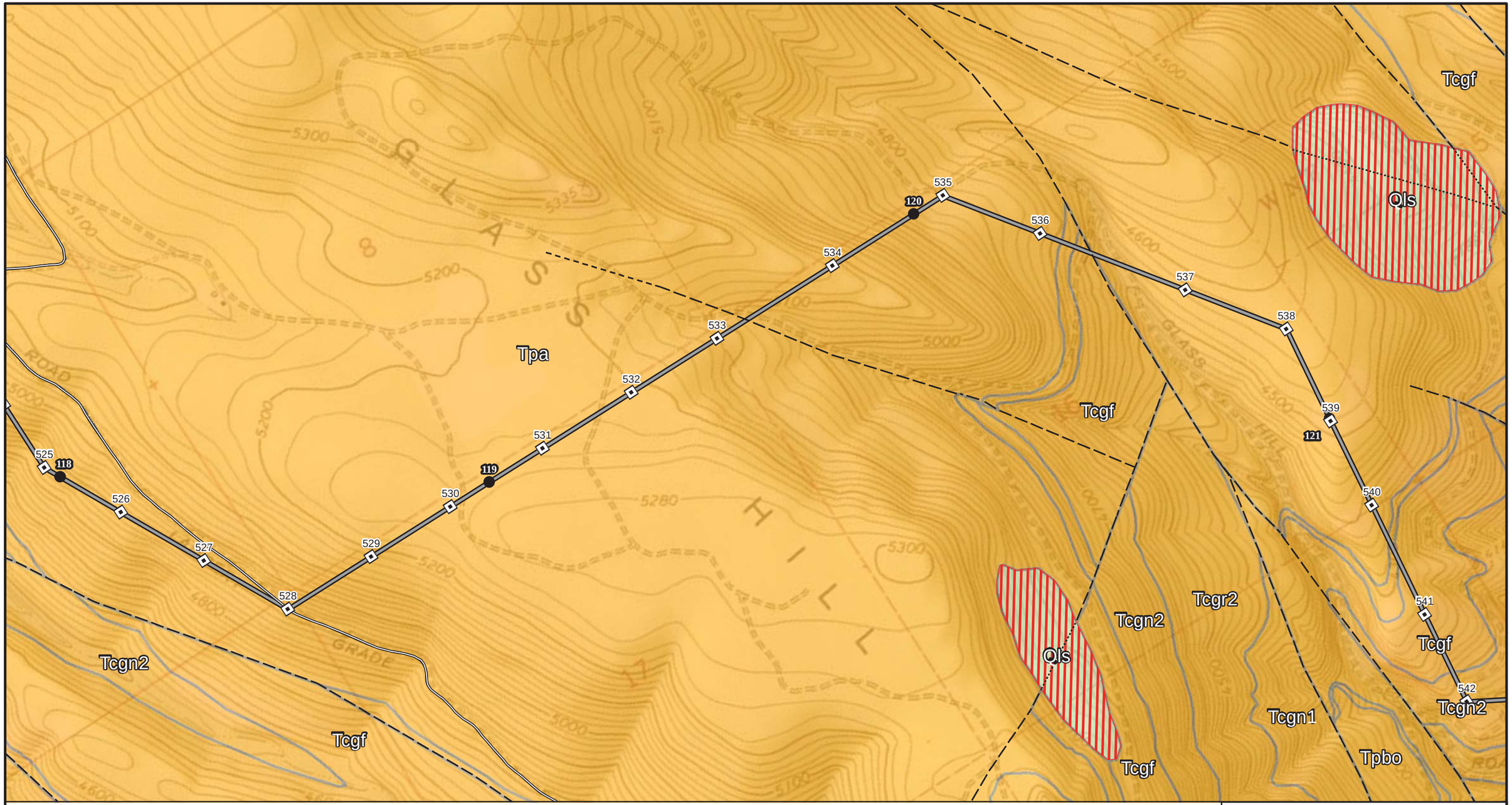

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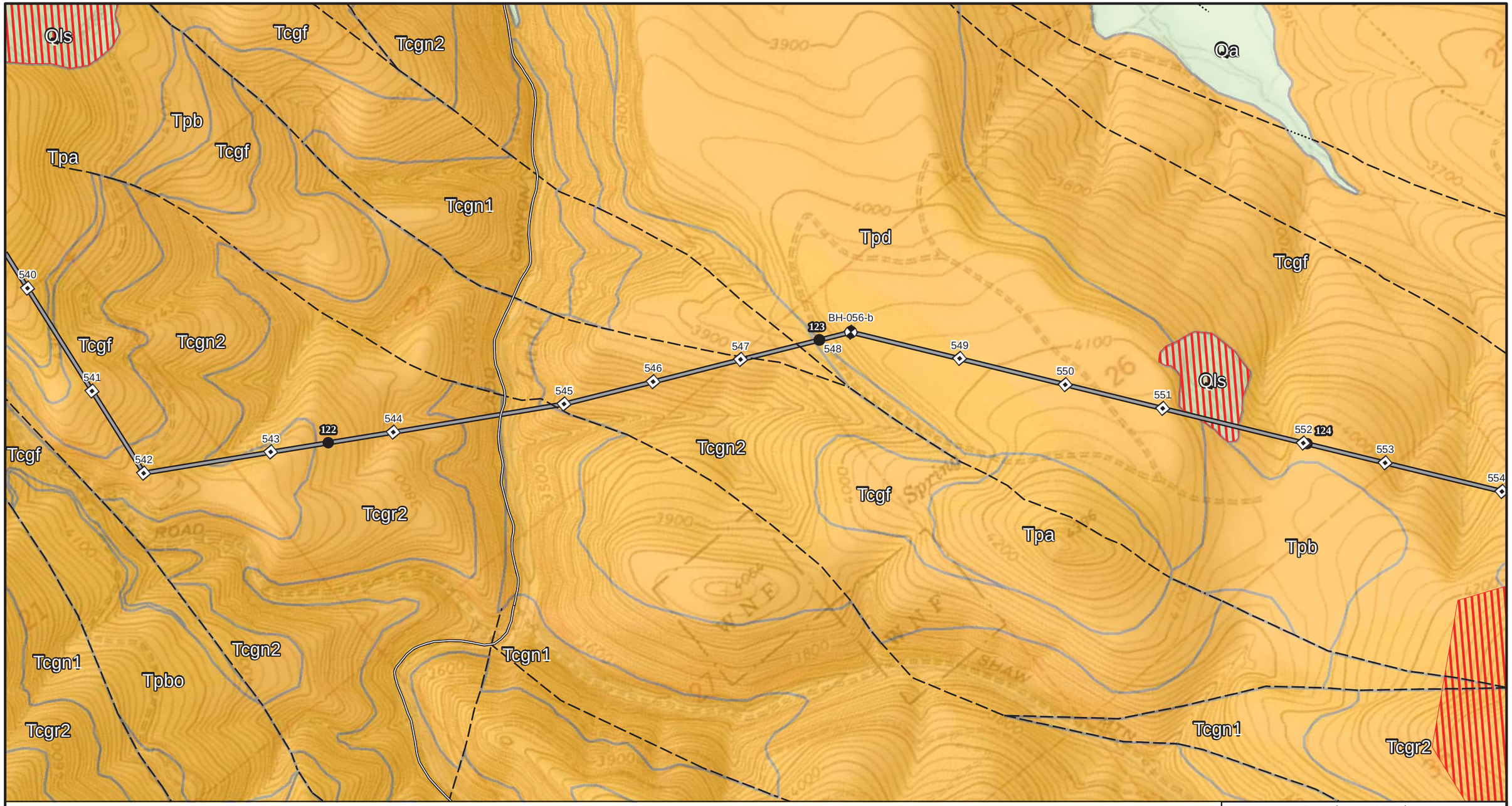

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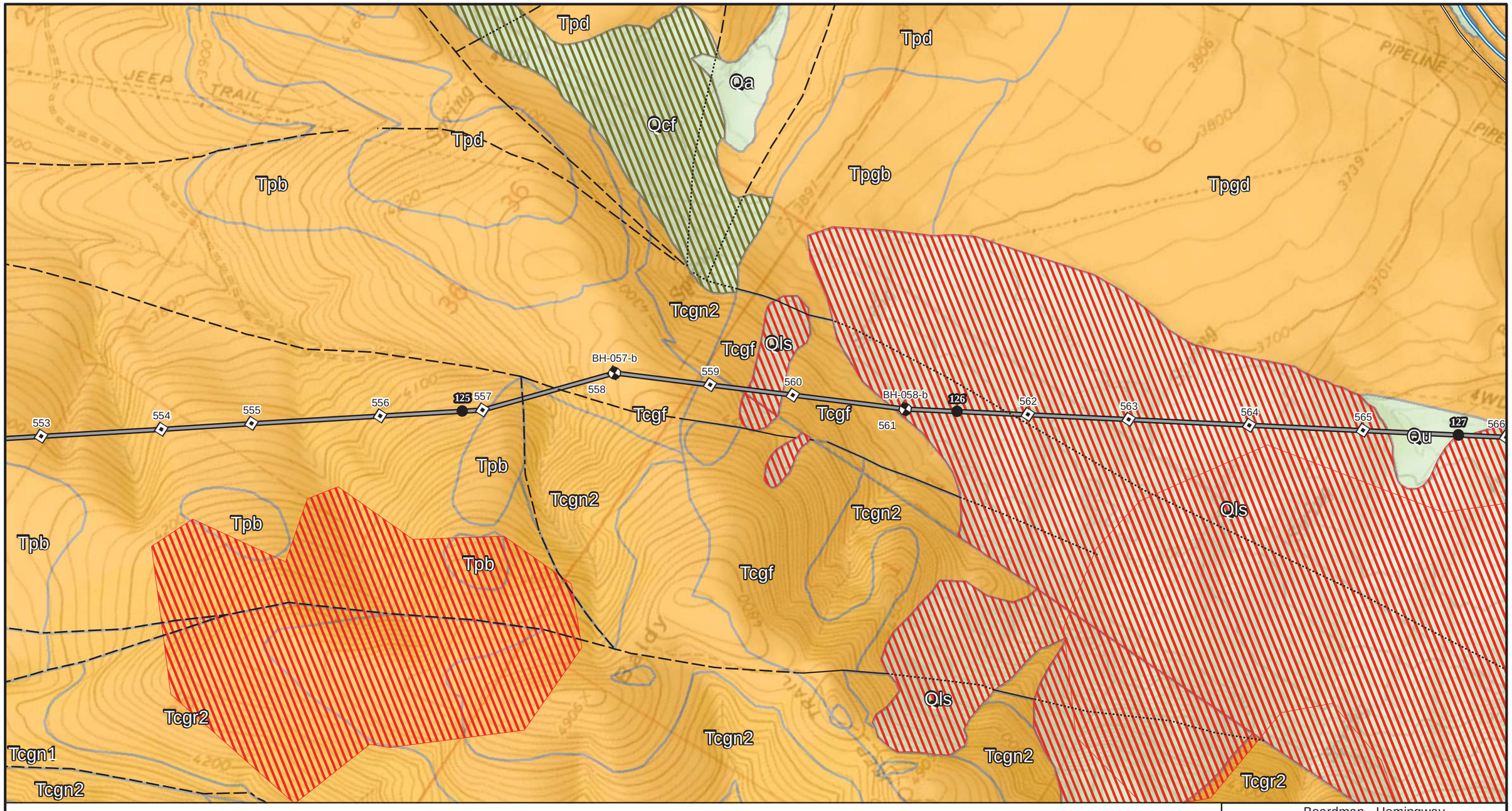

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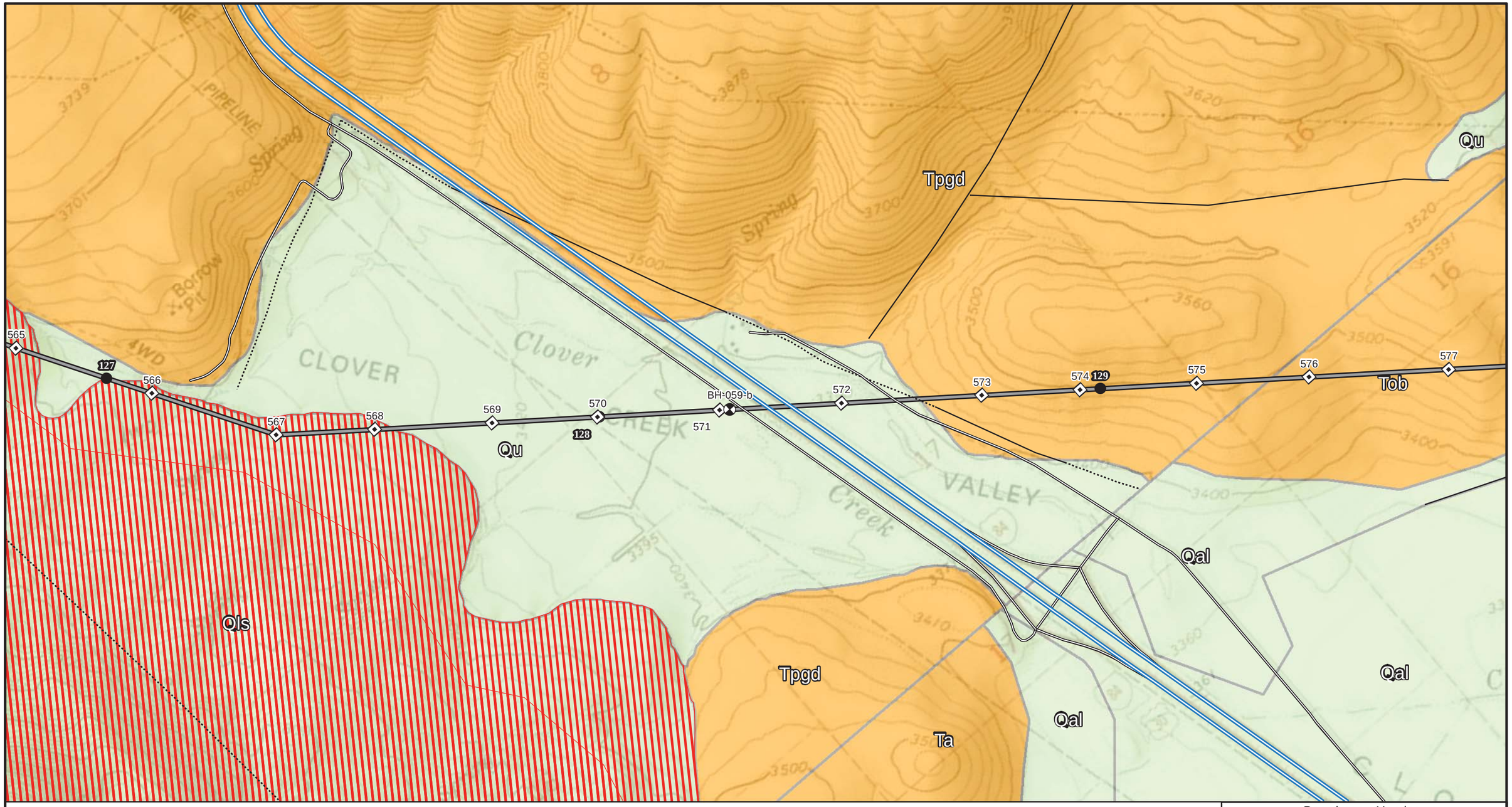

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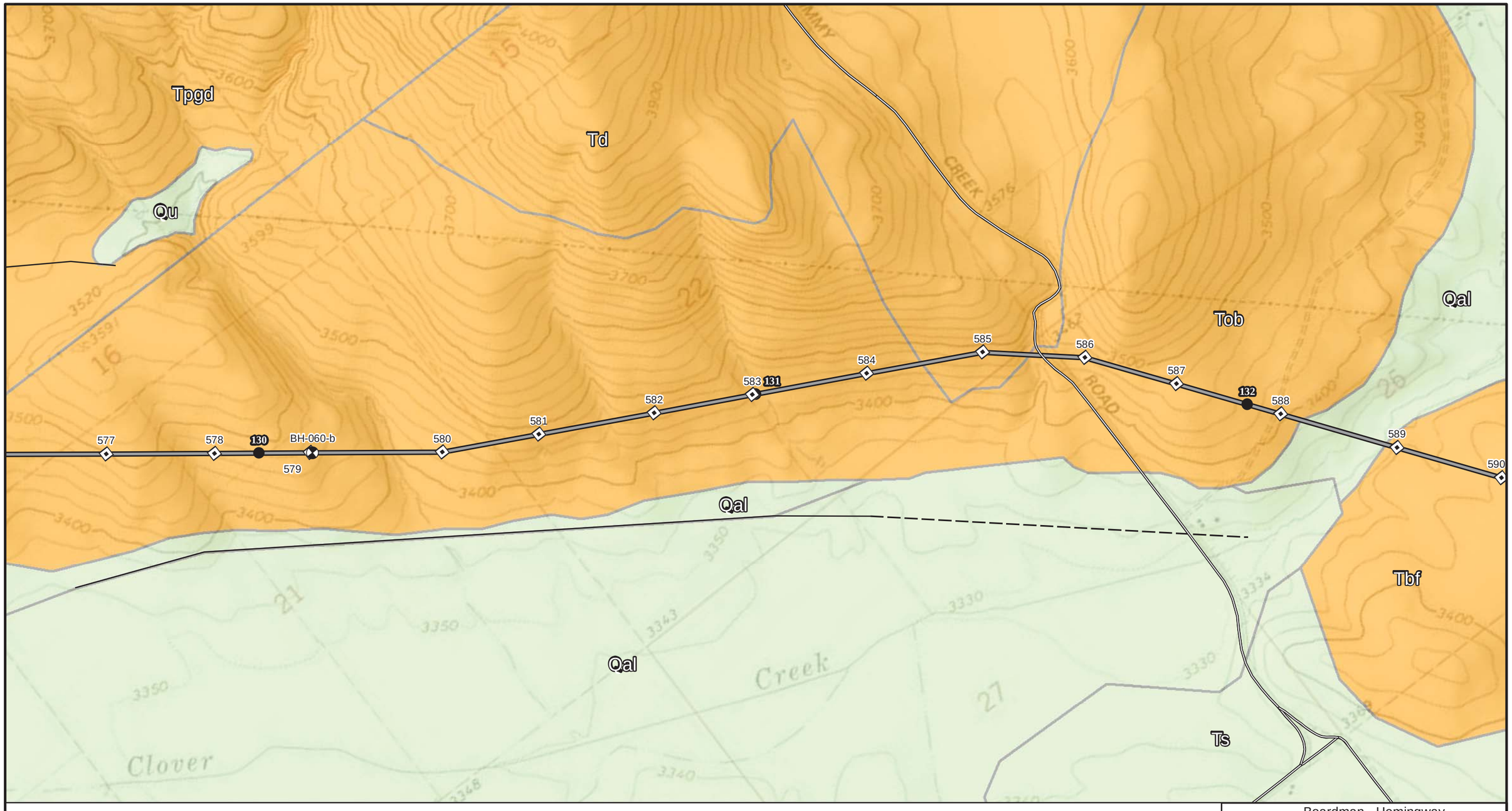

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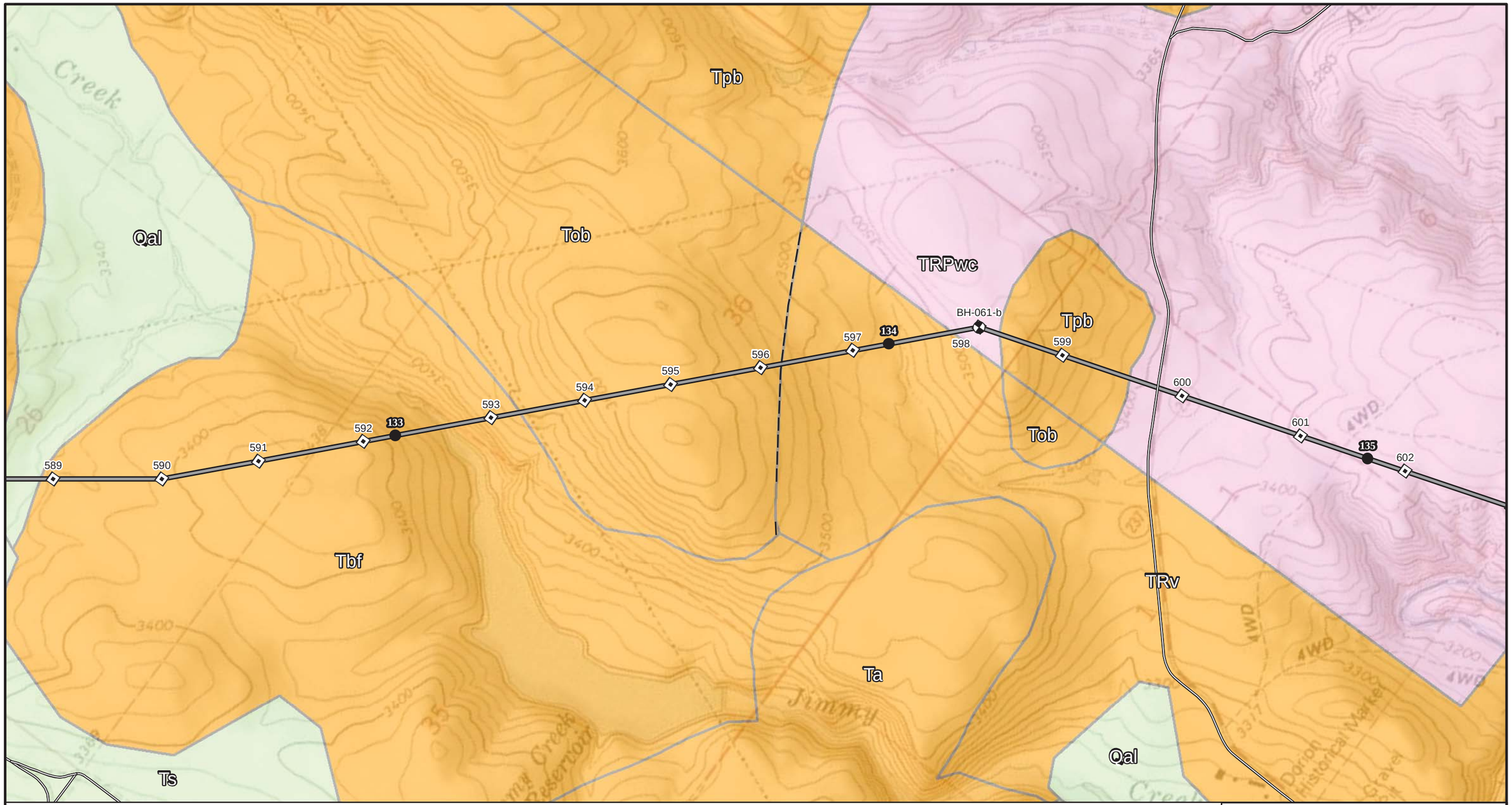

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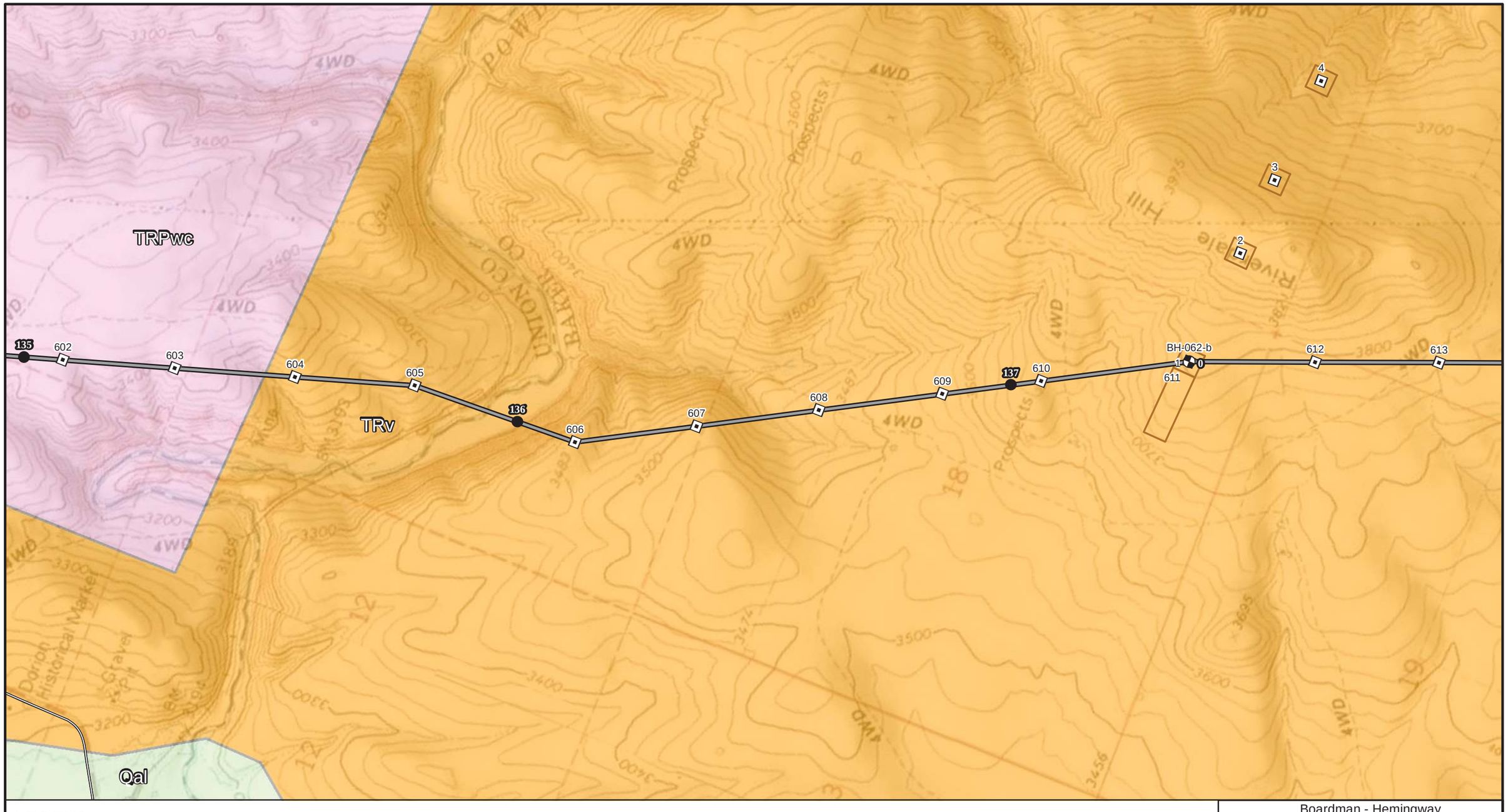

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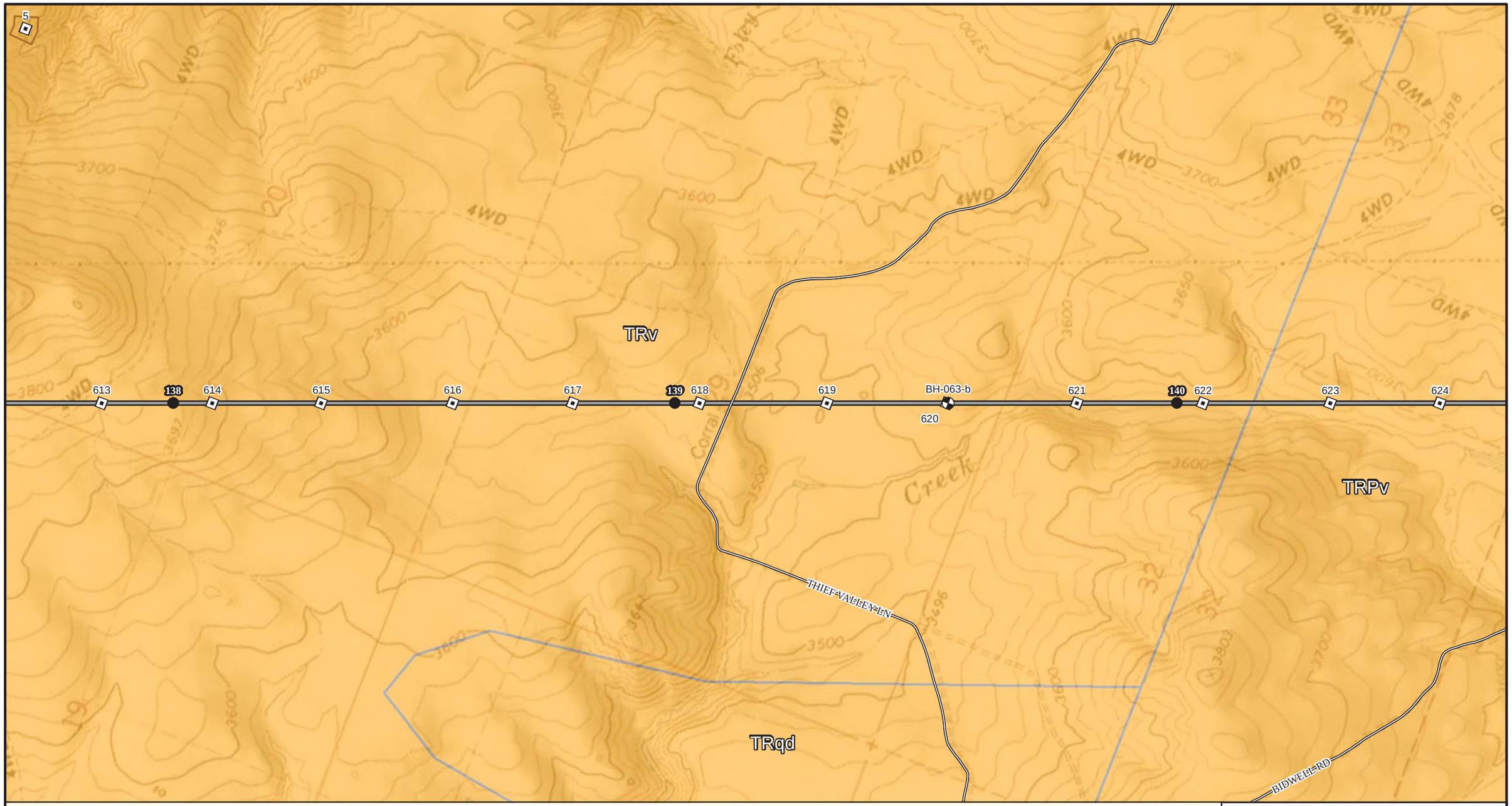

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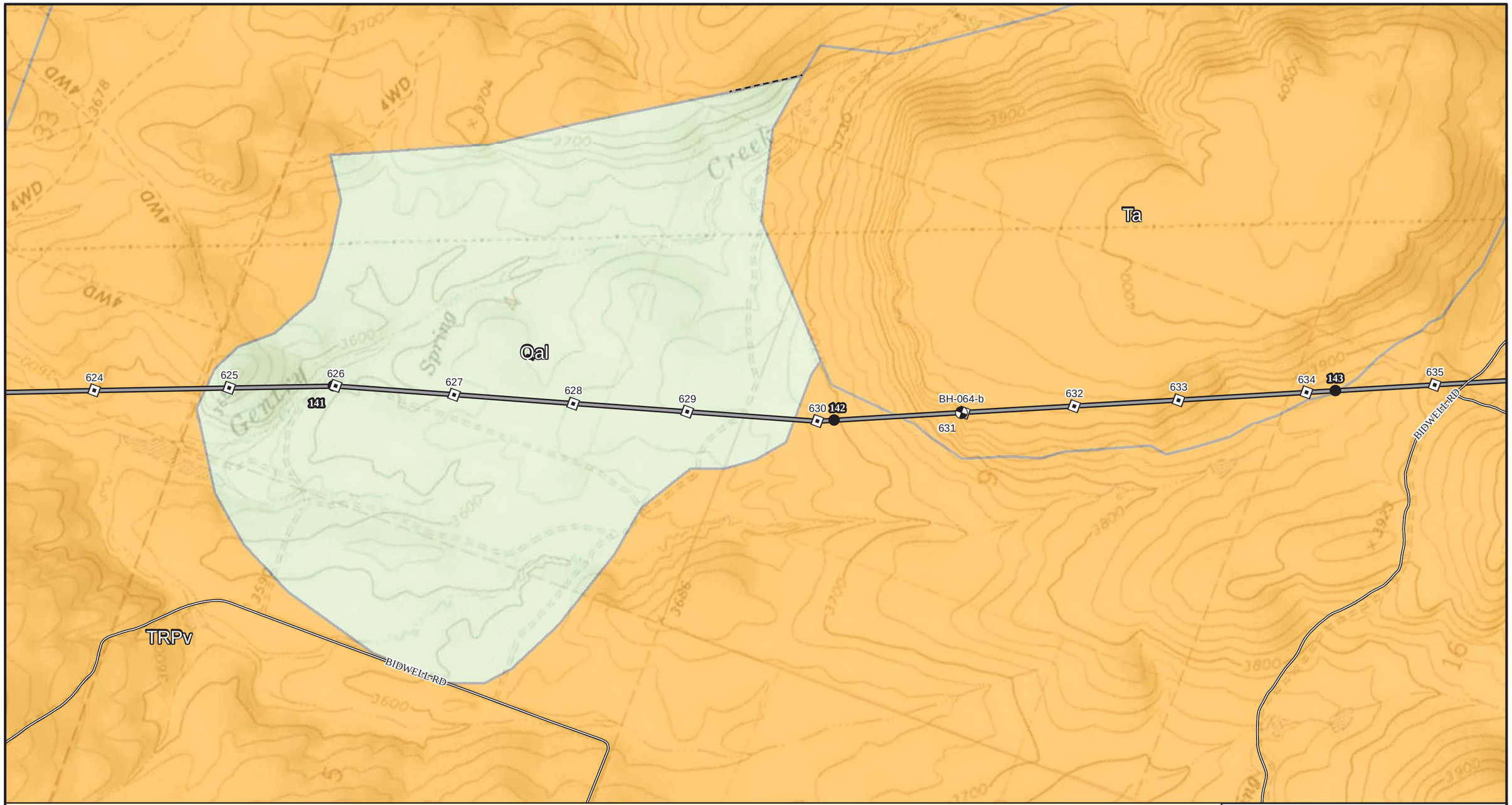

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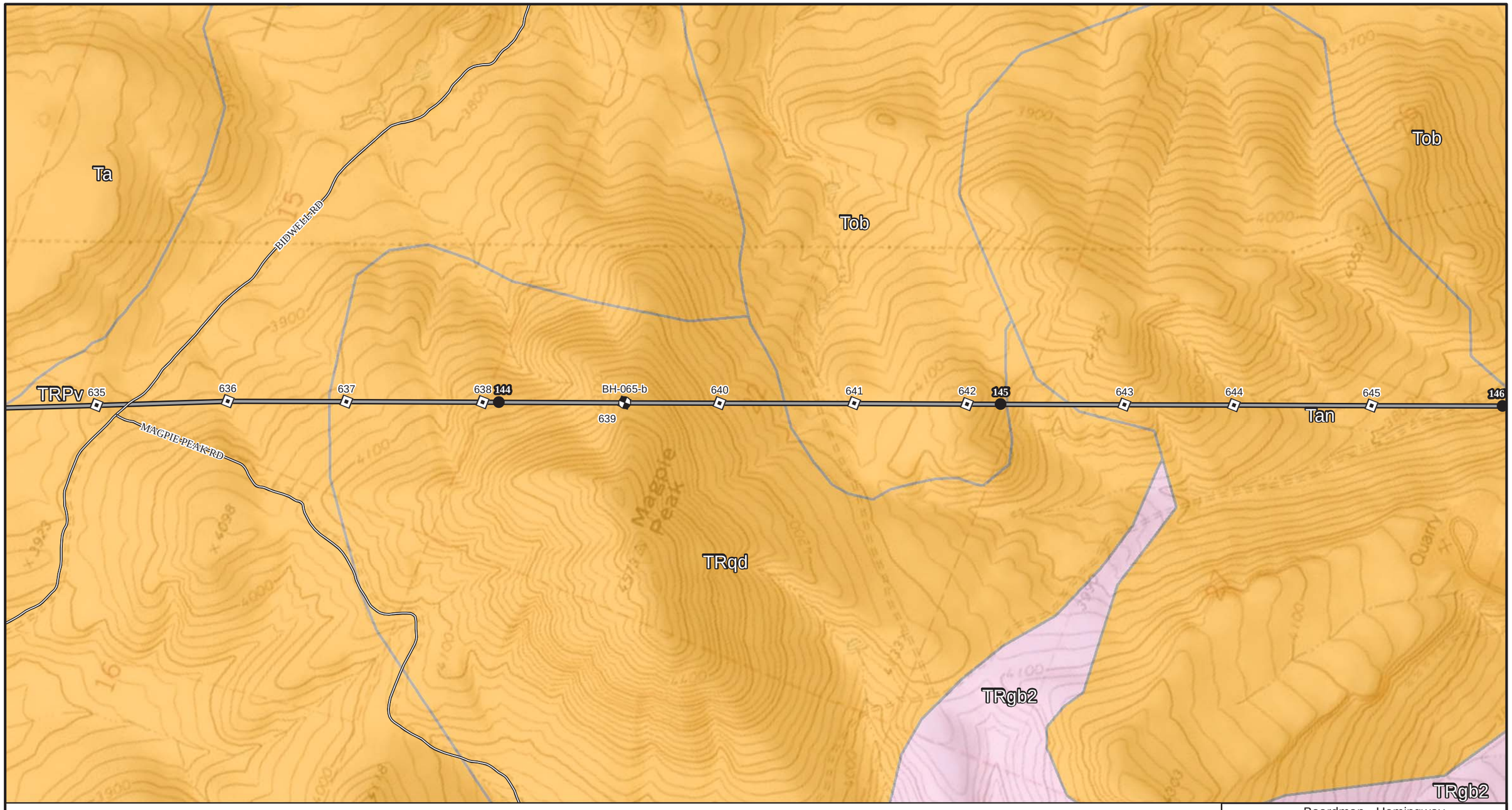

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- Landslide (SLIDO)
- Talus - Colluvium

FAULTS
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- Certain
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- Inferred and queried

COMMUNICATION
- Communication Power
- Communication Fiber

PRELIMINARY ACCESS PATHS
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- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
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- Existing Access, May Need Repairs
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- Primary Limited Access Road
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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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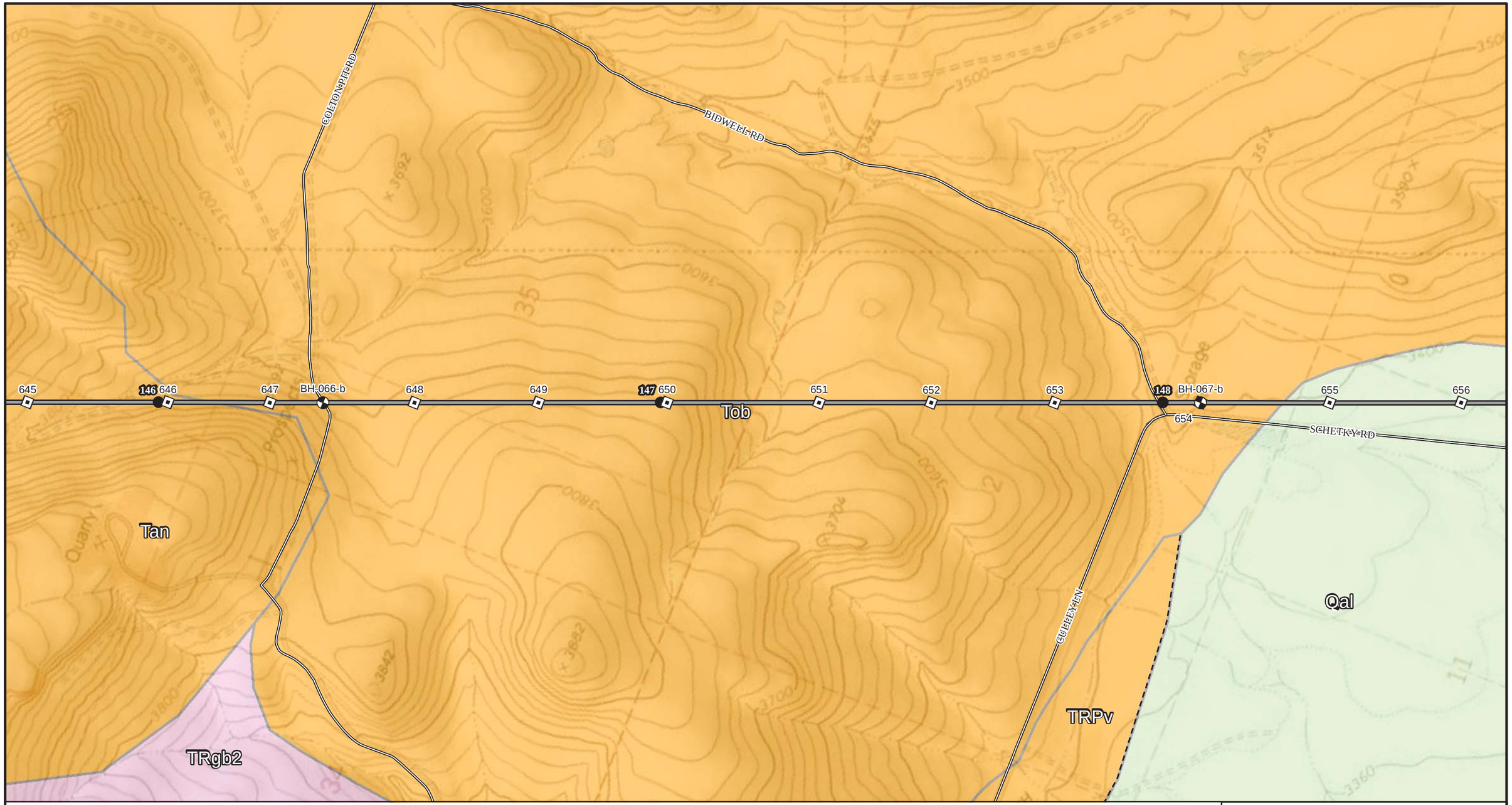

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TRANSMISSION FEATURES
- IPC Proposed Route
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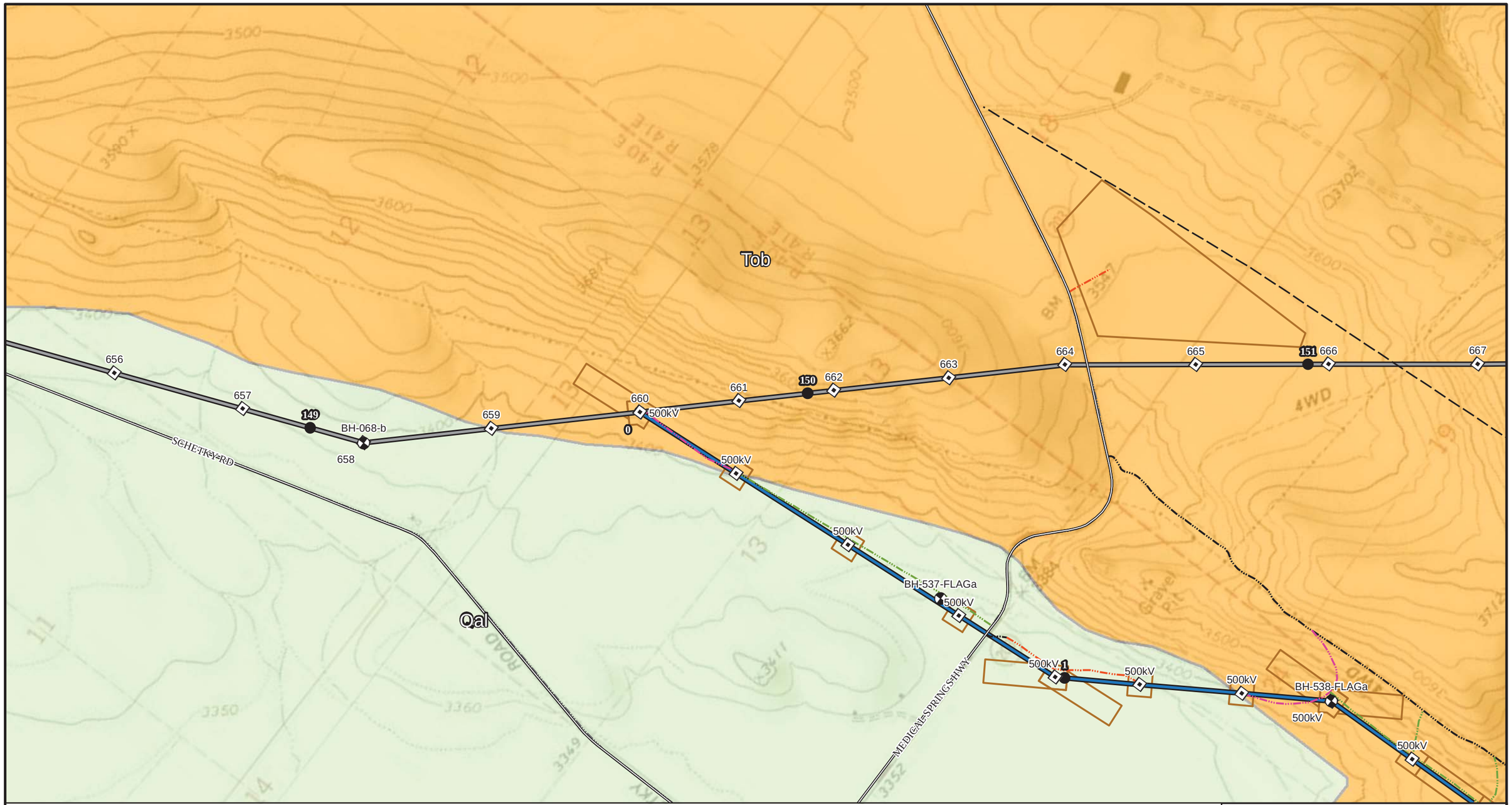

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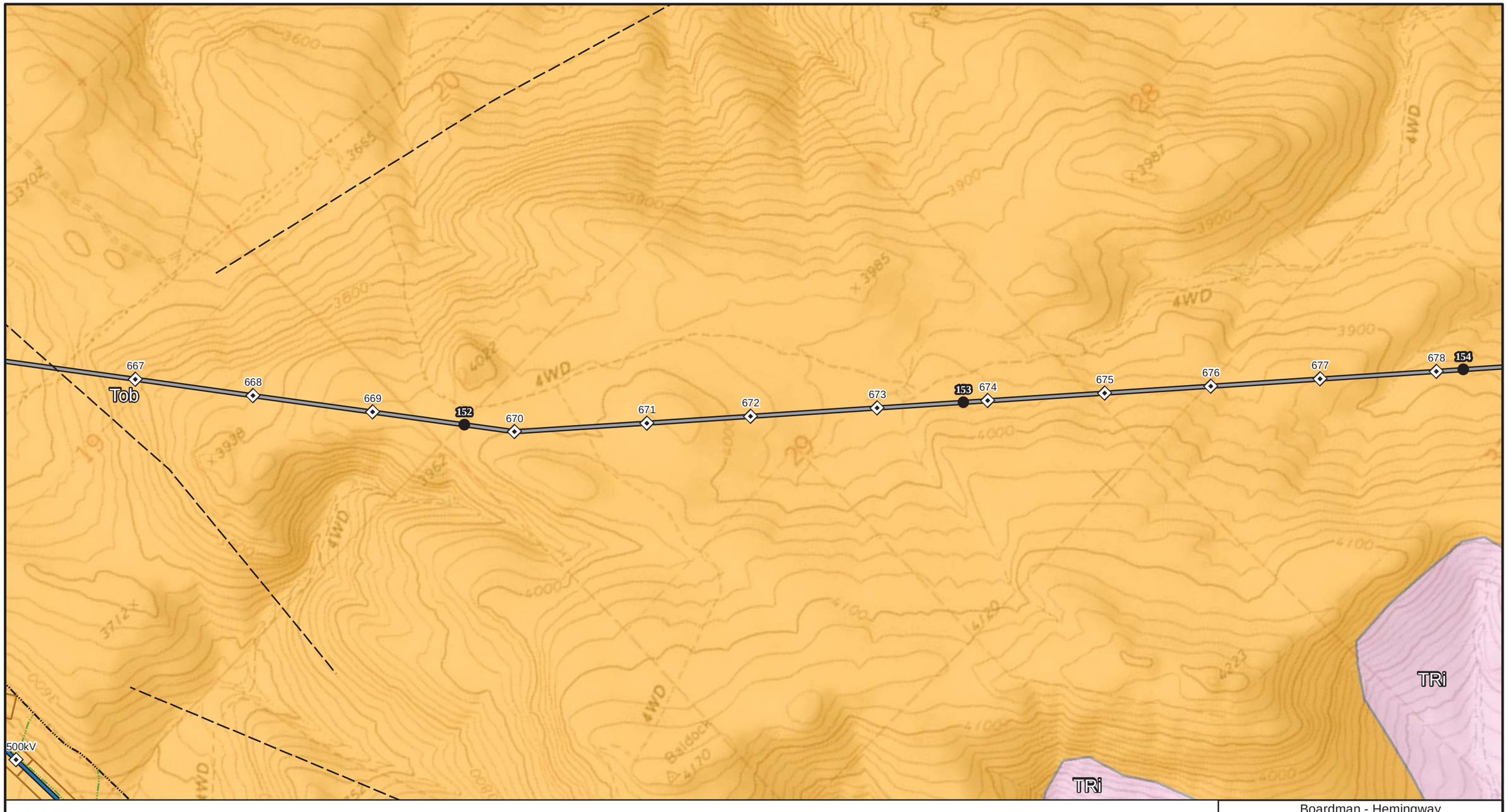

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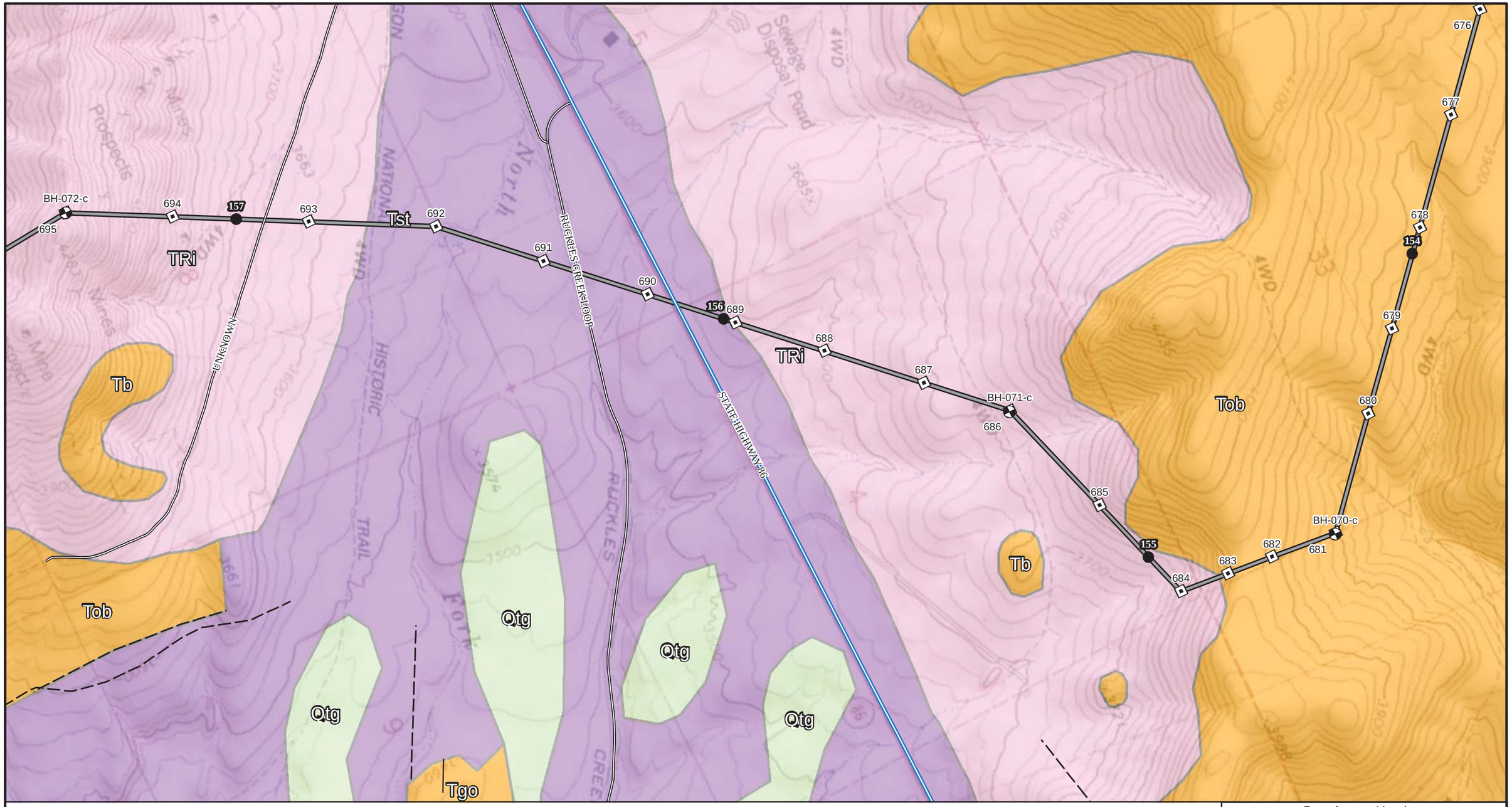

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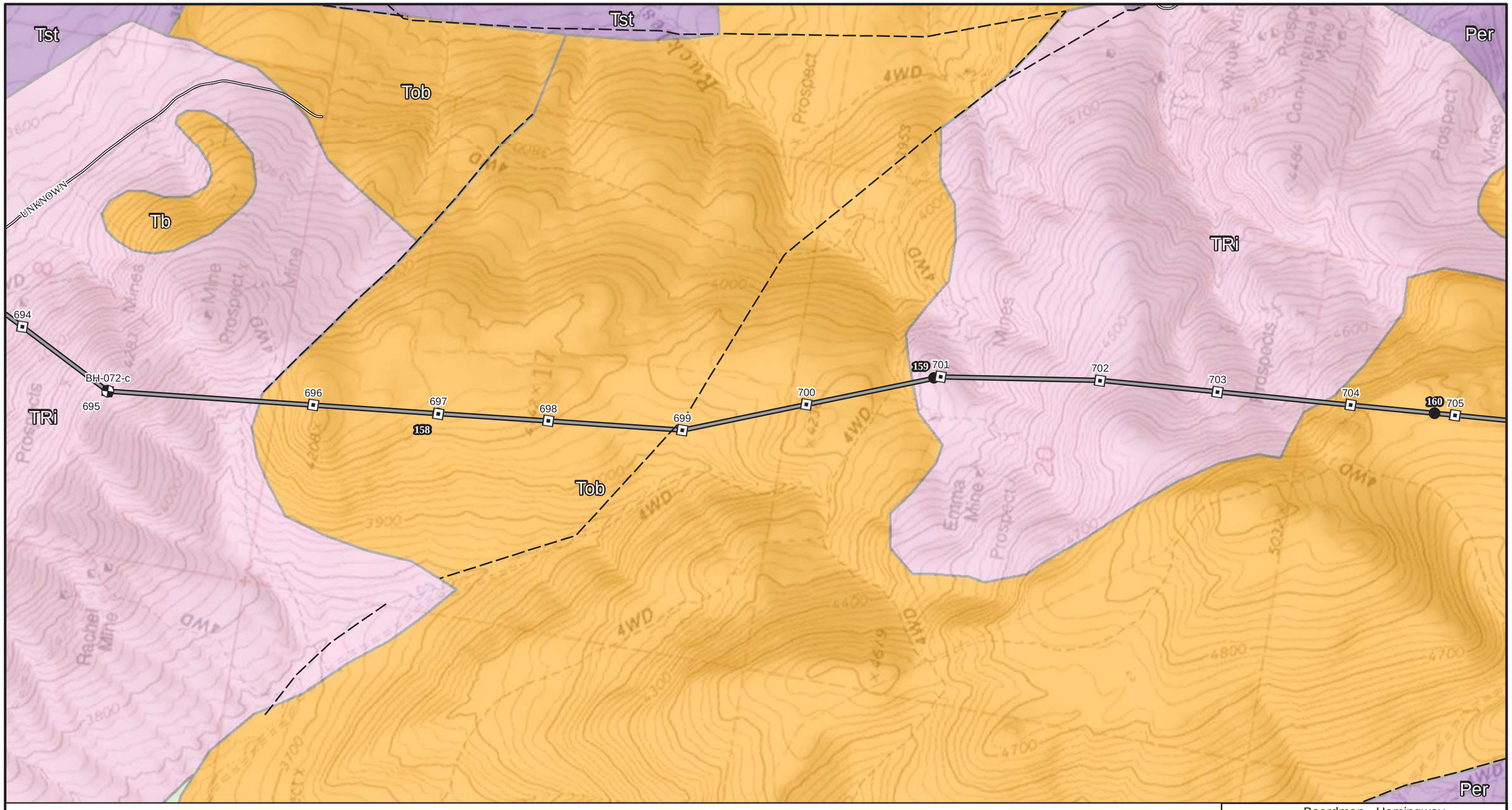

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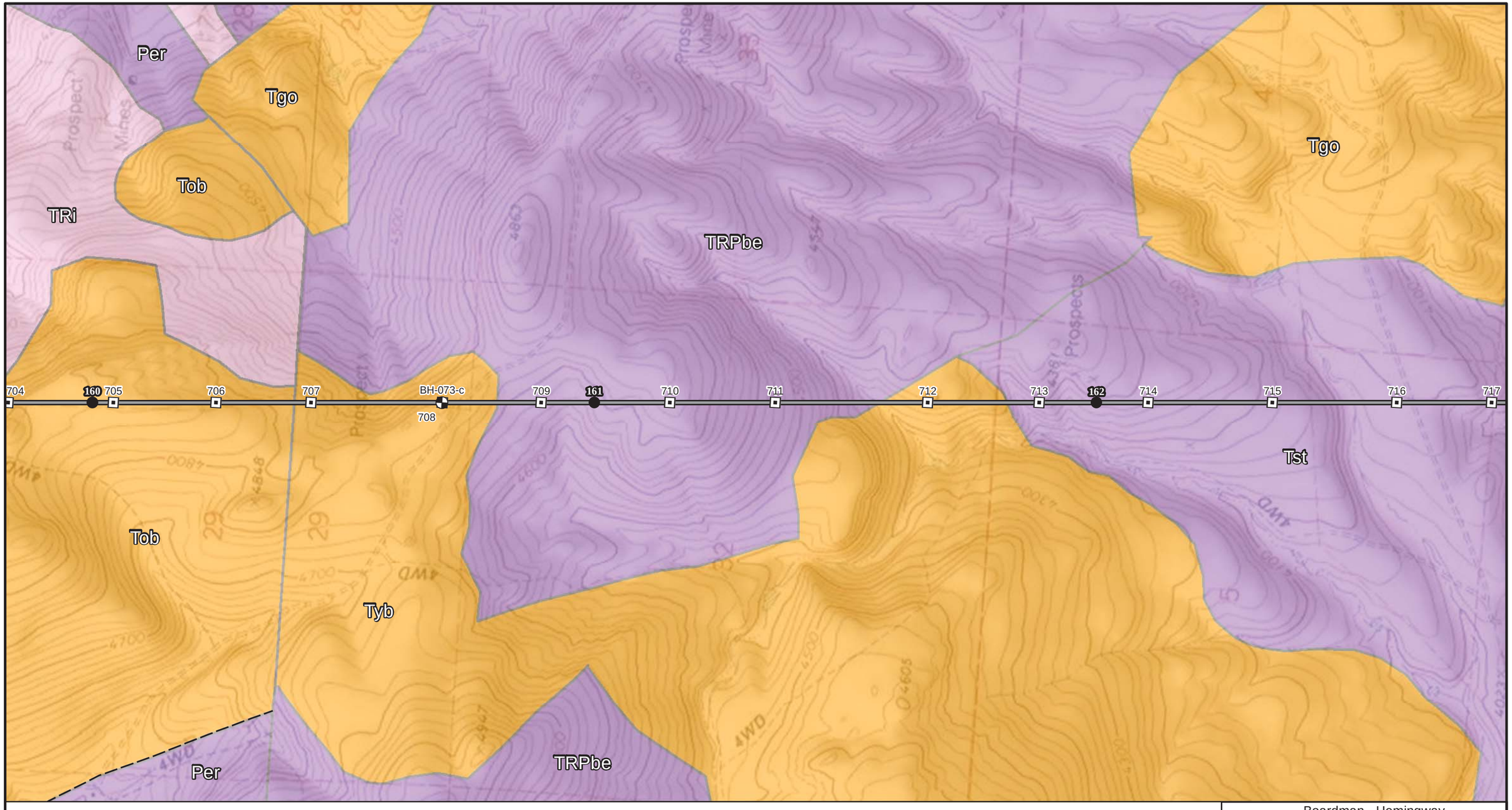

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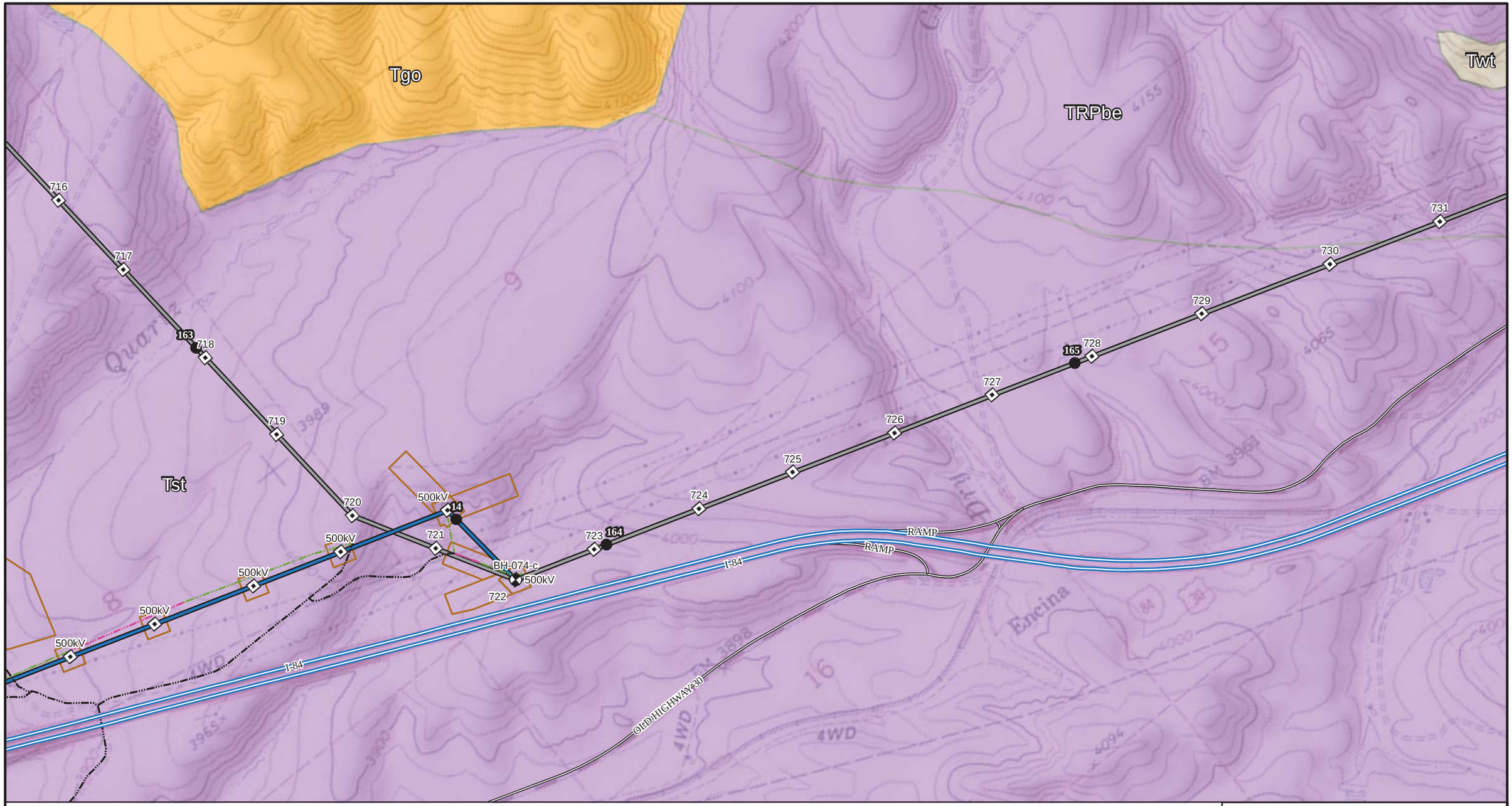

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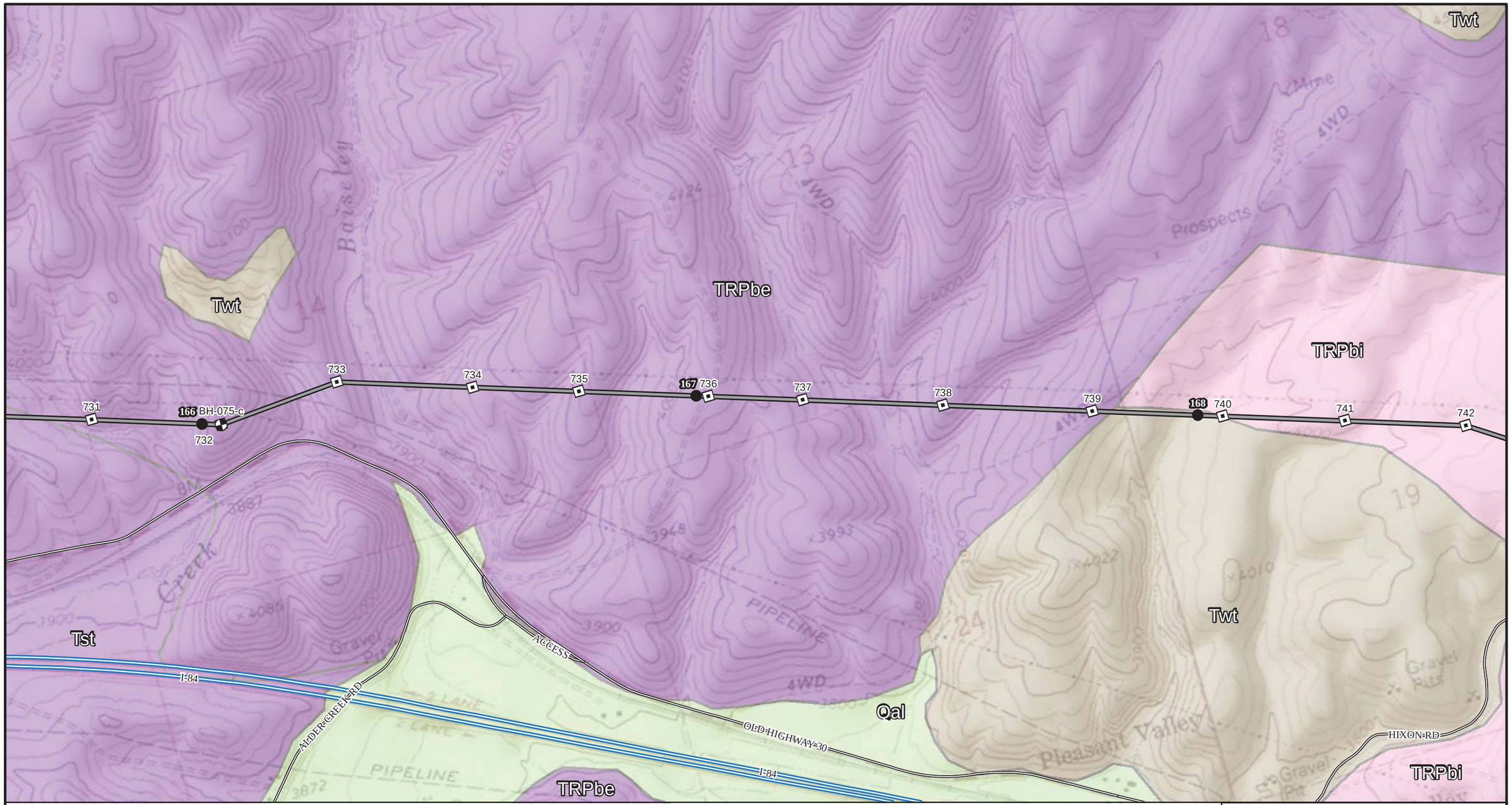

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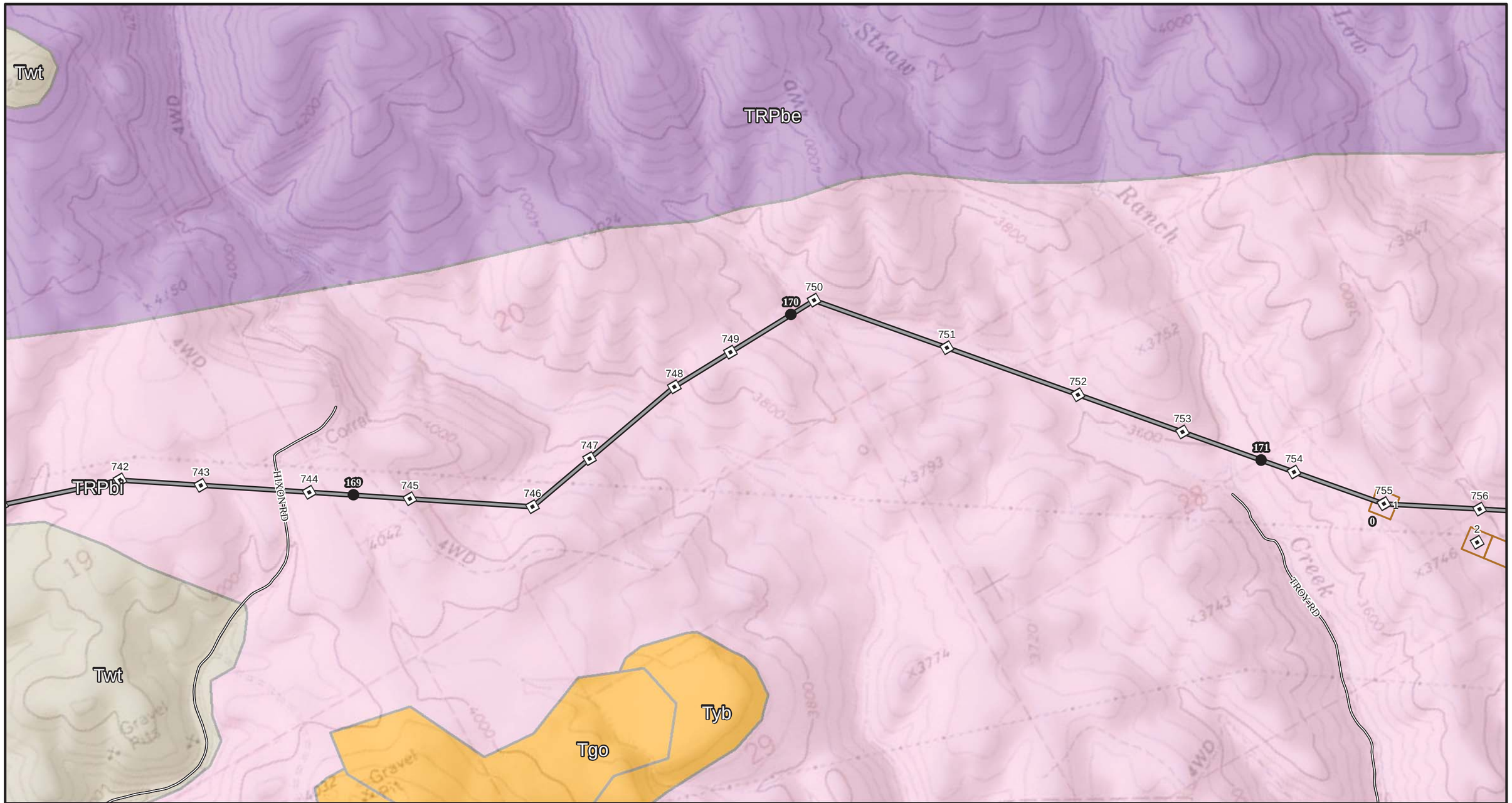

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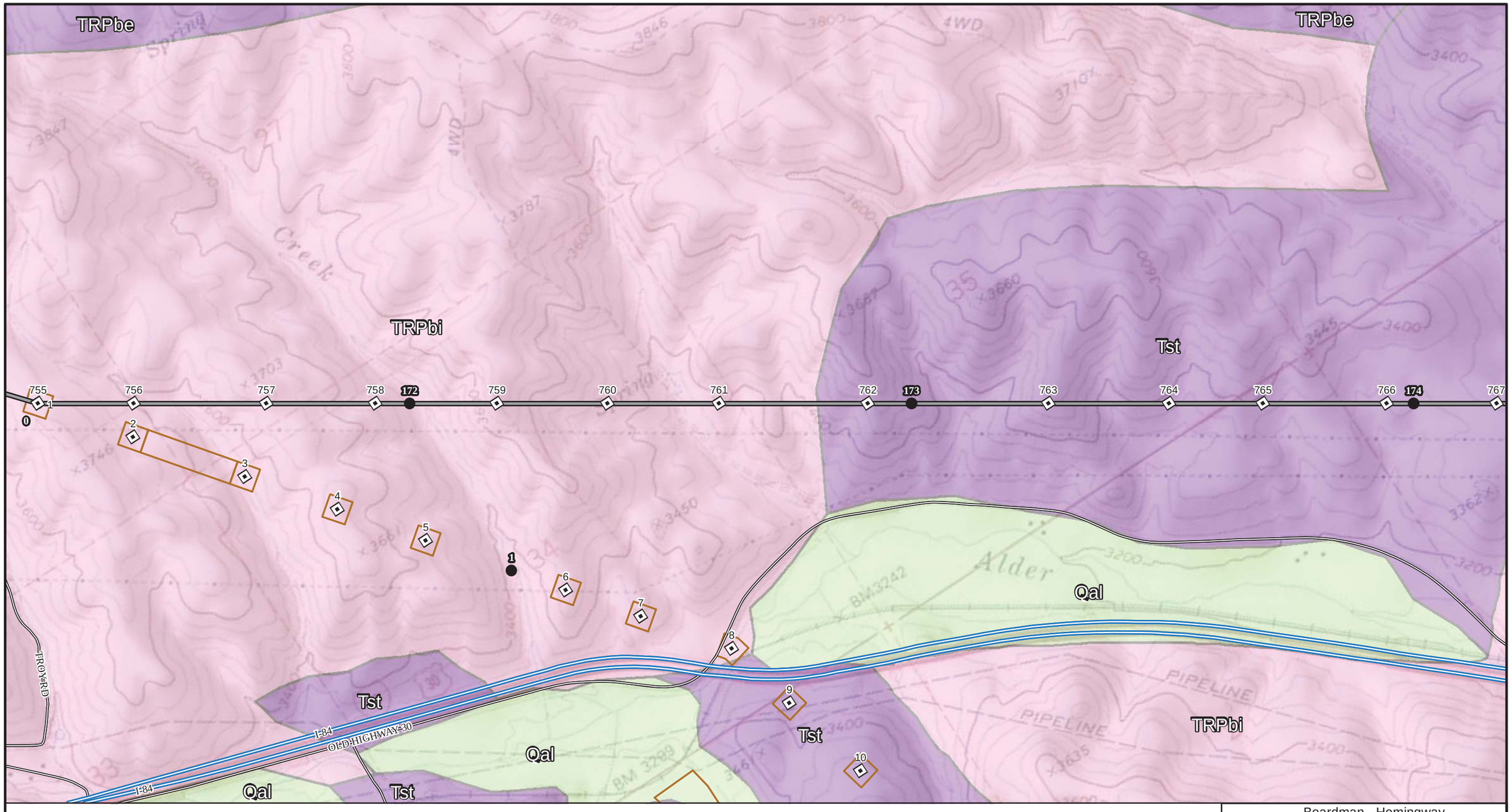

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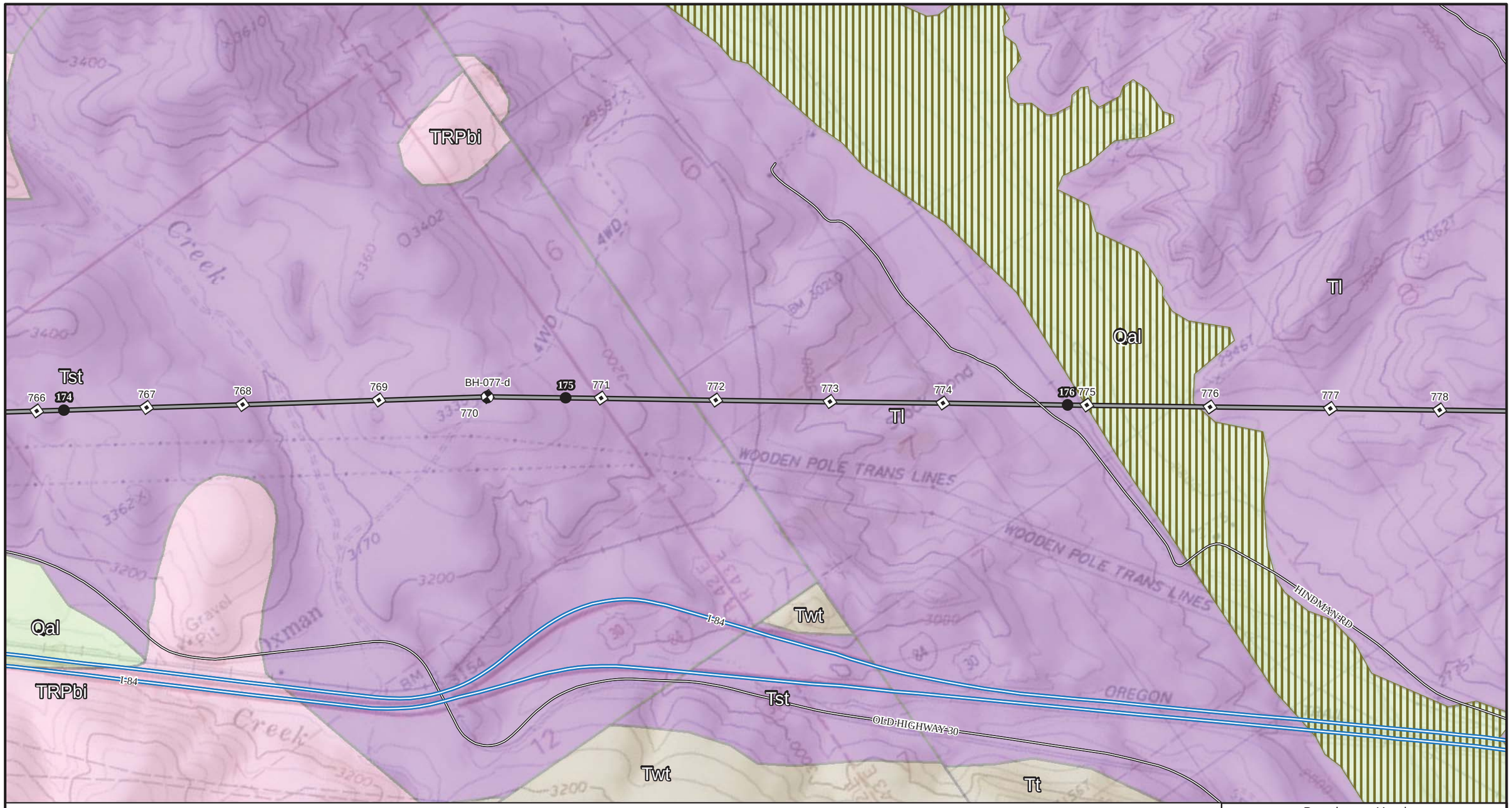

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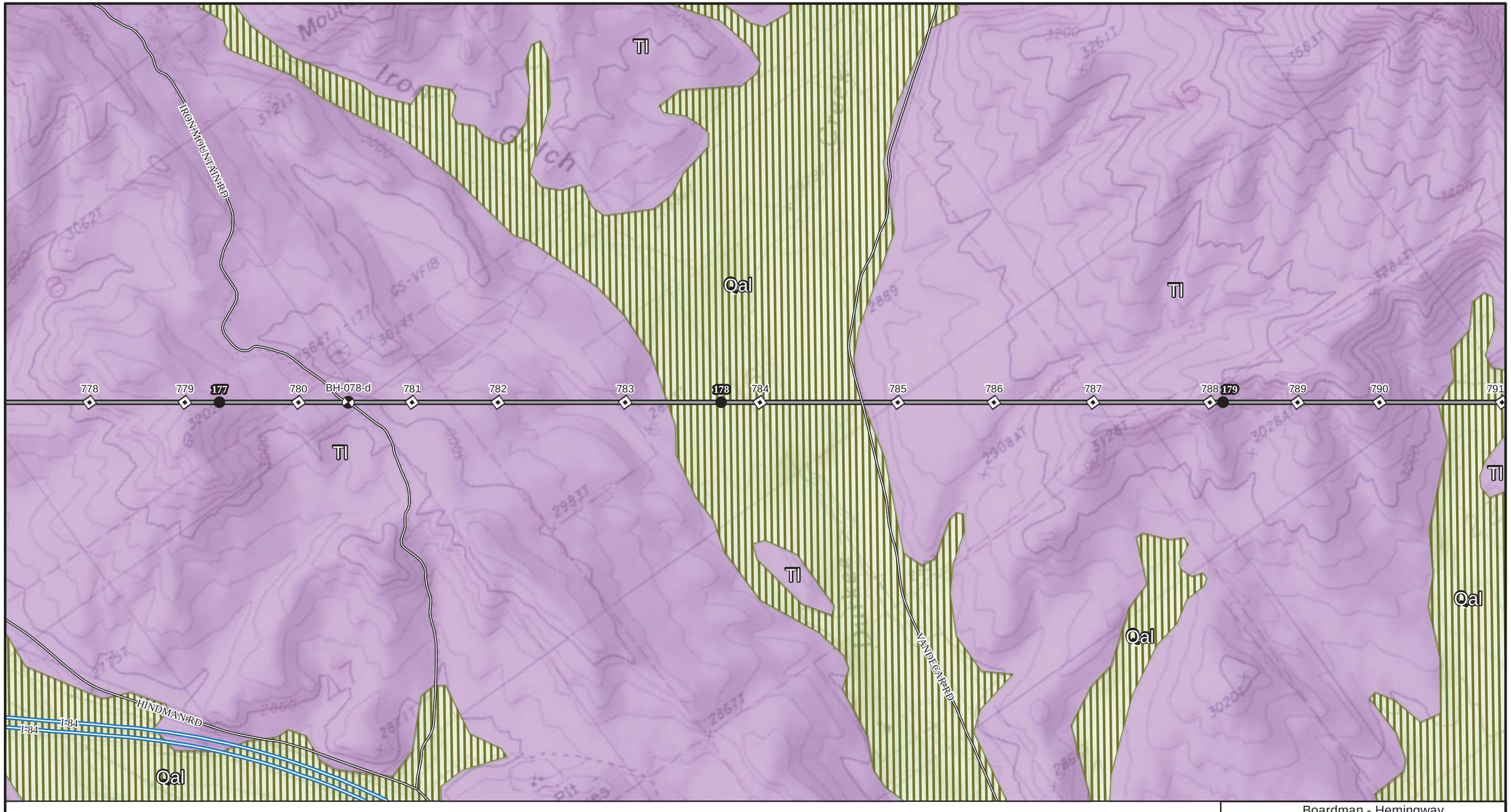

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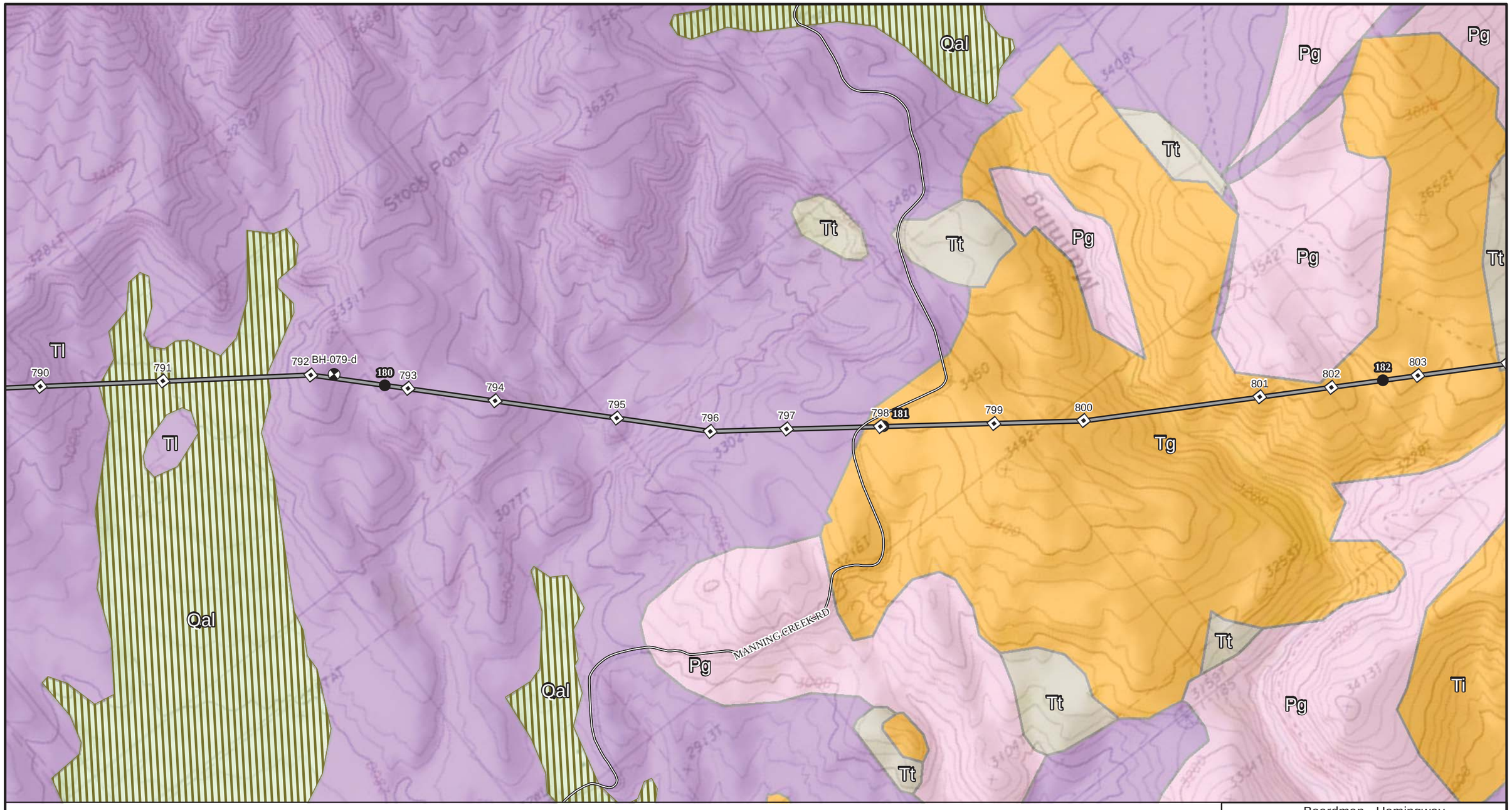

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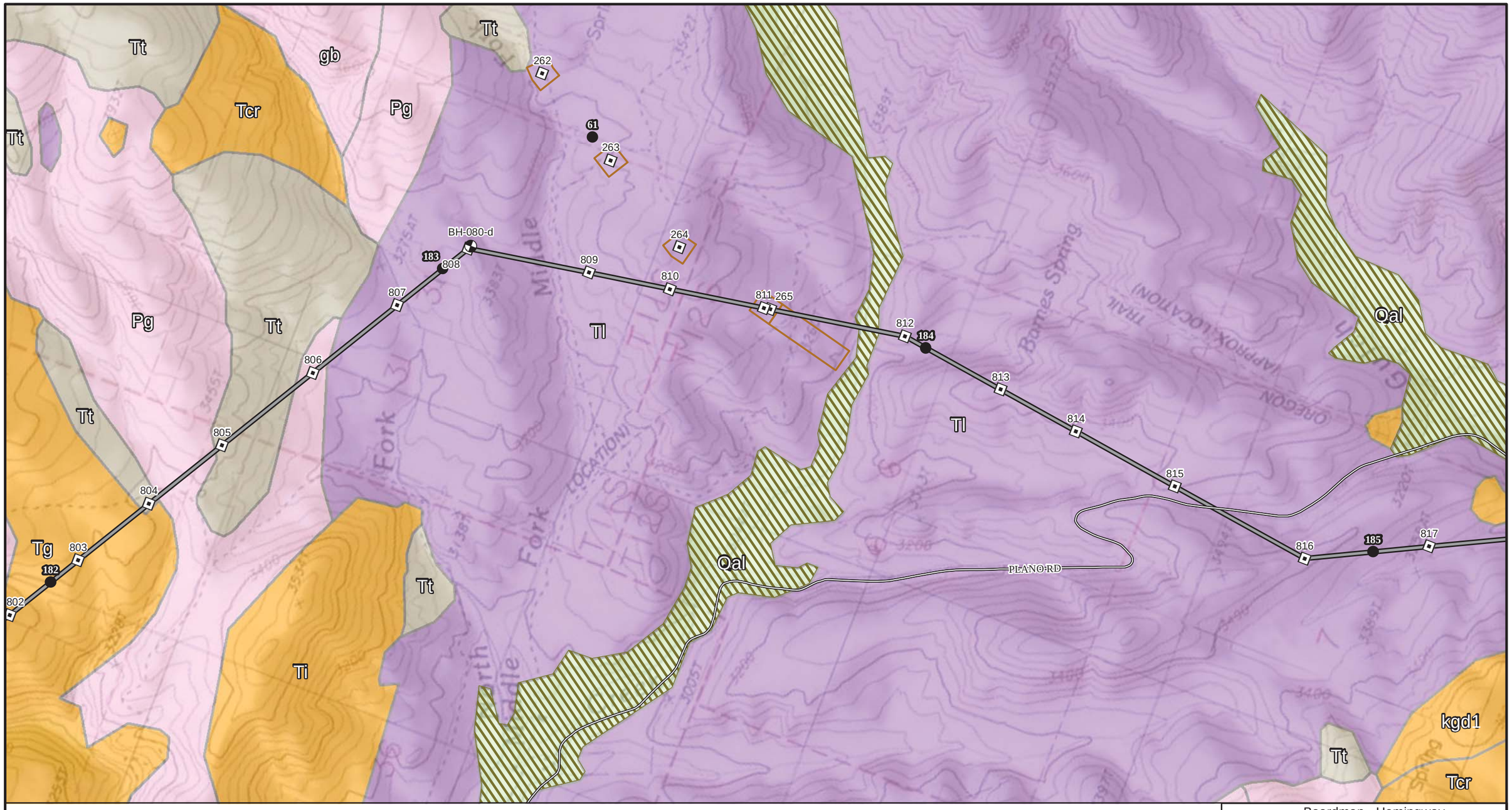

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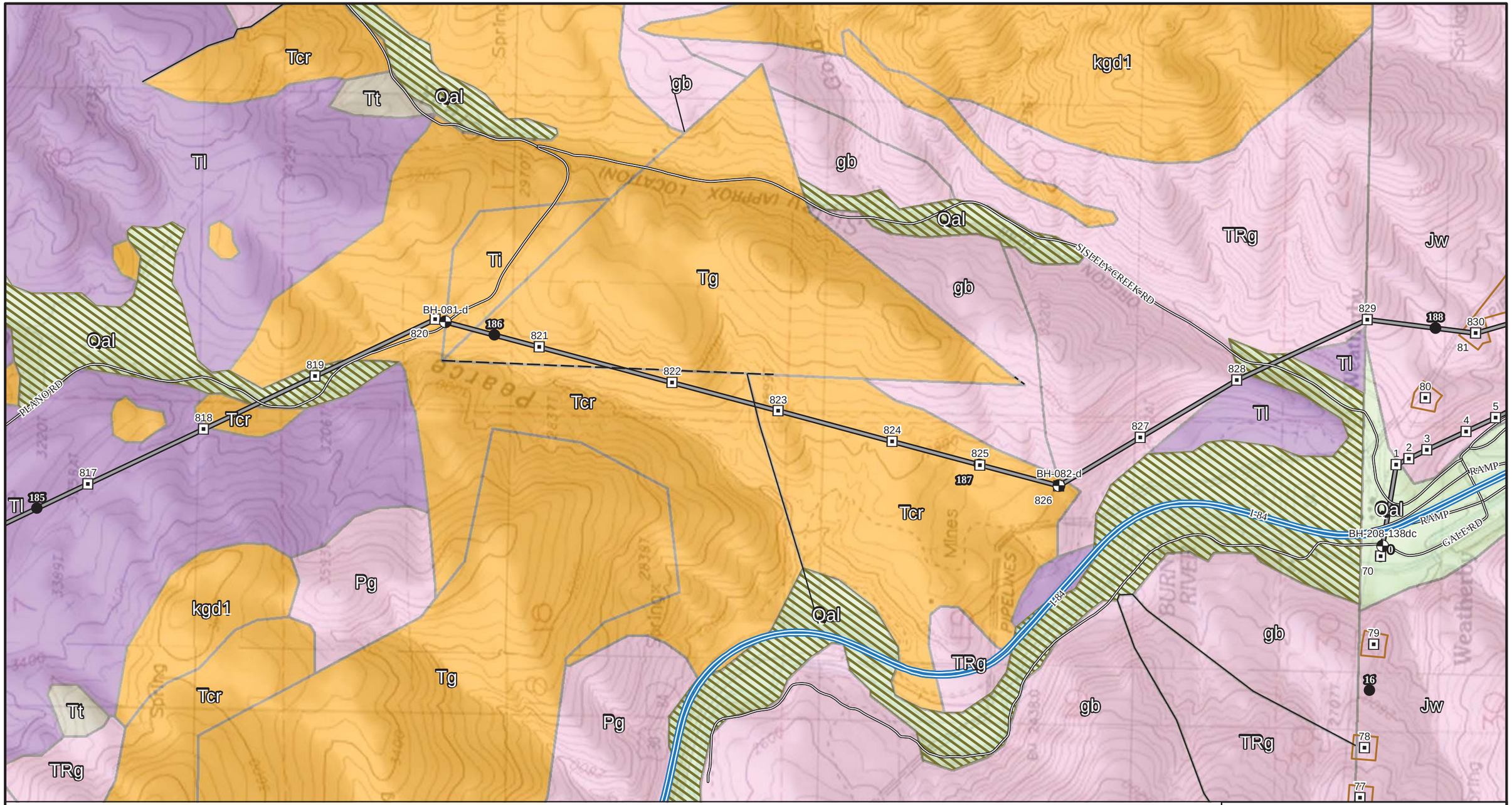

LEGEND

TRANSMISSION FEATURES
- IPC Proposed Route
- IPC Alternative
- NEPA Alternative
- Work Area
- Mileposts
- Towers
- Proposed Borehole

SURFICIAL GEOLOGY
- Igneous Rock
- Metamorphic Rocks
- Sedimentary Rocks
- Unconsolidated Rocks
- Volcaniclastic Rocks

LANDSLIDES
- Fan
- Landslide (SLIDO)
- Talus - Colluvium

FAULTS
- Approximate
- Approximate and queried
- Certain
- Concealed
- Inferred
- Inferred and queried

COMMUNICATION
- Communication Power
- Communication Fiber

PRELIMINARY ACCESS PATHS
- Bladed
- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
- Existing Access, To Be Improved
- Existing Access, May Need Repairs
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EXISITING TRANSPORATION ROADS
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NOTE
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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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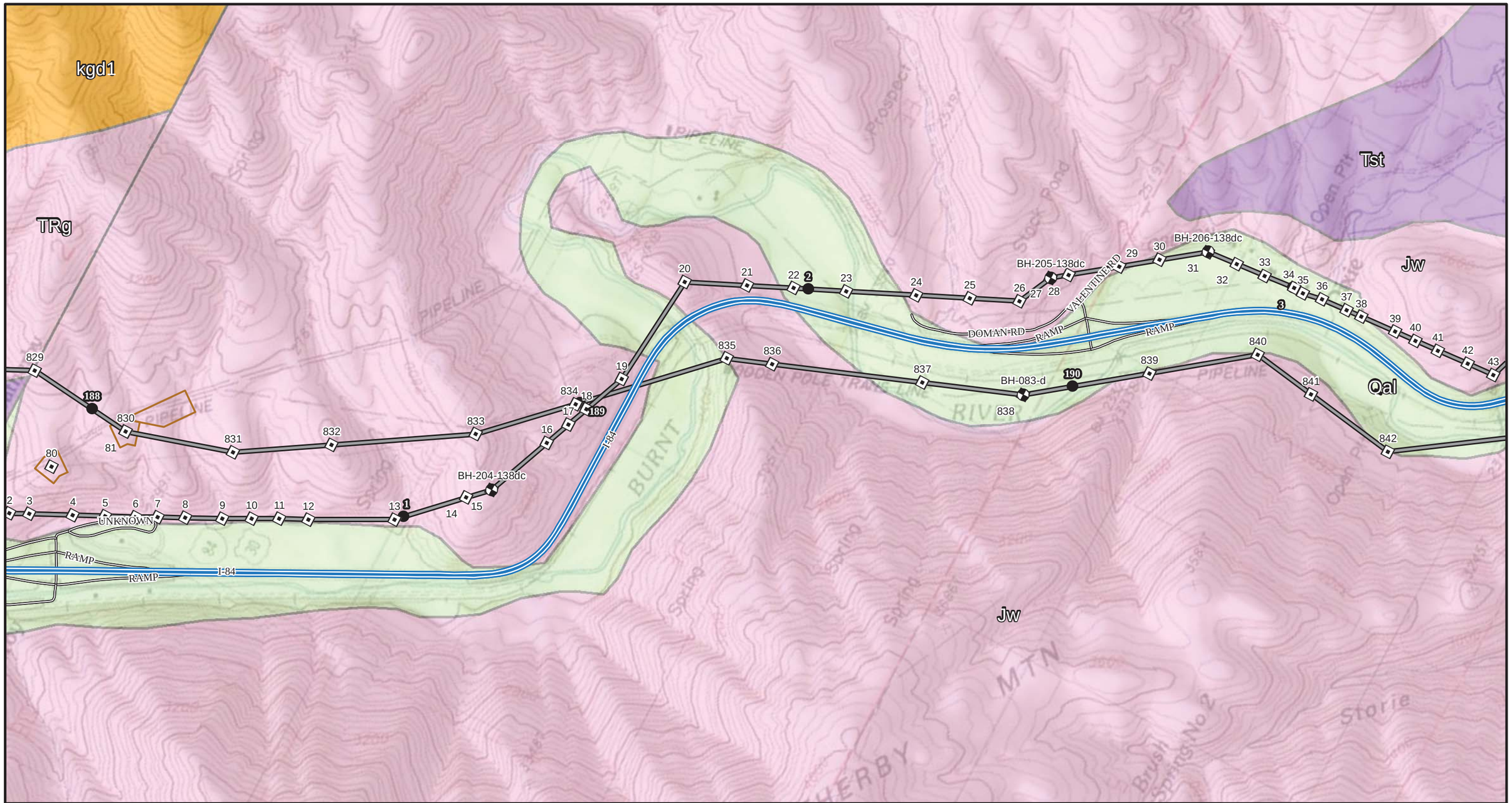

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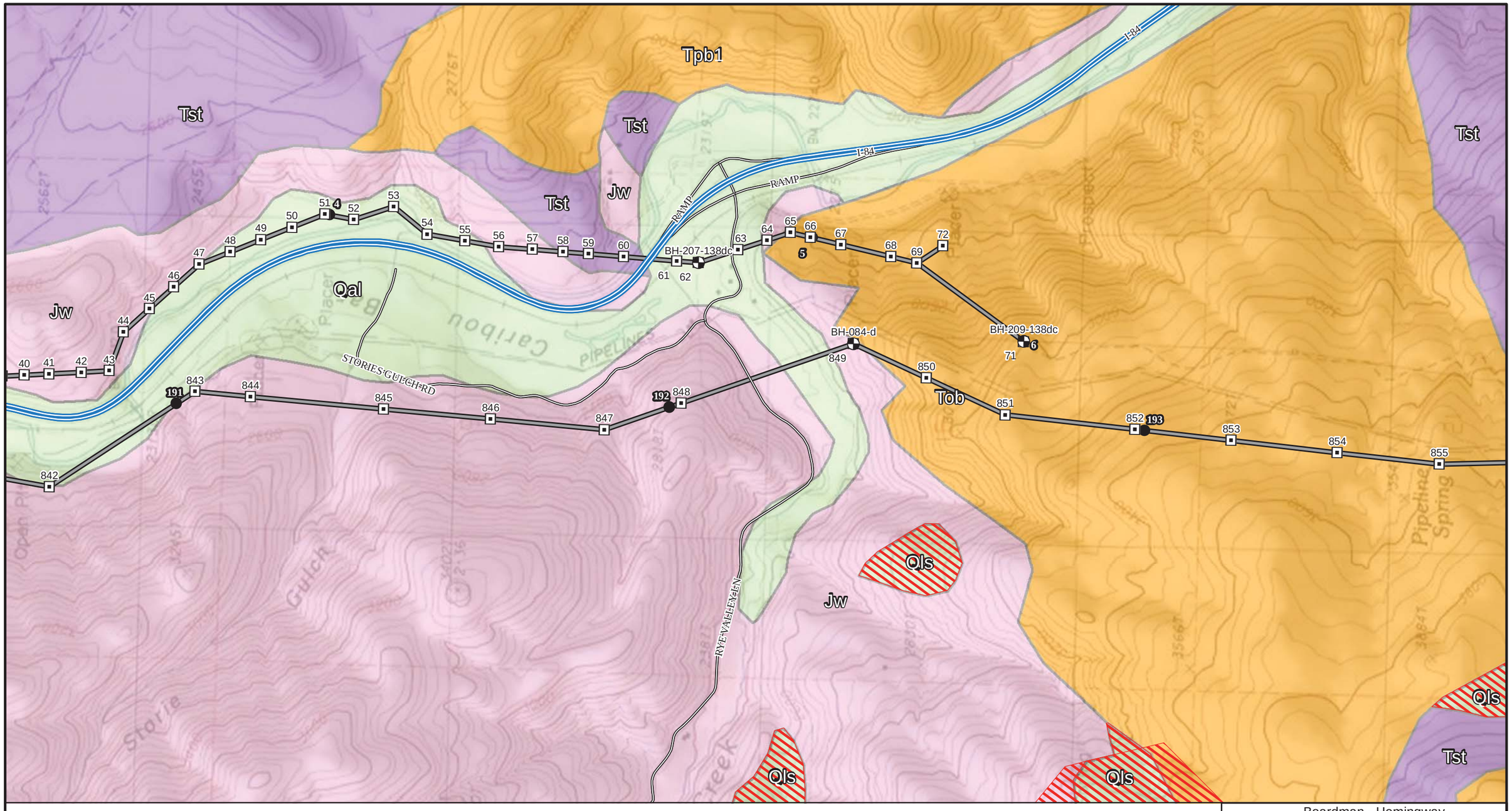

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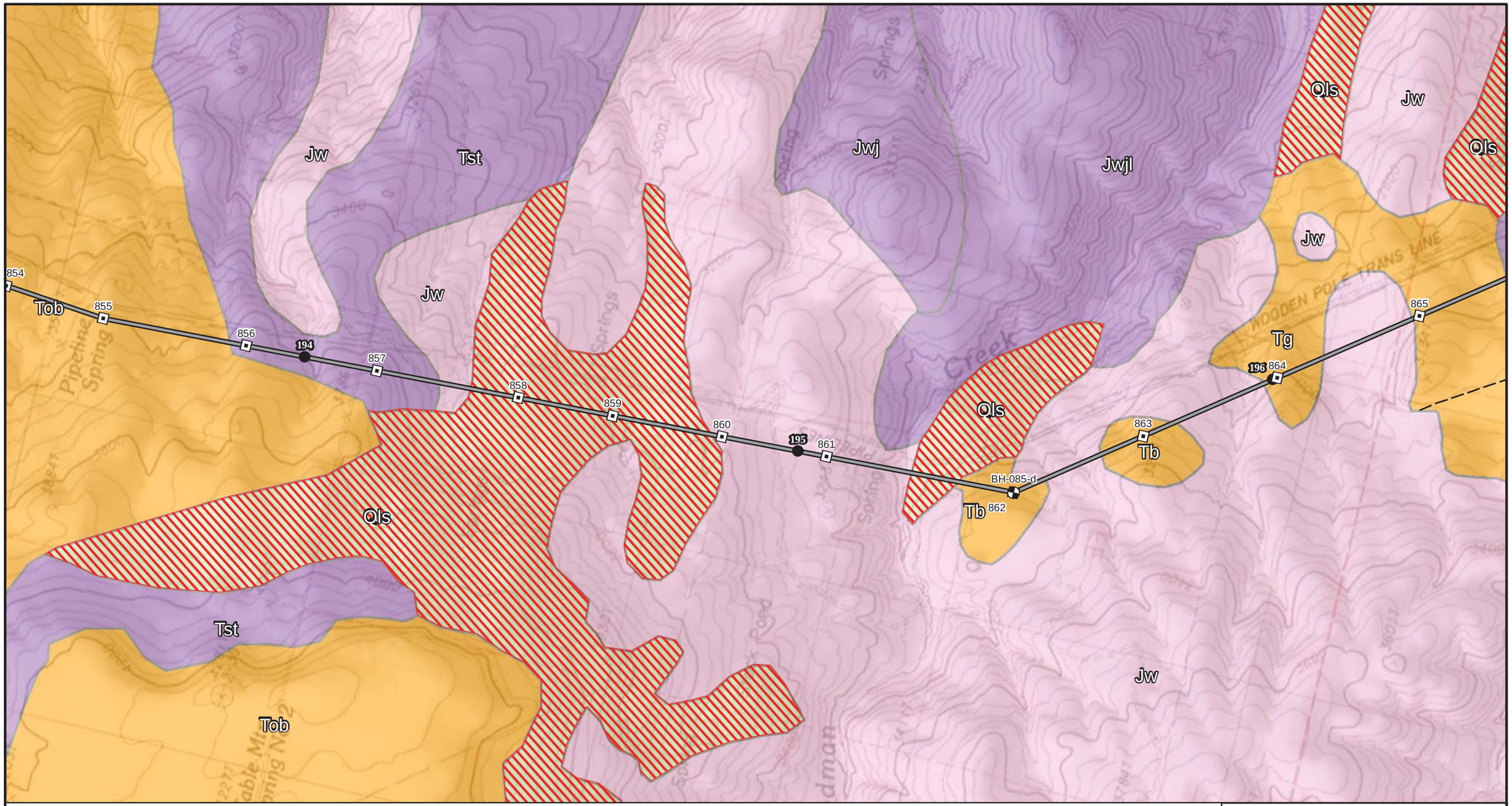

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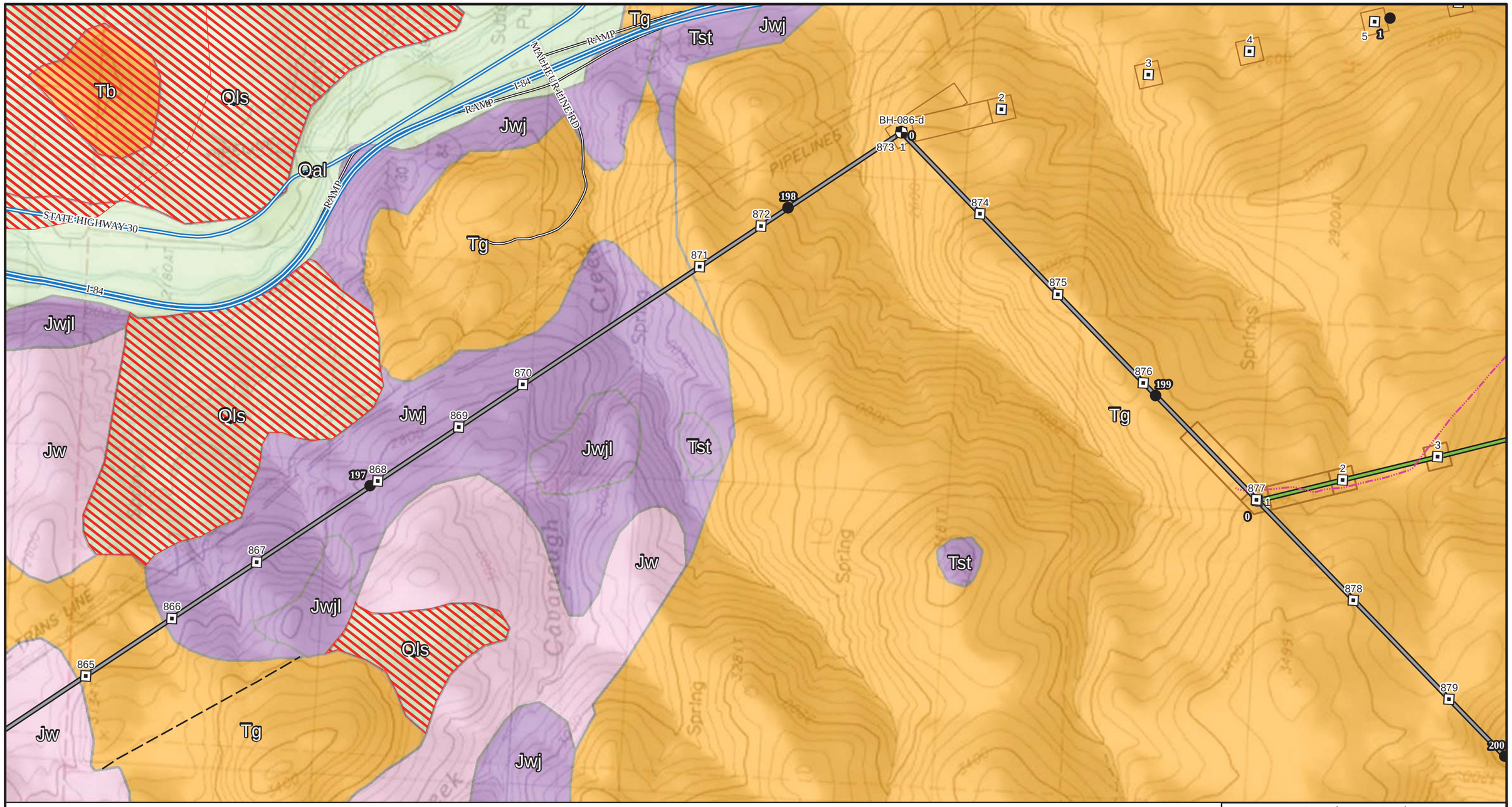

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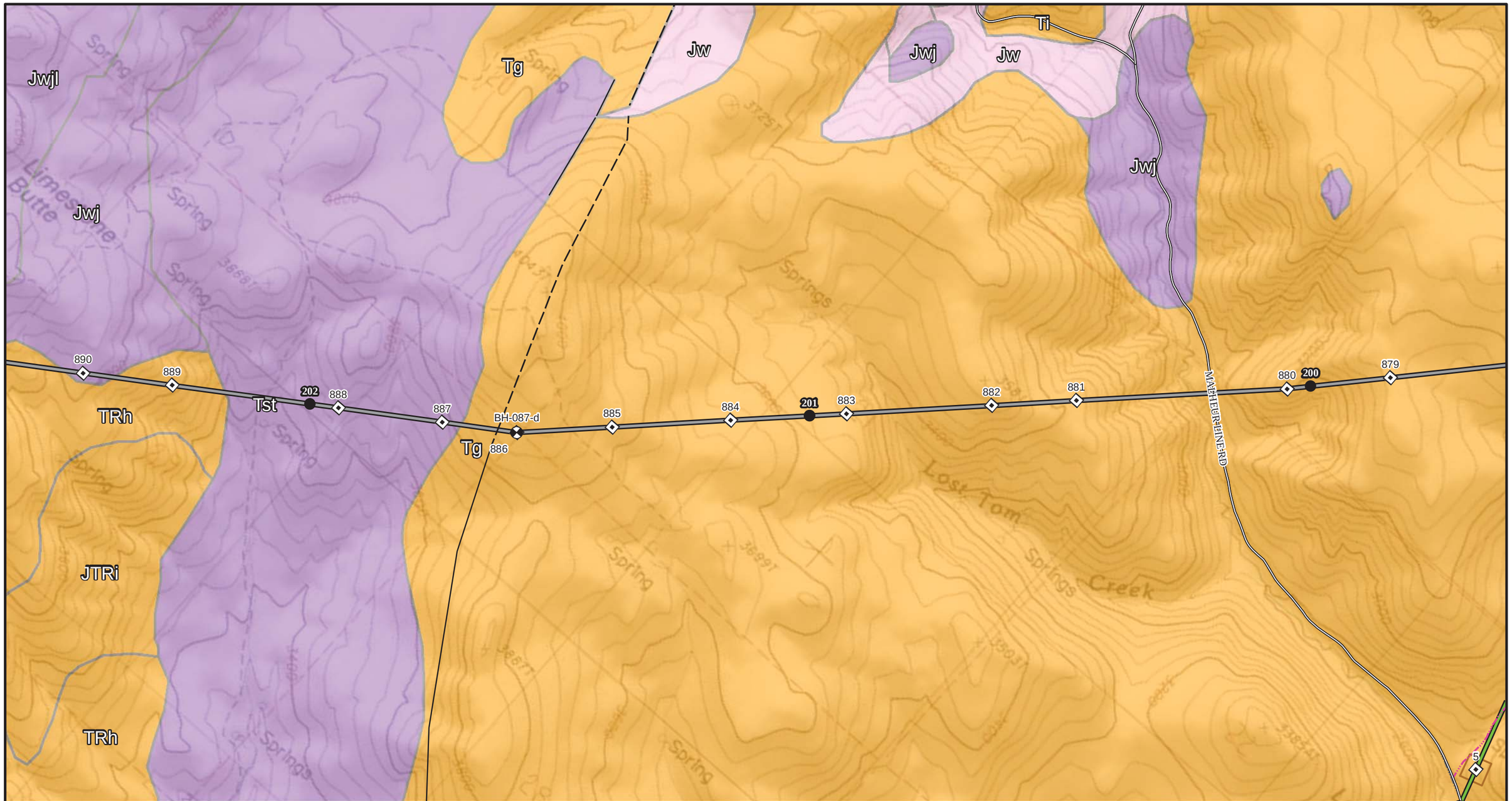

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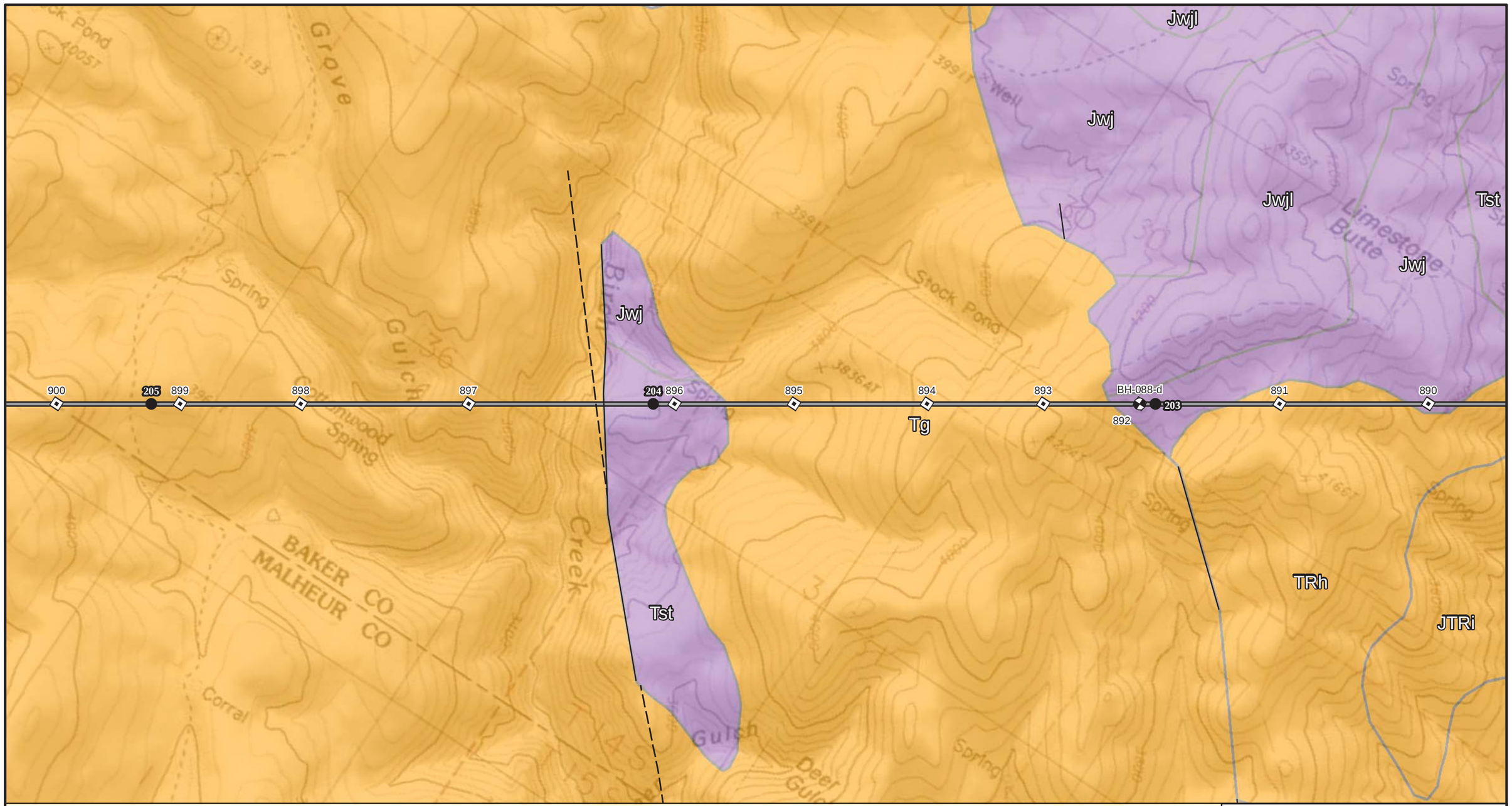

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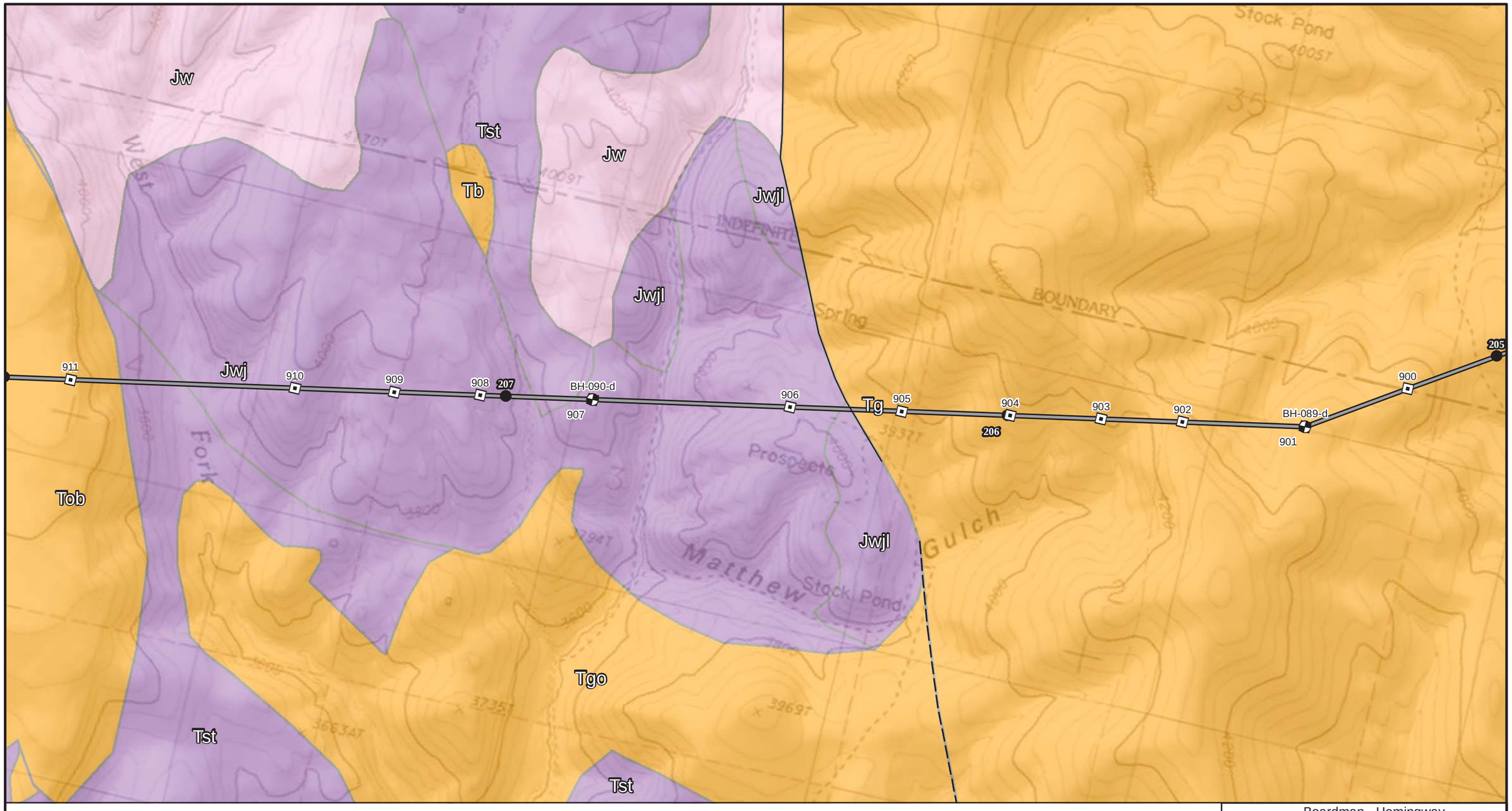

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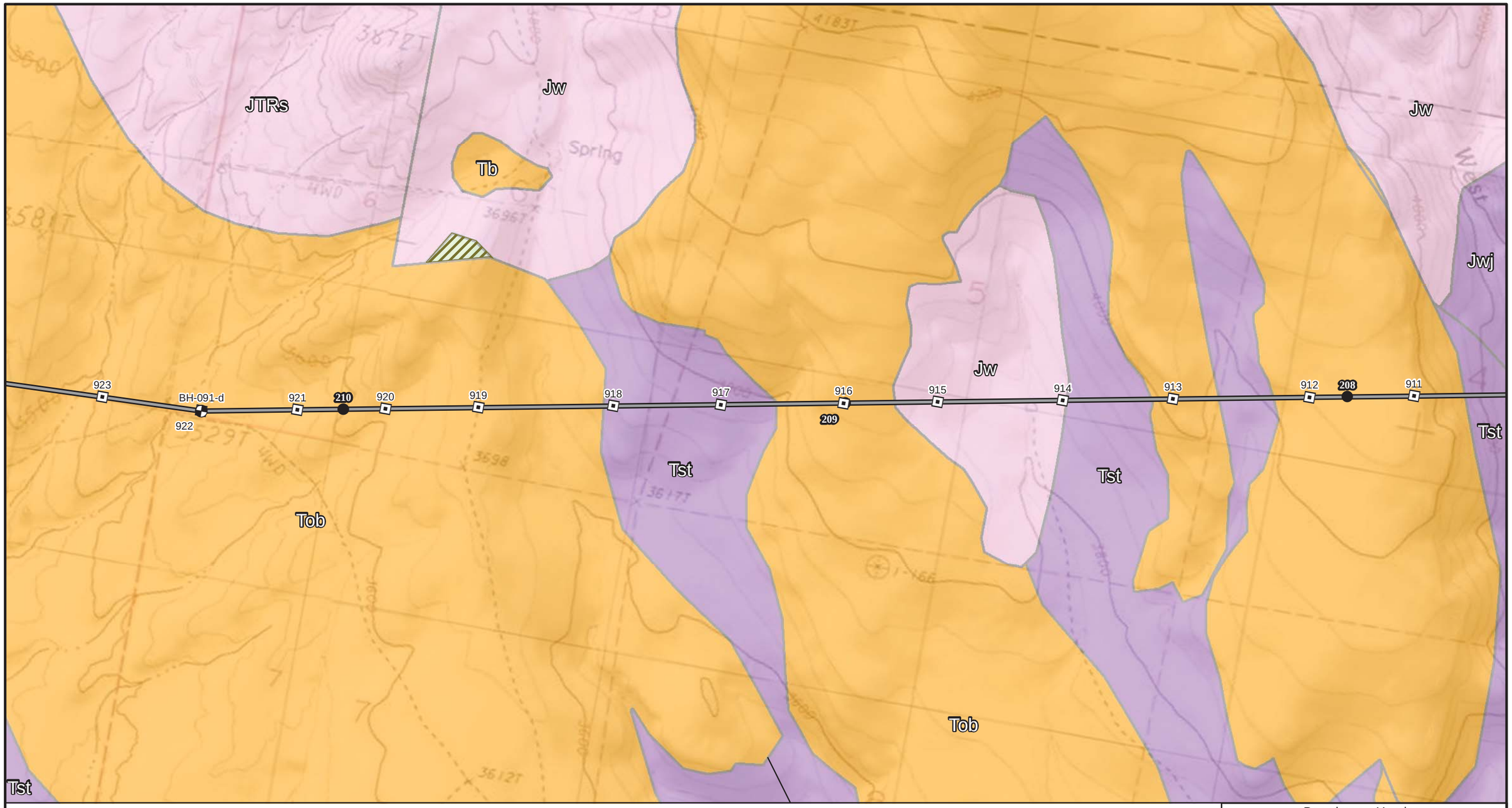

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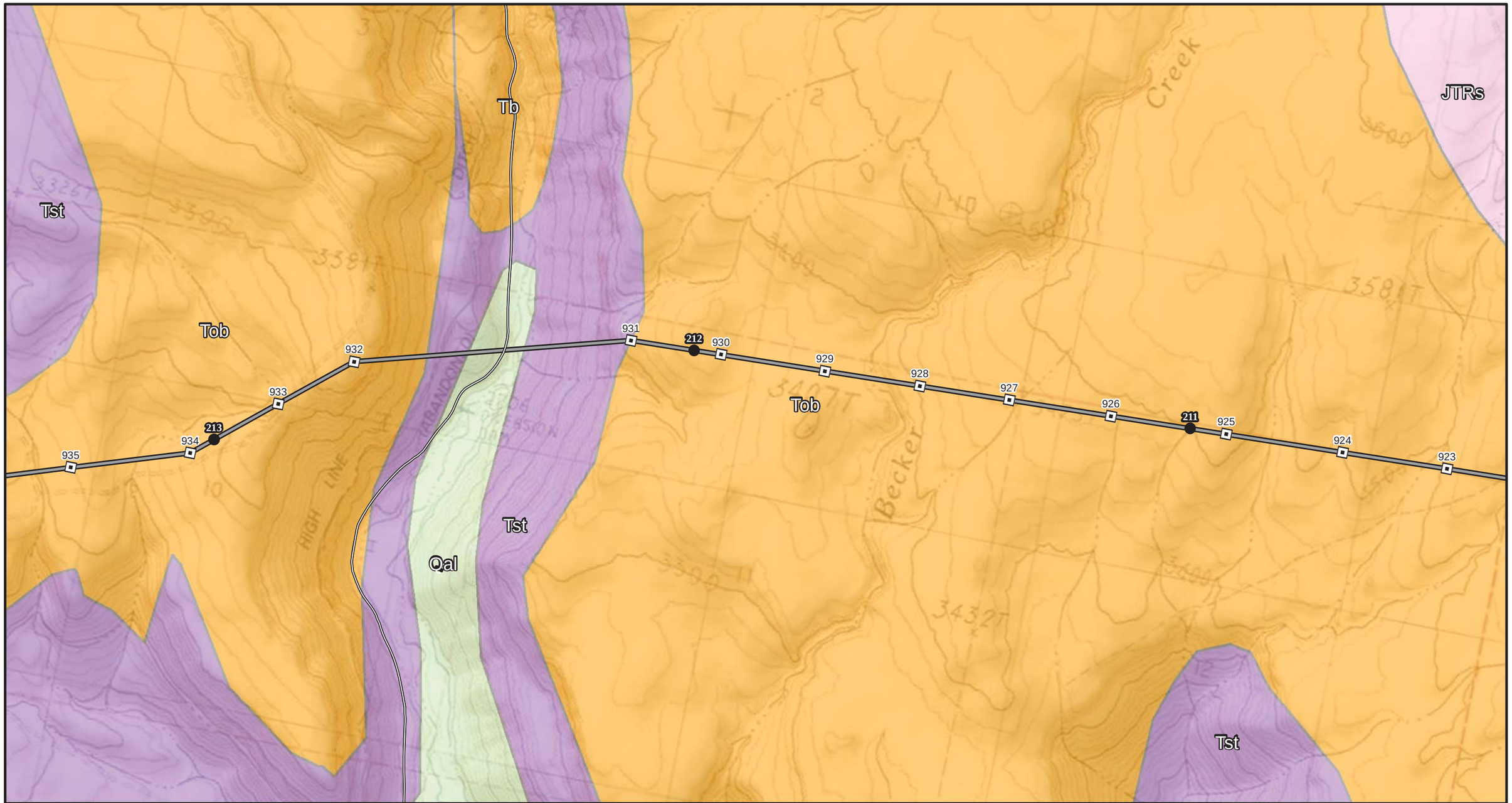

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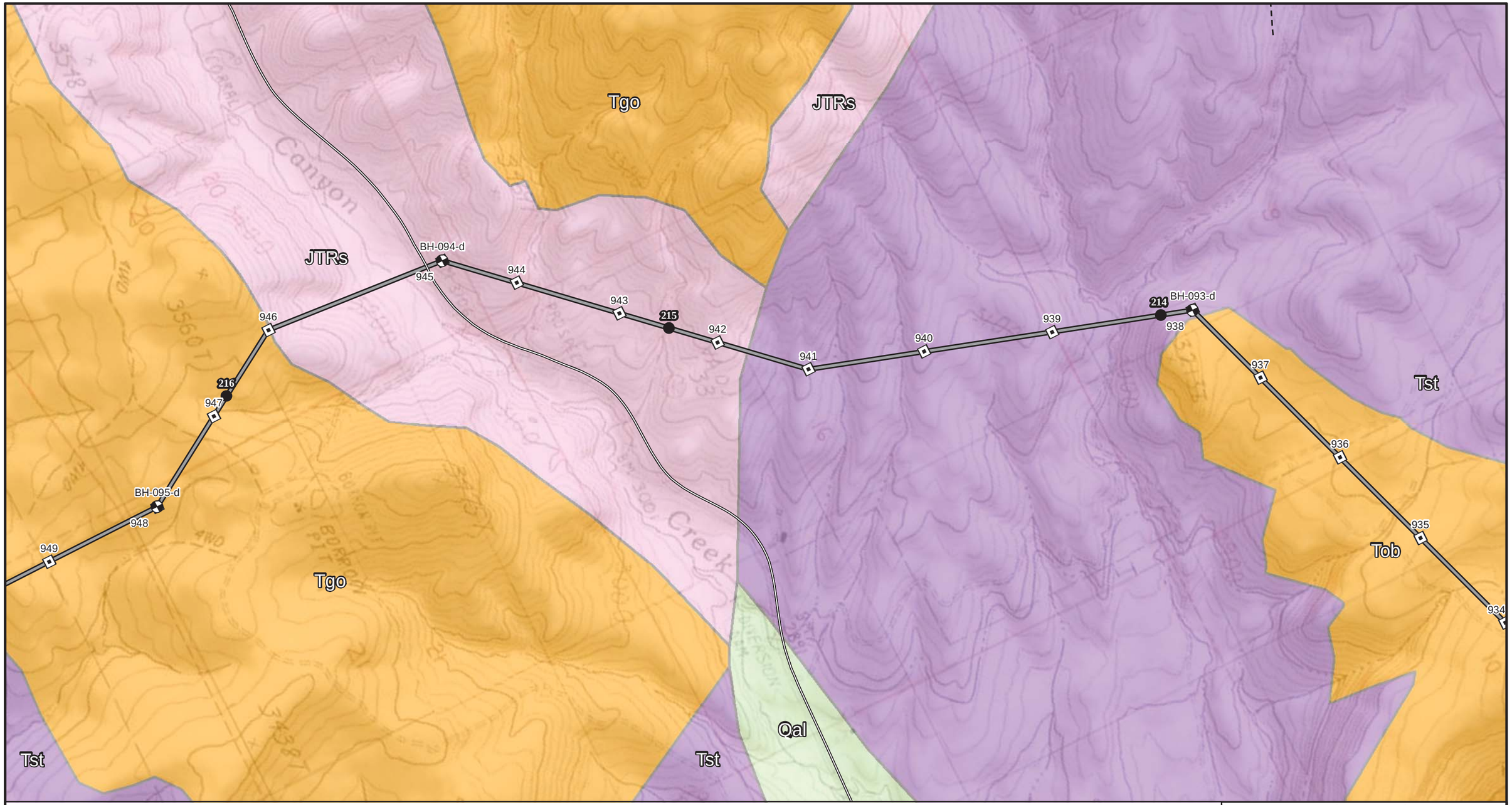

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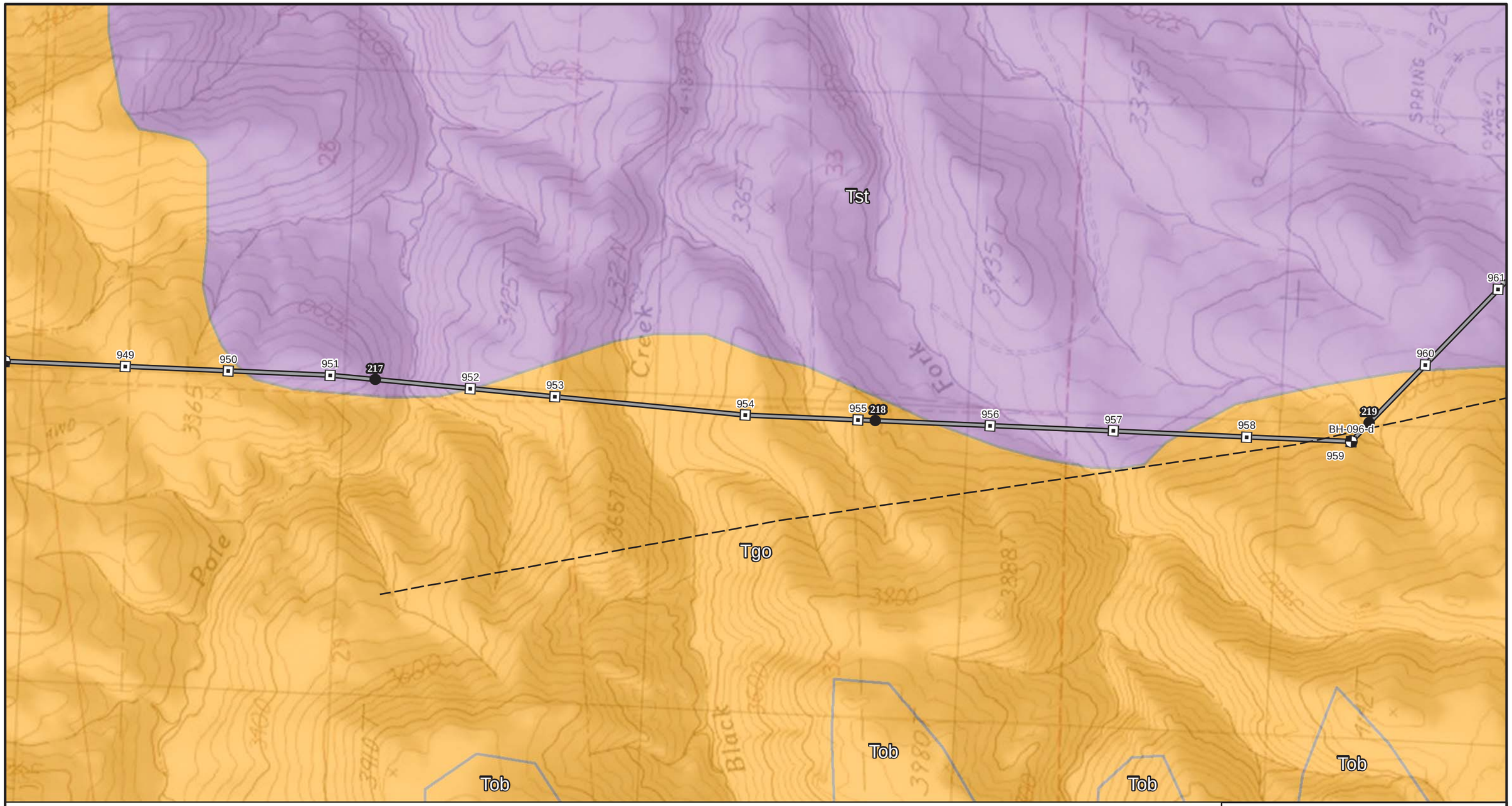

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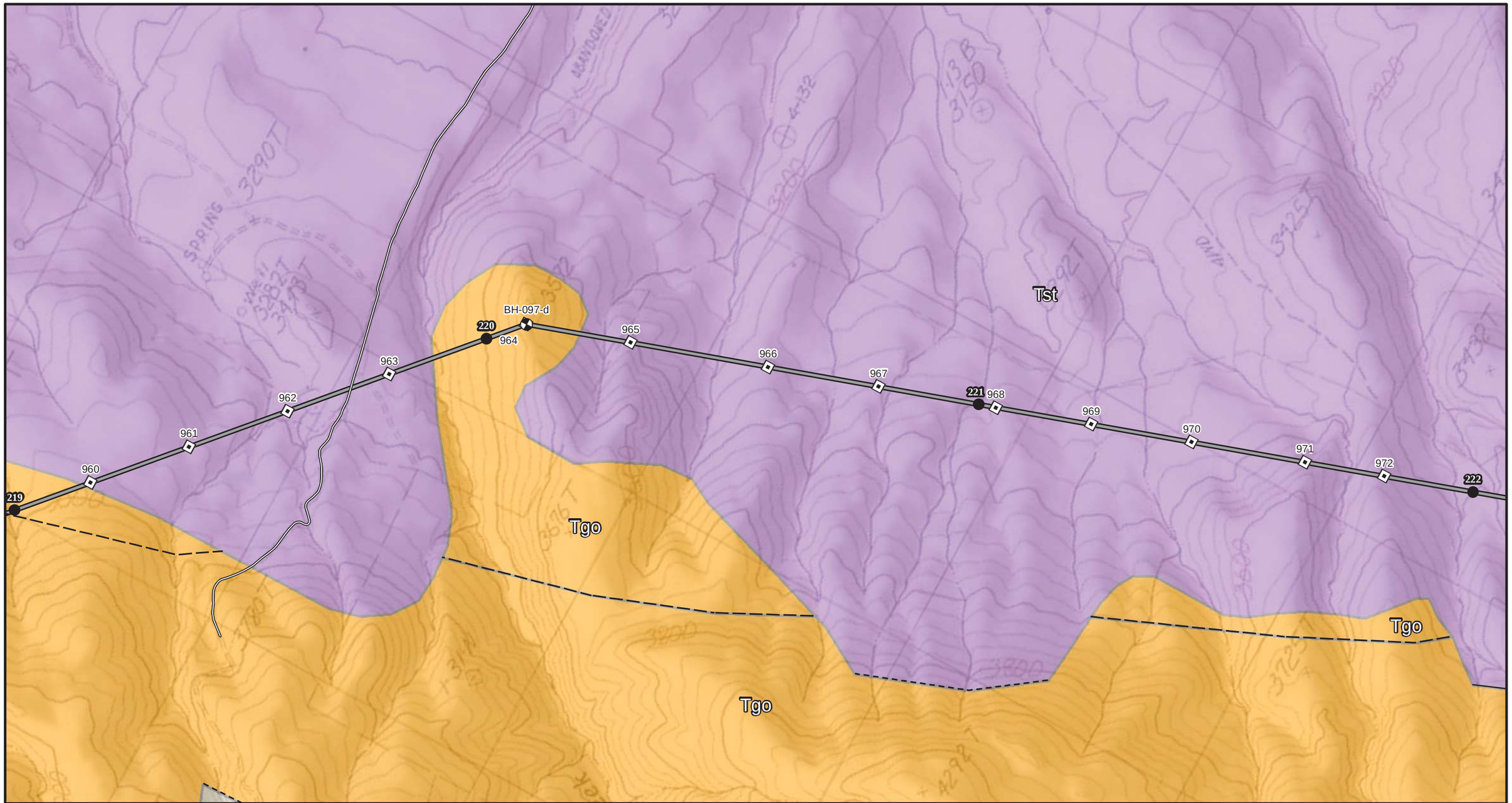

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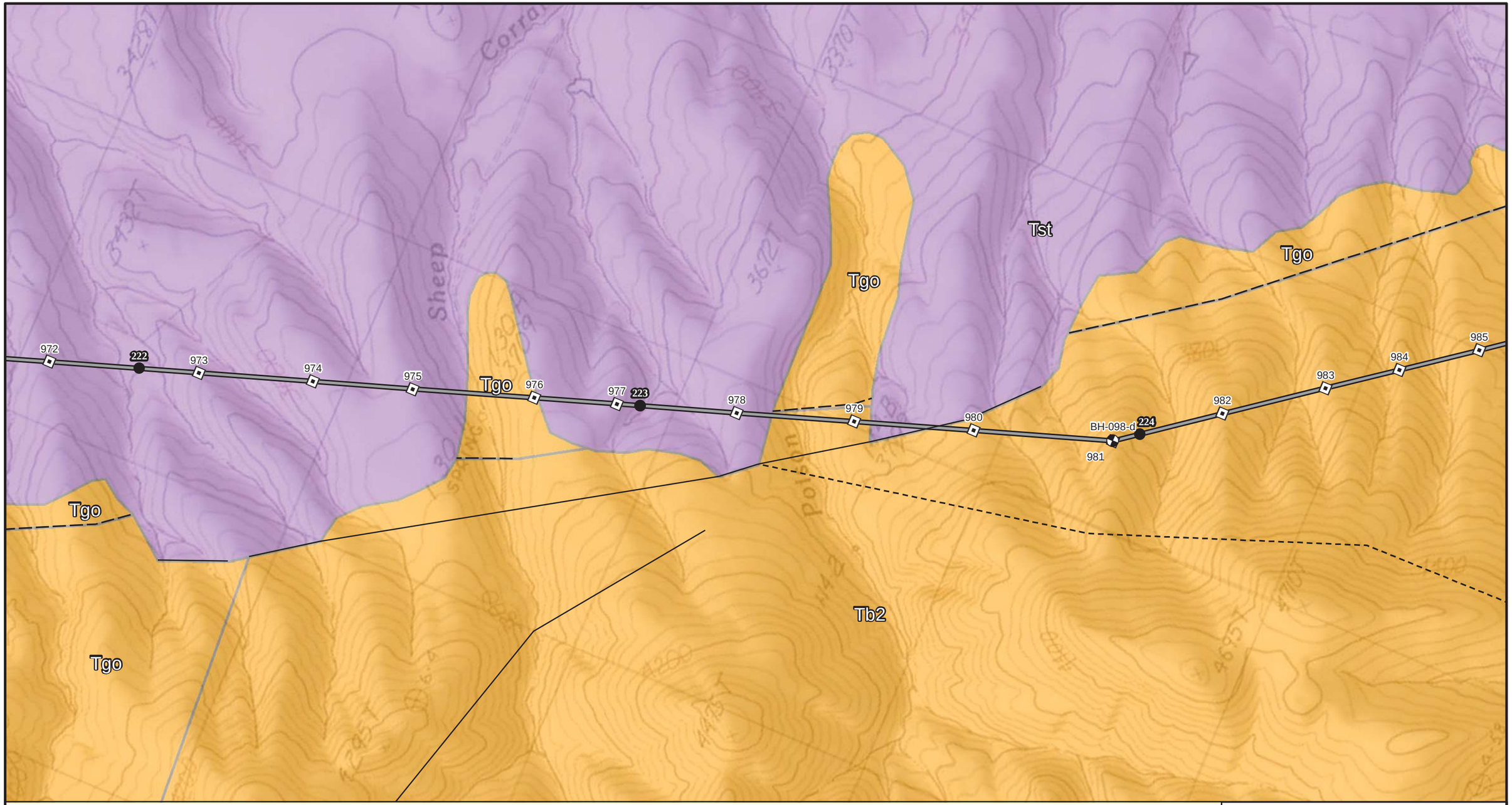

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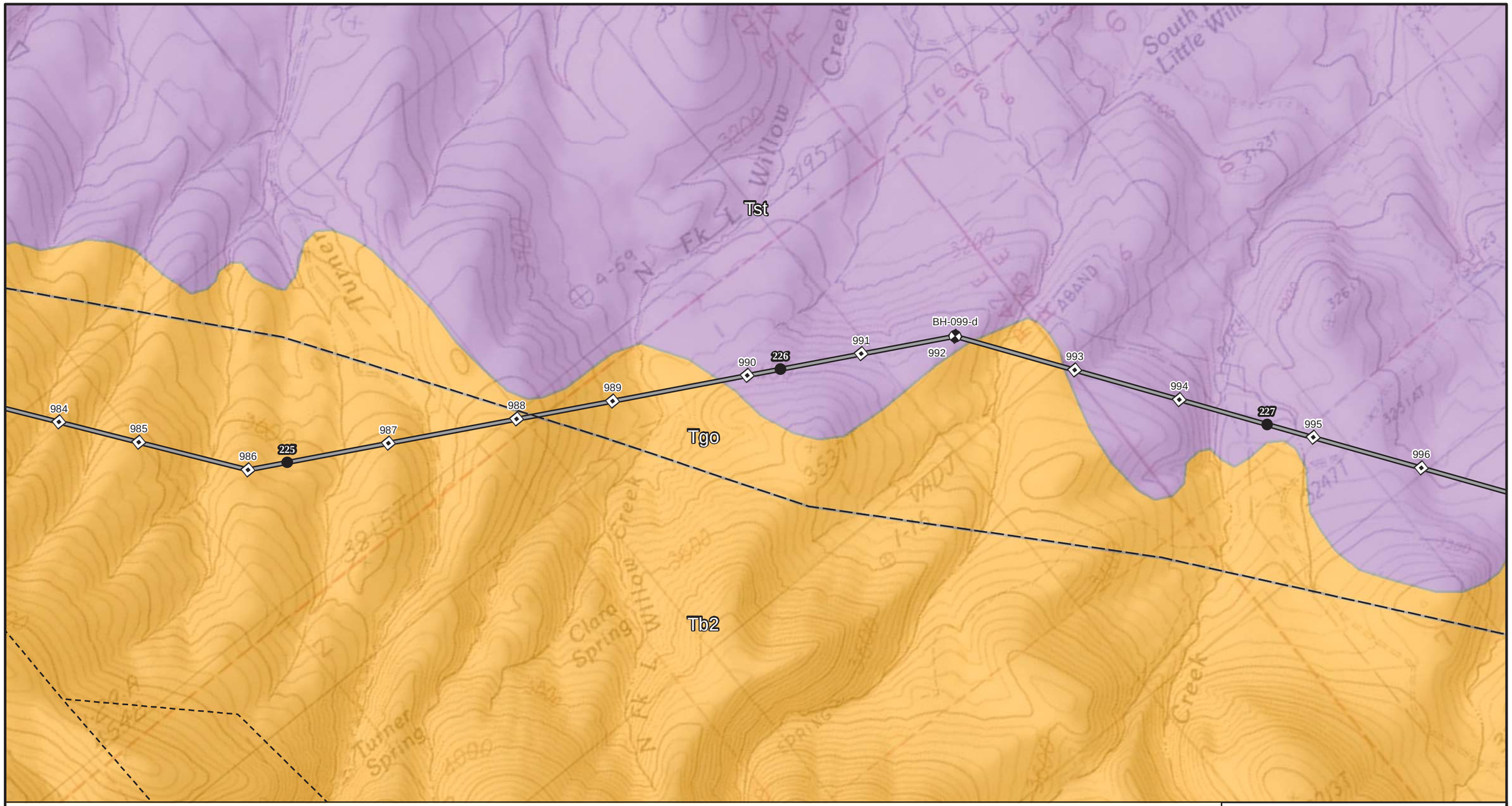

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FAULTS
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COMMUNICATION
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PRELIMINARY ACCESS PATHS
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- Overland Travel
- Overland with Clearing
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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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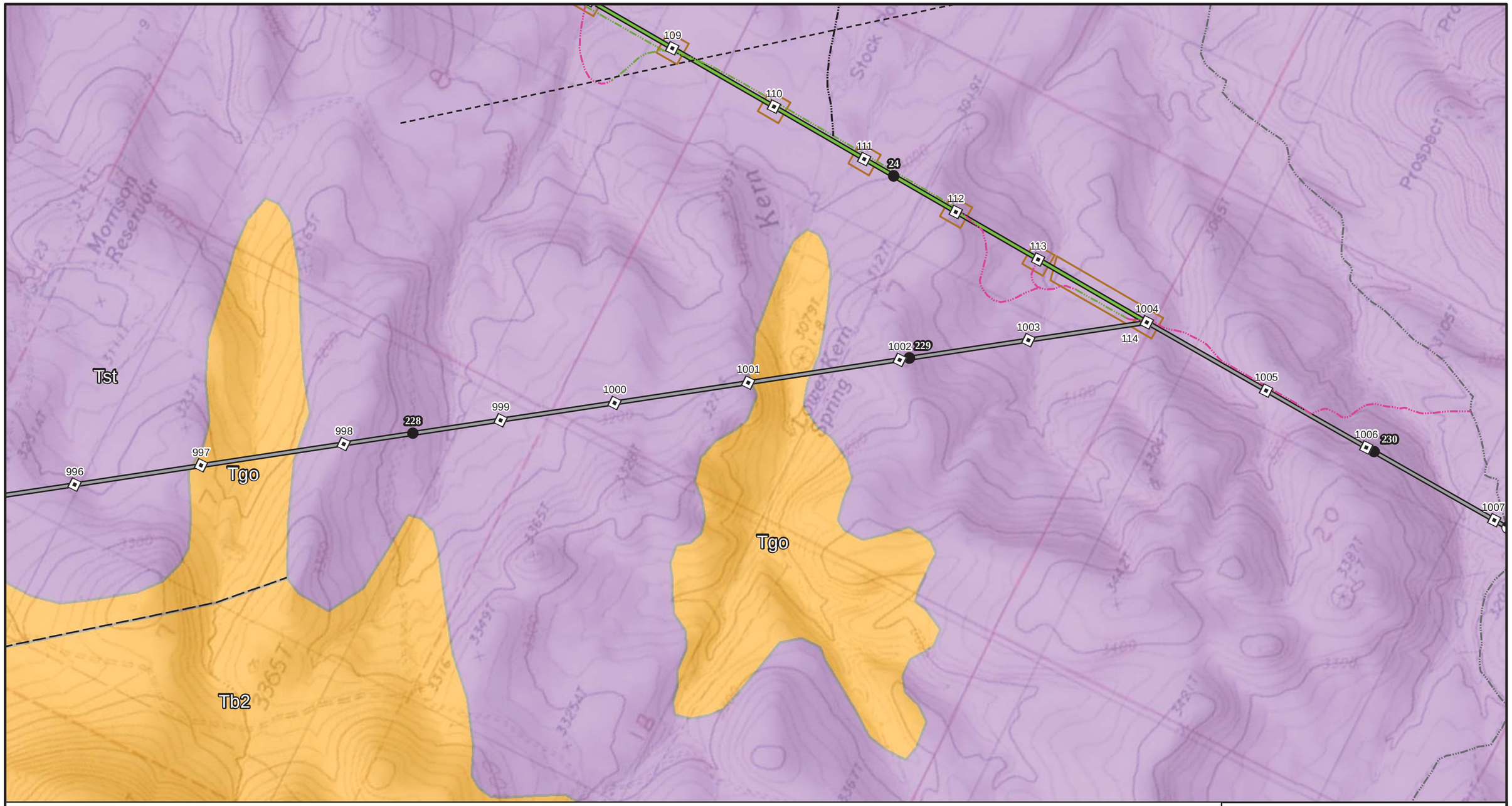

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TRANSMISSION FEATURES
- IPC Proposed Route
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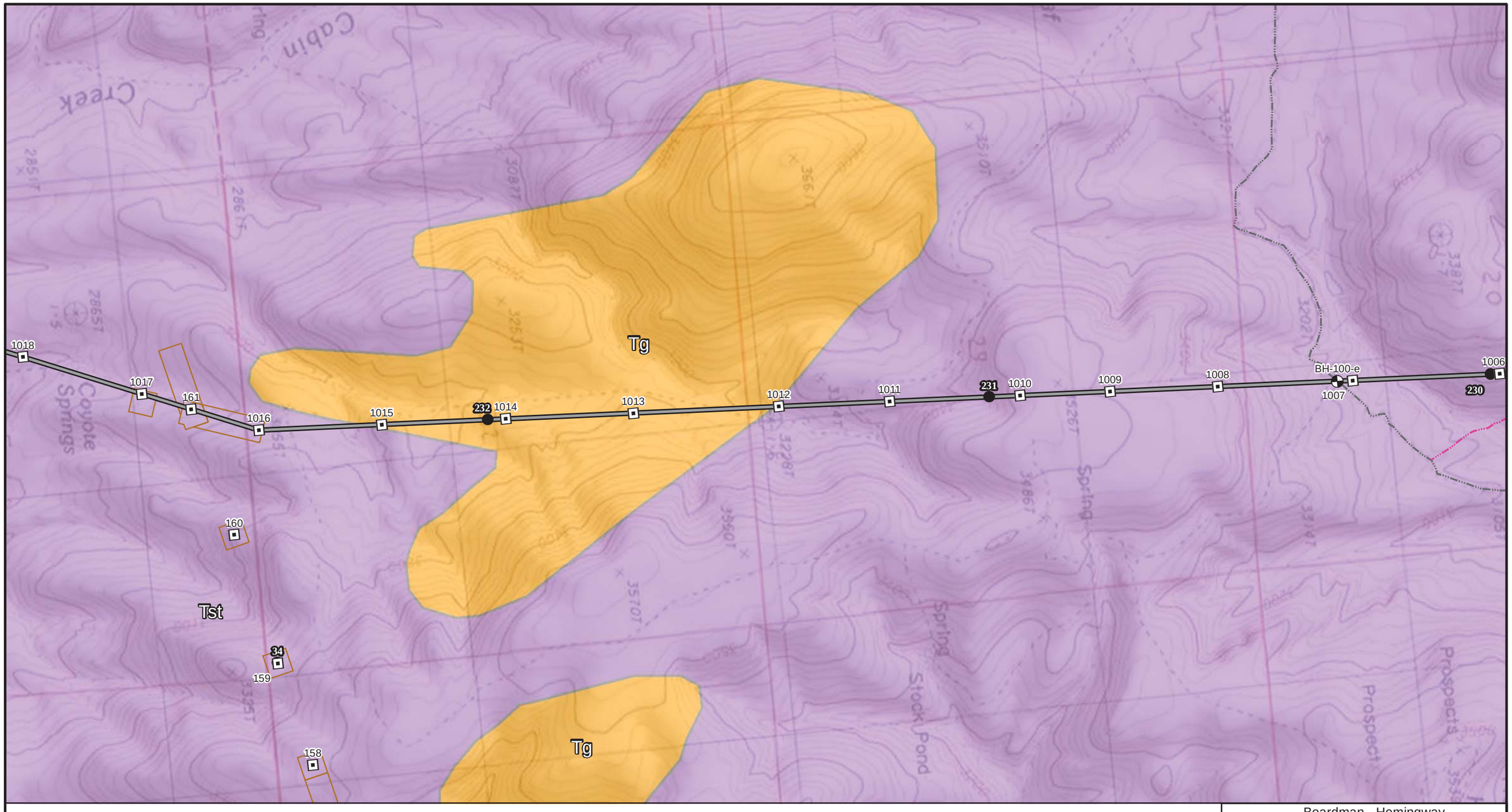

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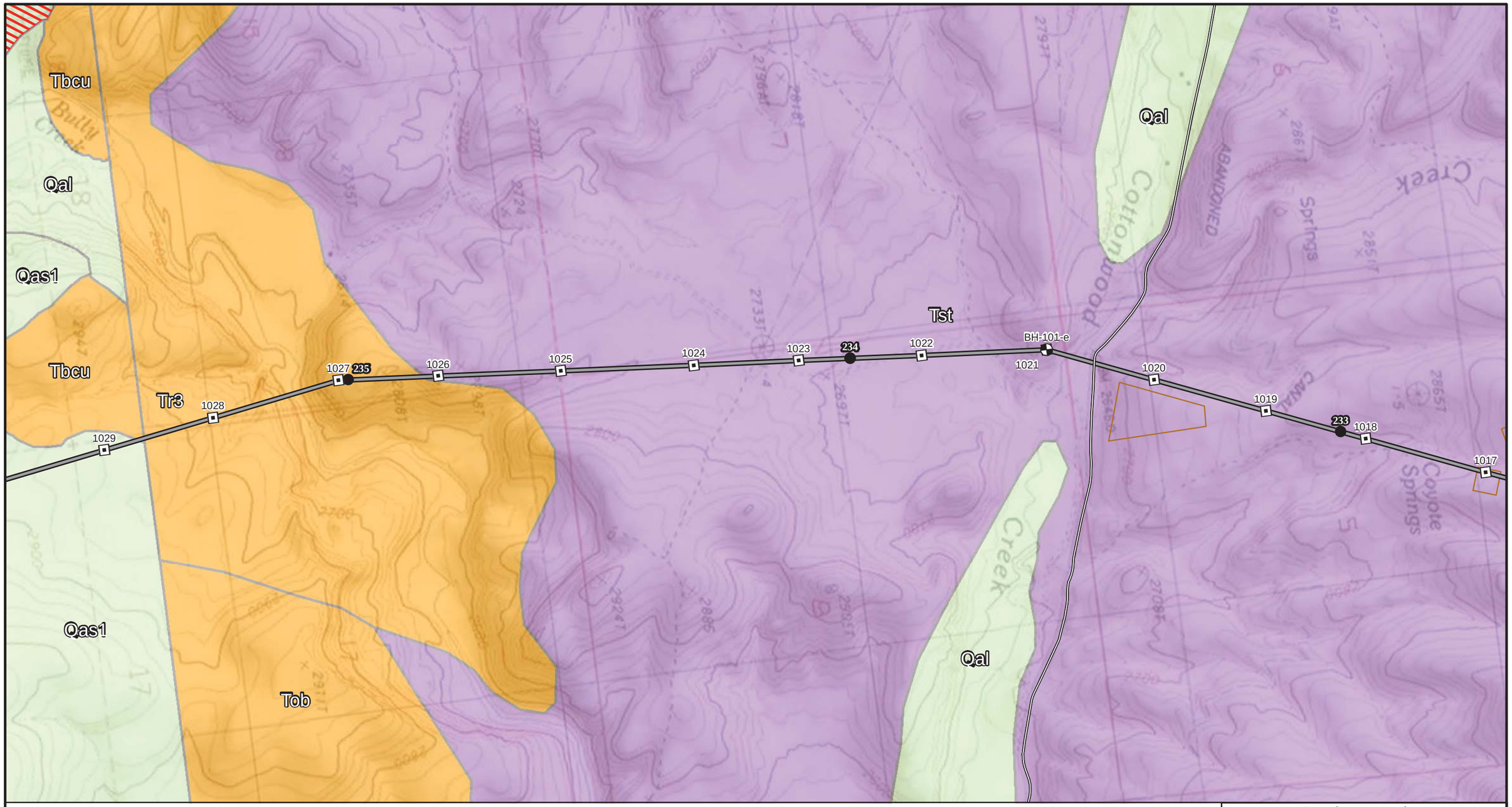

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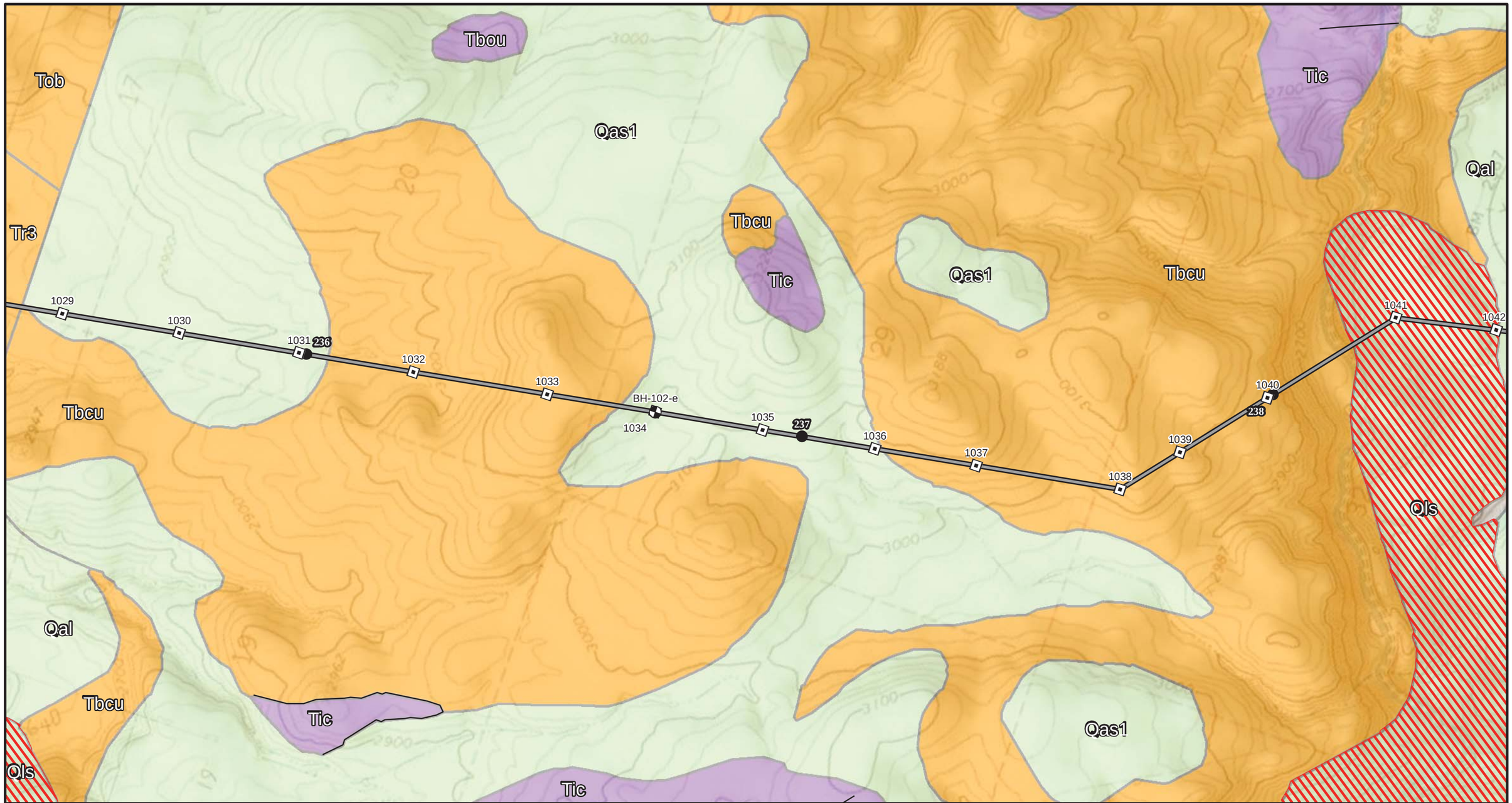

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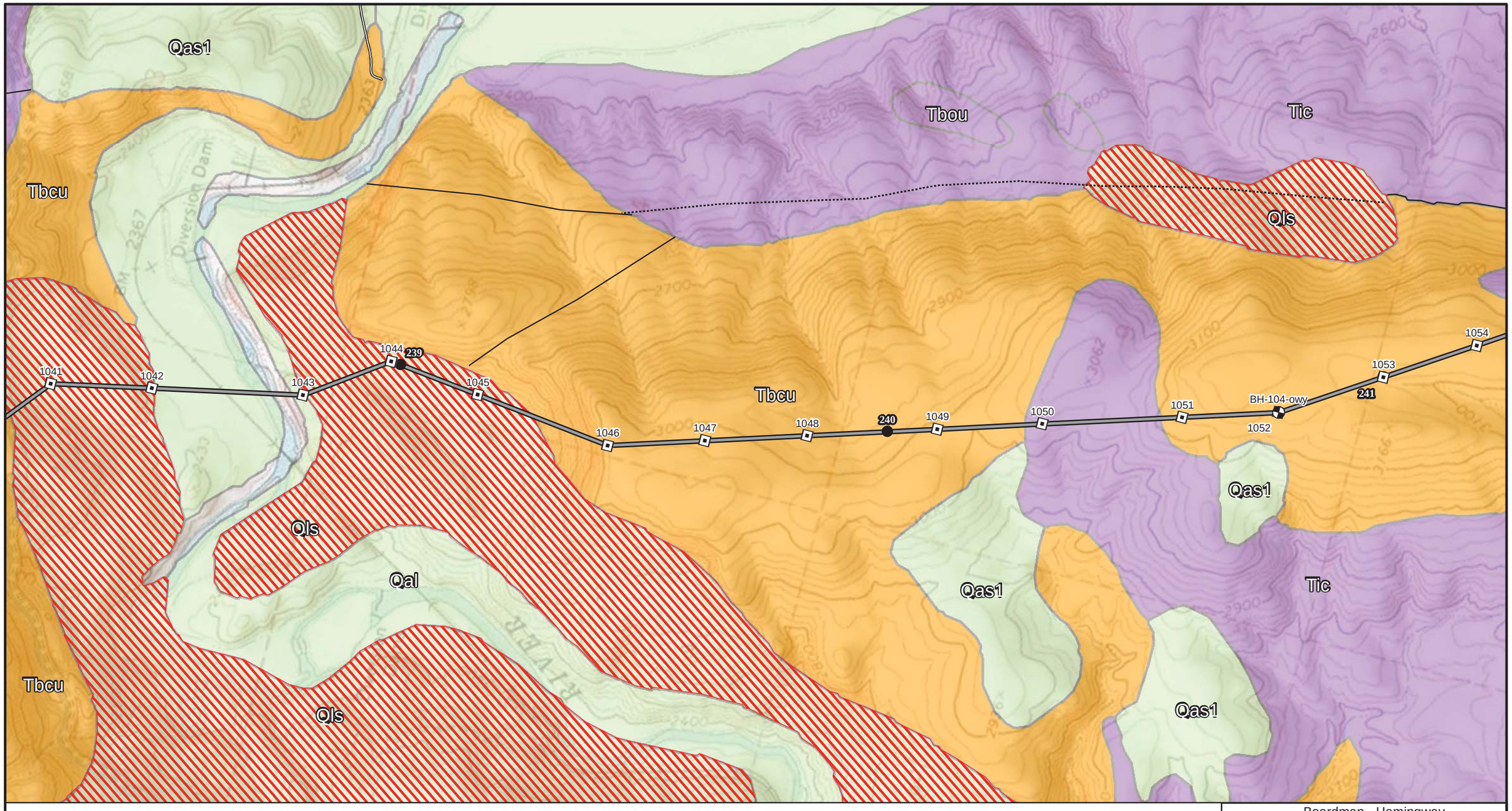

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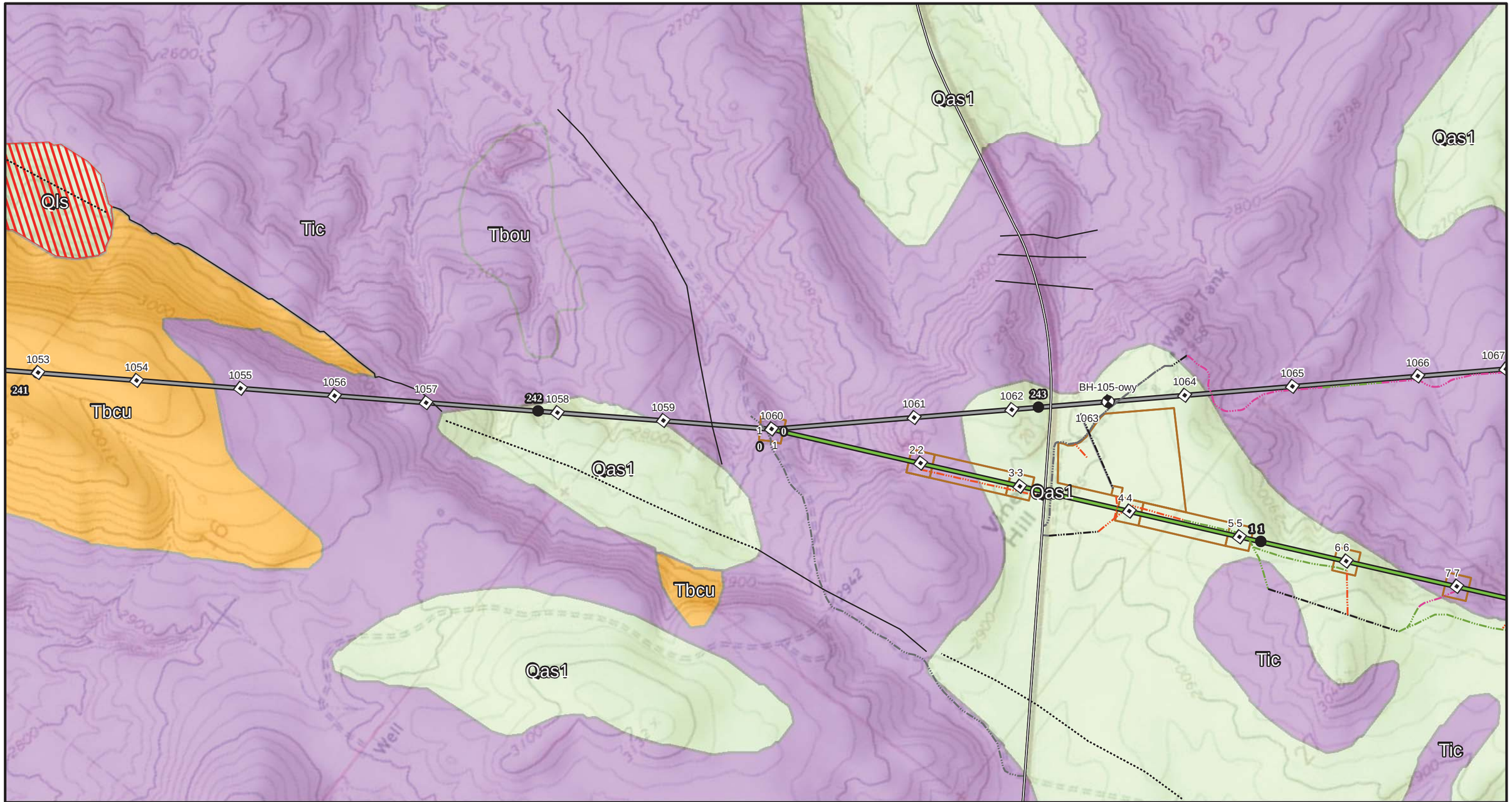

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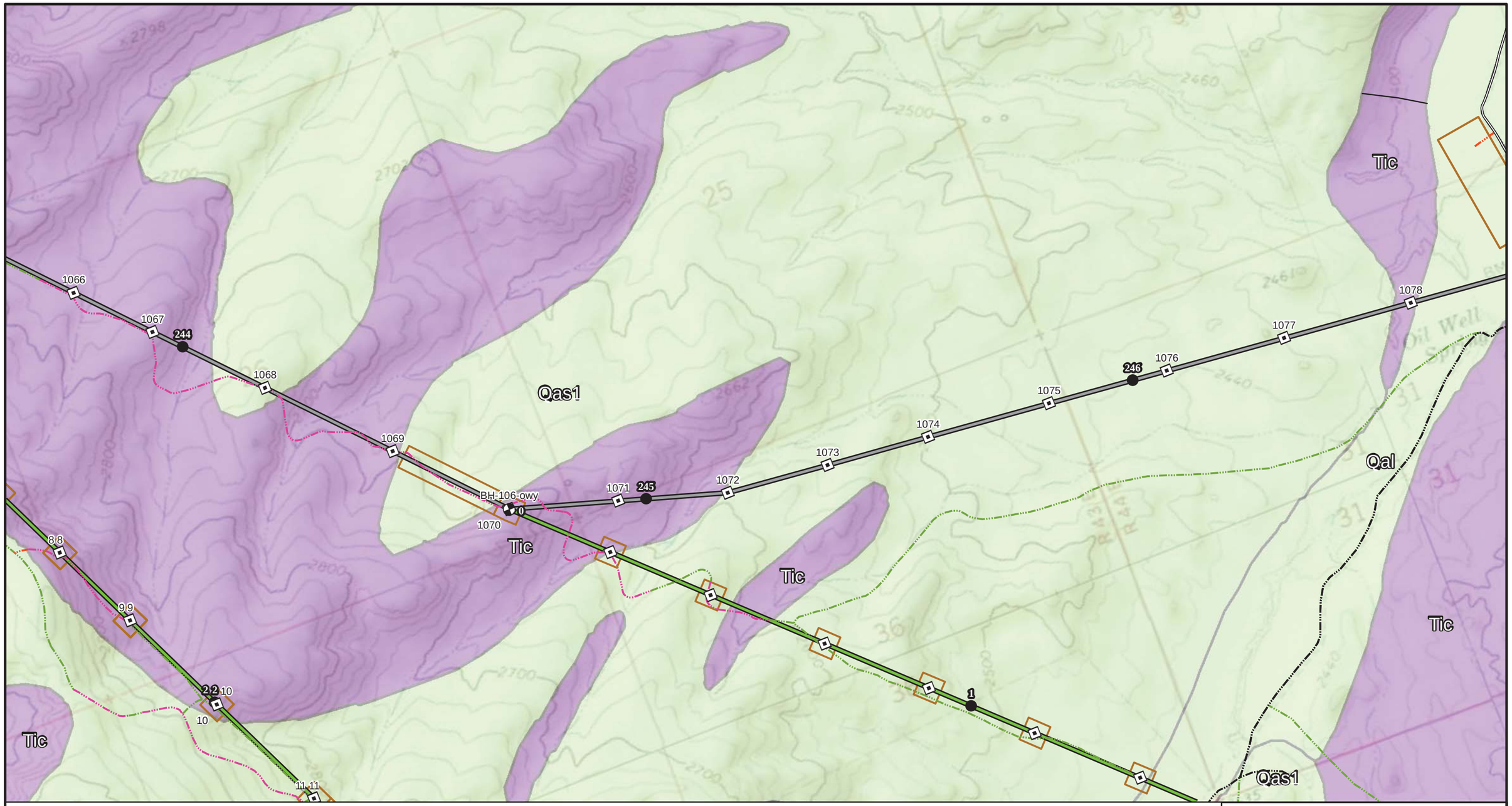

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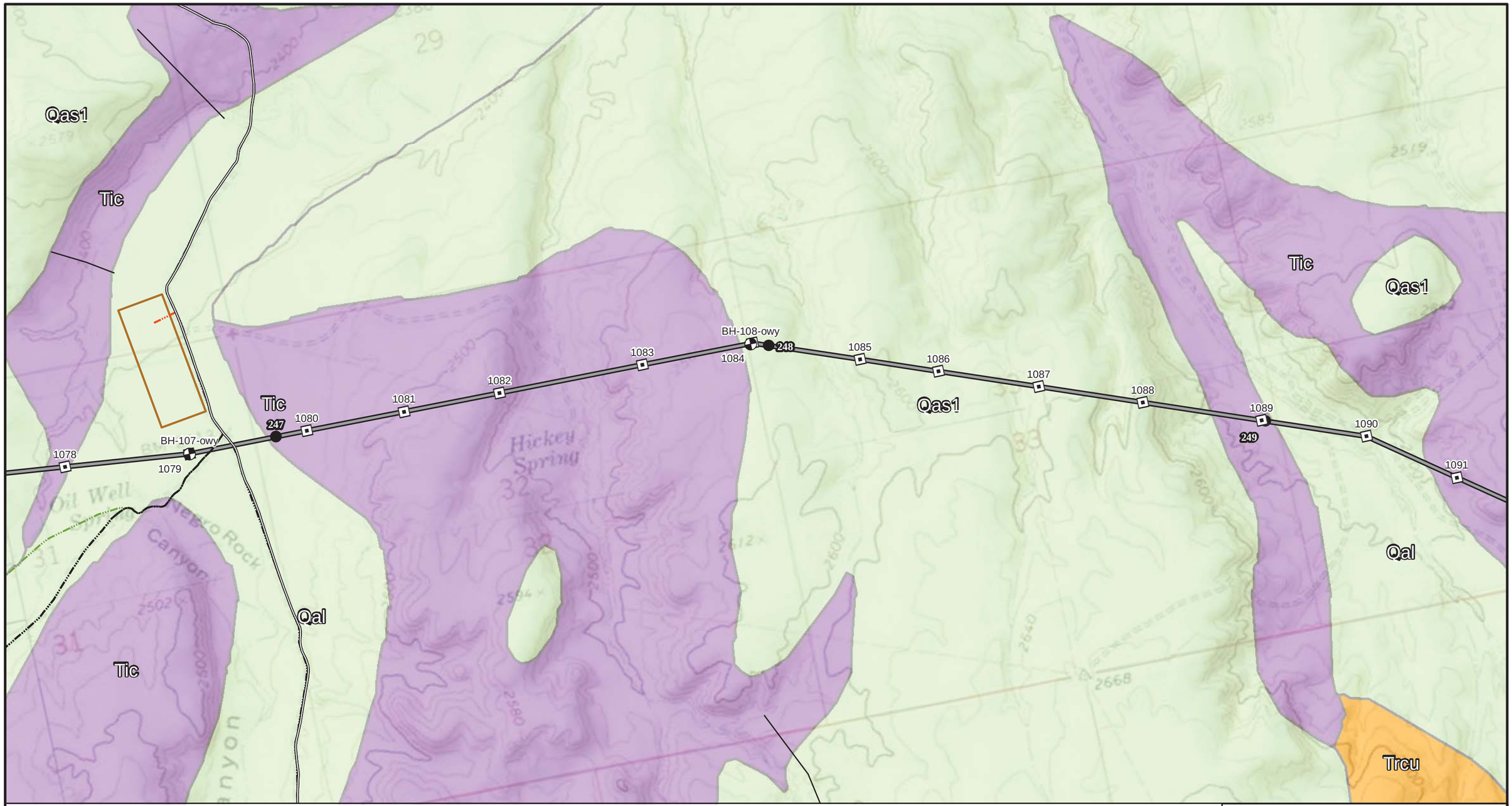

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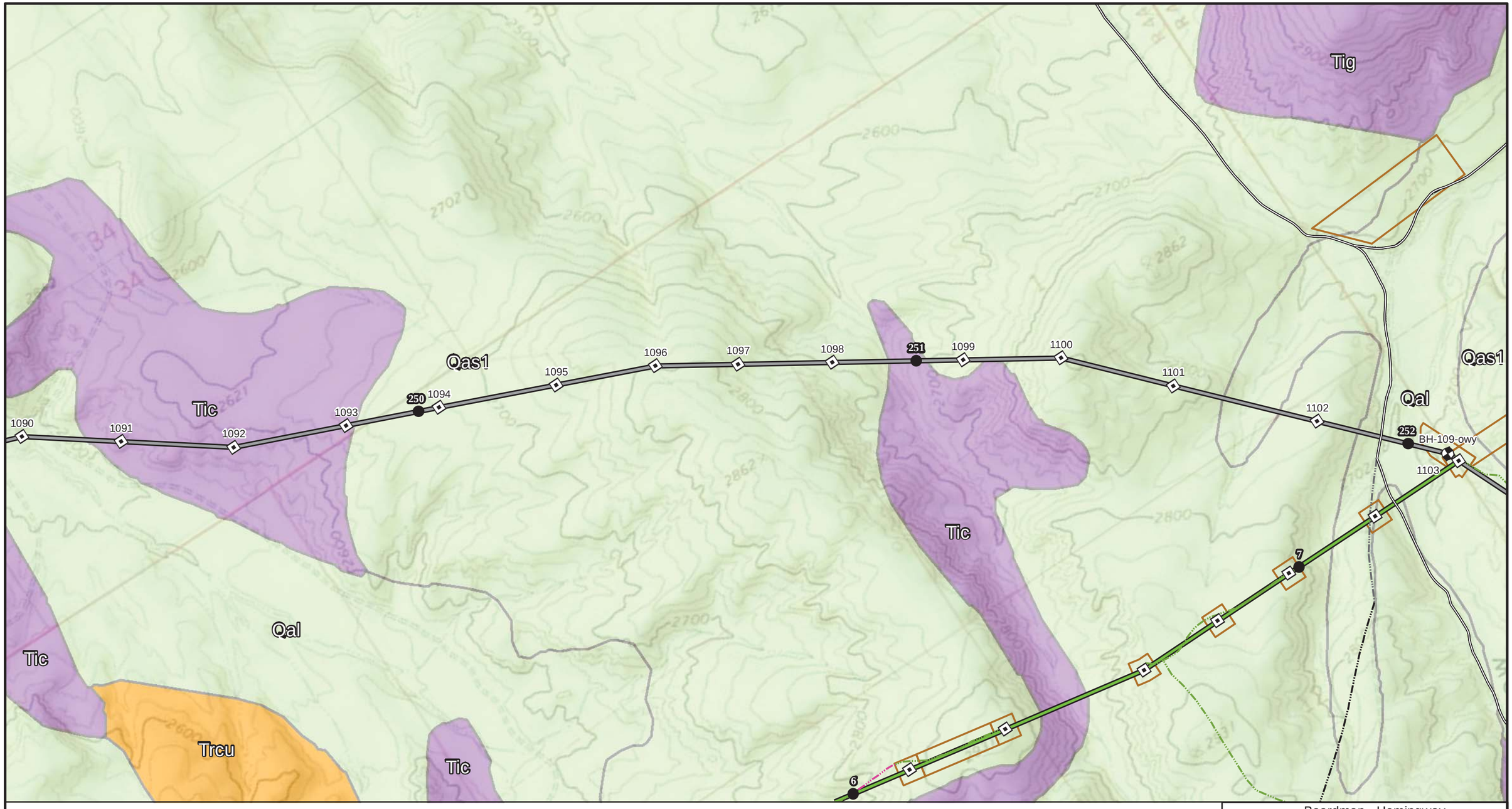

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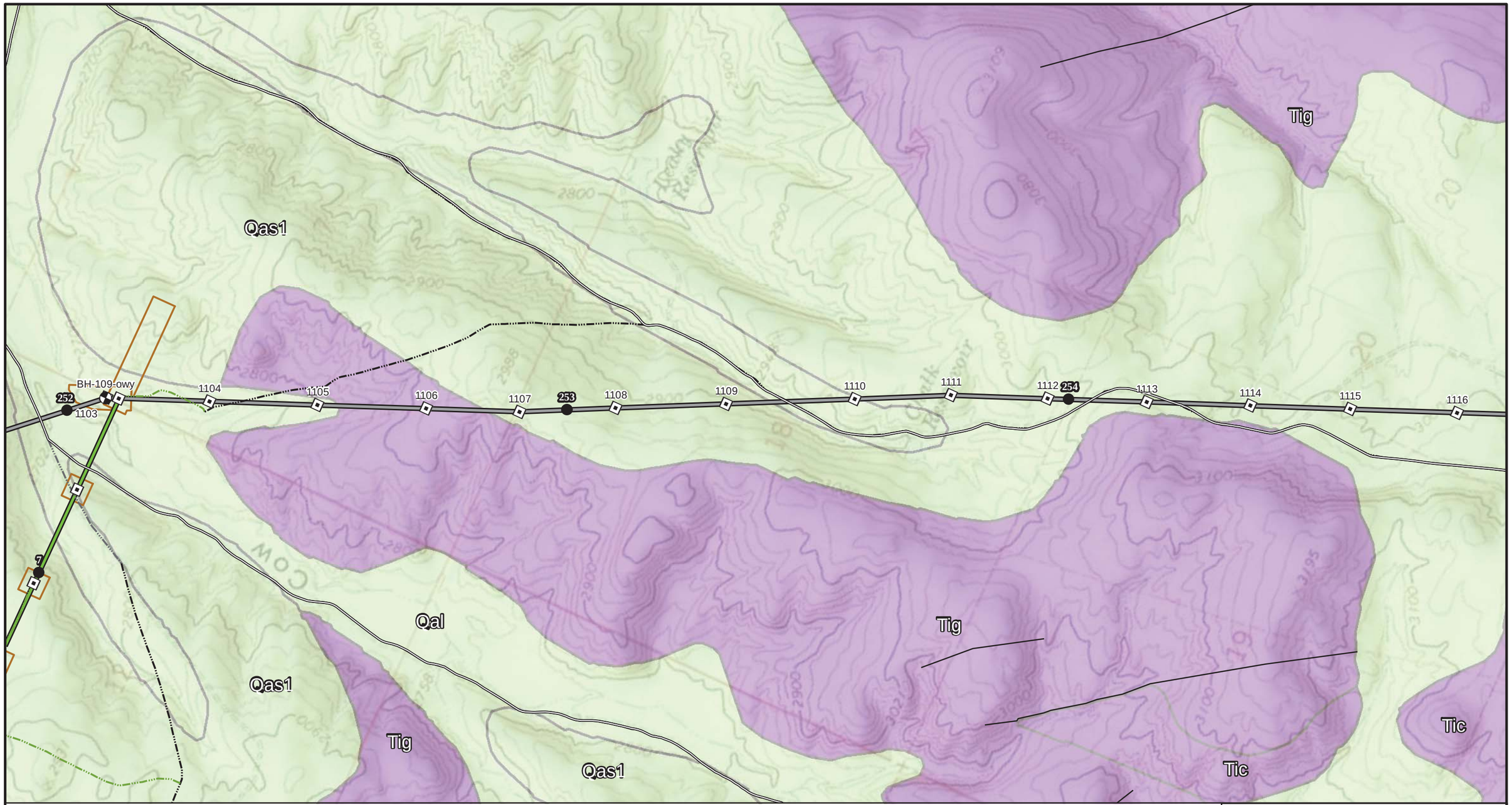

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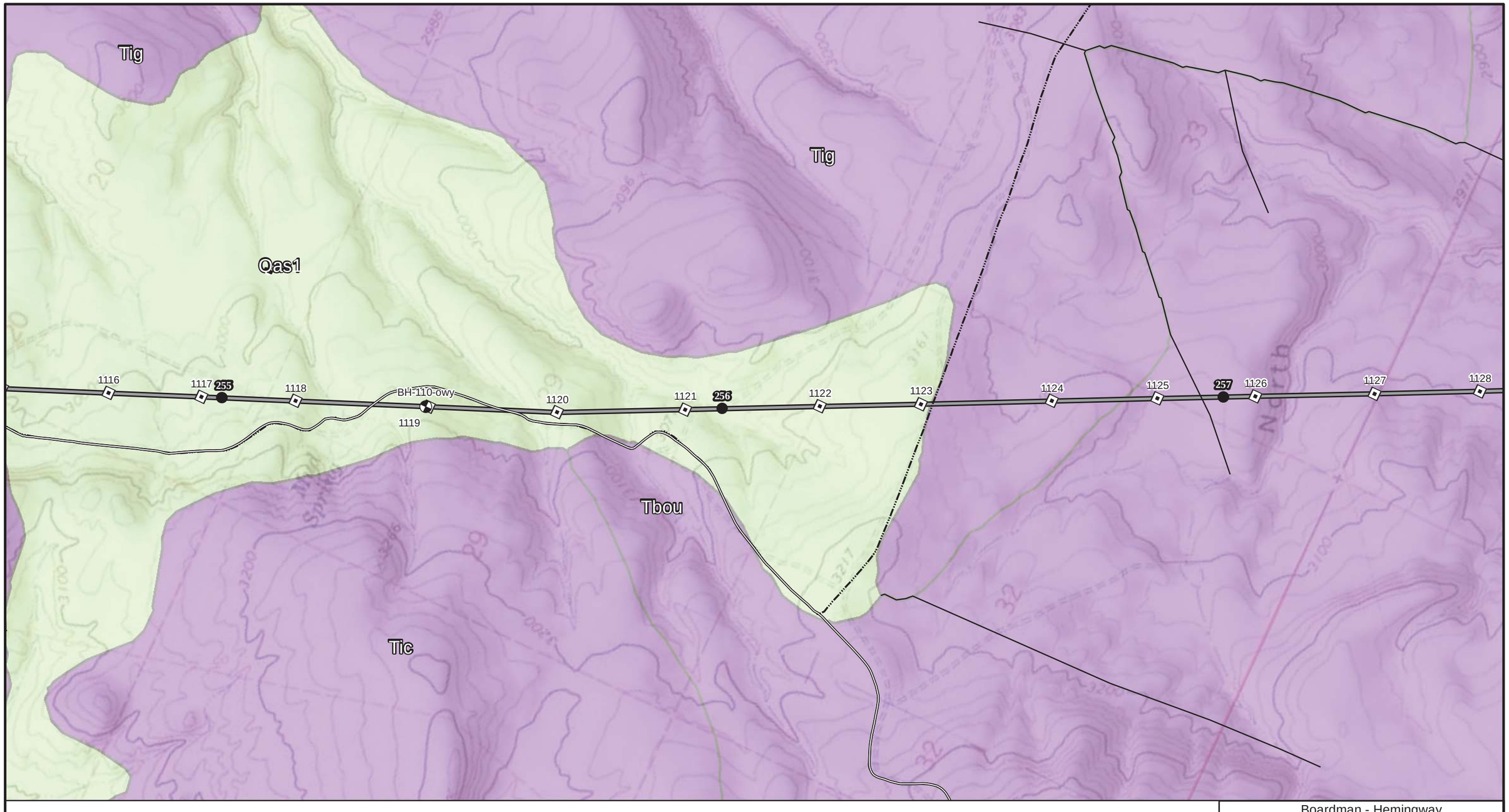

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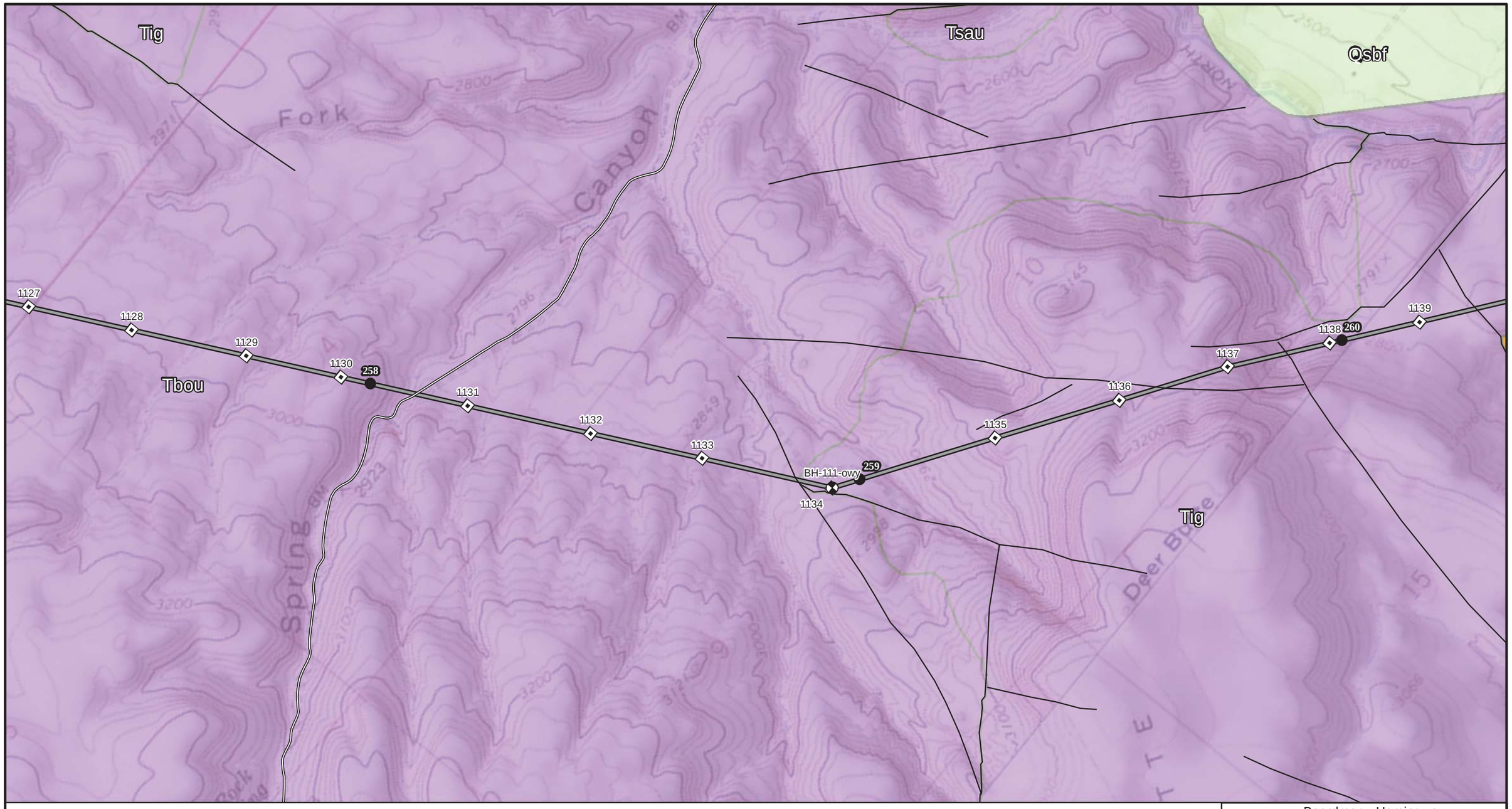

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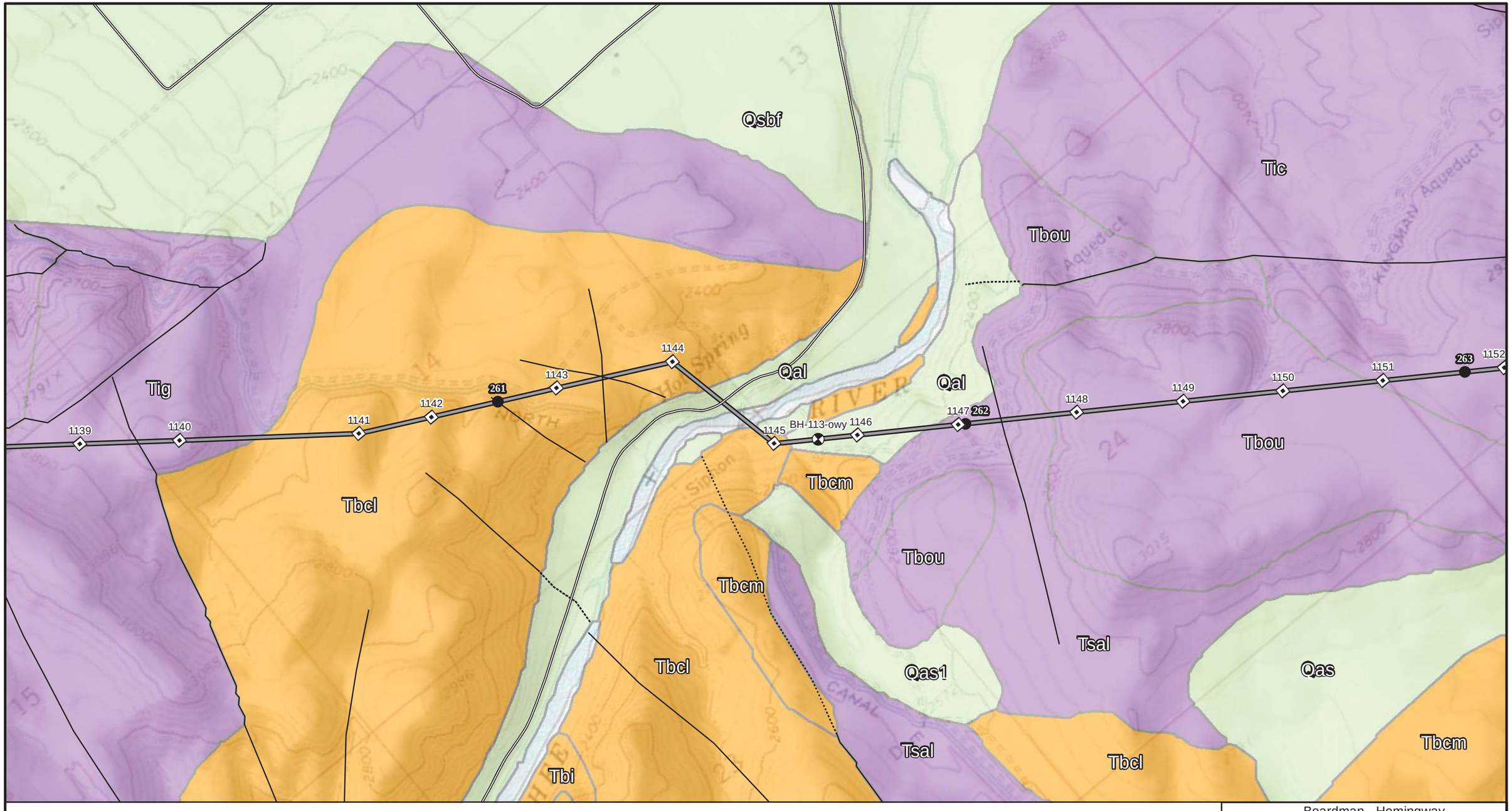

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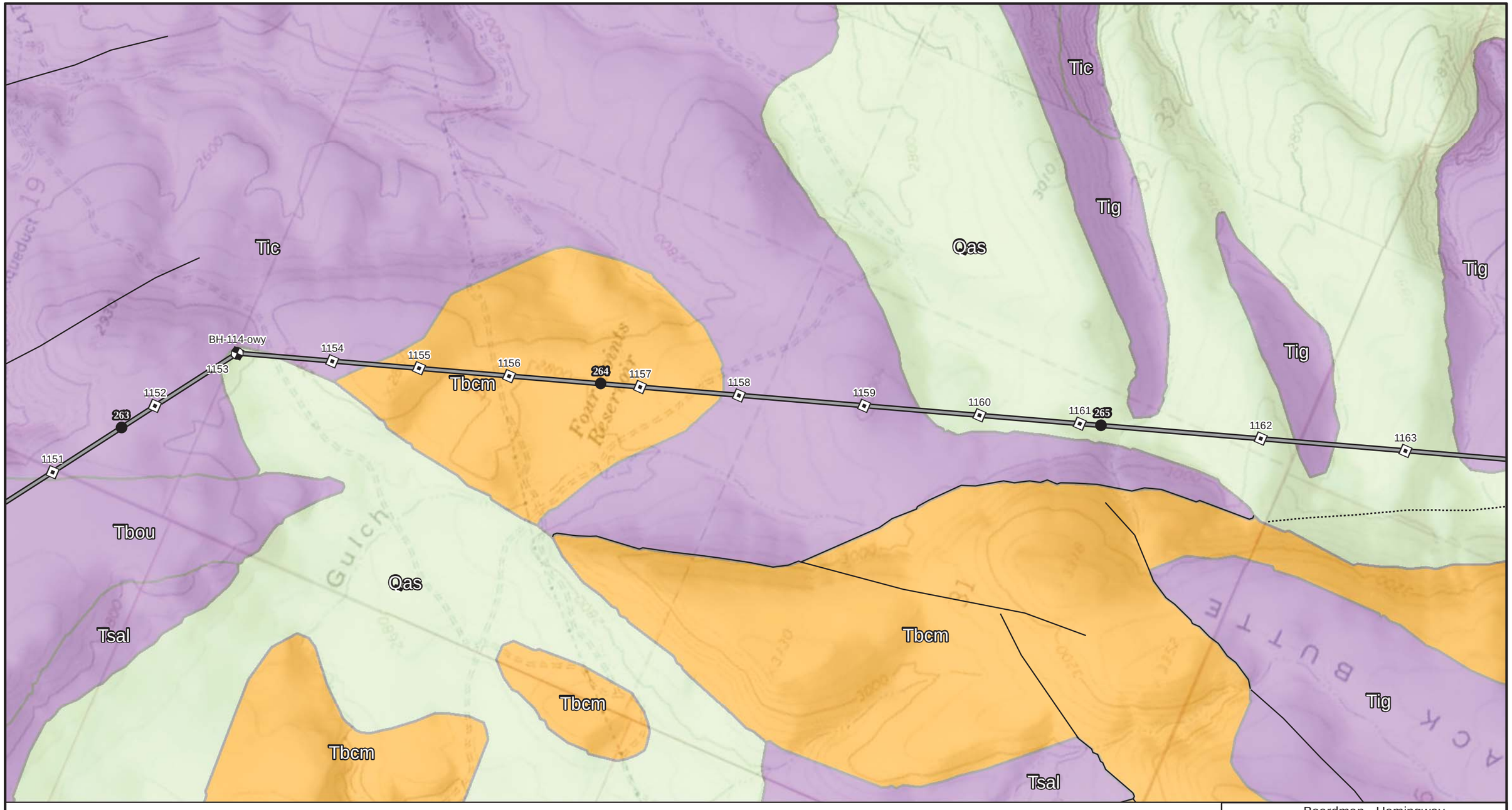

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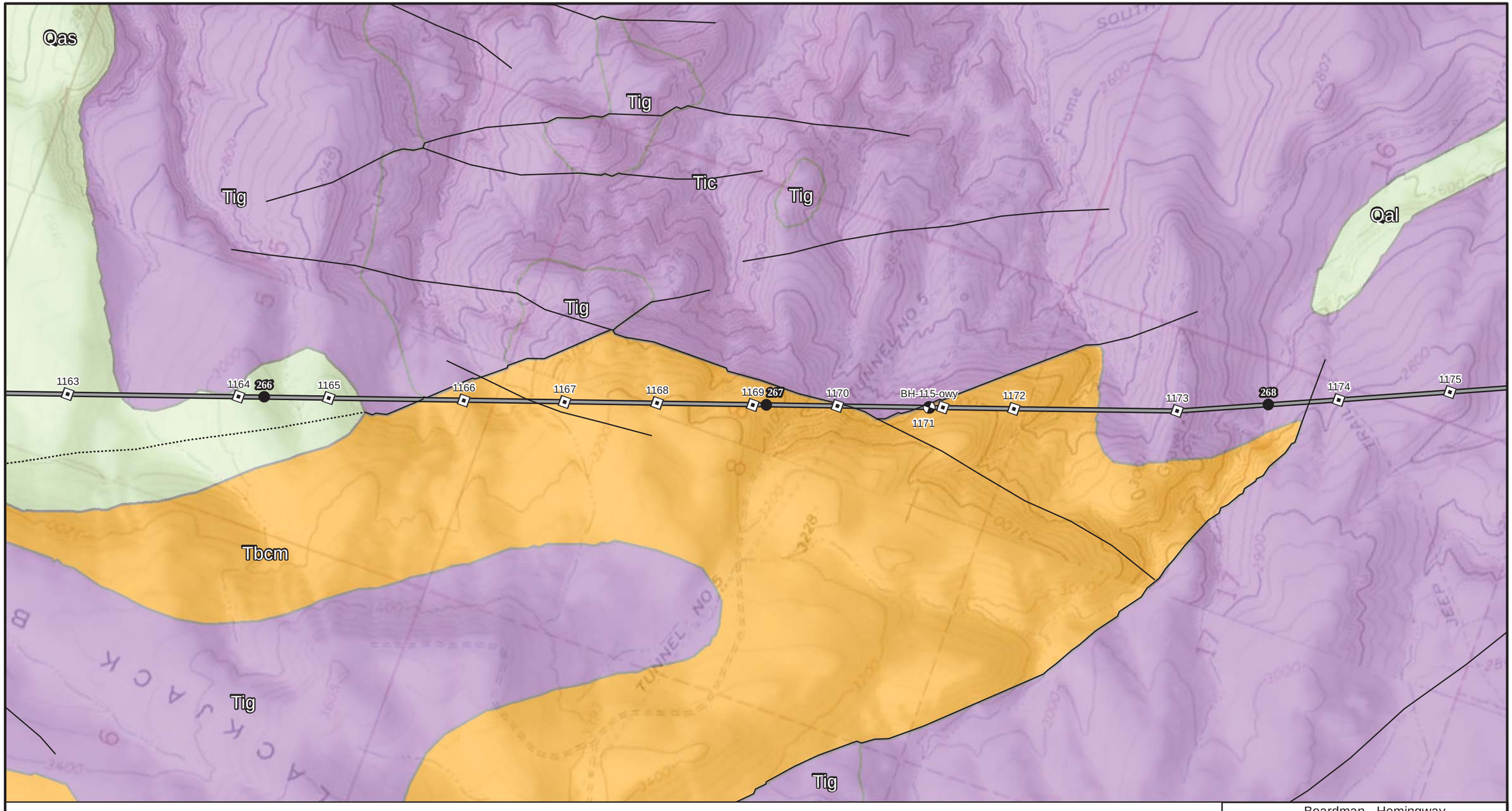

LEGEND

TRANSMISSION FEATURES

- IPC Proposed Route
- IPC Alternative
- NEPA Alternative
- Work Area
- Mileposts
- Towers
- Proposed Borehole

SURFICIAL GEOLOGY

- Igneous Rock
- Metamorphic Rocks
- Sedimentary Rocks
- Unconsolidated Rocks
- Volcaniclastic Rocks

LANDSLIDES

- Fan
- Landslide (SLIDO)
- Talus - Colluvium

FAULTS

- Approximate
- Approximate and queried
- Certain
- Concealed
- Inferred
- Inferred and queried

COMMUNICATION

- Communication Power
- Communication Fiber

PRELIMINARY ACCESS PATHS

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- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
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- Existing Access, May Need Repairs
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EXISITING TRANSPORATION ROADS

- Primary Limited Access Road
- Primary US and State Highways
- Railroad

NOTE
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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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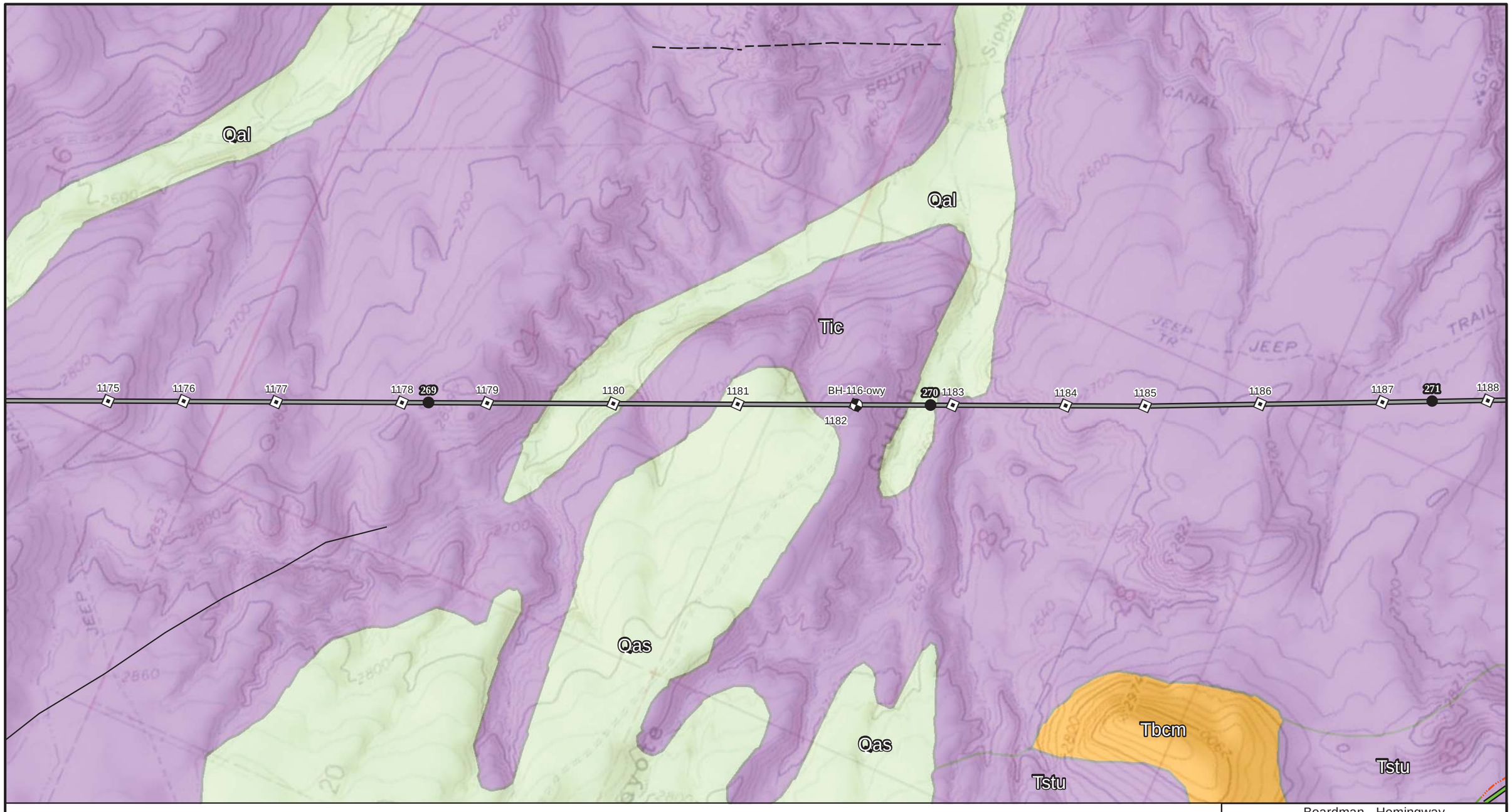

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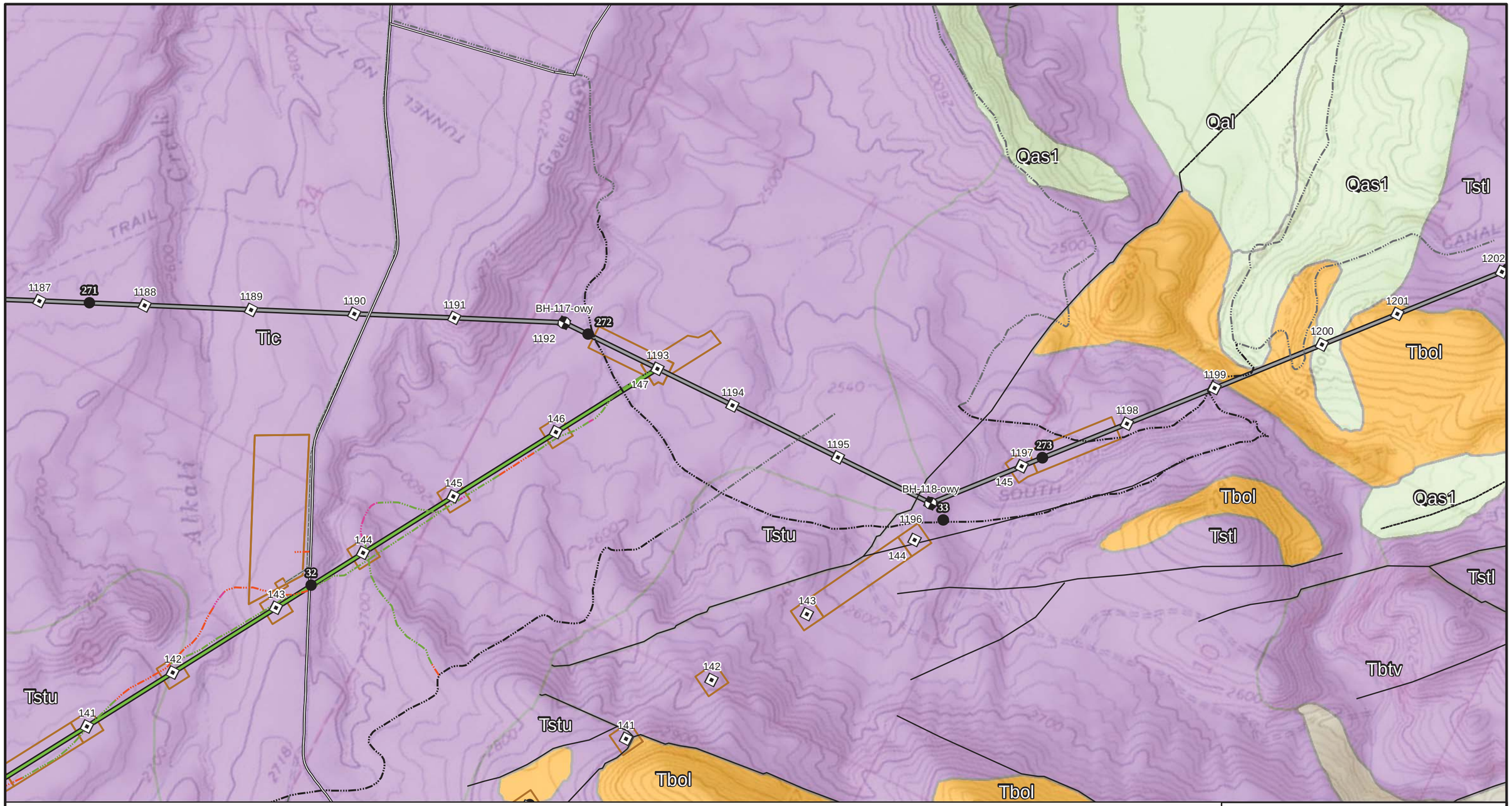

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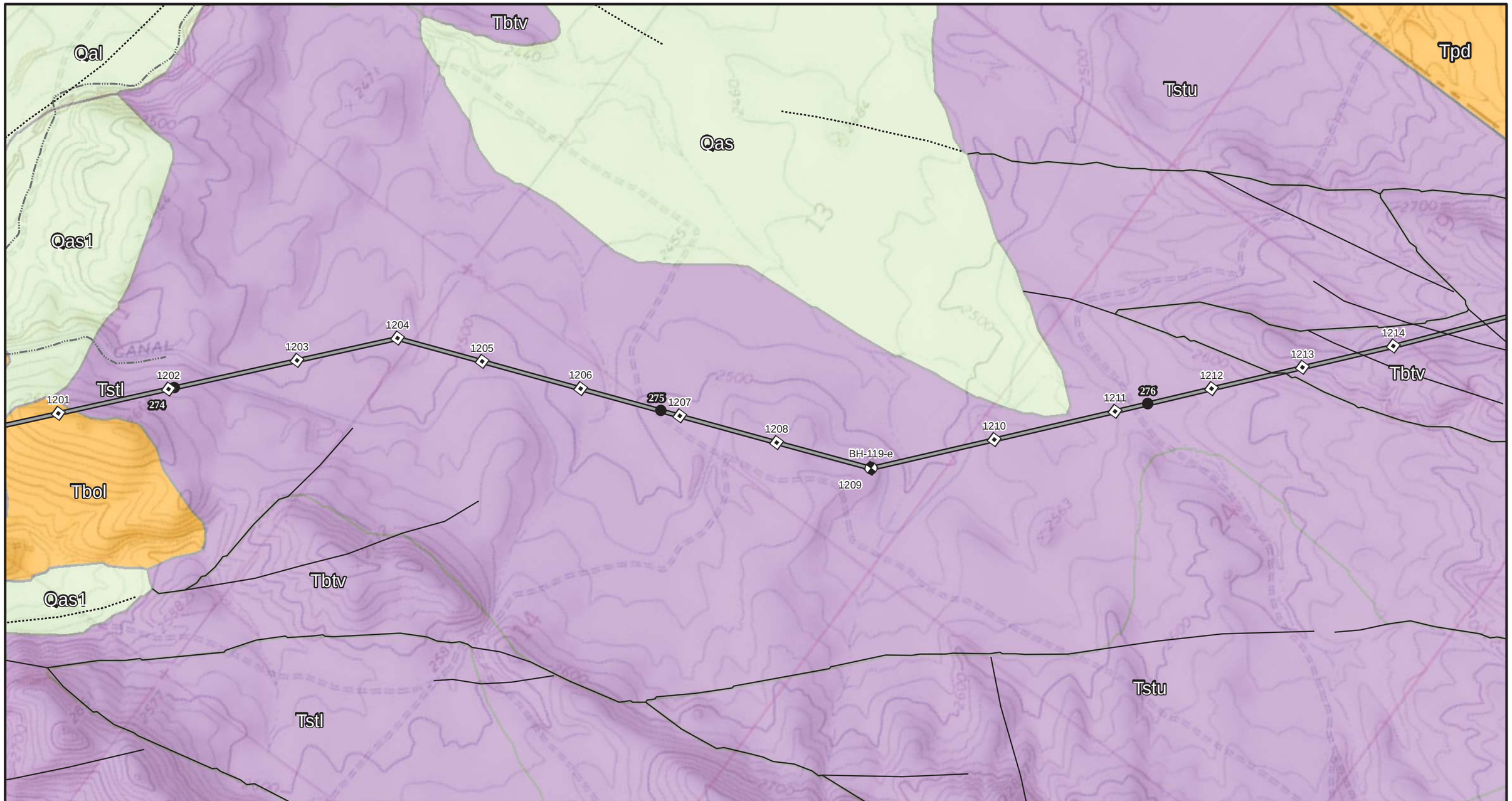

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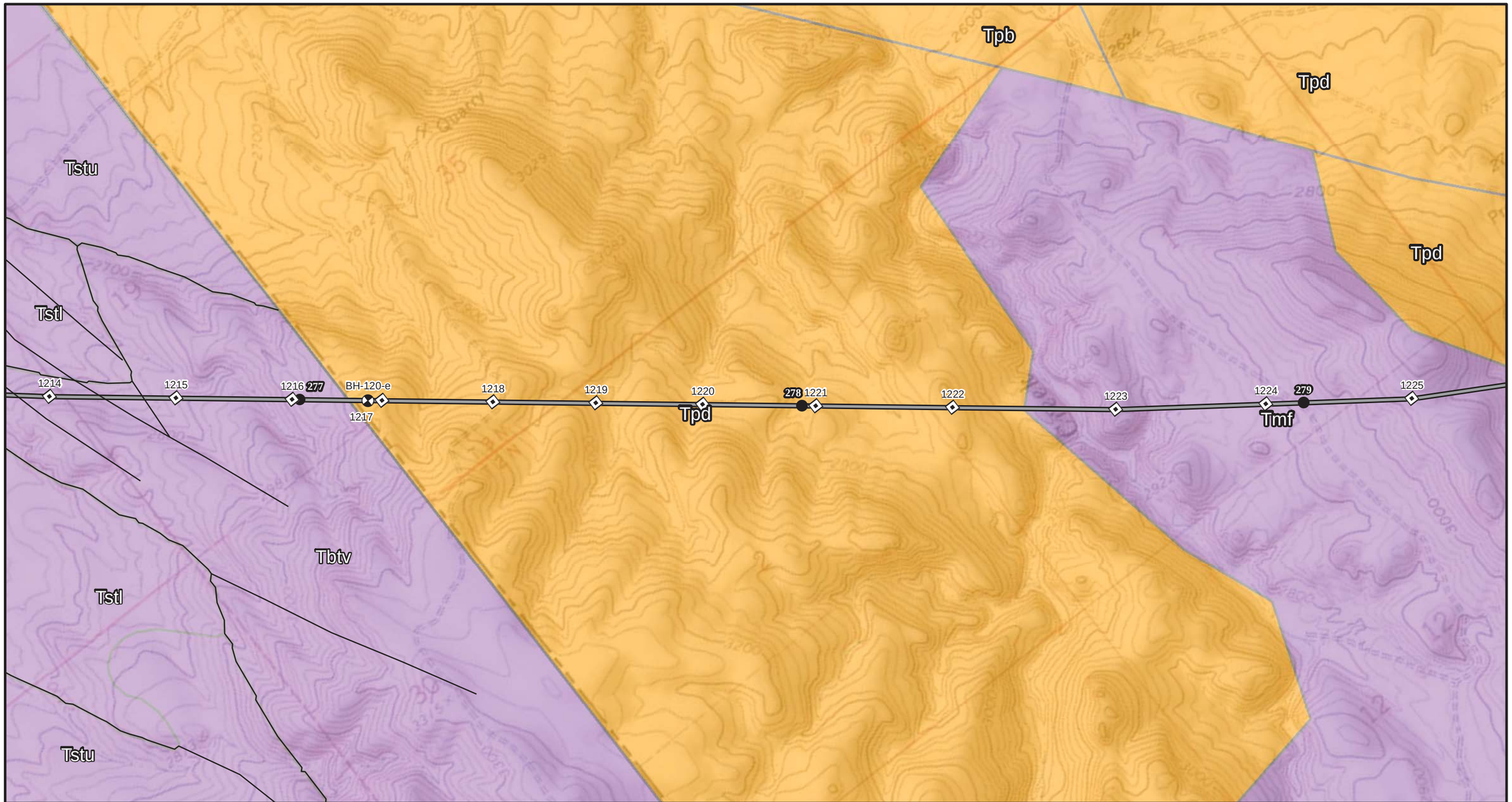

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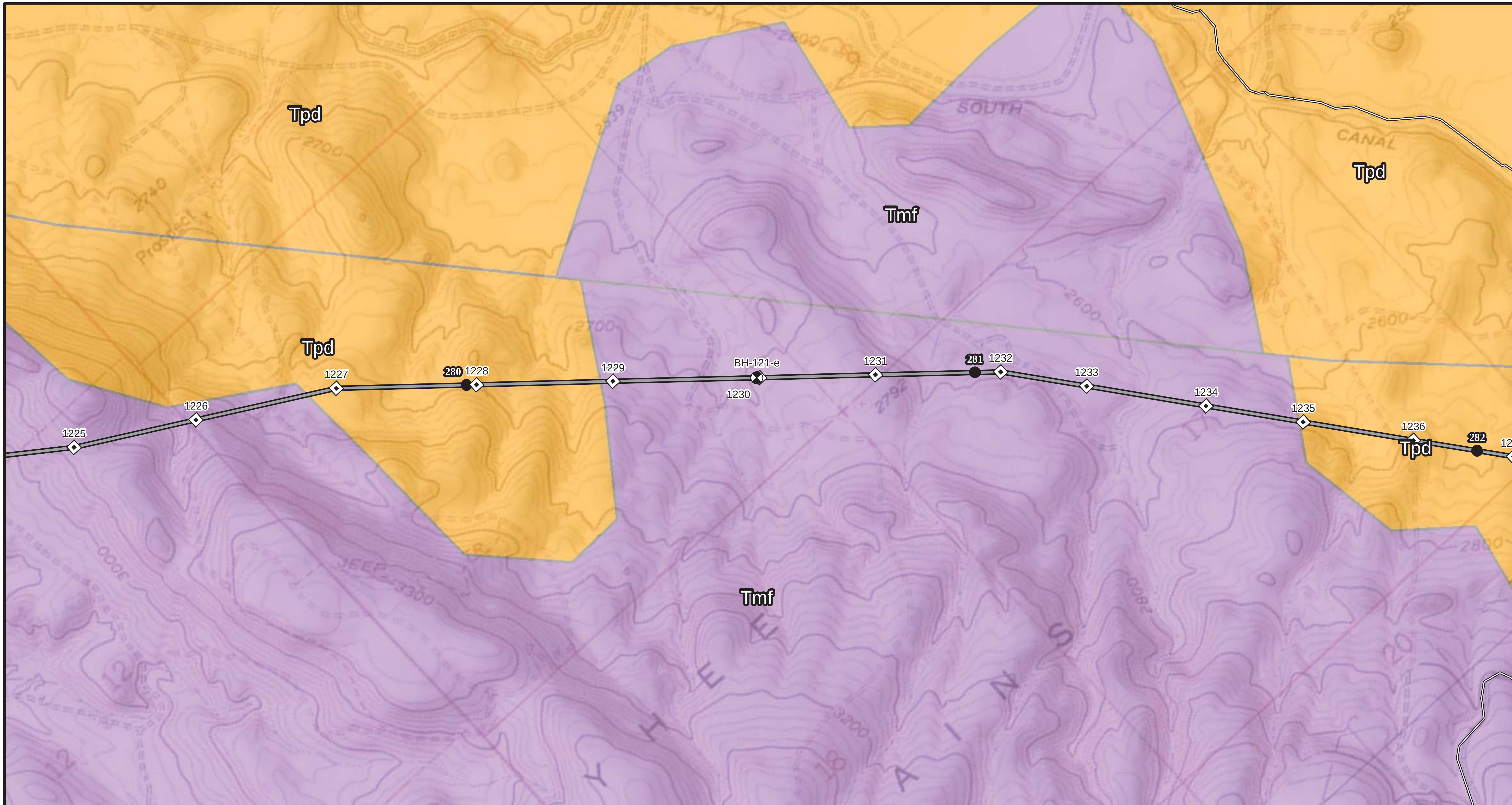

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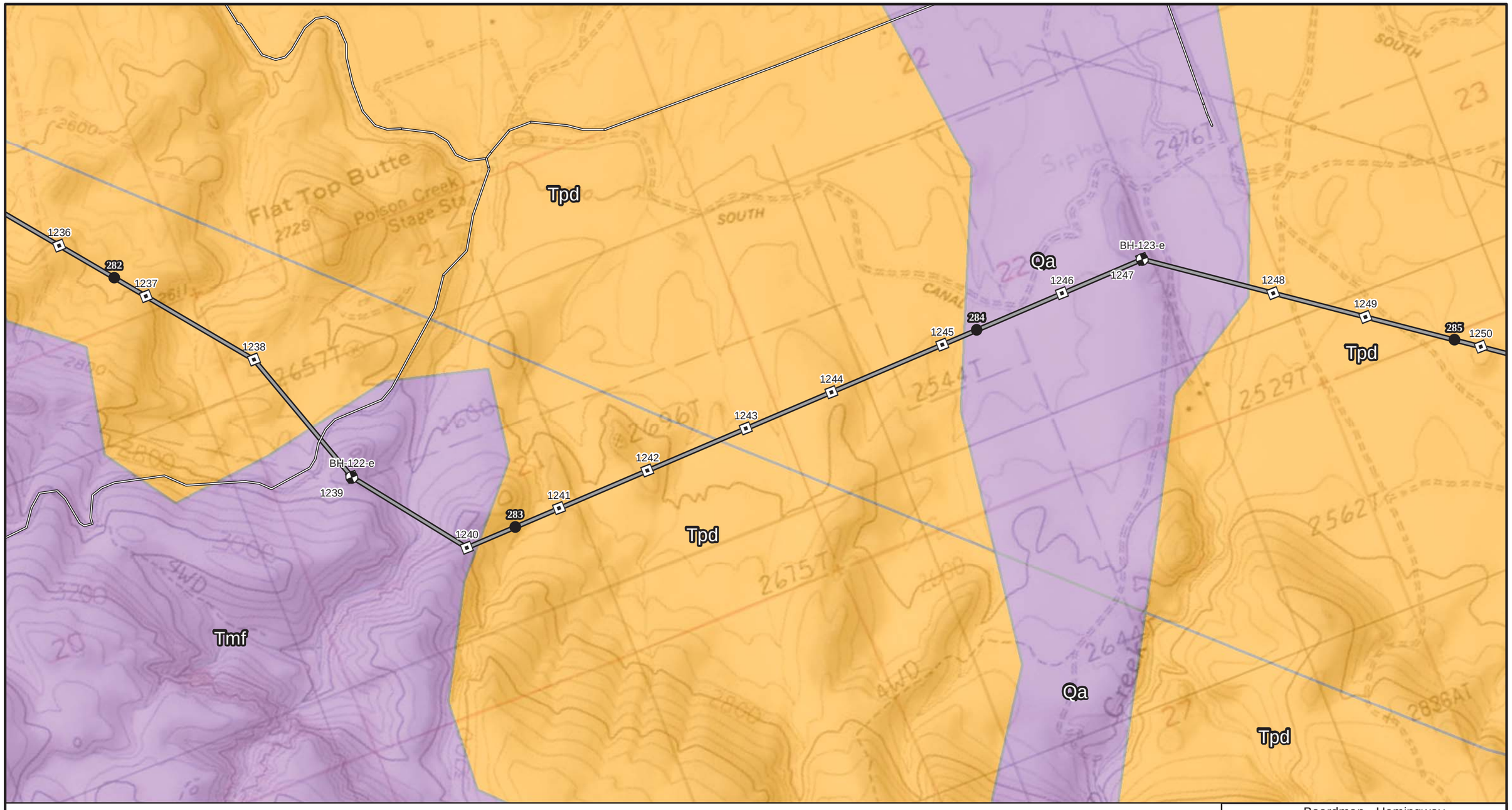

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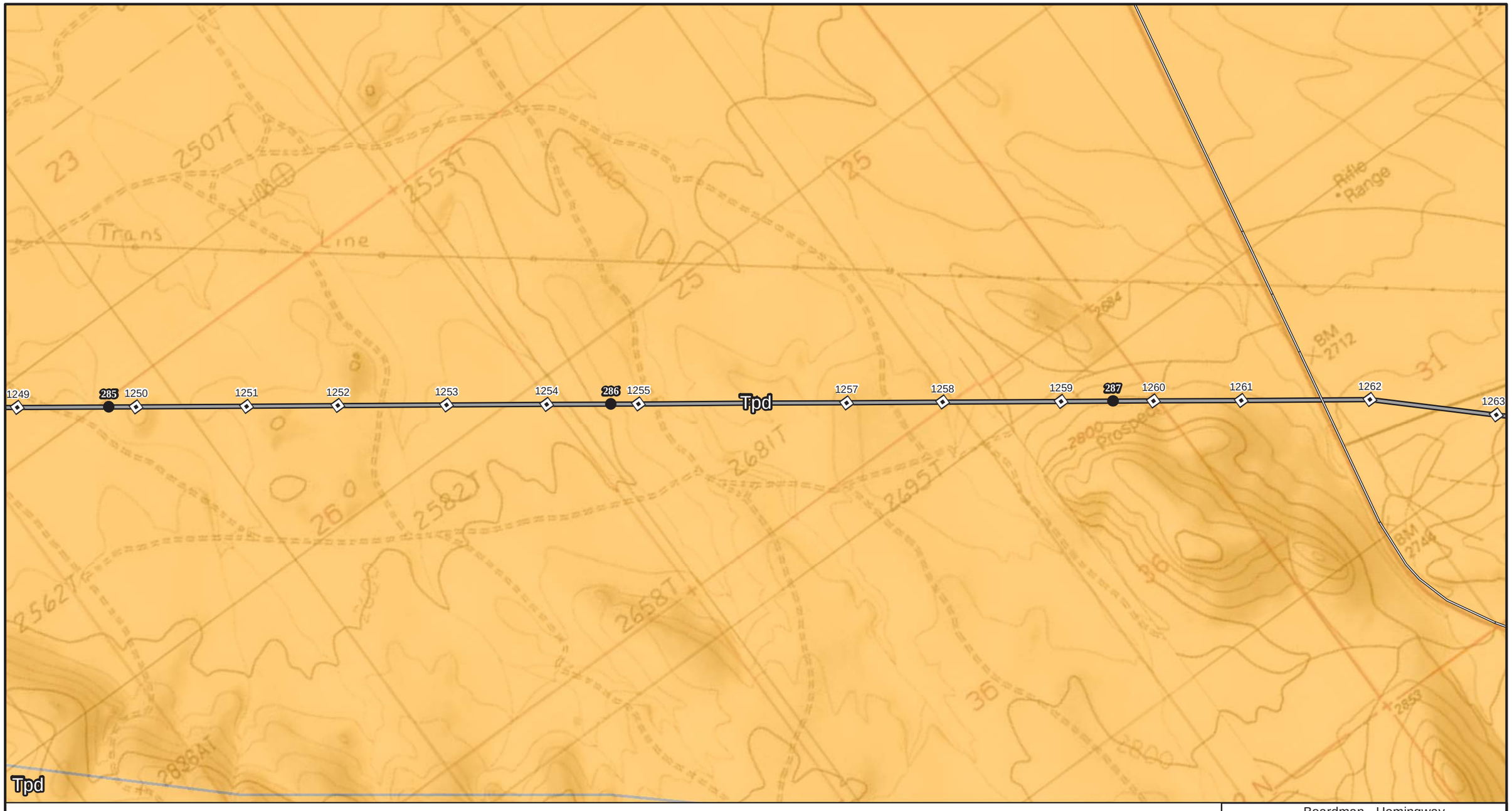

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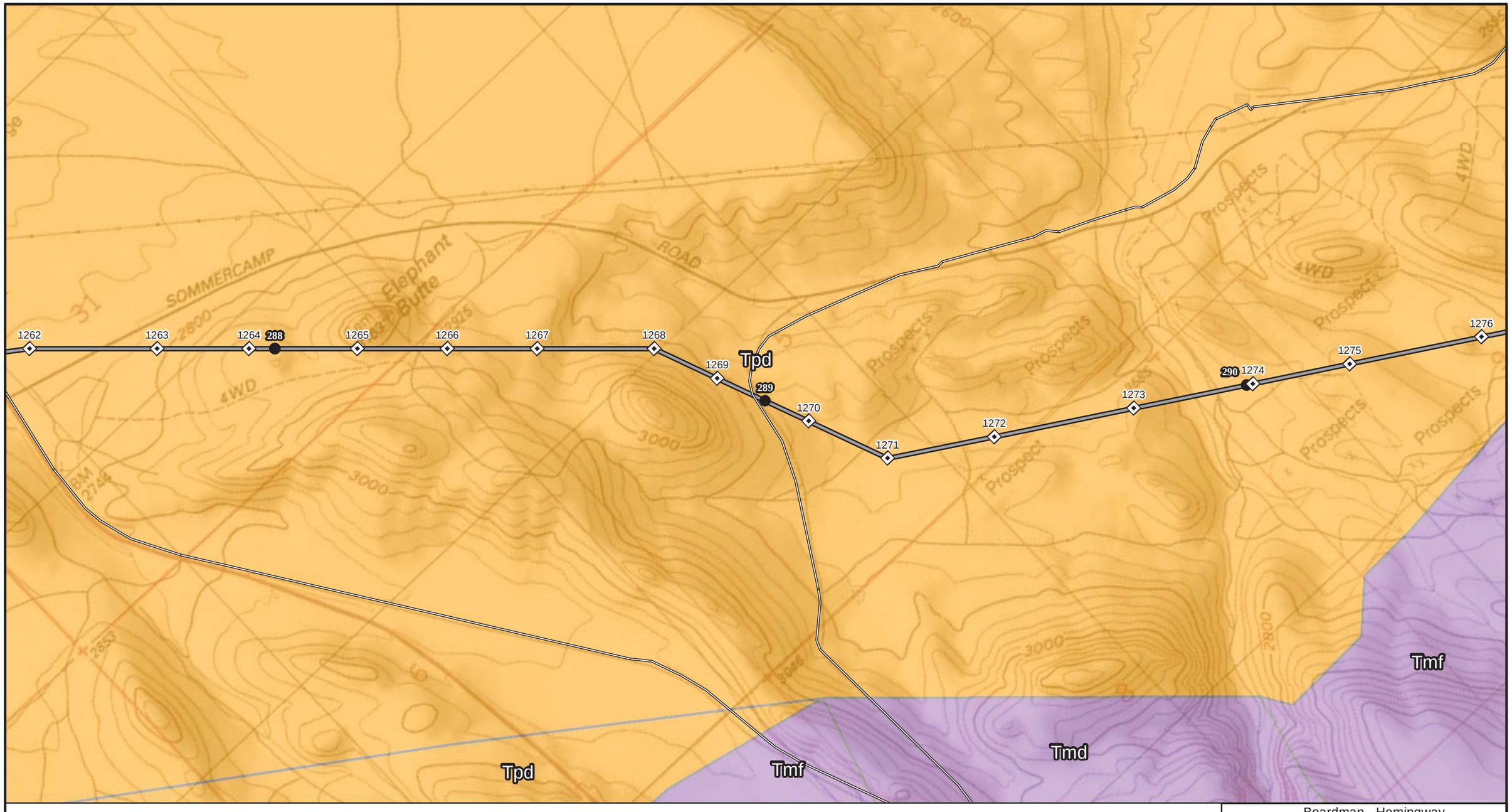

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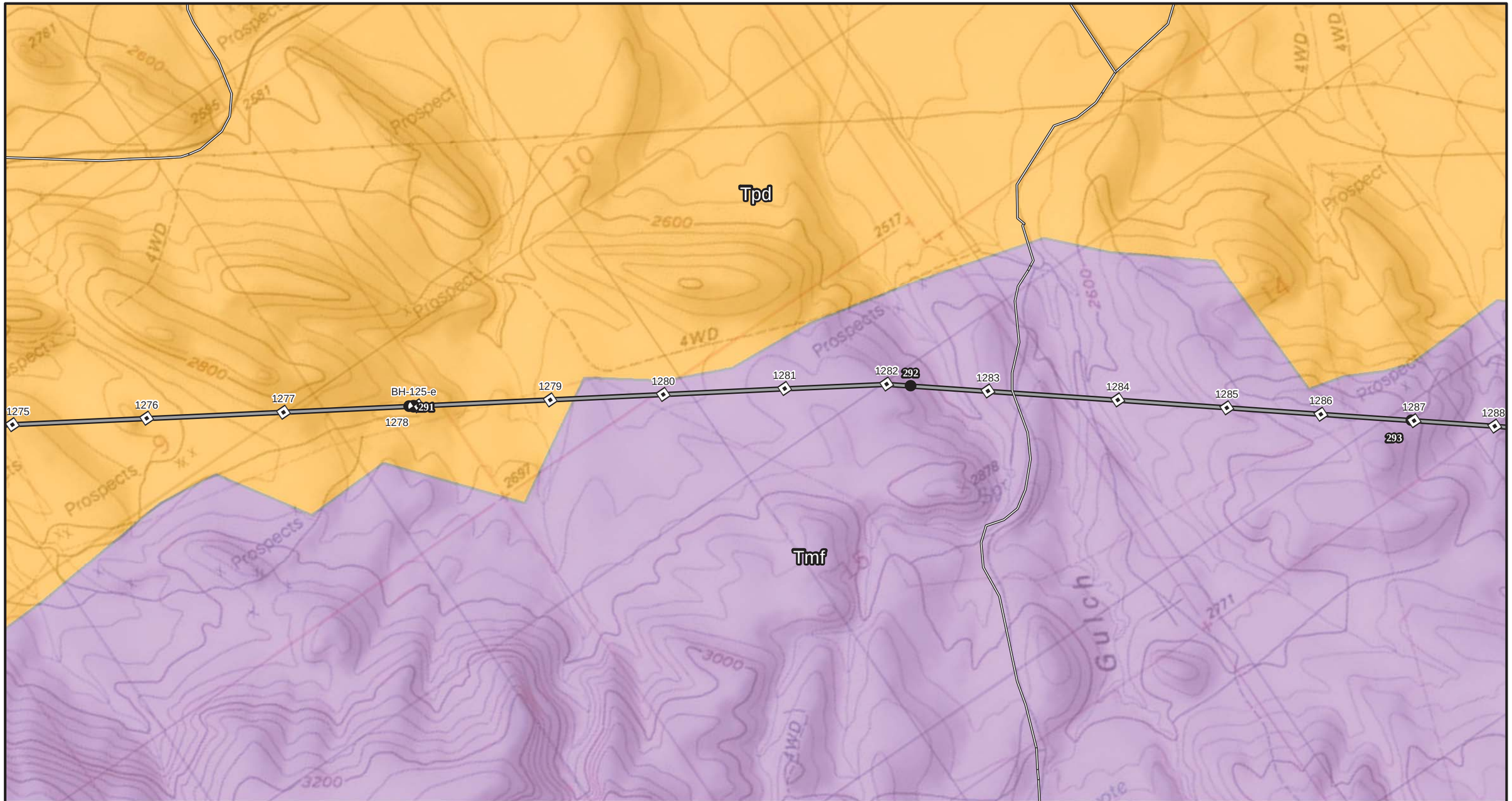

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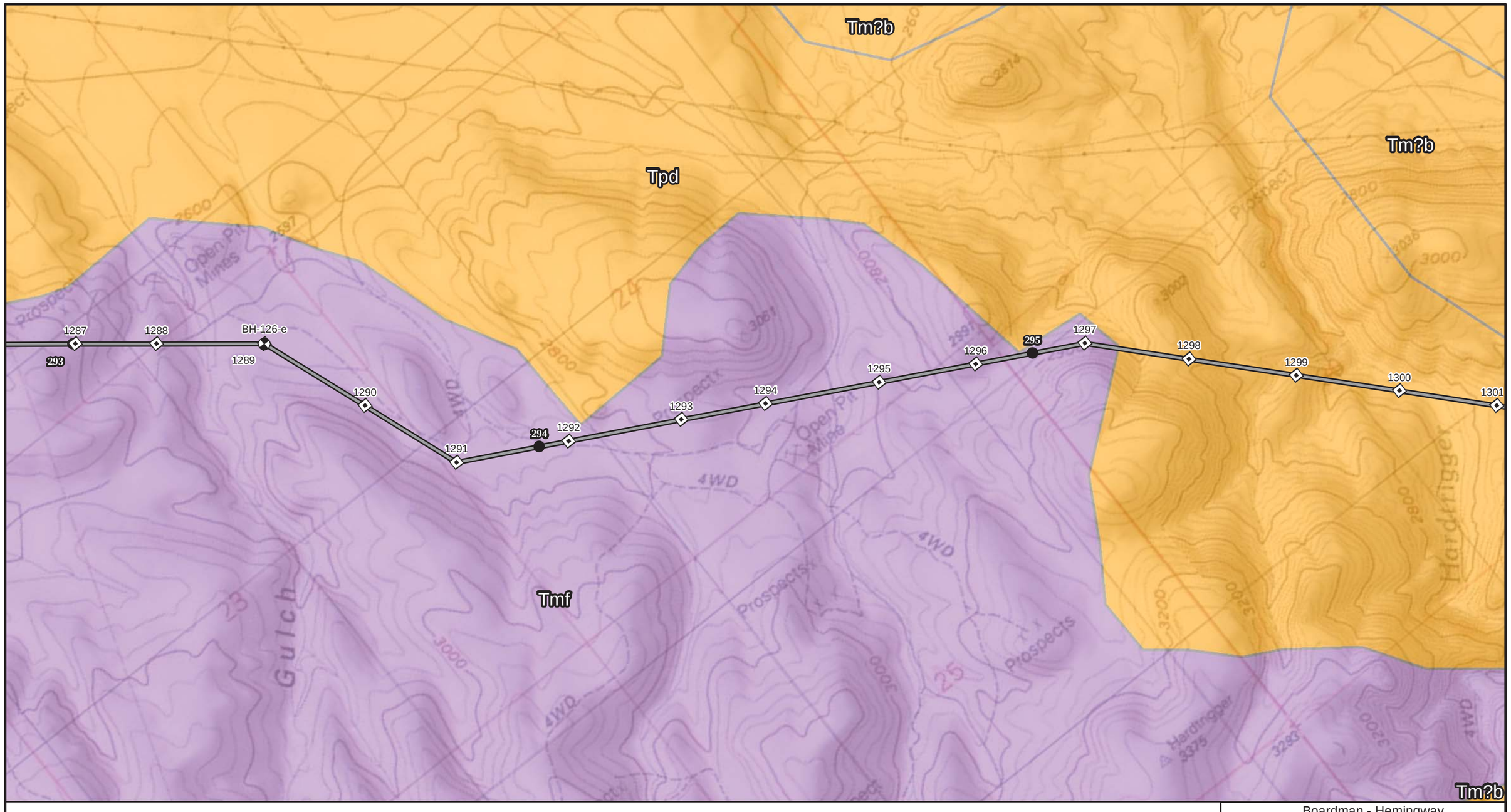

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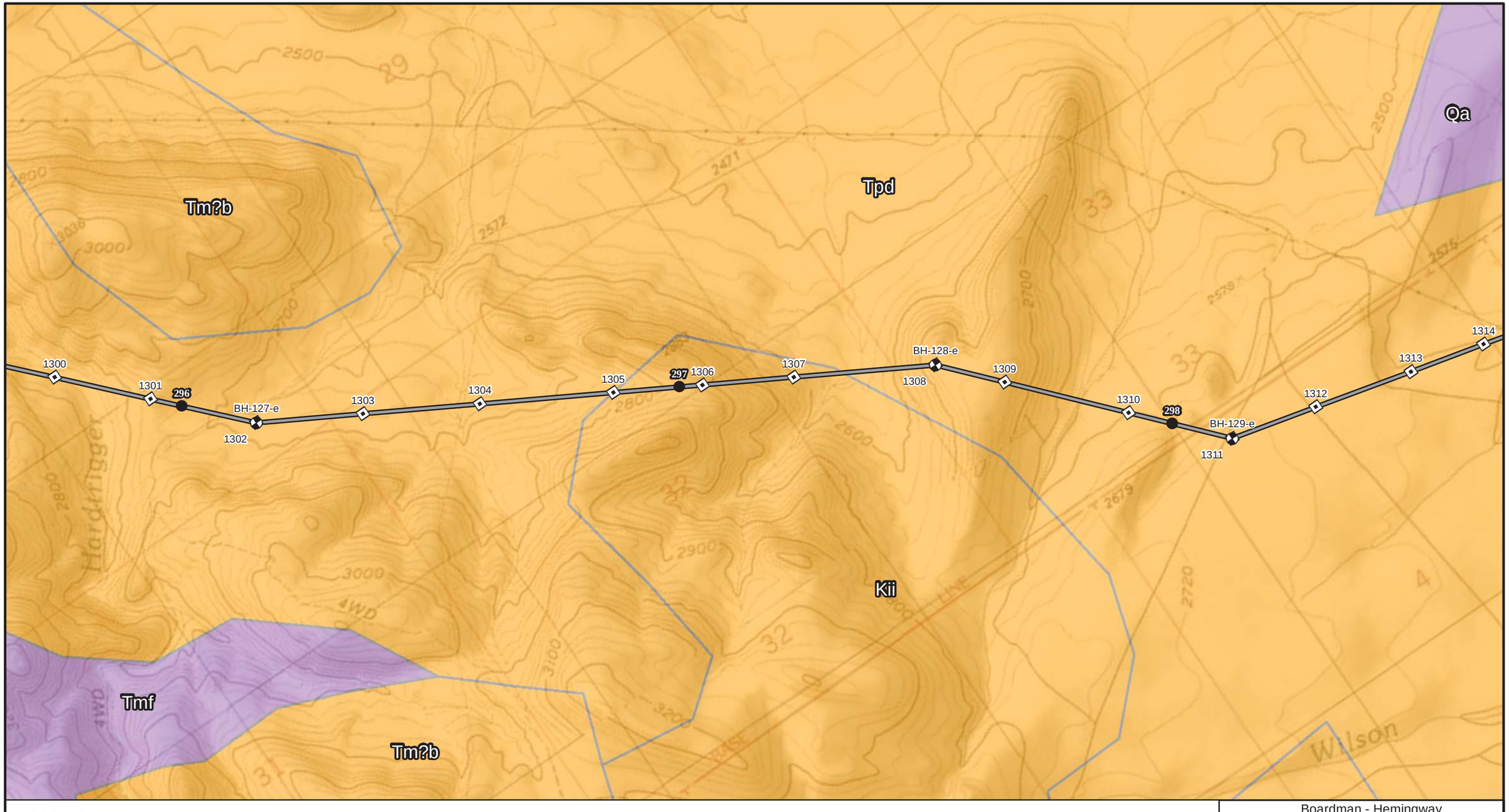

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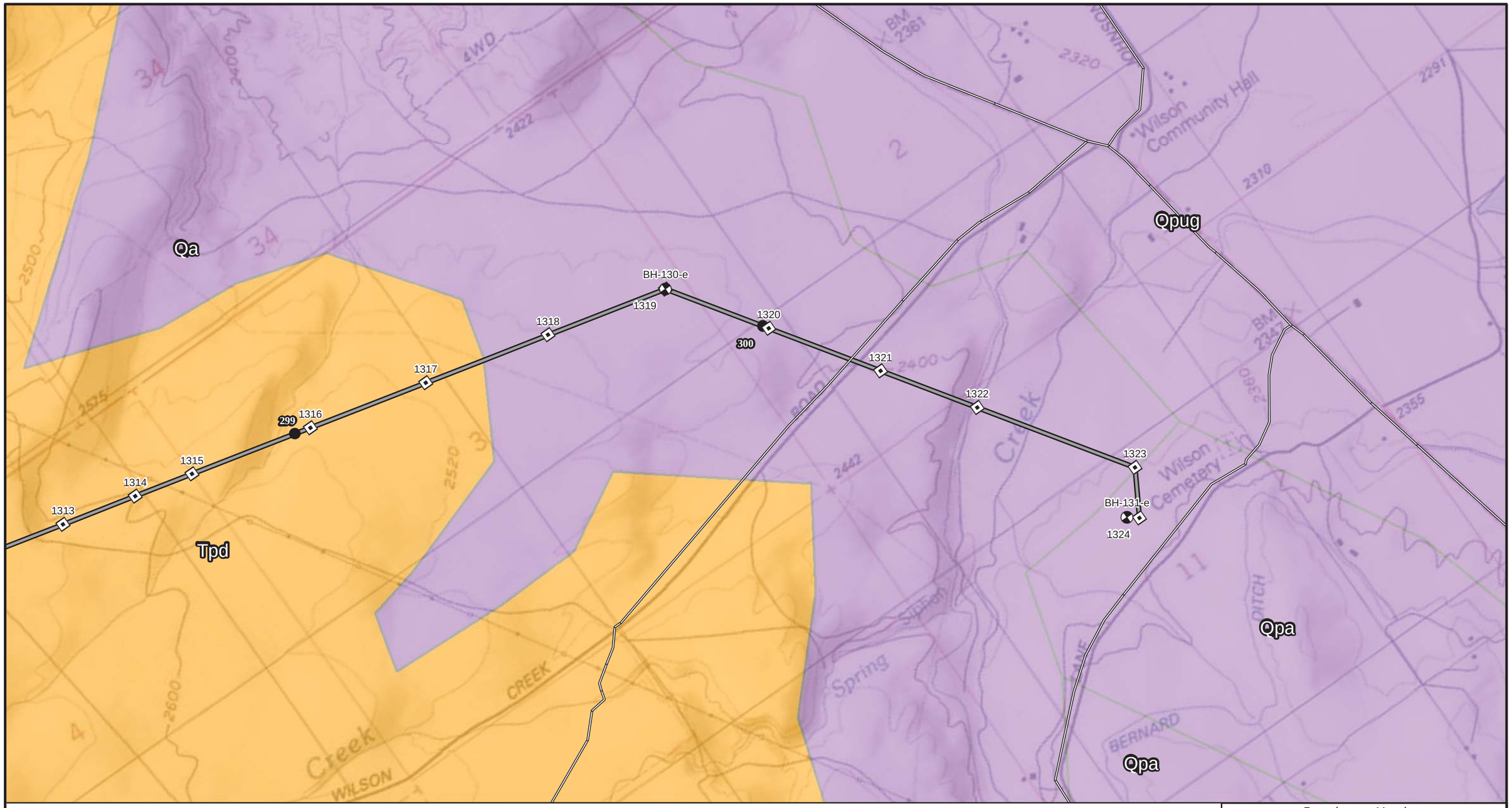

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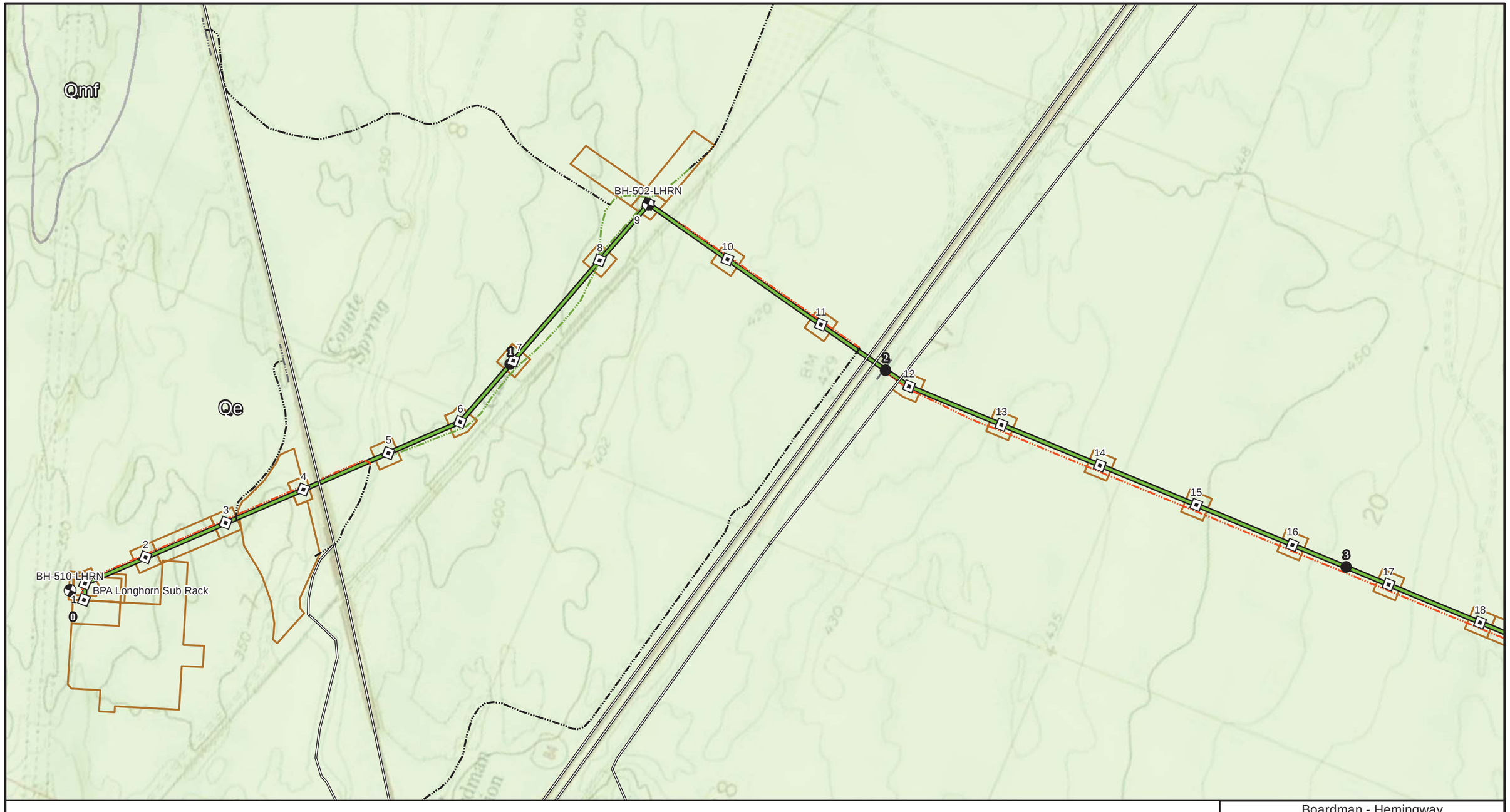

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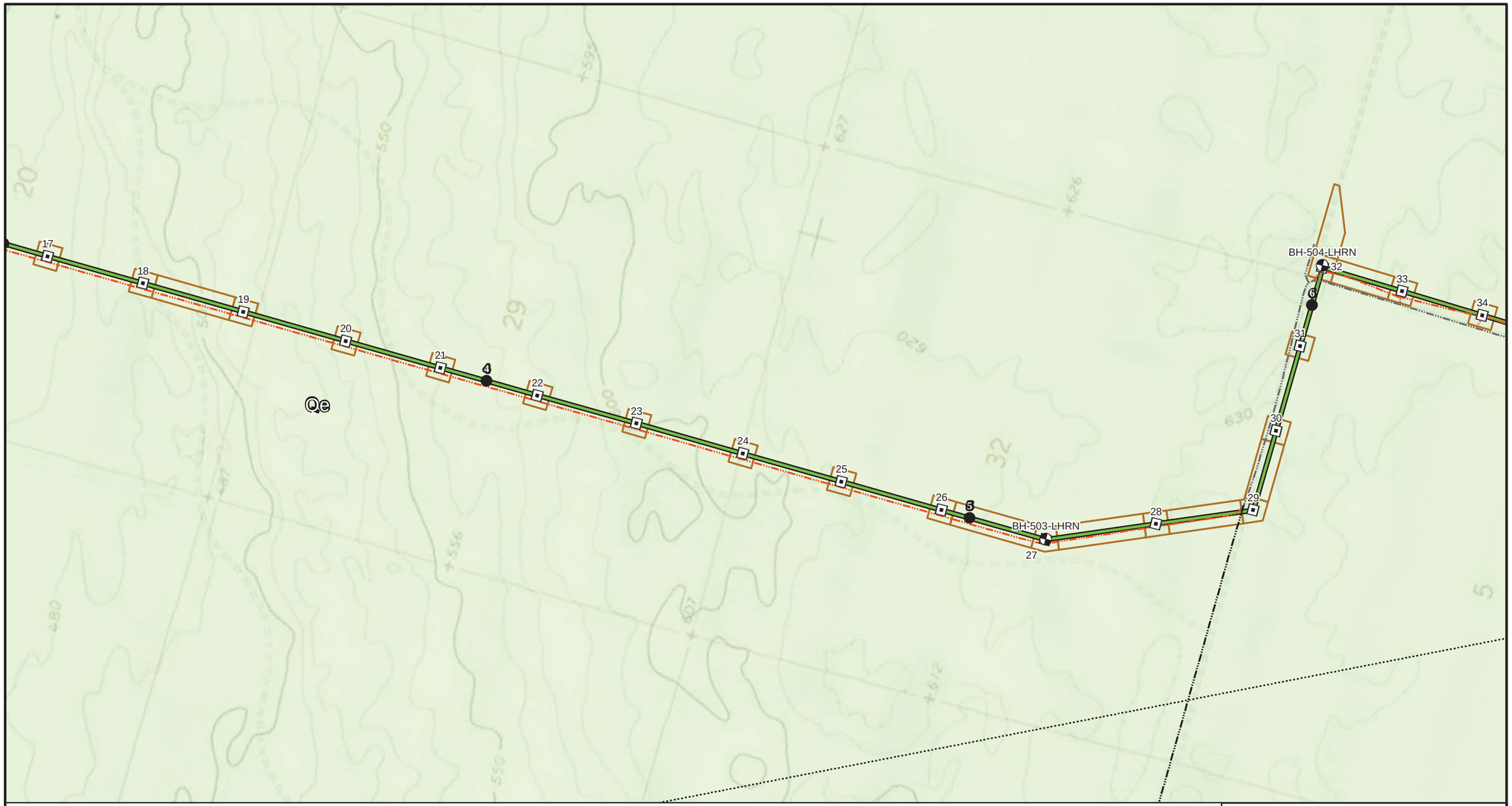

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COMMUNICATION
- Communication Power
- Communication Fiber

PRELIMINARY ACCESS PATHS
- Bladed
- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
- Existing Access, To Be Improved
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EXISITING TRANSPORATION ROADS
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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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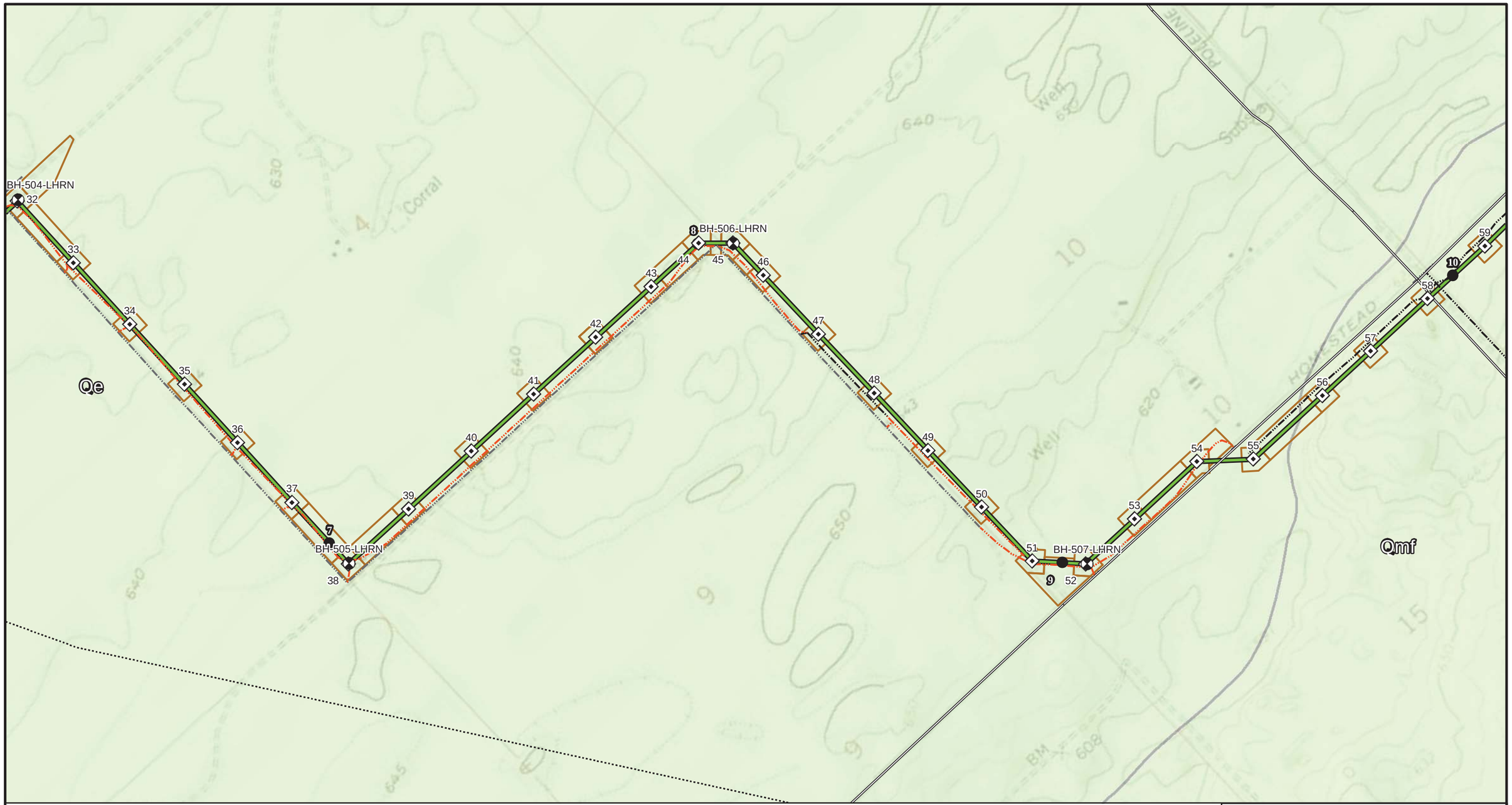

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- Landslide (SLIDO)
- Talus - Colluvium

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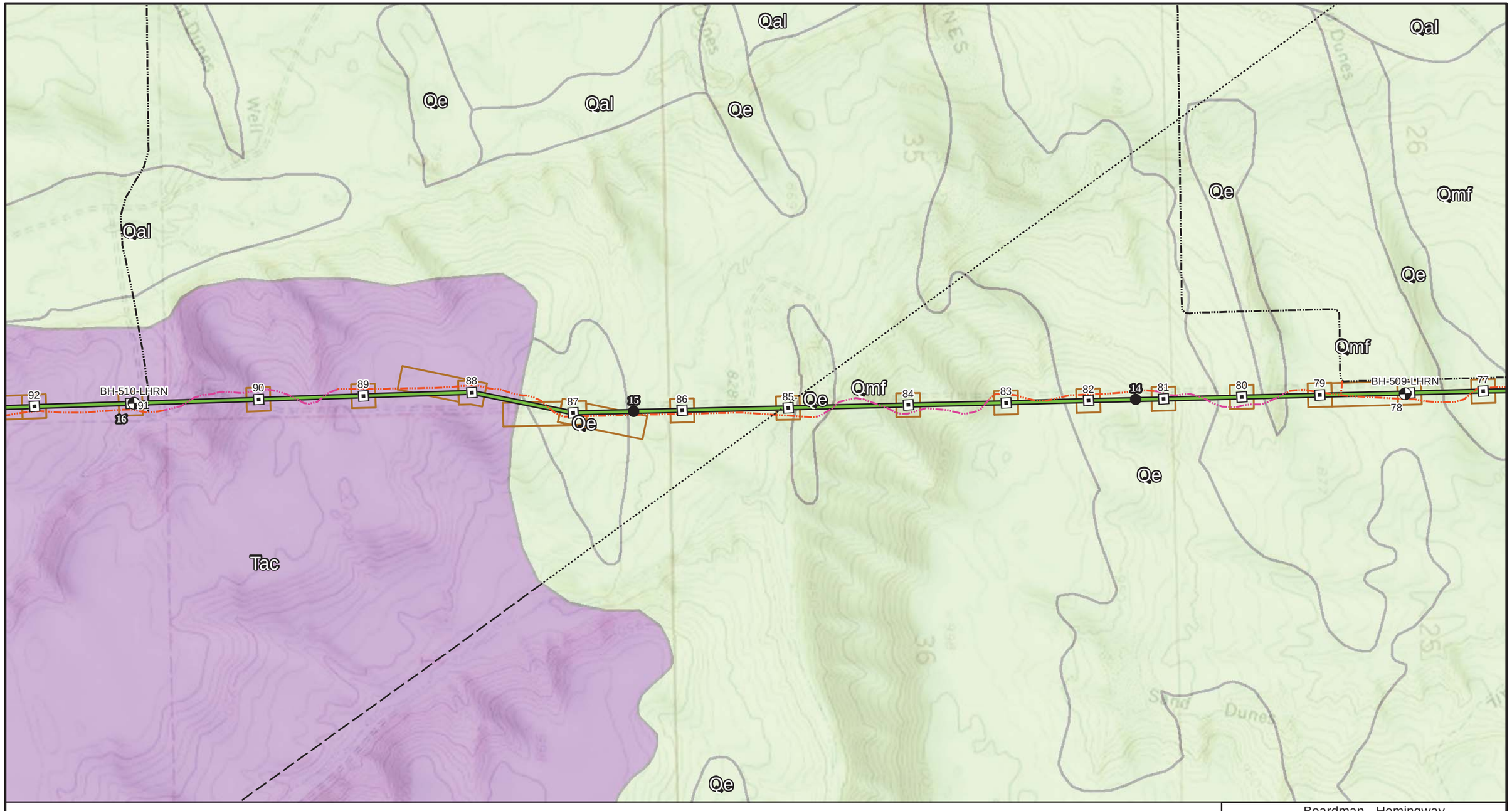

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Qf

Qmf

Tac

Qal

Sand Hollow

Sand Ridge Well

OREGON TRAIL

PIPELINE

7028

14

11

12

27 163 163 34 164 164 101 100 18 99 98 97 96 17 95 94 93 92 BH-510-LHRN 91 16

165

166

167

Tac

Tac

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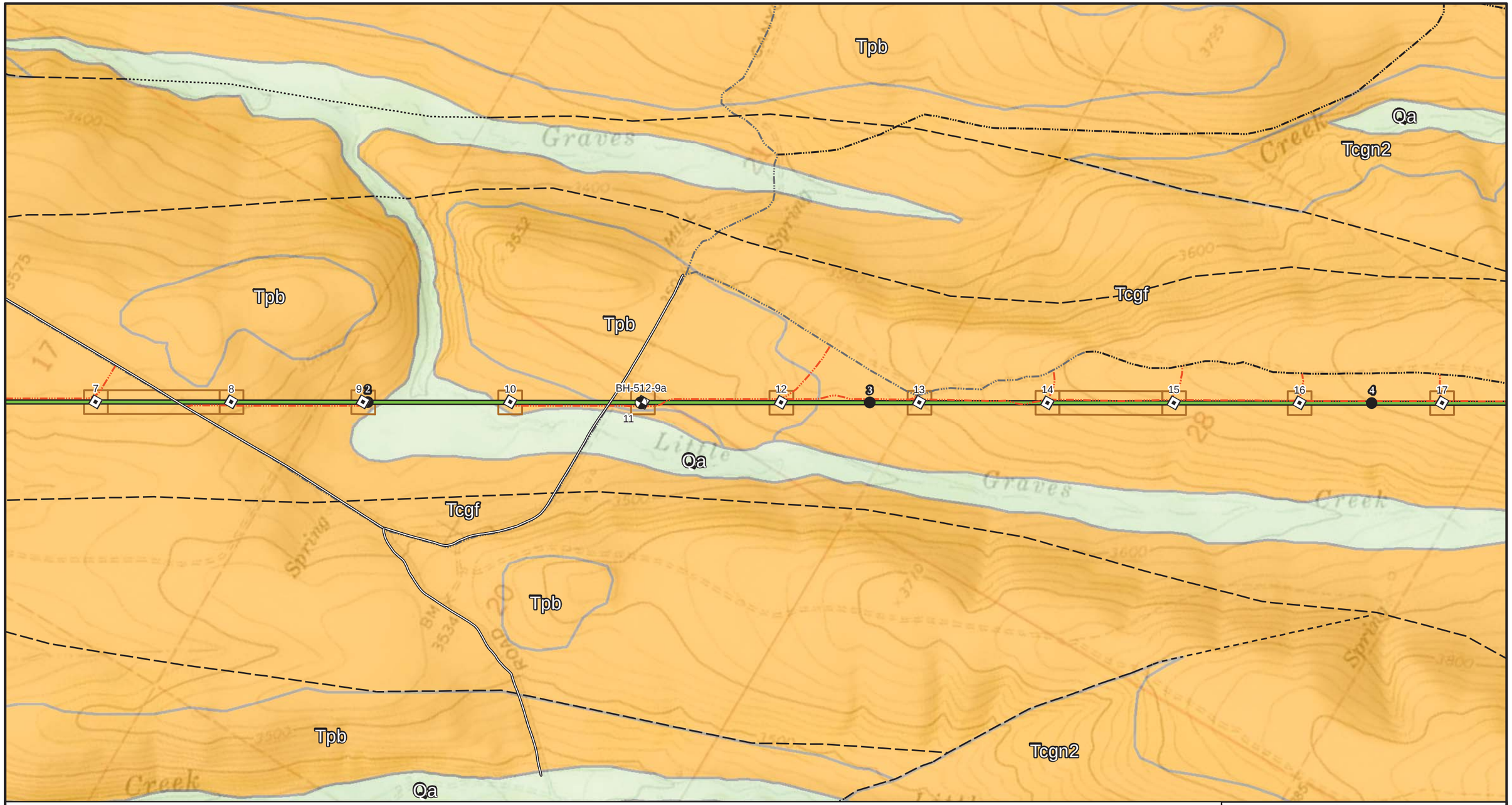

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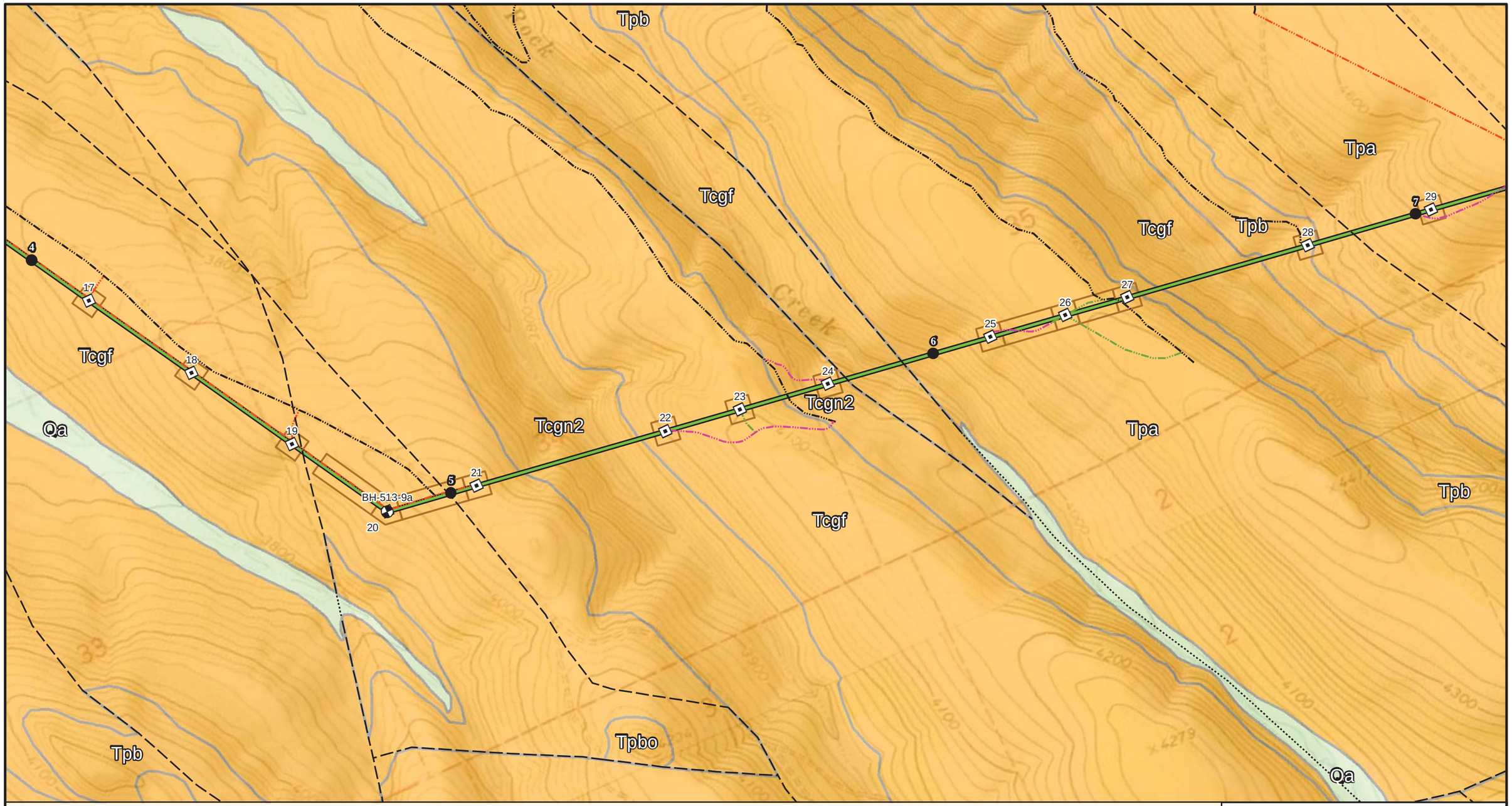

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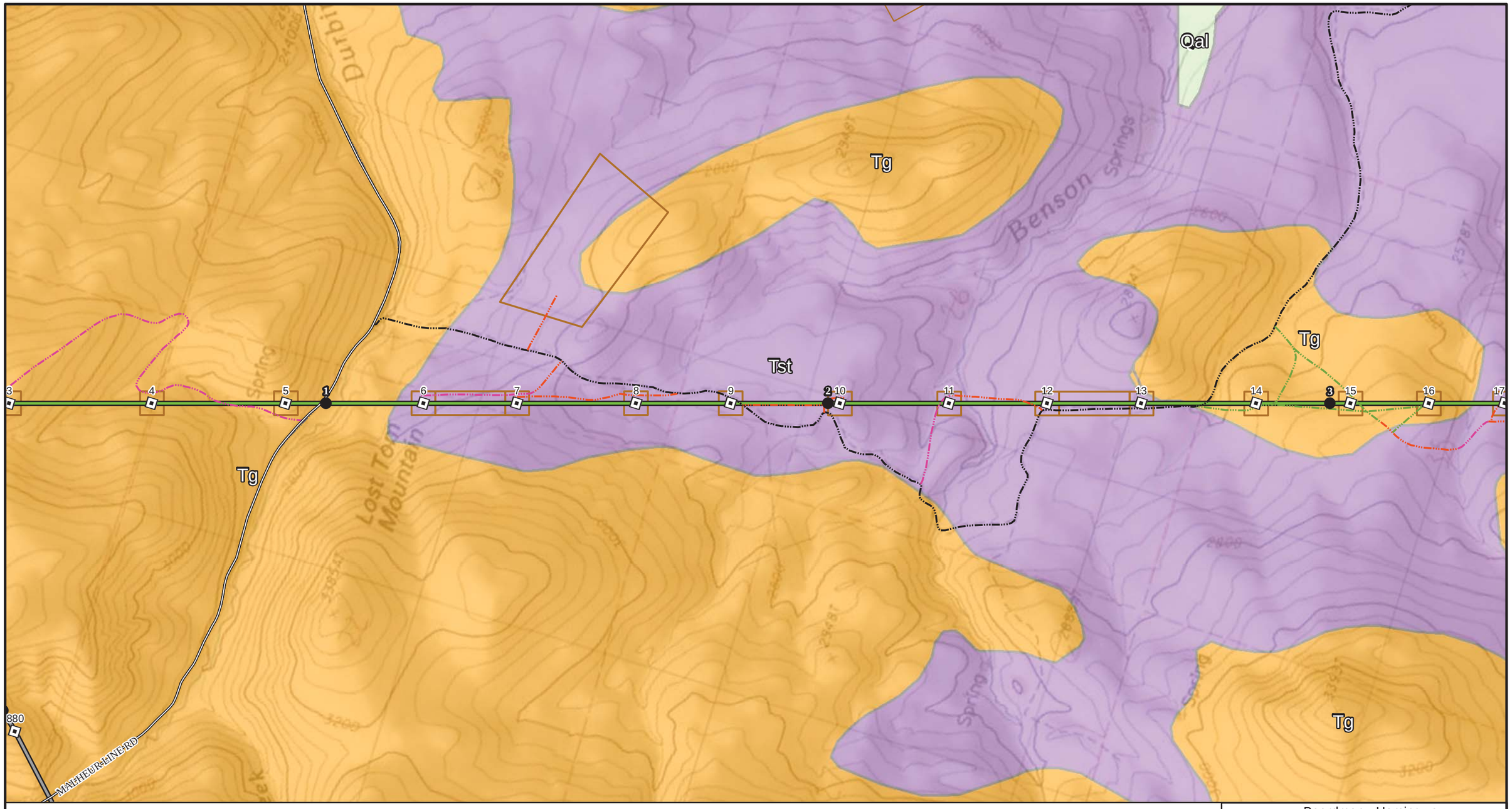

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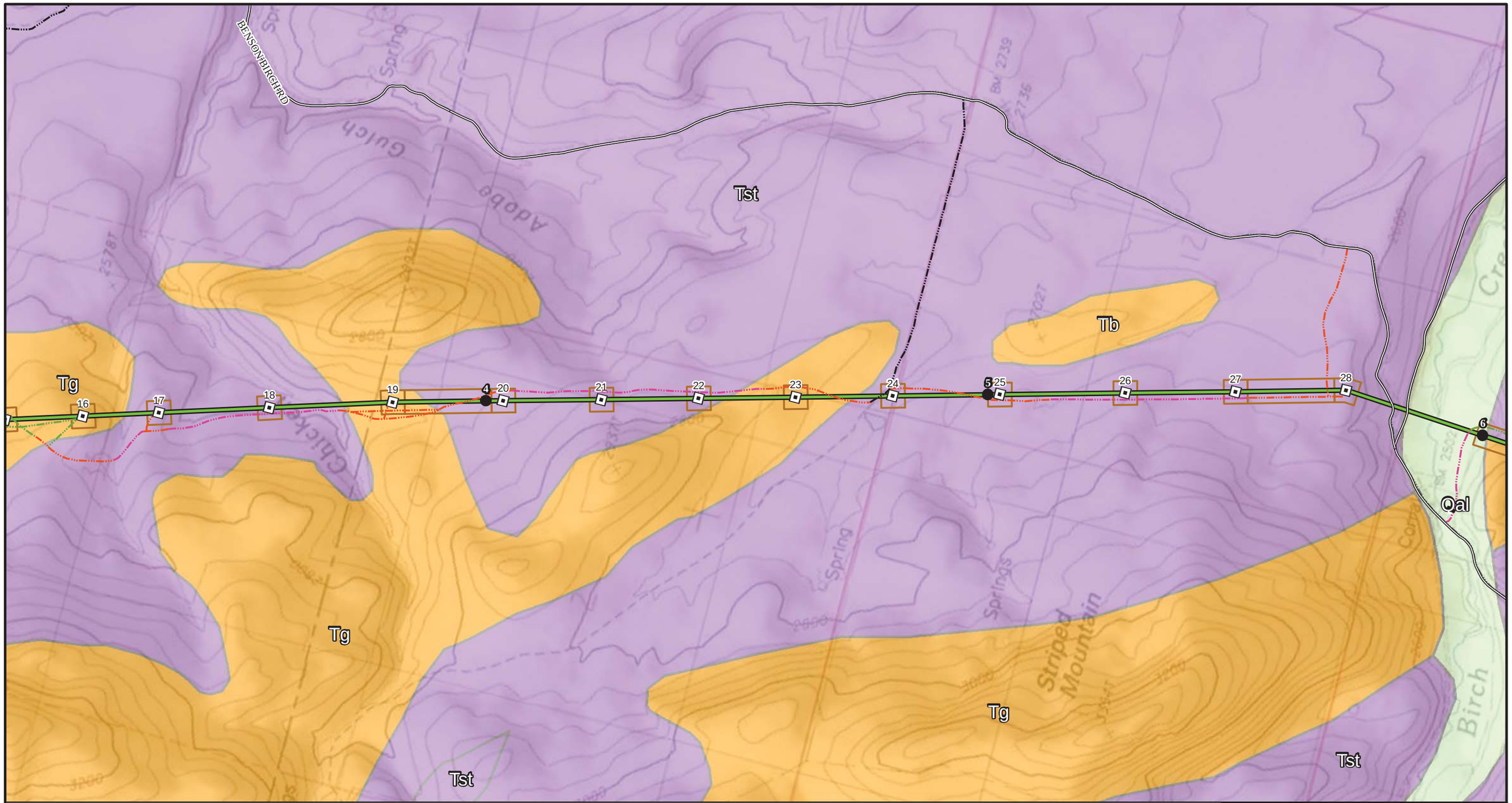

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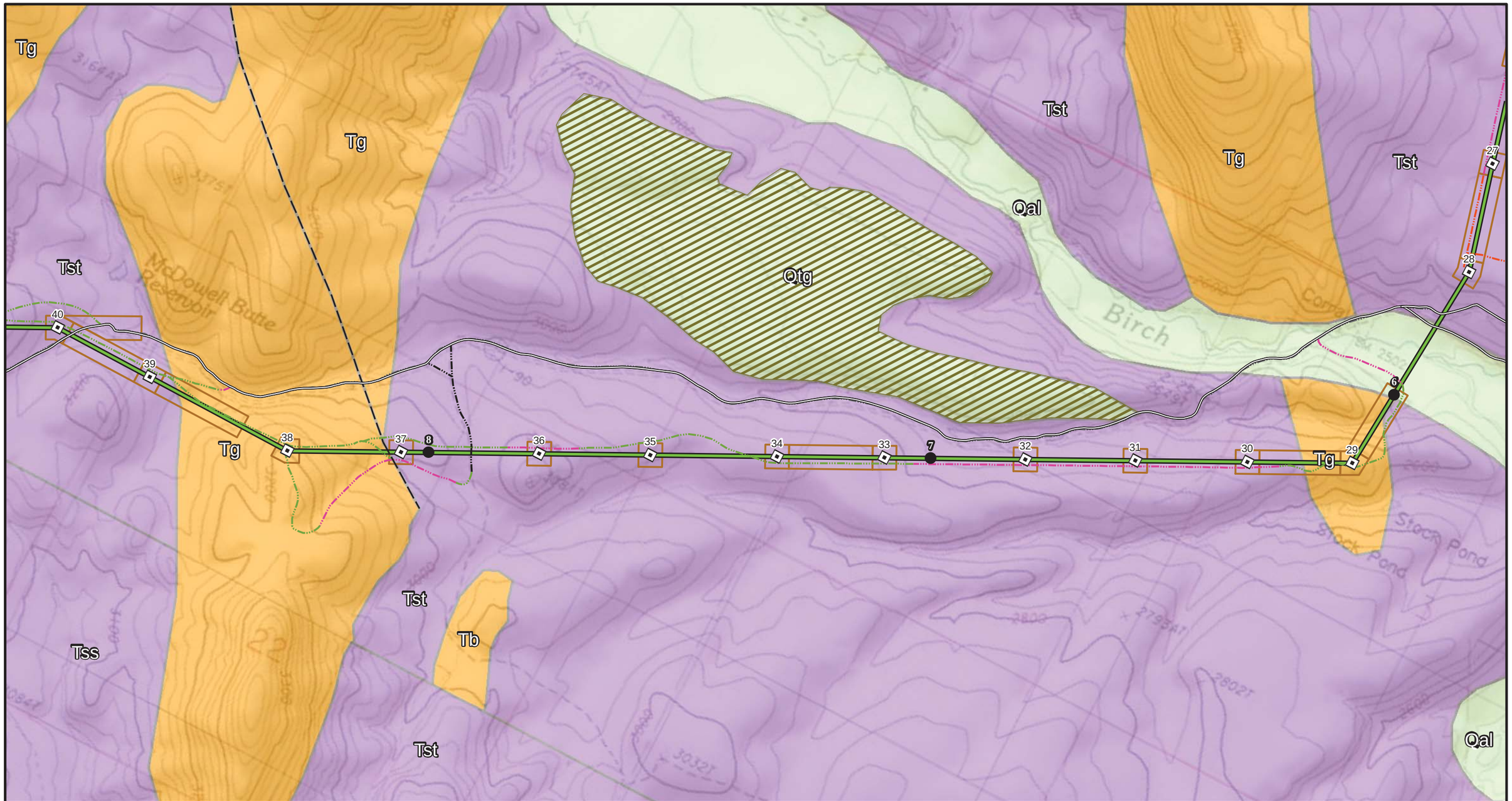

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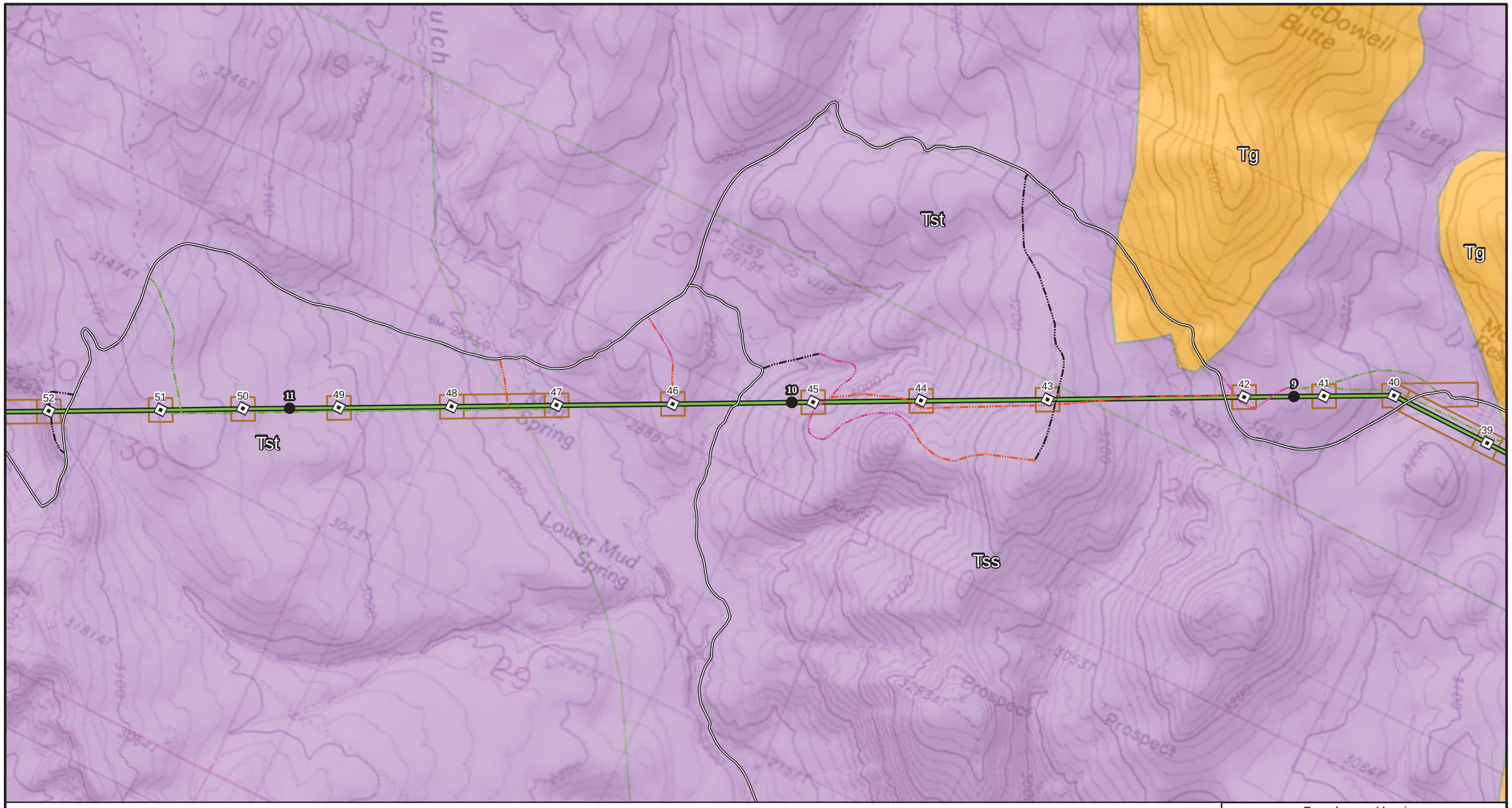

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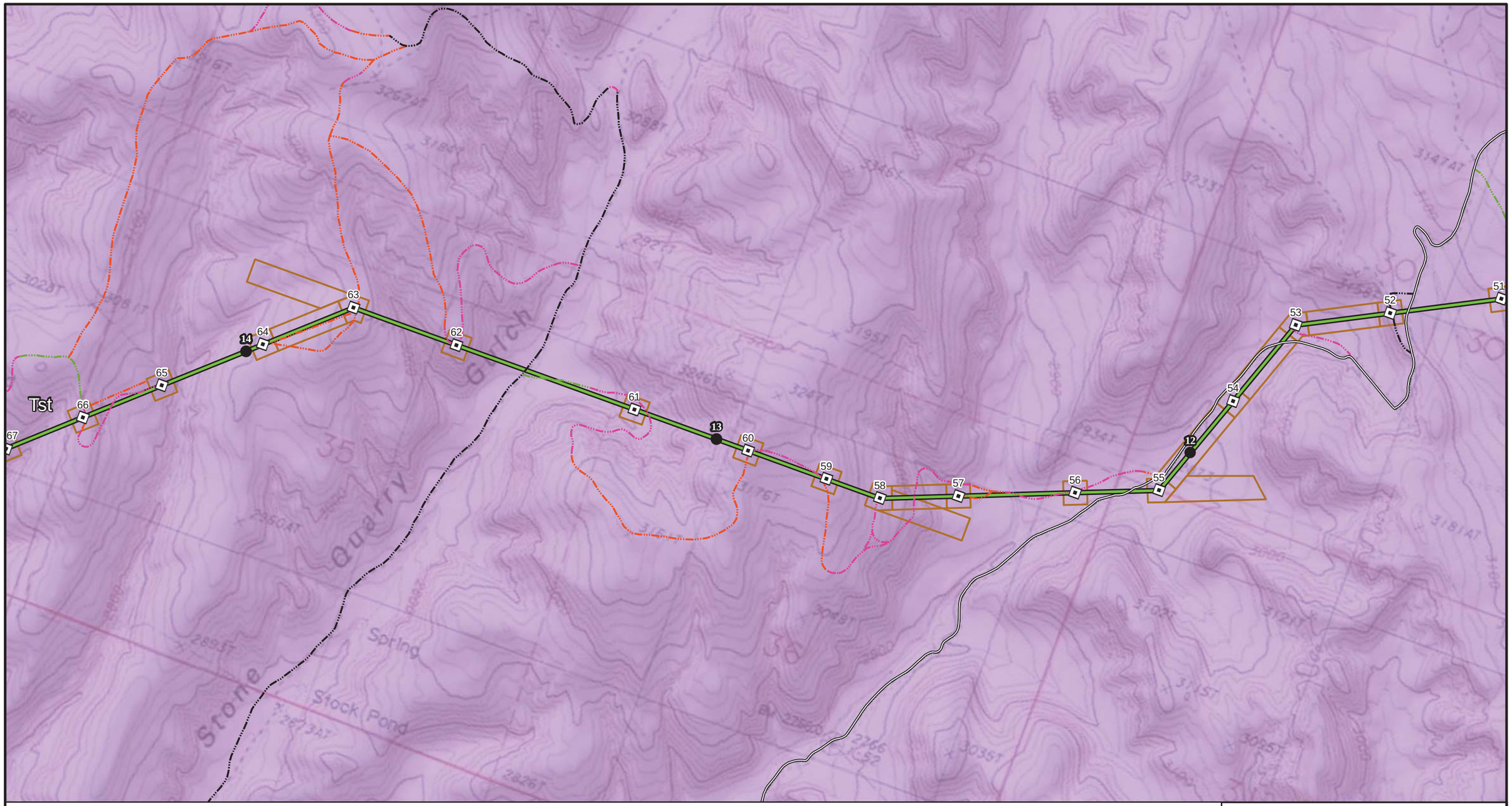

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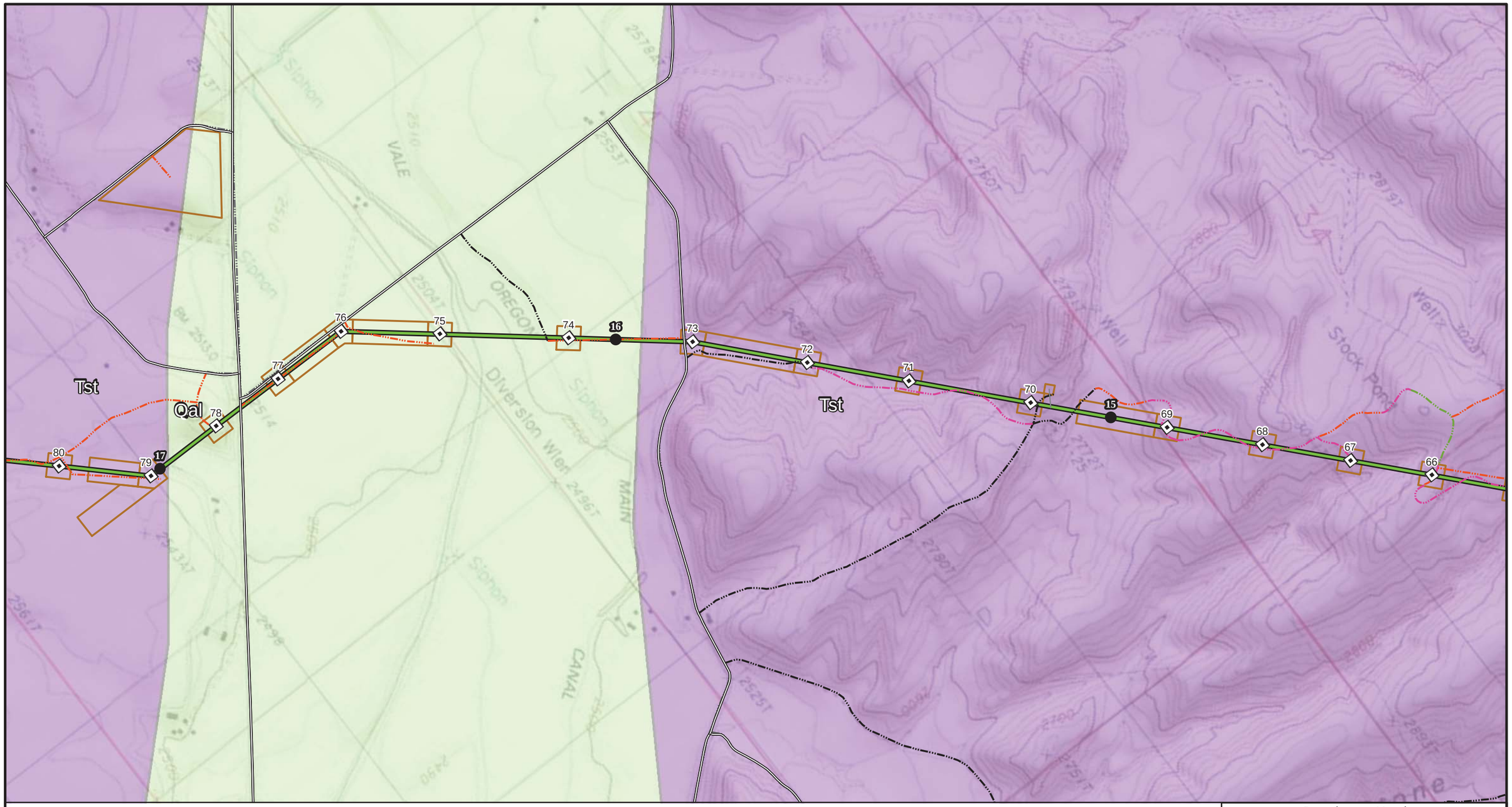

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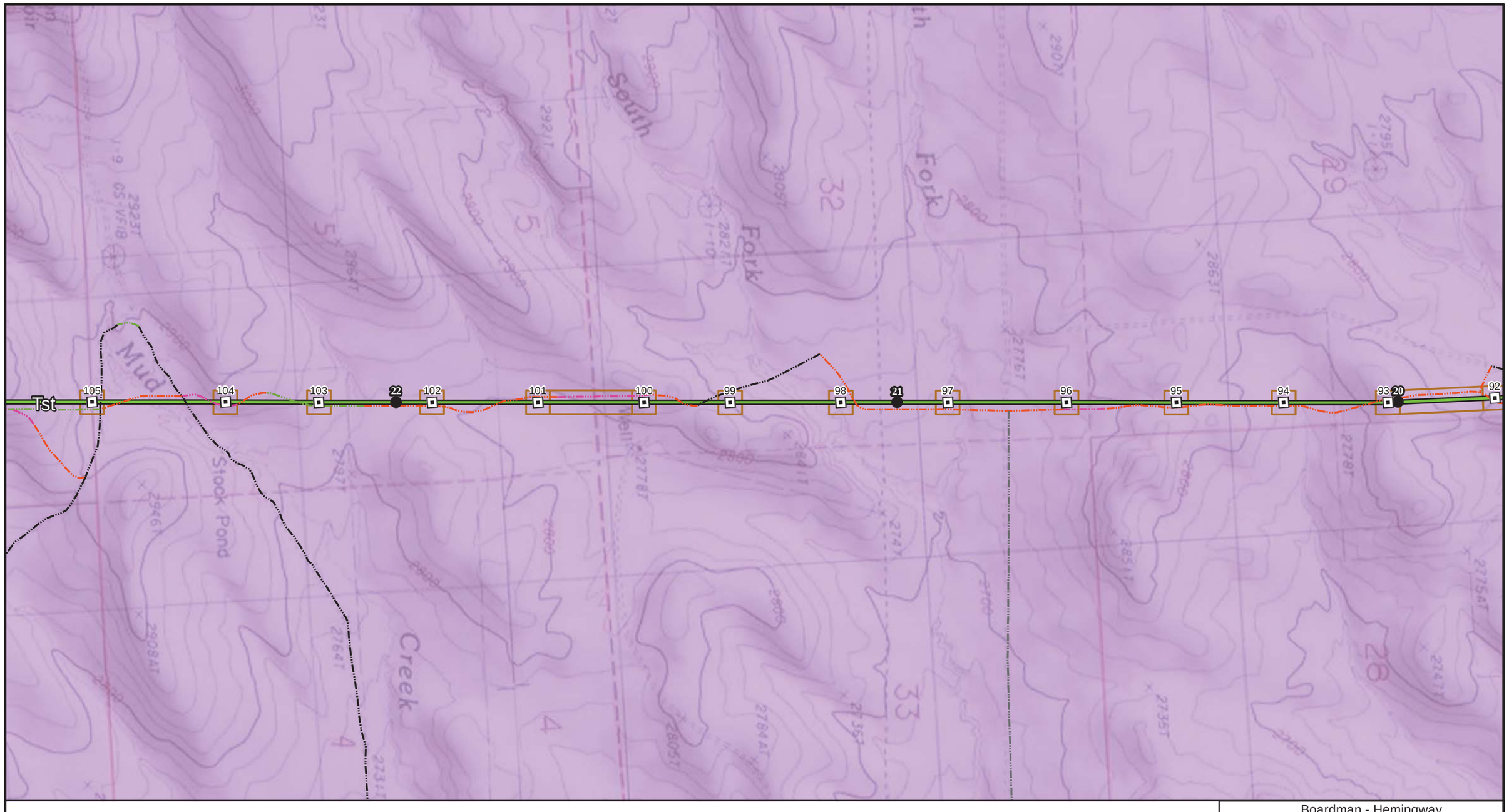

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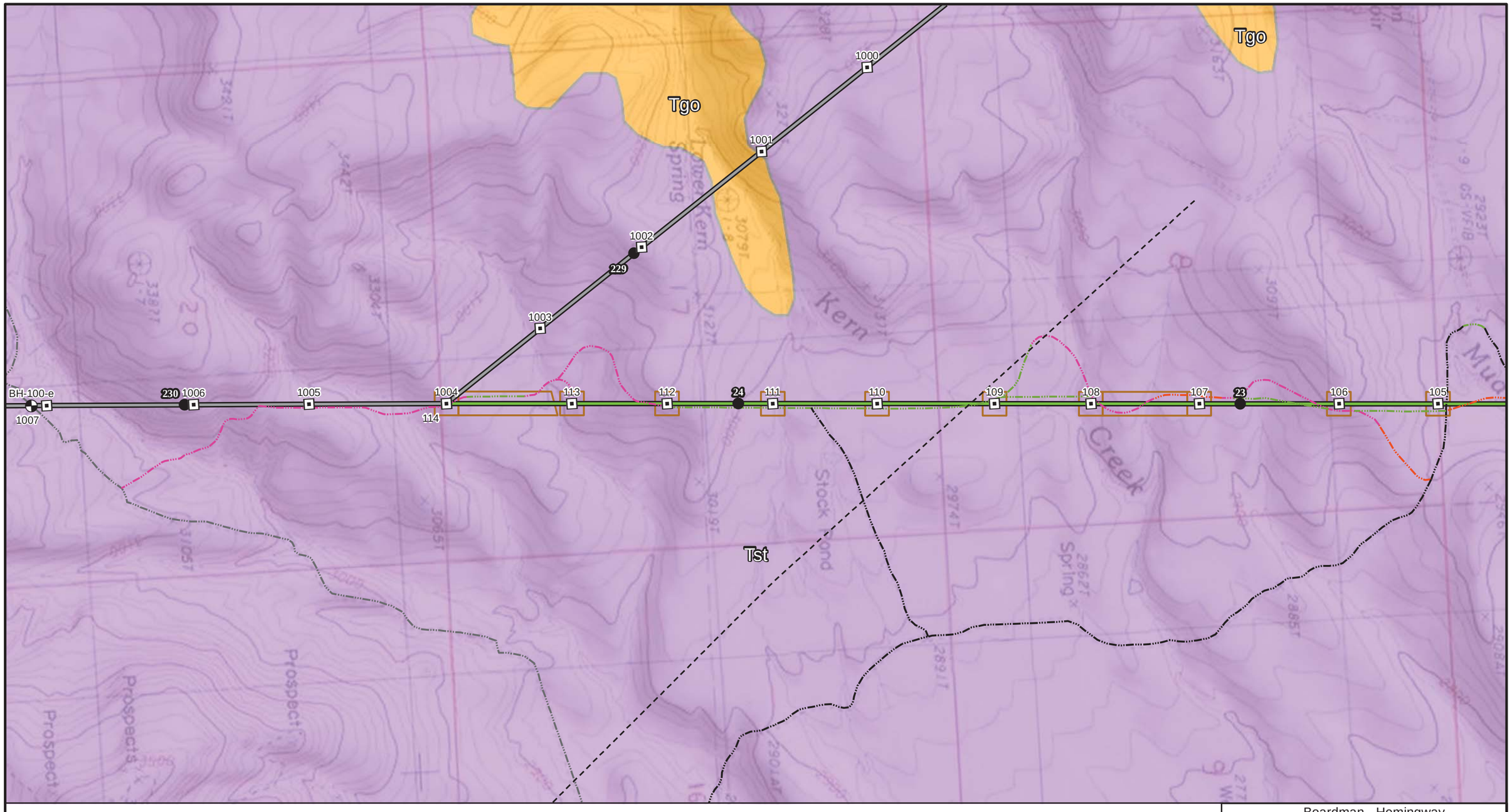

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- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
- Existing Access, To Be Improved
- Existing Access, May Need Repairs
- Existing Access, No Improvement

EXISITING TRANSPORATION ROADS
- Primary Limited Access Road
- Primary US and State Highways
- Railroad

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0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

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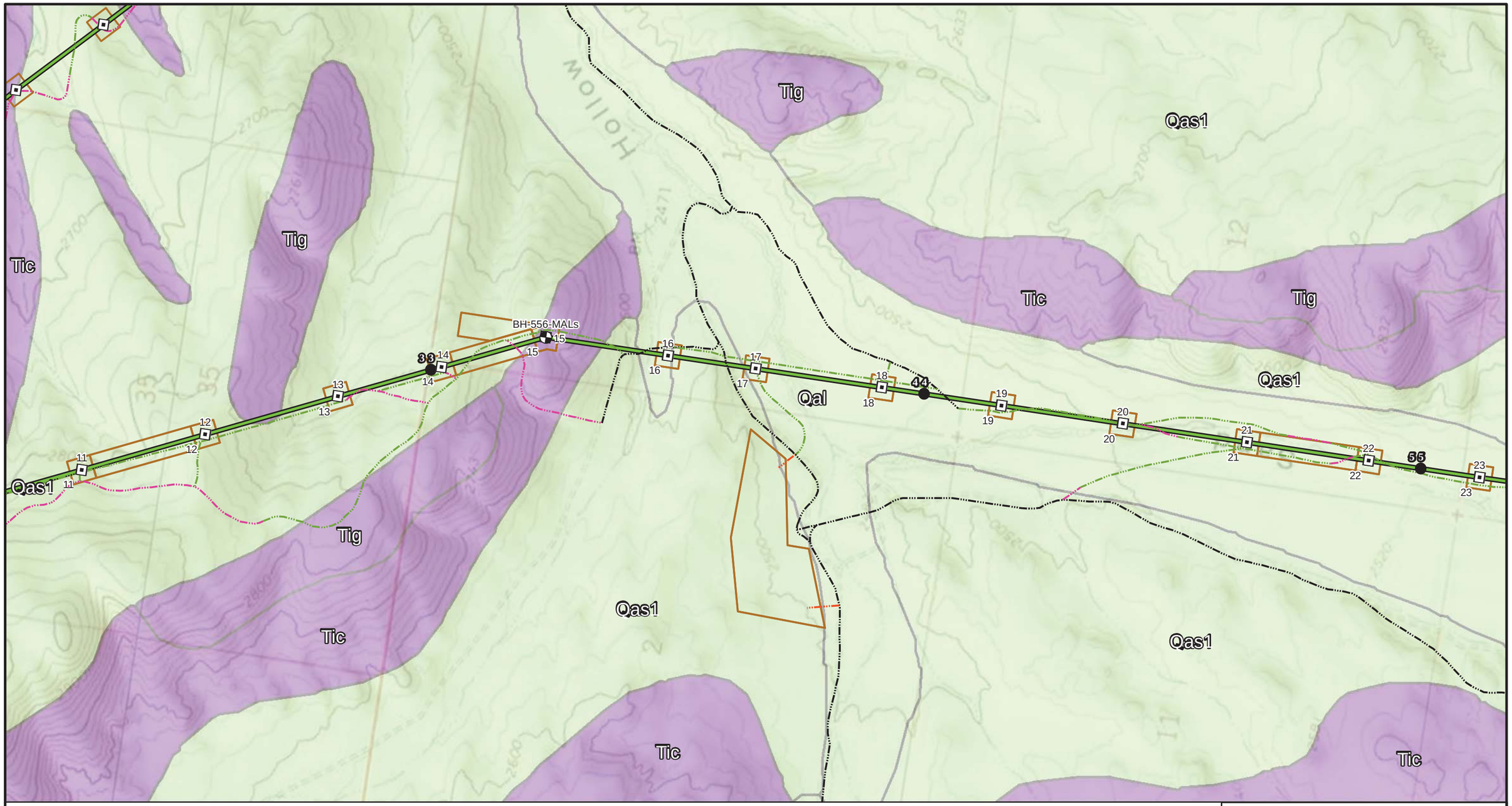

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TRANSMISSION FEATURES
- IPC Proposed Route
- IPC Alternative
- NEPA Alternative
- Work Area
- Mileposts
- Towers
- Proposed Borehole

SURFICIAL GEOLOGY
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- Metamorphic Rocks
- Sedimentary Rocks
- Unconsolidated Rocks
- Volcaniclastic Rocks

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- Landslide (SLIDO)
- Talus - Colluvium

FAULTS
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- Approximate and queried
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- Concealed
- Inferred
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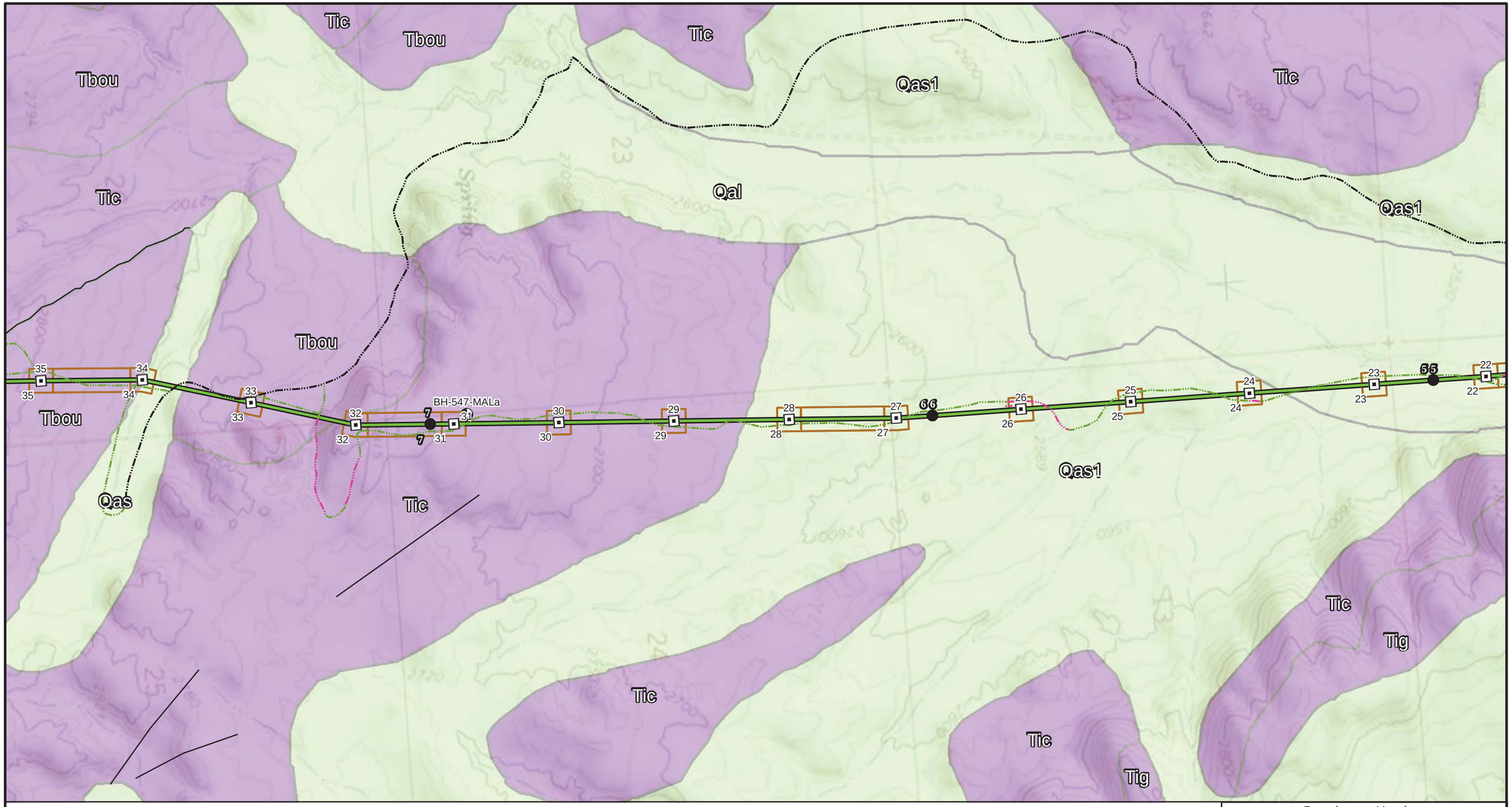

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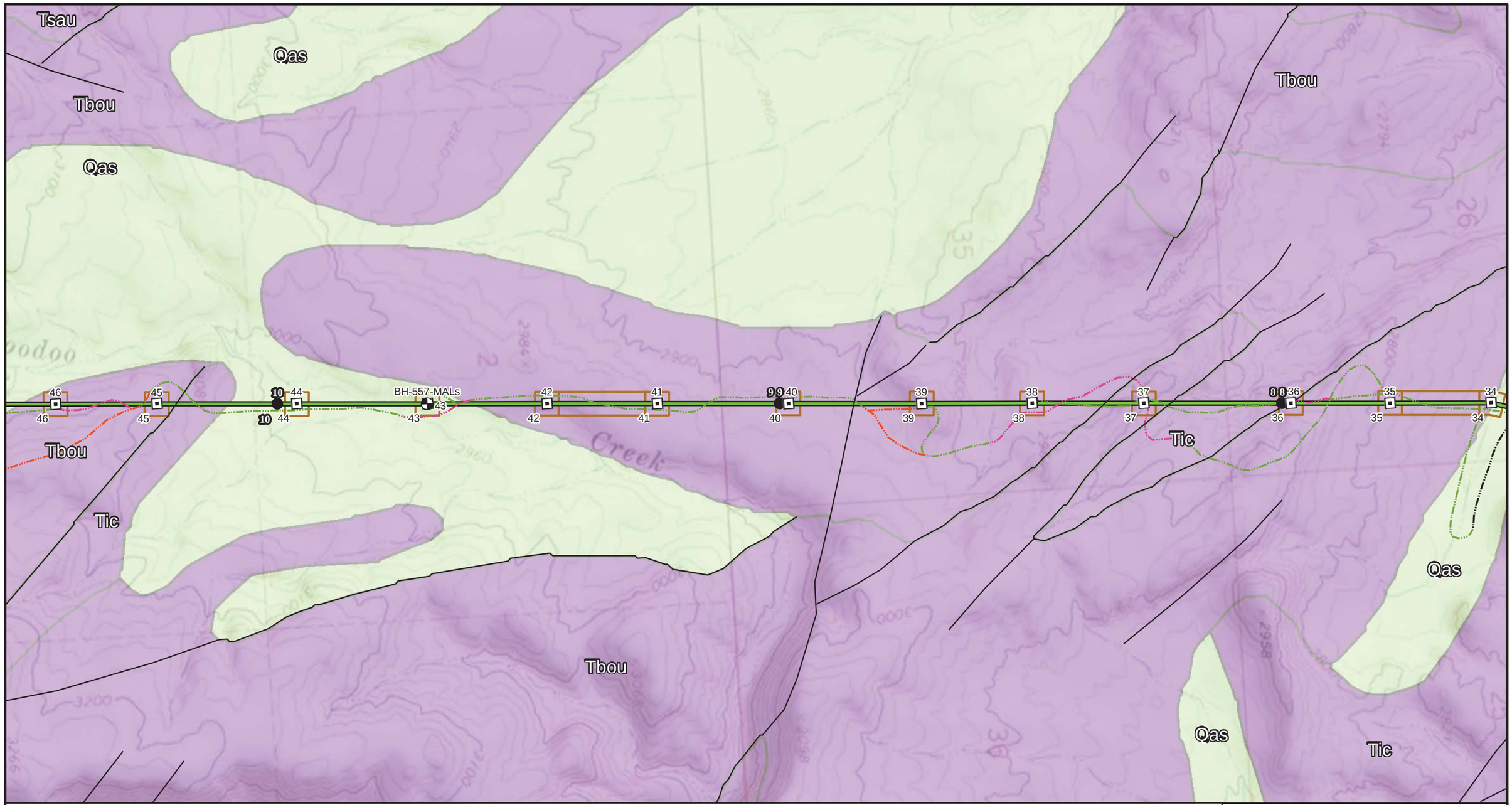

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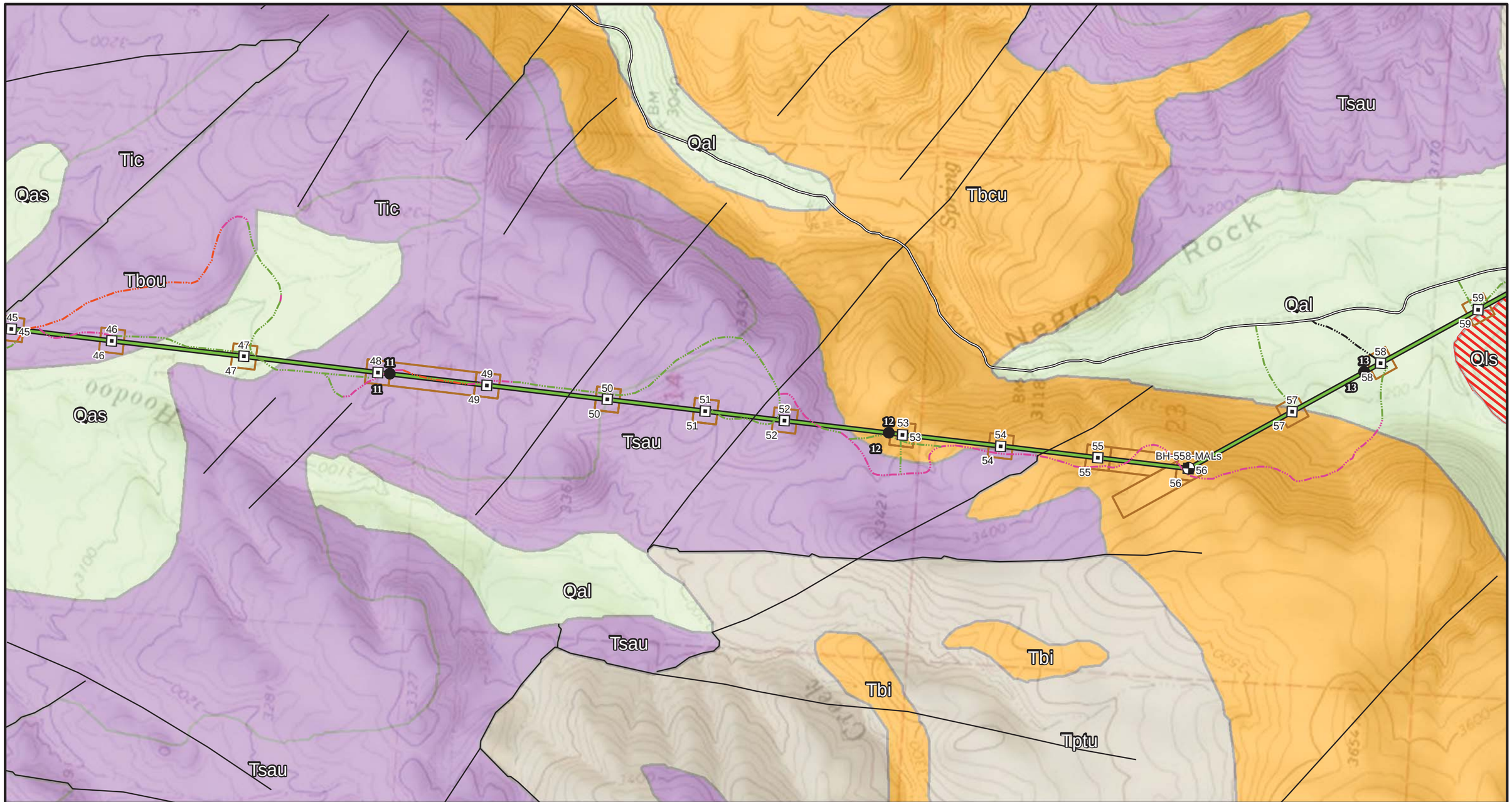

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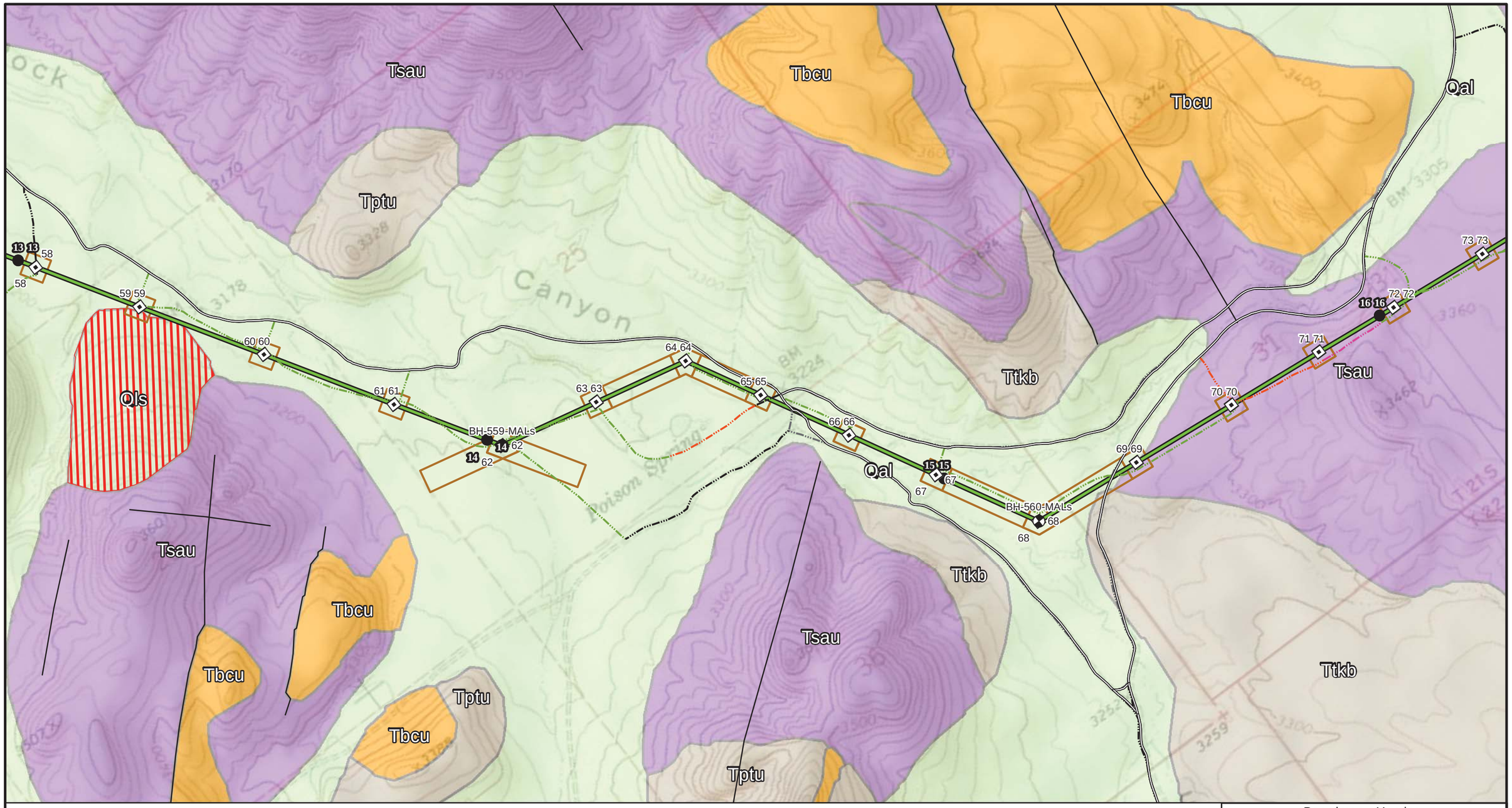

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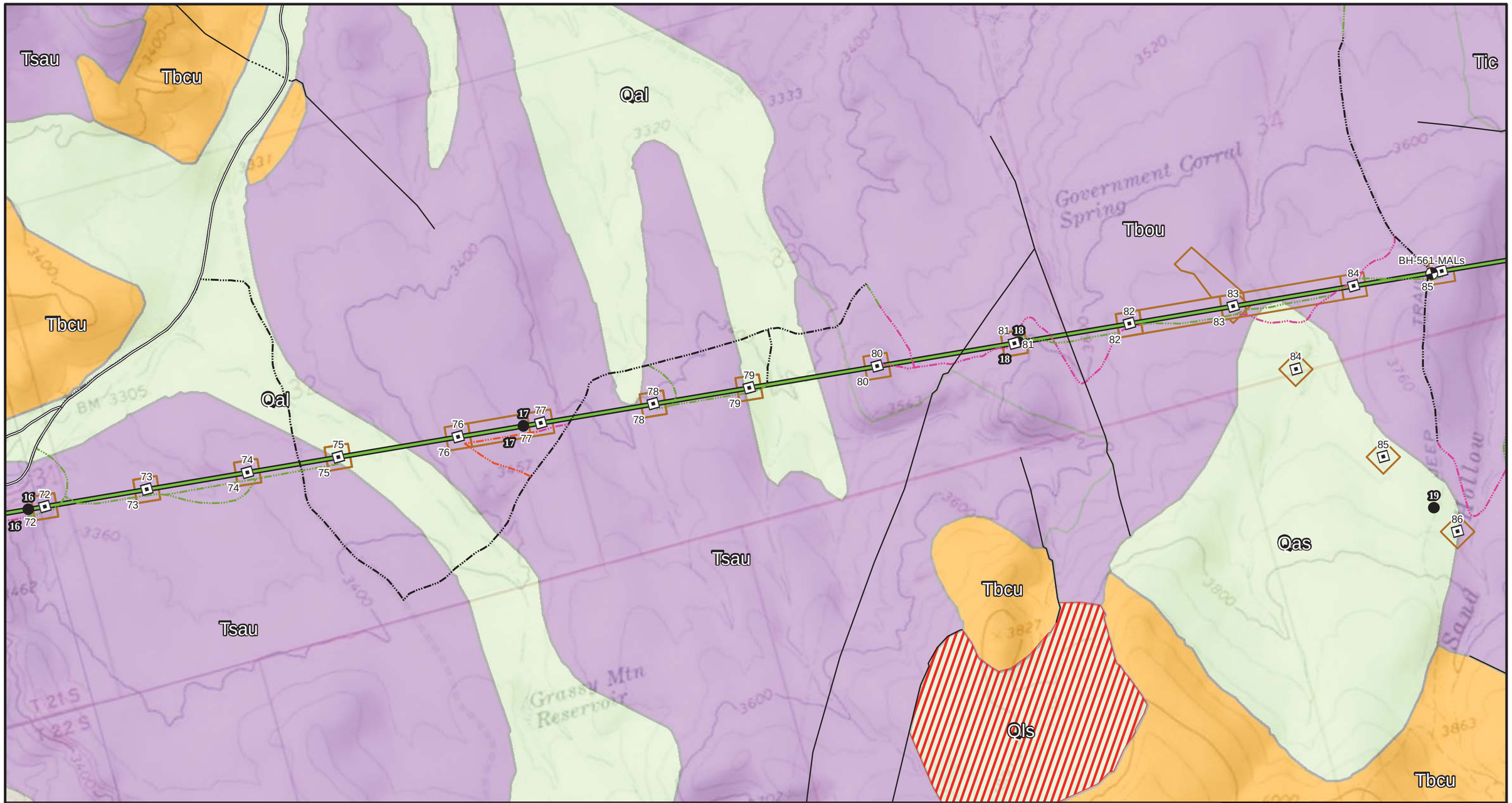

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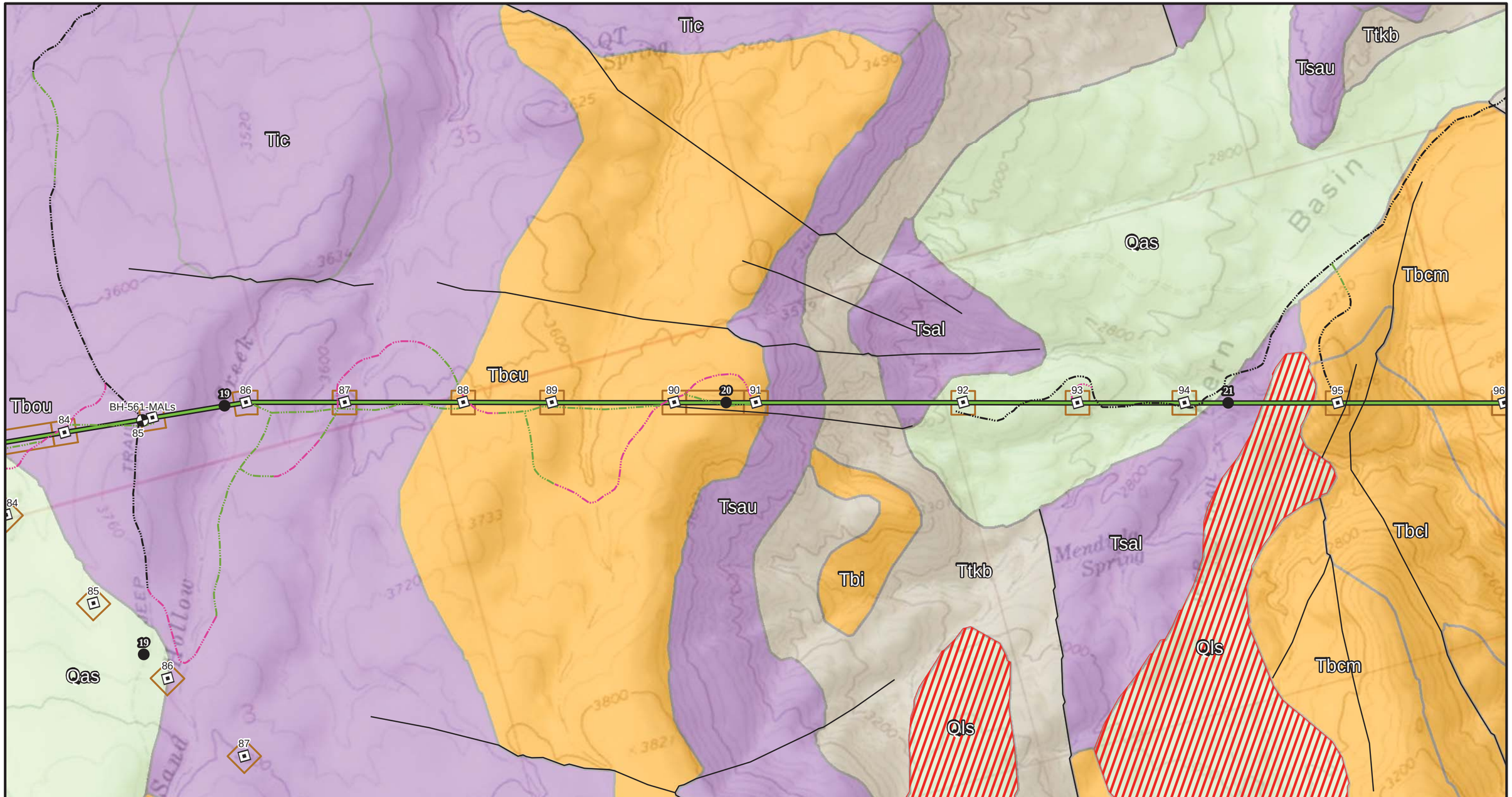

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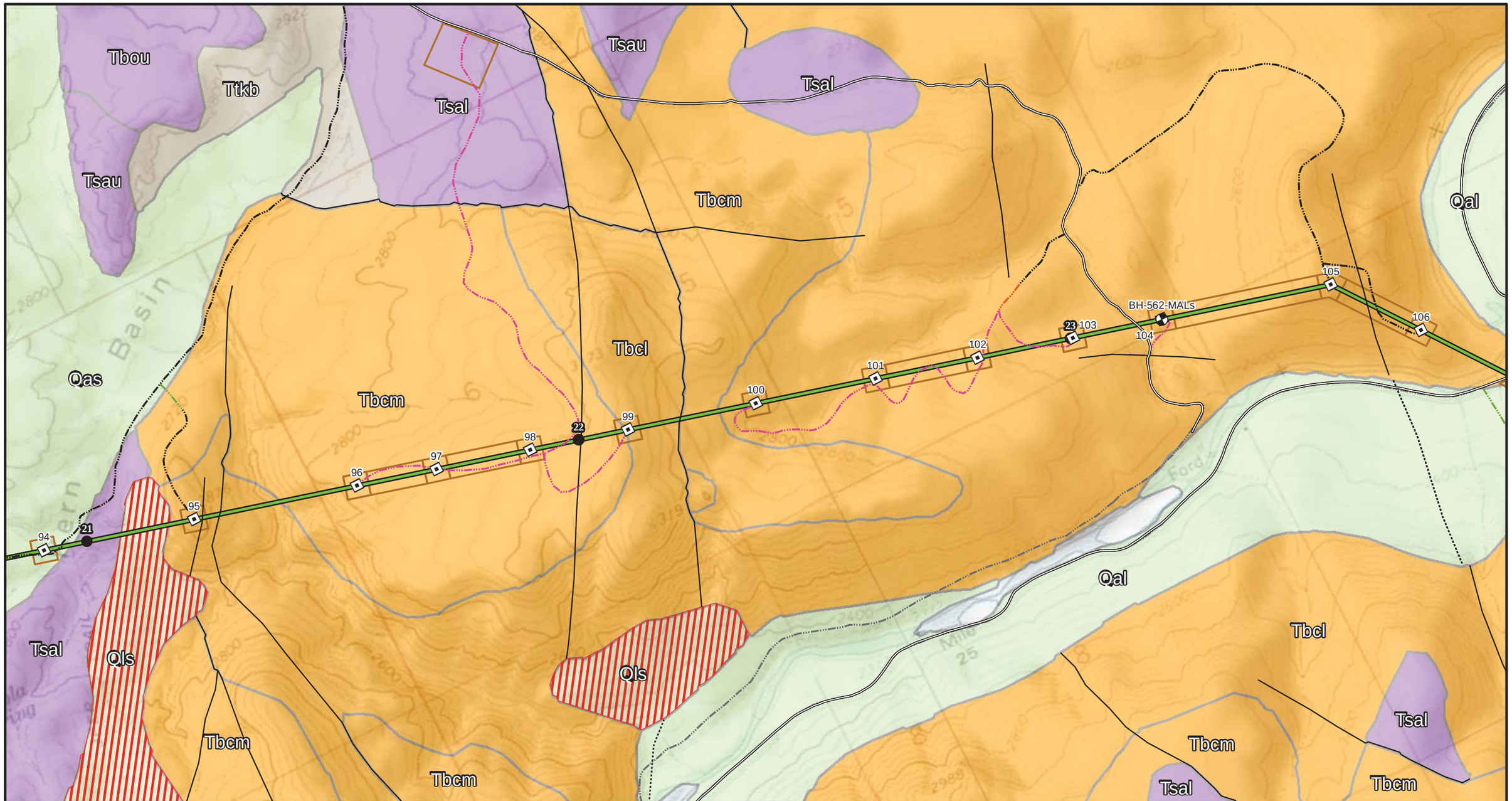

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BH-562-MALs
BH-563-MALs
BH-553-MALa
Tig
Tsal
Tbcm
Tbcl
Qal
117
116
115
114
113
112
111
110
109
108
107
106
26
25
24

LEGEND

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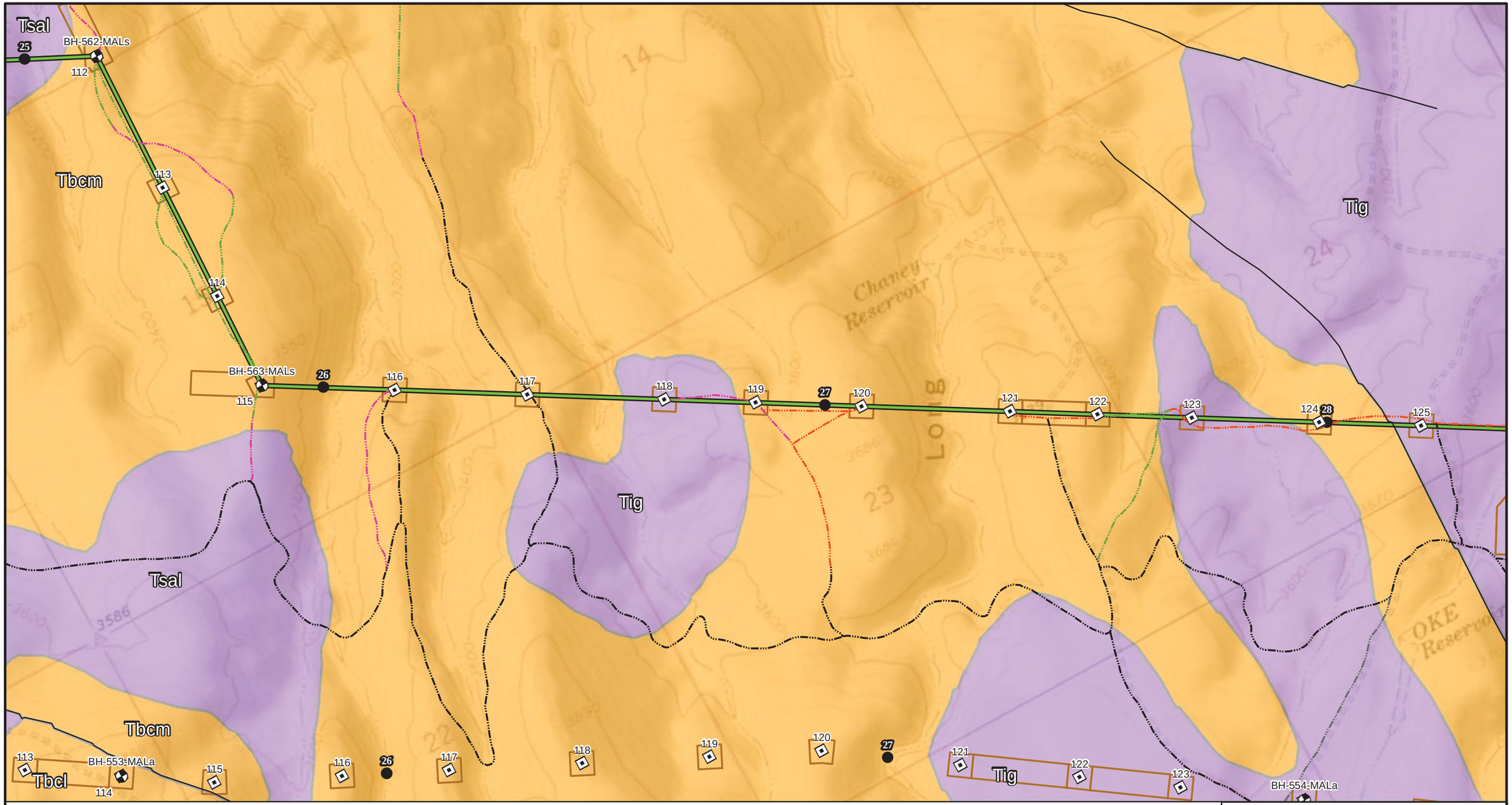

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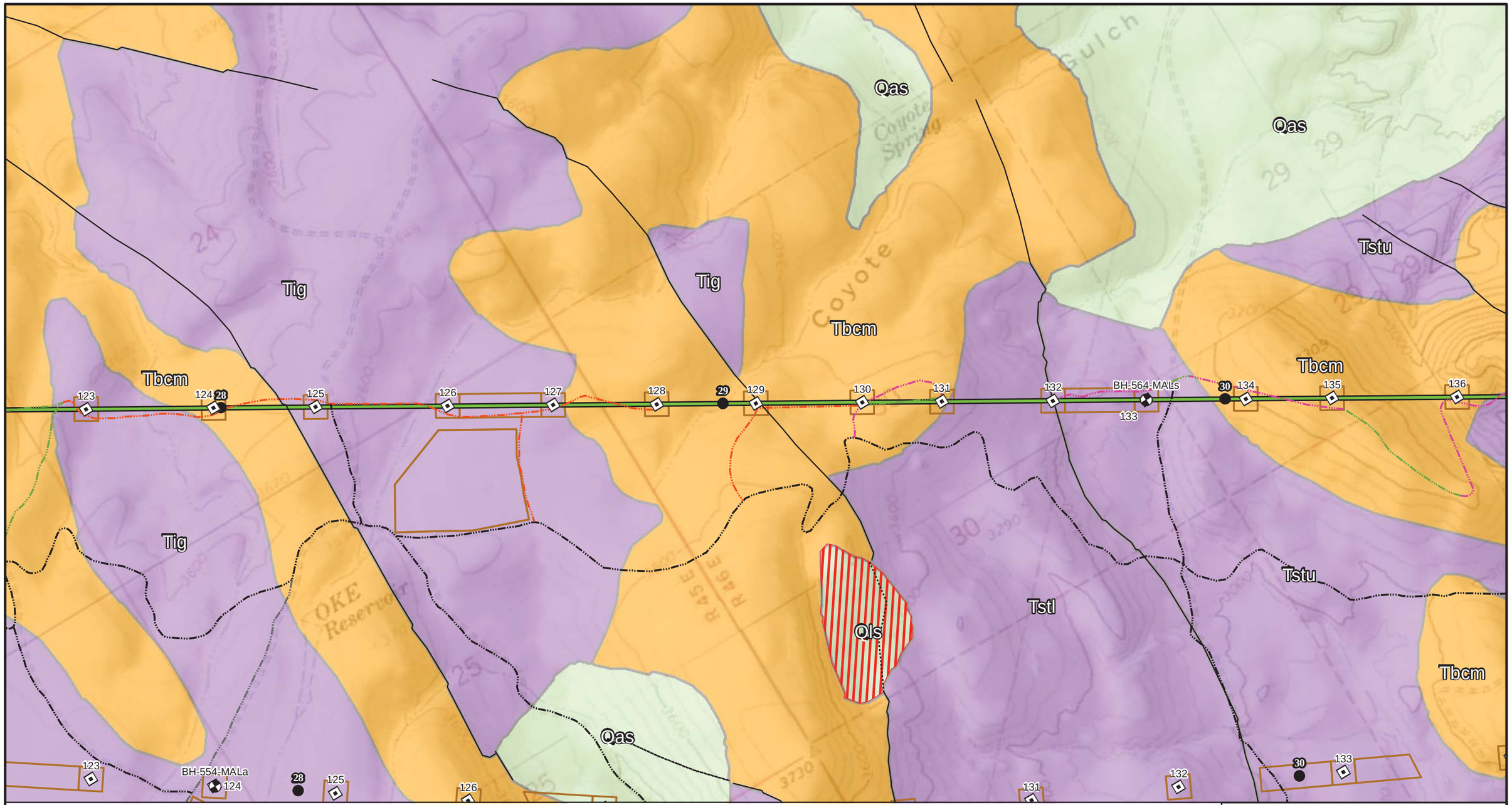

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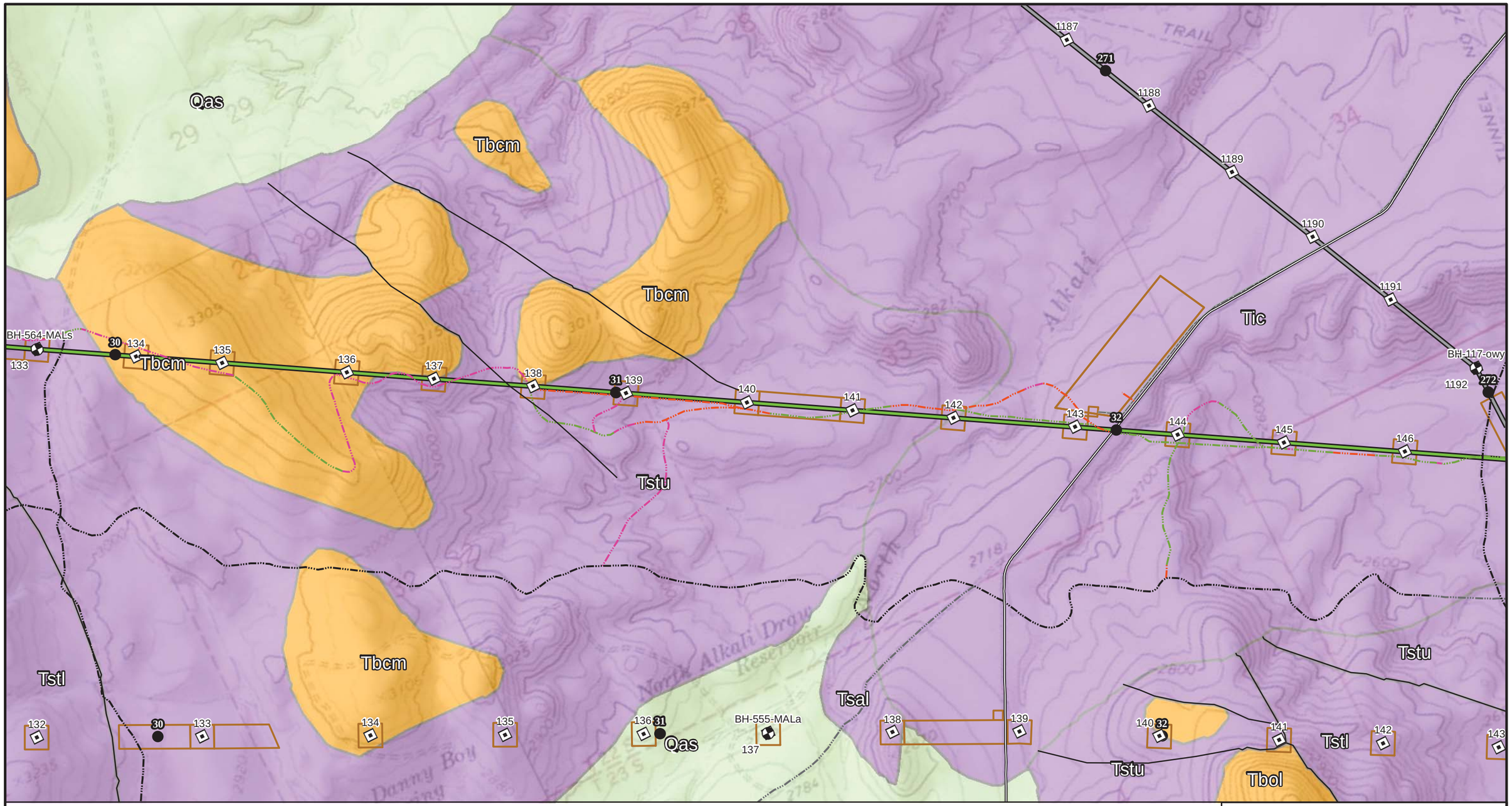

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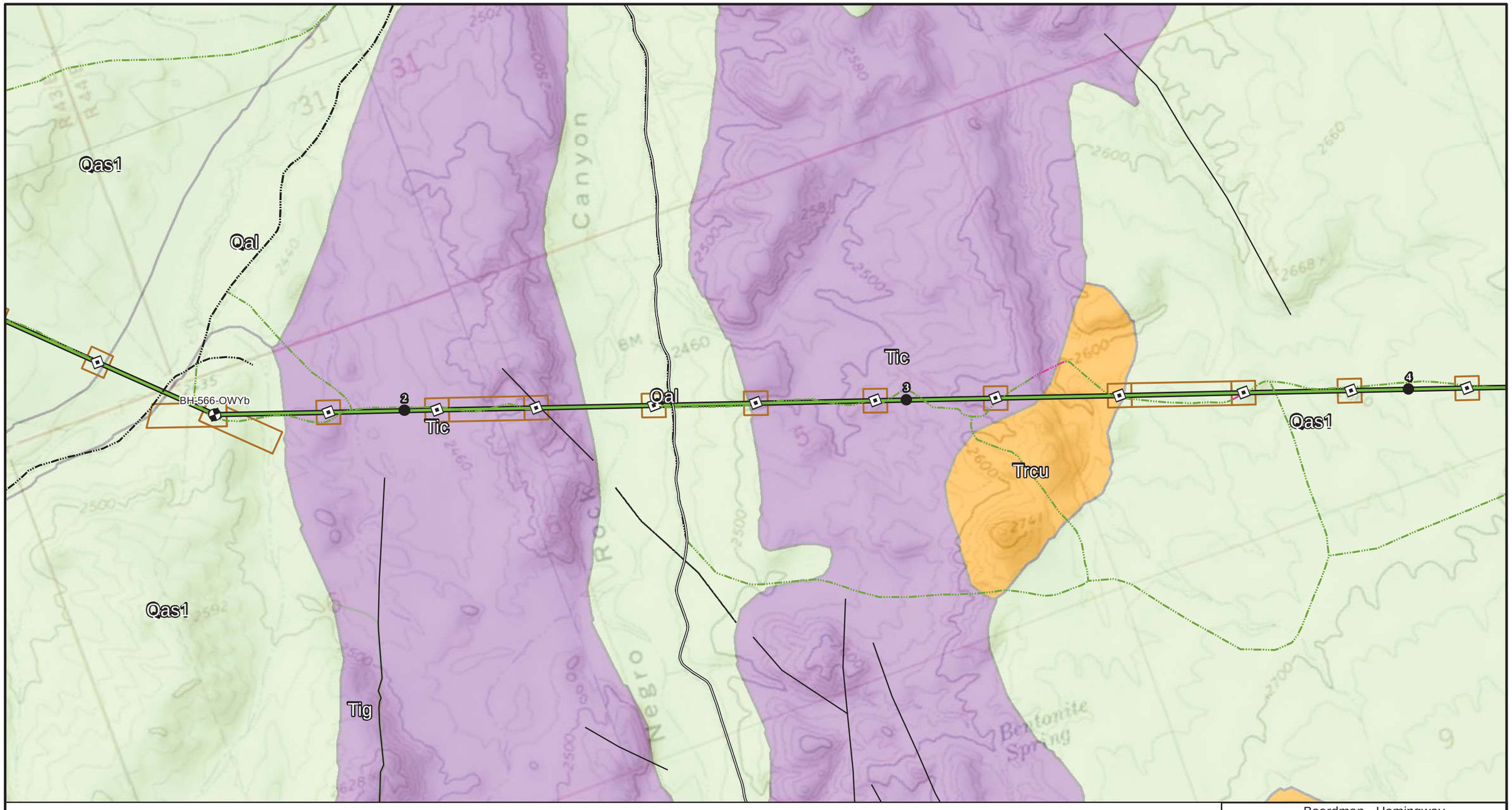

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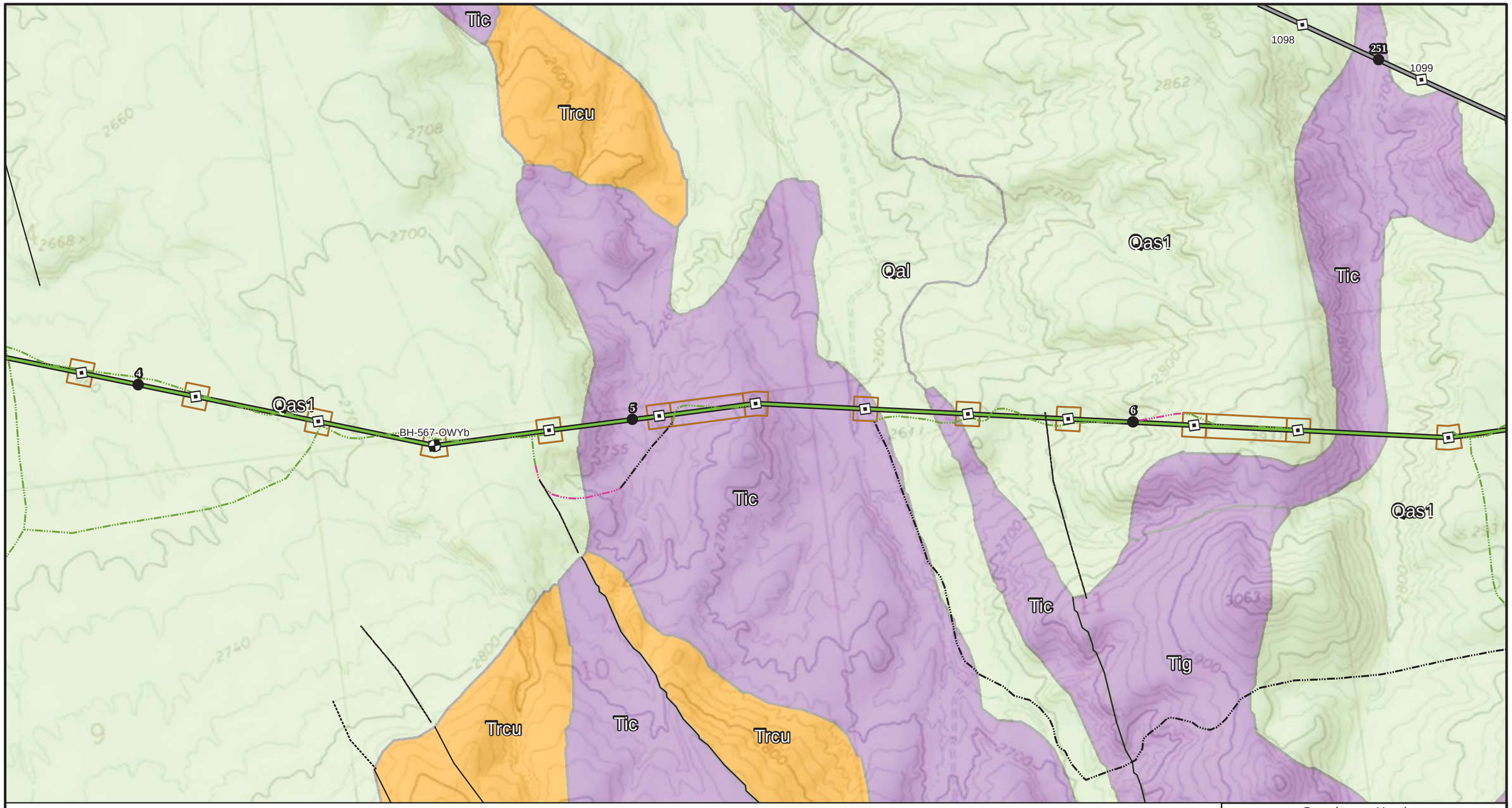

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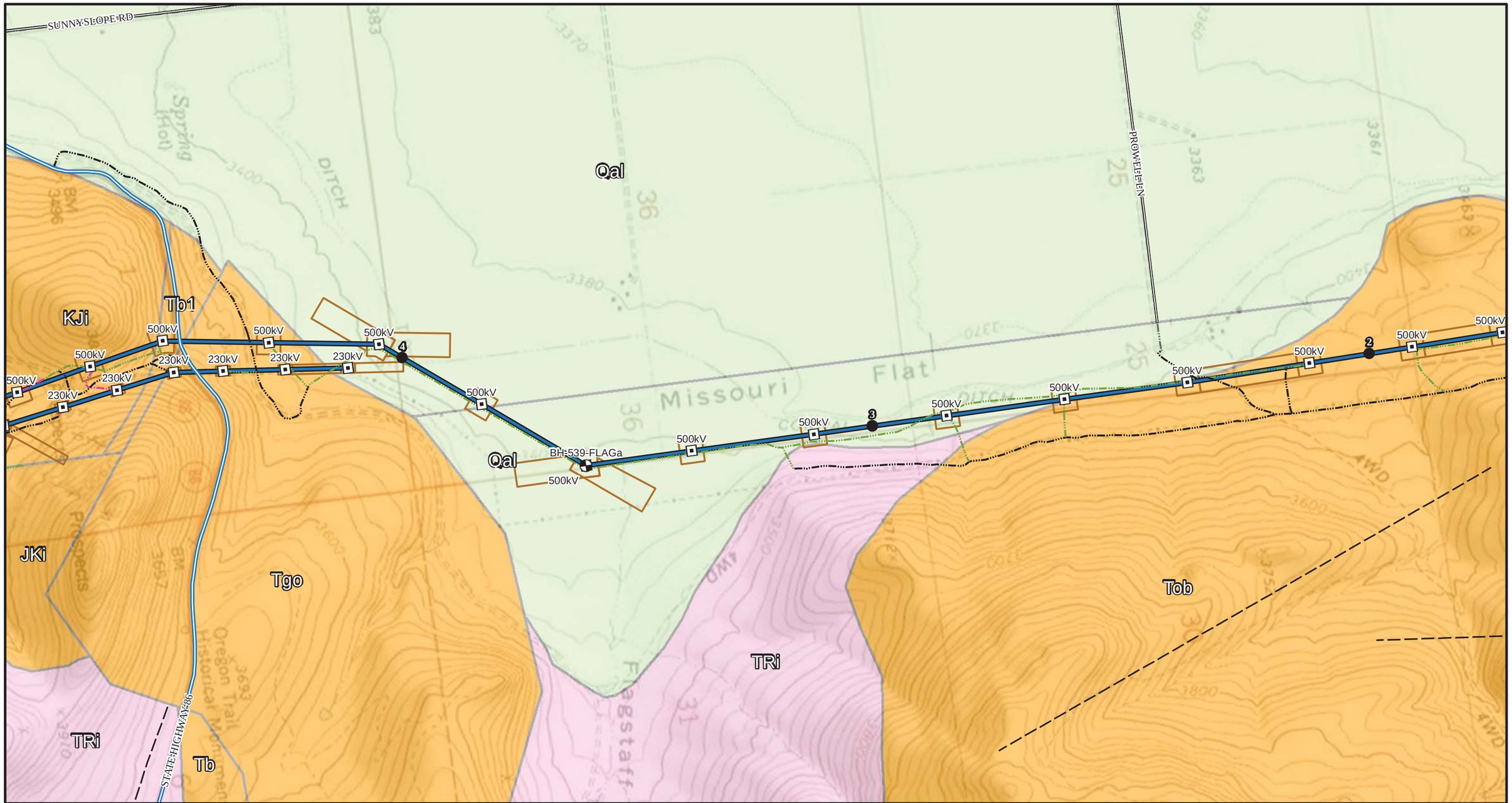

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LEGEND

TRANSMISSION FEATURES
- IPC Proposed Route
- IPC Alternative
- NEPA Alternative
- Work Area
- Mileposts
- Towers
- Proposed Borehole

SURFICIAL GEOLOGY
- Igneous Rock
- Metamorphic Rocks
- Sedimentary Rocks
- Unconsolidated Rocks
- Volcaniclastic Rocks

LANDSLIDES
- Fan
- Landslide (SLIDO)
- Talus - Colluvium

FAULTS
- Approximate
- Approximate and queried
- Certain
- Concealed
- Inferred
- Inferred and queried

COMMUNICATION
- Communication Power
- Communication Fiber

PRELIMINARY ACCESS PATHS
- Bladed
- Bladed ATV
- Overland Clear and Cut
- Overland Travel
- Overland with Clearing
- Existing Access, To Be Improved
- Existing Access, May Need Repairs
- Existing Access, No Improvement

EXISITING TRANSPORATION ROADS
- Primary Limited Access Road
- Primary US and State Highways
- Railroad

NOTE
For geologic unit descriptions see Table A-2

0 1,000 Feet

Boardman - Hemingway
500kV Transmission Line
Oregon - Idaho

GEOLOGY

August 2012 22-1-02947-200

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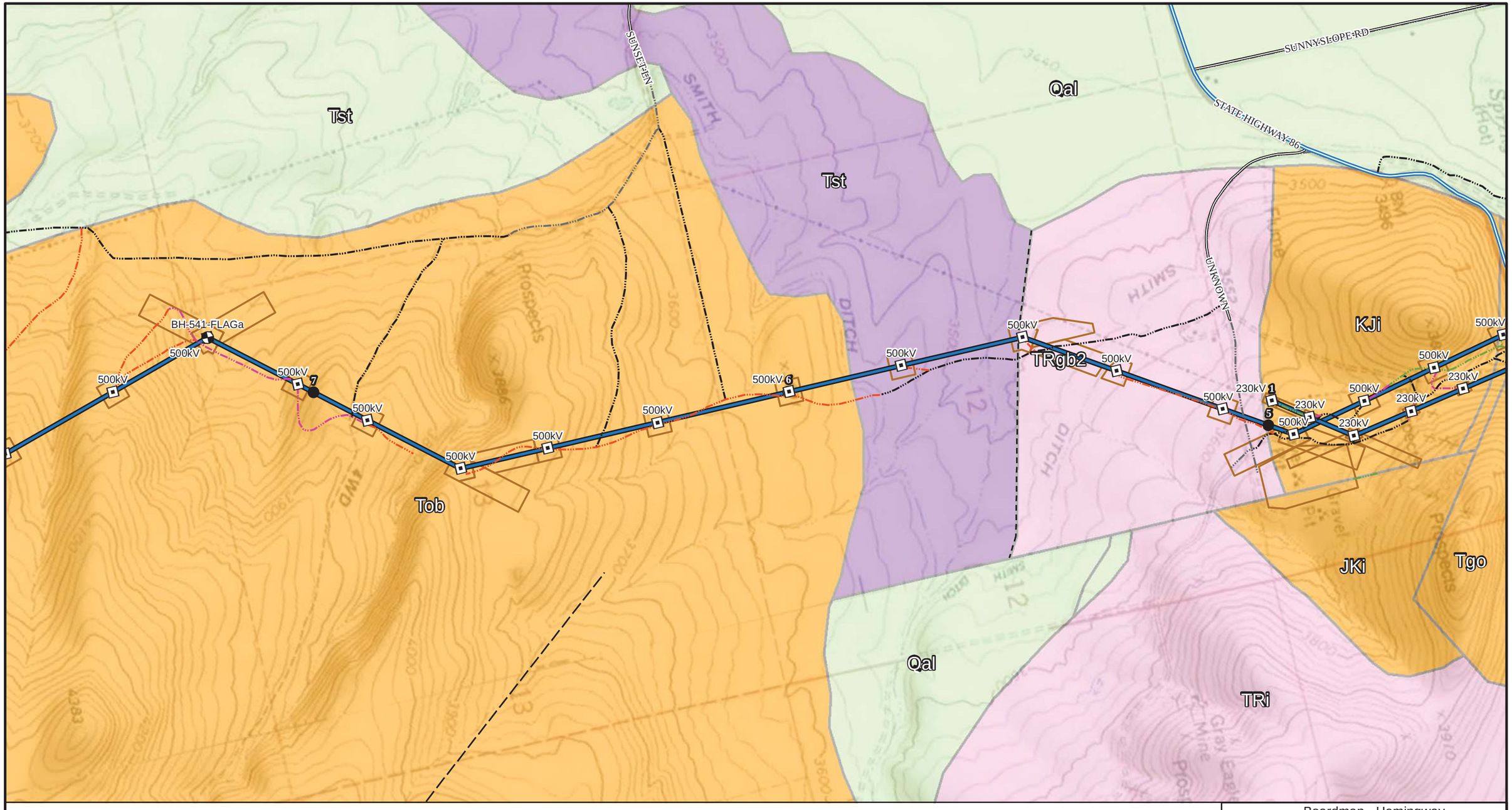

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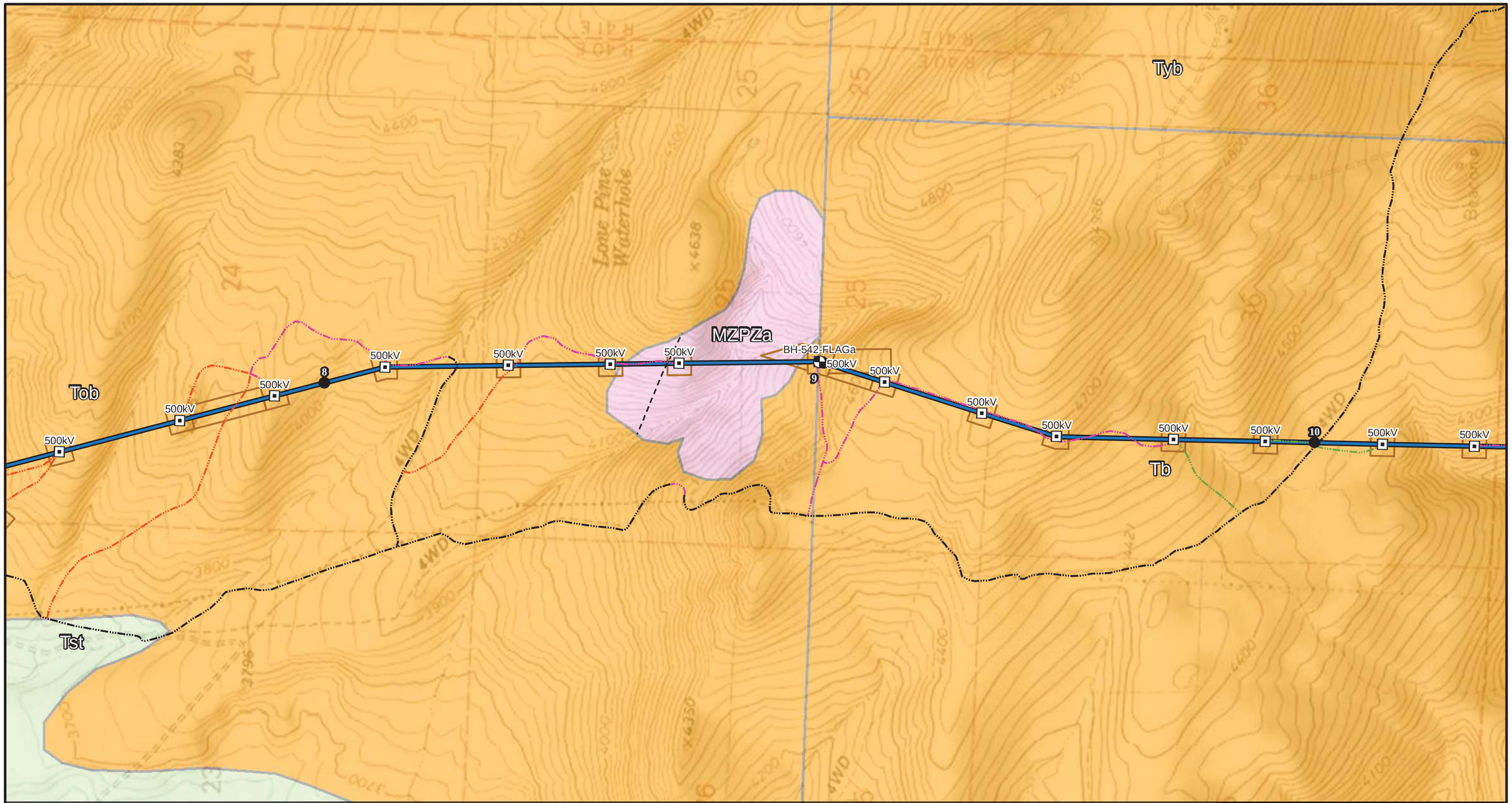

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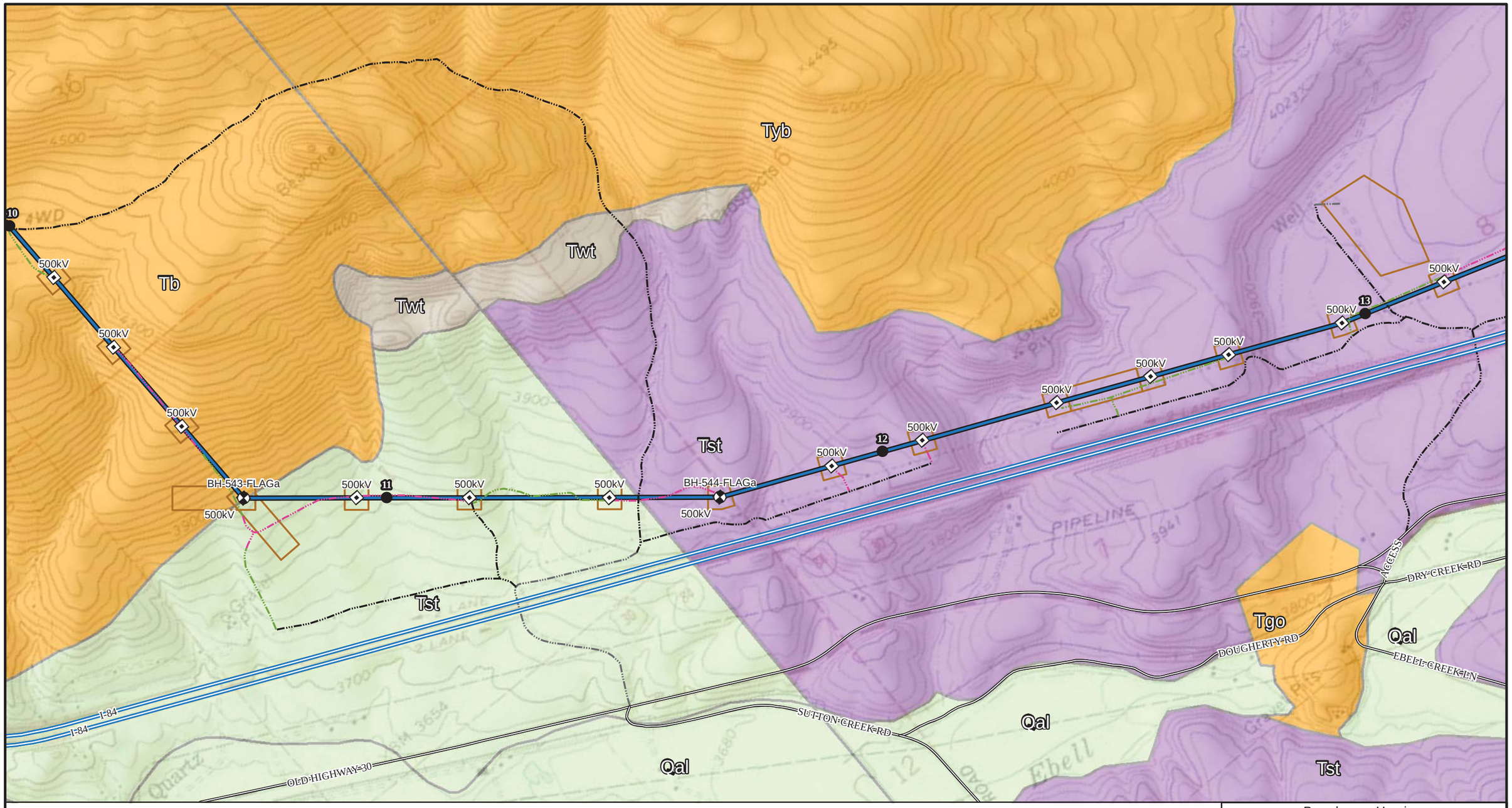

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