Alternatives Analysis Recommendation Memorandum

Brunner Road; BNSF Rail Separation

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Purpose of the Report

The David Evans and Associates (DEA) team was selected to evaluate and develop concepts for a grade-separation structure on Brunner Road at the Burlington Northern Santa Fe Railway (BNSF) crossing to remove the existing at-grade intersection. This report analyzes five alternative alignments for Brunner Road:

1. Realignment with an underpass at the BNSF crossing
2. Realignment while constructing an overpass at the BNSF crossing with a roundabout west of the railway
3. Realignment with a jughandle west of the railway and an overpass at the BNSF railway
4. Realignment of Brunner and Diagonal Road with an overpass at the BNSF crossing
5. no-build alternative

Through planning documents research, engineering analysis, and conversations with the highway district, a preferred alternative is recommended to advance into project development.

Background

Brunner Road, connecting State Highway 41 and US-95, is located within the Lakes Highway District of rural Kootenai County, Idaho. The road crosses the BNSF mainline at railroad milepost 34.72. 400-feet west of the railroad crossing is the intersection of Brunner, E Diagonal, and N Clagstone Road. The proposed project area was studied under the 2004 Bridging The Valley (BTV) planning document and will roughly impact 3000-feet of the existing Brunner Road.

Project Description

The project proposes to construct a structure to separate Brunner Road and the BNSF railway which will improve the throughput and safety of the existing road. Improvements will also be made to the intersection of Brunner, Diagonal, and Clagstone Road due to the projected vehicular traffic of Brunner to nearly double within the next 25 years. The intersection of Brunner with the railway is at an extreme skew angle (49 degrees), creating an unsafe condition due to intersection sight distance. Brunner has a posted speed limit of 50mph. The railroad intersection with Brunner is an extremely busy double track with a signal, horn, and gates, but vehicles can still bypass the gates. The intersection of Brunner with Diagonal and Clagstone is two-way stop controlled (from Diagonal/Clagstone). The Brunner/Diagonal/Clagstone intersection has large paved returns to allow turning movements. Diagonal has a posted speed limit of 50mph, although the curve of Diagonal that leads to Brunner is posted at 15mph. Clagstone has a posted speed limit of 50mph and has many driveways leading to Brunner. All roads are 2 lane rural roads with varying shoulder width. With the alternatives, the separation of Brunner and the BNSF railway will be accomplished with a structure, causing a realignment of Brunner and a reconfiguration of the Brunner/Diagonal/Clagstone intersection.

A vicinity map showing the project locations can be found in **Appendix A**.

Project Purpose

The purpose of this project is to construct a structure to separate the intersecting traffic movements of Brunner Road with the BNSF railway to increase safety and eliminate travel delays due to railway traffic between State Highway 41 and US-95 Roadways.

Project Need

The project is needed to increase safety and improve mobility on Bruner Road. Brunner Road is a major transportation corridor that is projected to experience a significant increase in traffic in the coming years.

Adopted Planning

Bridging the Valley

The Bridging the Valley (BTV) corridor plan is to separate vehicle traffic from train traffic in the 42 mile corridor between Spokane, Washington and Athol, Idaho. The separation of railroad and roadway grades in this corridor, which currently includes 75 railroad roadway crossings, will promote future economic growth, traffic mobility, traffic safety, and train whistle noise abatement.

The Brunner Road over the BNSF is a BTV project.

Excerpted from: http://kmpo.net/BridgingtheValley.html

Lakes Highway District Transportation Plan

Lakes Highway District completed a transportation plan in 2014. The plan identified various capital improvement projects. The transportation plan references the BTV study and utilizes the concept plan for funding and cost estimating purposes.

Summary of Public Involvement and Stakeholder Engagement

Meetings with the Lakes Highway District to discuss the alternatives occurred throughout the concept process. Their comments were recorded and addressed during the engineering phase.

Engaging the public in a manner that incorporates their needs and concerns into the decision-making process is an important element of the Bridging the Valley study process. A website for the project is at www.BridgingTheValley.org. Outreach to land owners and other project stakeholders is ongoing. Because right-of-way will be required for the project, the design team will be in contact with property owners to explain the right-of-way process and potential property impacts. These contacts will offer each owner the opportunity to provide input and ask questions. Stakeholders will be kept informed throughout the design process.

Right-of-Way Impacts

The realigned Brunner Road will impact private property owners (permanent right-of-way acquisition) and a new permanent easement across the BNSF. Major impacts to the parcels are only expected on undeveloped areas with no relocations or buildings impacted. Potentially minor grading impacts to parcels that are developed may happen based on alternatives. The new permanent easement across the BNSF will simply show the change in location of Brunner and provide an easement for highway district maintenance and use of the area by the traveling public.

Utilities

The project proposes to realign Brunner Road and impact the Brunner/Diagonal/Clagstone intersection and the roadway of Diagonal and Clagstone Road leading to the proposed intersection. These improvements will impact above and below ground utilities. Known utilities include:

- Avista Gas –
- Sprint fiber optics –
- Kootenai Electric –
- Bitterrot Water Company –
- Adelphia Cable –
- Verizon GTE telephone –

It is anticipated that a utility hearing will be held before Final Design Submittal to offer an opportunity for the utilities to be heard.

Project Design Criteria

The project will be designed in accordance with the Lakes Highway District, the Idaho Transportation Department (ITD) and the American Association of State Highway Transportation Officials (AASHTO) standards. According to Kootenai Metropolitan Planning Organization's 2014 Rural Federal Functional Classification map, Brunner Road and Diagonal Road are rural major collectors, and Clagstone Road is a rural minor collector.

Design Speed

Finding: Brunner, Diagonal, and Clagstone Road are posted at 50 mph. The curve leading to the intersection from Diagonal to Brunner is posted at 15 mph.

Recommendation: The removal of the at-grade BNSF crossing on Brunner Road located east of the Brunner/Diagonal/Clagstone intersection will eliminate many of the existing safety issues and increase the capacity of Brunner Road. However, the design of the bridge over the BNSF railroad will be primarily driven by the design speed and geometry of the intersection of Brunner/Diagonal/Clagstone and achieving clearance regarding the BNSF railway. Horizontal and vertical curves on Brunner will be designed for the 50mph posted speed, except for Alternative 2. No changes to the current posted speeds are proposed for Diagonal or Clagstone, except for Alternative 2. The jughandle that links Brunner and Diagonal was designed at 35mph. A summary of the proposed posted and design speeds are as follows:

Roadway	Existing Posted Speed	Design Speed			
		Alt 1	Alt 2	Alt 3	Alt 4
Brunner	50MPH	50MPH	35MPH	50MPH	50MPH
Diagonal	40MPH	50MPH	35MPH	50MPH	50MPH
Clagstone	40MPH	50MPH	35MPH	N/A	N/A
Jughandle	N/A	N/A	N/A	35MPH	N/A
Realignment	N/A	N/A	N/A	N/A	50mph

Roadway Width

Finding: Brunner, Diagonal, and Clagstone roads currently consist of 2-12' lanes with shoulder widths that vary between 2' and 4'.

Recommendation: Improved roadways will meet Lakes Highway District Standards with 2-12' lanes and 5' paved shoulders with a 2' gravel shoulder. The proposed roadway widths are as follows:

Roadway	Lane Width	Existing Shoulder Width	Proposed Shoulder Width
All Proposed Roads	12'	Varies – 2' to 4'	5' paved (2' gravel)

Appendix B has detailed design criteria for the various elements of the project.

Alternatives Analysis

Five (5) design alternatives were developed and analyzed for the project. Alternative #1 was developed under the Bridging the Valley project, consisting of lowering Brunner and constructing bridges for the BNSF railway to create a roadway underpass for Brunner. Alternative #2 considers shifting Brunner that lies east of the railway southwards to cross the railway via a bridge, constructing a roundabout southwest of the existing intersection where the proposed Brunner Road is. Alternative #3 proposes a realignment of Brunner with a bridge over the railway, requiring a jughandle to connect Brunner with Diagonal west of the intersection. Alternative #4 involves constructing a realignment road that shifts Brunner southward and over the railway using a bridge, connecting with the existing Diagonal Road via an intersection southwest of the railway crossing. Finally, Alternative #5 is the "No-Build" alternative. These alternatives are discussed in detail in the following sections.

Alternate #1, Underpass

This alternative proposes to shift and lower the alignment of Brunner to the south. Due to the lowering of the roadway, an underpass will be constructed where the proposed Brunner alignment and the BNSF railway meet about 0.12 miles south along the tracks of the existing at-grade intersection. The existing intersection of Brunner/Diagonal/Clagstone will be shifted southwards about 400-feet, aligning with the proposed Brunner alignment. The bridges constructed for the BNSF railway over Brunner is set at a bridge skew of 90°. To achieve roadway clearance, the road would be dug roughly 17-feet below the existing grade line where the railways are. There will be a temporary railway shoo-fly constructed during the roadway construction to maintain railway level of service. The three railway bridges to be constructed are 118-feet long.
Advantages and disadvantages of the underpass alternative are as follows:

Advantages:

- Minimal detour impacts for automobiles
- Maintains posted automobile speeds
- Advances the BTV plan

Disadvantages:

- Most expensive due to railroad shoo-fly ($5 mil)
- Second largest right of way impact

- Interferes with normal railroad operation while roadway is being constructed
- Proposed roadway and intersection are lowered below existing ground
- Underpass has reduced sightlines and could cause snow removal/stormwater issues
- Would likely not be supported by BNSF

The estimated construction costs for Alternative #1 is approximately $19.9M. An exhibit showing Alternative #1 may be found in **Appendix C.**

Alternate #2, Roundabout with Overpass

During the concept development of the project, the design team took a fresh look at the Bridging the Valley proposed layout and location. One of the principal constraints and constructability issues for the alternative was the construction of a temporary railroad crossing. This could be alleviated if a roadway bridge was constructed instead of an underpass and railway bridges. In order to construct a roadway bridge with a lesser skew angle, Brunner Road was shifted southwards, causing the existing intersection of Brunner/Diagonal/Clagstone to shift southwards as well. The proposed intersection would be a roundabout, with Diagonal and Clagstone being slightly adjusted to the proposed roundabout. The roundabout was carefully designed to not impact the existing Brunner alignment for constructability purposes. This allows for two-way traffic to be maintained through most of the construction of the proposed roadway and bridge. It also simplifies the coordination between the contractor and the BNSF, avoiding potential delays and costs during construction. The new overpass crossing between Brunner and the BNSF railway is about 0.12 miles south of the existing at-grade crossing. The proposed roundabout center is located approximately 320-feet southwest of the existing intersection. The proposed bridge in this alternative is 263-feet long by 32-feet wide.
The roundabout alternative has these advantages and disadvantages:

Advantages:

- Lowest cost
- Shortest bridge
- Lowest right of way impact
- Service of Brunner Road could be maintained for the majority of construction
- Roundabout will increase level of service over existing intersection
- BNSF has seen and supports this alternative

Disadvantages:

- Requires the most borrow due to raising the roadway nearly 24-feet to clear the railway
- Requires barrier for most of the roadway
- Construction could cause significant detours for Diagonal and Clagstone Road
- Design speed is lower than posted speed

The estimated construction costs for Alternative #2 is approximately $14.6M. The exhibits showing alternative #2 can be found in **Appendix D**.

Alternate #3, Jughandle with Overpass

A traditional intersection design with an overpass was sought, leading to an alternative possessing a jughandle. This alternative has Brunner shifted southwards, with a bridge constructed over the railway and Diagonal Road, with the proposed Brunner Road tying into the existing Brunner Road. About 0.14 miles west of the existing intersection a proposed intersection would be built on the proposed Brunner to construct the jughandle, which would connect Brunner and Diagonal Road. The jughandle would continuing to Diagonal Road about 0.17 miles along Diagonal Road south of the existing intersection. Diagonal Road would be adjusted to accommodate a new intersection between itself and the jughandle by slightly altering the roadway profile. The existing intersection of Brunner/Diagonal/Clagstone would have no eastbound or westbound access, and would eliminate the at-grade railway crossing. Clagstone Road would not be altered. The bridge length for this alternative is 400-feet long by 32-feet wide.

The advantages and disadvantages of the jughandle alternative are located below:

Advantages:

- Second lowest cost
- Low right of way impact
- Removes existing Brunner/Diagonal/Clagstone intersection, with it having no traffic control needed
- Posted speed is maintained
- Does not impact the existing Brunner/Diagonal/Clagstone intersection
- Minimal detour impacts

Disadvantages:

- Requires significant borrow due to raising the roadway nearly 24-feet to clear the railway
- Jughandle is 35 MPH instead of 50 MPH like the surrounding roads
- Long bridge span
- Two intersections instead of the present one
- Requires barrier for most of the roadway

The estimated construction costs for Alternative #3 is approximately $15.4M. The exhibits showing alternative #3 can be found in **Appendix E**.

Alternate #4, Brunner/Diagonal Realignment with Overpass

A potential realignment of Brunner Road was entertained during the concept development phase. Brunner Road east of the railway would be shifted southwards and elevation raised to construct a bridge over the railway and Diagonal Road south of the existing crossing. The roadway once past the bridge, now called Realignment Road, would not tie into existing Brunner Road, but instead would curve south to tie into Diagonal Road about 0.5 miles south along Diagonal Road from the existing Brunner/Diagonal/Clagstone intersection. Diagonal Road 0.25 miles south of the Brunner/Diagonal/Clagstone intersection and 0.25 miles north of the tie-in of Realignment and Diagonal Road would curve westward to meet Realignment Road creating an intersection. This would restore access of the new proposed road to northbound travel. There would be no impact to the existing Brunner Road west of the existing intersection. There would be no impact to Clagstone Road. Roadway east of

the existing intersection would be removed, eliminating the at-grade railway crossing. Bridge length for the alternative is 436-feet long by 32-feet wide.
Advantages and disadvantages of the alternative are as follows:

Advantages:

- Minimal detour impacts
- Design speed is the same as the existing posted speeds for all roadways
- Does not impact Clagstone Road
- Easy constructability

Disadvantages:

- Requires significant borrow due to raising the roadway nearly 24-feet to clear the railway
- Requires barrier for most of the roadway
- Existing Brunner/Diagonal/Clagstone intersection would still require traffic control
- Proposed roadway afflicts longer commutes over the railway due to realignment
- Longest roadway length of alternatives
- Longest bridge of alternatives
- Highest cost of alternatives
- Largest right of way impact

The estimated construction costs for Alternative #4 is approximately $17.7M. The exhibits showing alternative #4 can be found in **Appendix F**.

Alternate #5, No-Build Alternative

This alternative does not improve the hazardous at-grade intersection and railroad crossing and does not address the need to increase safety and improve mobility. Therefore, this alternative is not recommended.

Engineering Analysis Matrix

The five alternatives described above were compared and ranked in an engineering analysis matrix. The analysis matrix looks at important project criteria and quantifies them for a numerical comparison. The criteria in the analysis matrix included Right-of-Way Impacts, Project Footprint (Environmental Impact), Constructability, Traffic Operations, Safety, Public Perception, BNSF Preference, Long-Term Maintenance, and Construction Costs. These criteria were given a weight to match what the perceived value of each are to the project. A weight of 10 would mean it is of the highest importance whereas a 1 would mean the criterion is not very important.

Based on the criteria, each alternative was scored within a range of 1 to 10, 10 being the best or most favorable and 1 being poor or least favorable. The scores were multiplied by the weights to obtain a numerical product where the higher the number, the better result. Cost estimates for the four build alternatives can be found in **Appendix G** and the engineering analysis matrix can be found in **Appendix H**.

Recommendation

The proposed alternatives satisfy the goals and objectives for the project. However, Alternative #2 (Roundabout with Overpass) does so at less cost compared with the other overpass alternatives and with greater traffic operational efficiency compared to all alternatives. The lower cost is primary attributable to the shorter bridge over the BNSF, fewer properties impacted through the right of way acquisition process, and a shorter overall road length. Additional project criteria were analyzed in the engineering analysis matrix. A summary of the costs and the engineering analysis matrix are shown in the table below.

	Alternative #1, Underpass	Alternative #2, Roundabout w/ Overpass	Alternative #3, Jughandle w/ Overpass	Alternative #4, Brunner/Diagonal Realignment w/ Overpass	Alternative #5, No-Build
Construction Cost	**$19,898,000**	**$14,585,000**	**$15,319,000**	**$17,659,000**	**N/A**
Total Score (High is Best)					

Based on analysis provided in the narrative of this memorandum and the engineering analysis matrix, **it is recommended that Alternative #2 be used as the preferred alternative.**

Appendix A – Vicinity Map

Township 53 N
Range 3 W
Sections 29, 30, 31, 32

Figure 1
Project Vicinity

Legend
Project Study Area

N

0 0.15 Miles

Brunner Road Grade Separation
Kootenai County, Idaho
Lakes Highway District
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Appendix B – Project Design Criteria

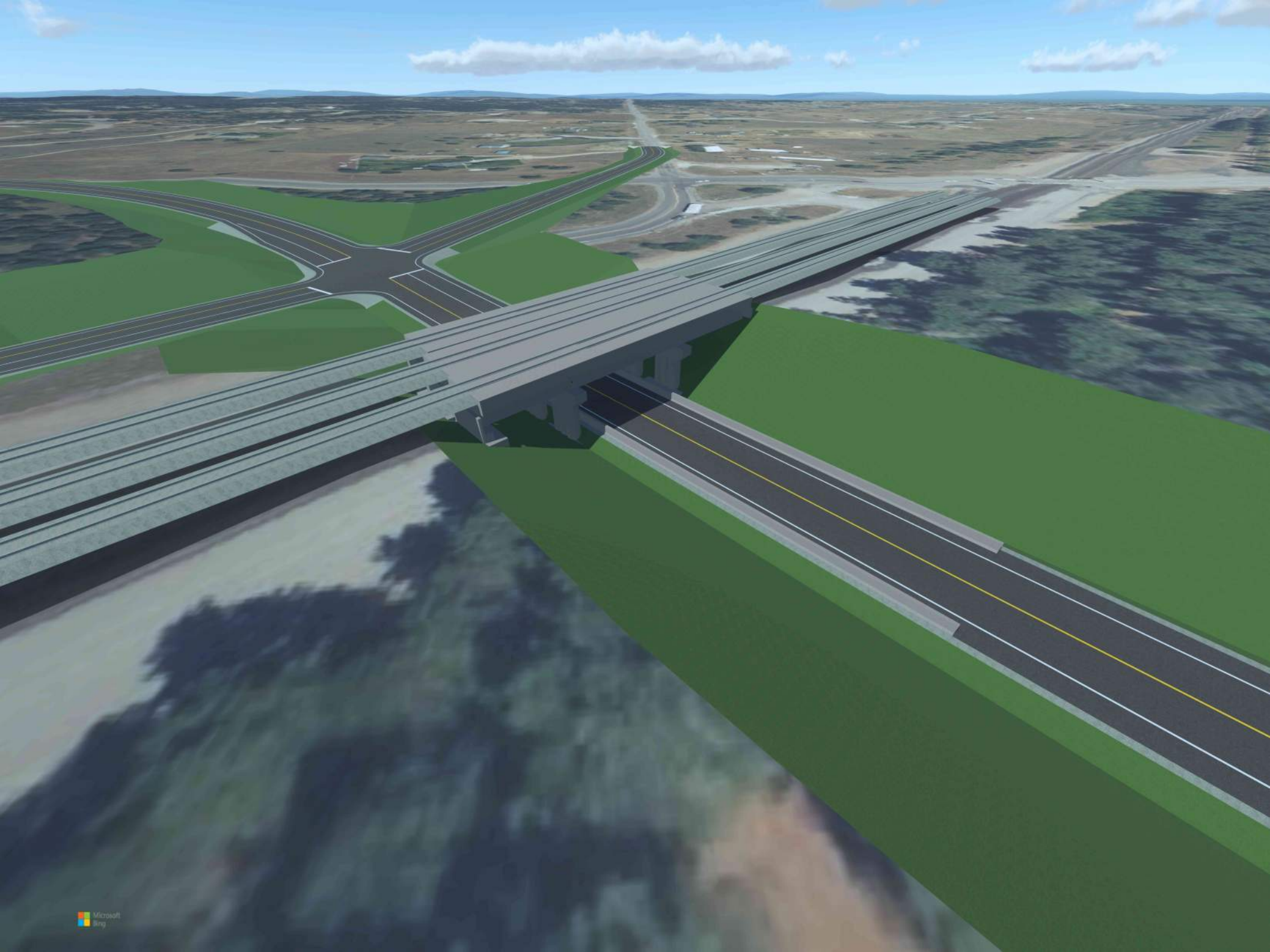
ROADWAY DESIGN GUIDELINES

DESIGN CRITERIA RESOURCES:
IDAHO TRANSPORTATION DEPARTMENT DESIGN MANUAL - Most Current (ITD)
AASHTO - A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS, 2018 (AASHTO)
HIGHWAY STANDARDS FOR THE ASSOCIATED HIGHWAY DISTRICTS, KOOTENAI COUNTY ID 2019 (LHD)
TRANSPORTATION PLAN LAKES HIGHWAY DISTRICT 2014 (TPLHD)
LAKES HIGHWAY STANDARD PLANS 2023 (SD)
Manual on Uniform Traffic Control Devices - Most Current (MUTCD)

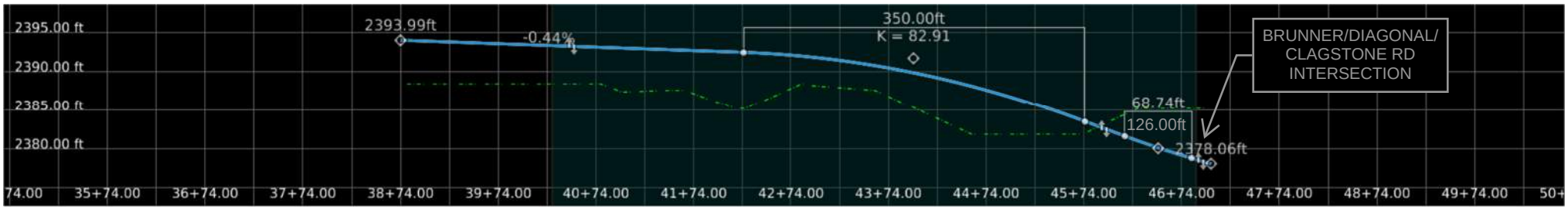
		Brunner	Clagstone	Diagonal	
DESIGN GUIDELINE	CRITERIA BASIS	STANDARD	STANDARD	STANDARD	COMMENTS
Functional Classification	ITD 335.03; / LHD Classification Map	Rural Major Collector	Rural Minor Collector	Rural Major Collector	KMPO 2014 Functional Classification Map
Ownership		LHD	LHD	LHD	
Terrain	ITD 335.05 / AASHTO	Level	Level	Level	
Design Speed (mph)	ITD 335.07 / AASHTO Ex 6-1	50	50	50	Posted Speed Limits
Stopping Sight Distance (ft)	LHD 305.01 / AASHTO Table 3-1	425	425	425	
TRAFFIC					
TRAFFIC REPORT					
Average Daily Traffic					
Directional Design Hourly Volume					
Percent of Truck					
Minimum Level of Service	LHD pg. 90 / AASHTO 6.2.1.3	C	C	C	
GEOMETRY					
HORIZONTAL					
Minimum Radii - Depends on max superelev. (ft)	AASHTO table 3-9	833'	833'	833'	
Maximum Superelevation	LHD 304.01	6	6	6	LHD: 2 to 4% is desireable
VERTICAL					
Maximum Grade (%)	LHD 304.01	6	6	6	
Minimum Grade (%)	LHD 304.01	0.5	0.5	0.5	
Rate of Vertical Curvature (Ksag) (Stopping)	LHD 305.01	96	96	96	Lmin = 3V (150')
Rate of Vertical Curvature (Kcrest) (Stopping)	LHD 305.01	84	84	84	Lmin = 3V (150')
Rate of Vertical Curvature (Kcrest) (Passing)	LHD 305.01	1203	1203	1203	
Vertical Clearance - Roadway Structures (ft)	LHD 308.01	16	16	16	
Vertical Clearance - Railroad (ft)	UPRR-BNSF Joint Guidelines	23'-6"	23'-6"	23'-6"	Low chord to top of track. Abutments located off rail property
CROSS SECTION					
NO.OF TRAVEL LANES	AASHTO 6.2.2.2	1 Each Way	1 Each Way	1 Each Way	
Lane Width (ft)	AASHTO Table 6-5	12	12	12	11' minimum, 12' is preferred
Bike Lane Width (ft)	TPLHD Figure 7, SD-1A	2 (west) / 4.5 (east)	0	4.5	Brunner West Class III, East Class II. Class II & III can be part of shoulder.
Shoulder Width - Outside (ft)	LHD 306.03	5'(2')	5'(2')	5'(2')	Paved (Gravel), Eric requested 5' paved
Shoulder Width - Inside (ft)		NA	NA	NA	Shared Median
Normal Crown (%)	SD-1	2	2	2	
Minimum Clear Zone Distance - CUT - 5:1 To 4:1 Slope (ft)	AASHTO Roadside Design Guide pg. 3-3	14	14	14	
Minimum Clear Zone Distance - FILL - 6:1 Slope (ft)	AASHTO Roadside Design Guide pg. 3-3	14	14	14	
Surfacing Depth (in)	SD-1	4	4	4	
Base Depth (in)	SD-1	4	4	4	
Ballast Depth (in)	SD-1	12	12	12	
INTERSECTIONS					
Signalization		No	No	No	Stop controlled intersections
Design Vehicle	ITD 555.02, 555.03. 555.04 for Pavement Markings	WB-67	WB-67	WB-67	Use for Roadway edges. SU for pavement markings.
Right Turn Radius (ft) - Simple Curve w/Taper	AASHTO Ex. 9-19; Radius, Offset, Taper	125, 4.5, 30:1	125, 4.5, 30:1	125, 4.5, 30:1	LHD: OK to use same as ITD
Right Turn Radius (ft) - 3 Centered Curve		440/65/440	440/65/440	440/65/440	LHD: OK to use same as ITD
Accelleration/Decelleration lanes	AASHTO exhibit 10-70 & 10-73	No	No	No	
Acceleration/Decelleration Taper Rates	AASHTO pg. 845/AASHTO pg. 715	N/A	N/A	N/A	
Pedestrian Access	TPLHD Table 7	No	No	Yes	Only identified for Diagonal, talk of "seperated facility"
Bicycle Facilities		Yes	No	Yes	Roadway shoulder

Appendix C – Alternative #1 Exhibits

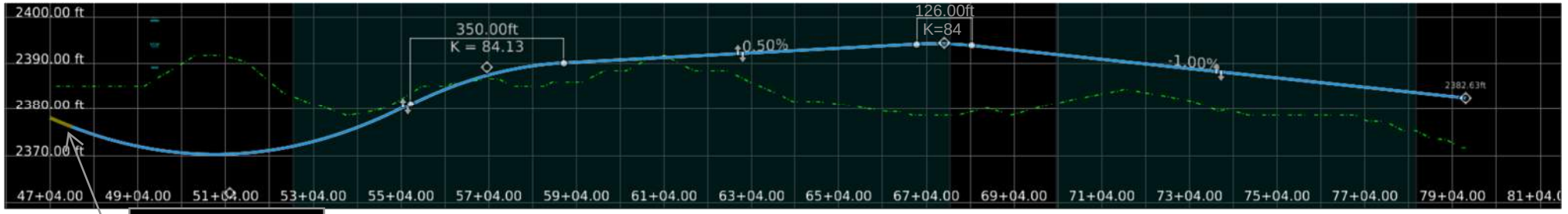

Alternative 1:
Underpass
N CLAGSTONE RD
W BRUNNER RD
BRIDGE
SKEW =90°
E DIAGONAL RD
E BRUNNER RD


Microsoft
Bing

W BRUNNER RD

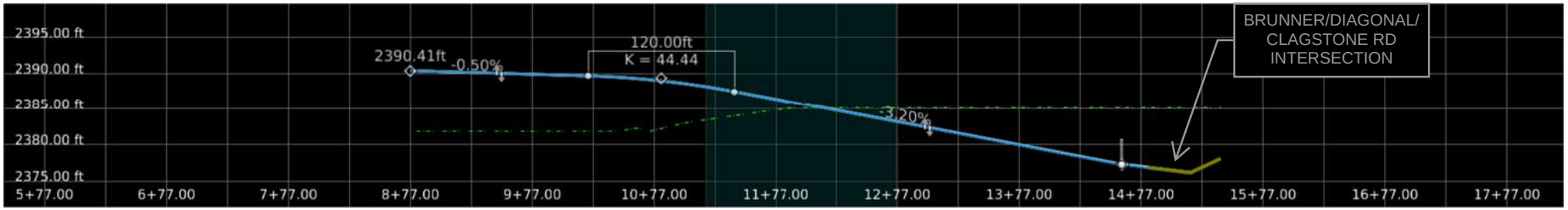


E BRUNNER RD

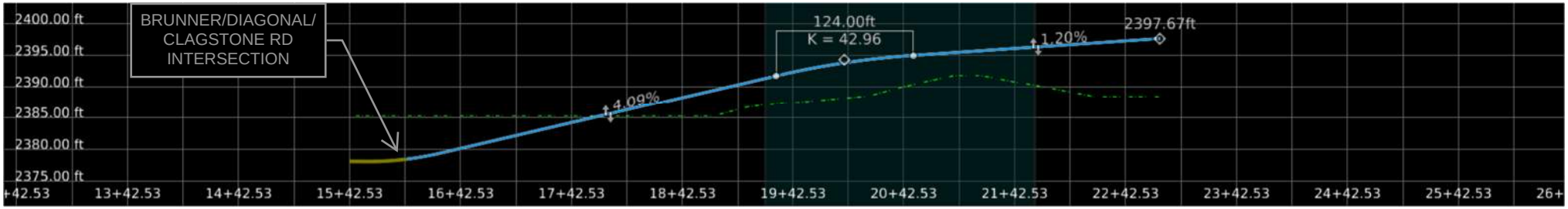


BRUNNER/DIAGONAL/
CLAGSTONE RD
INTERSECTION

E DIAGONAL RD



N CLAGSTONE RD

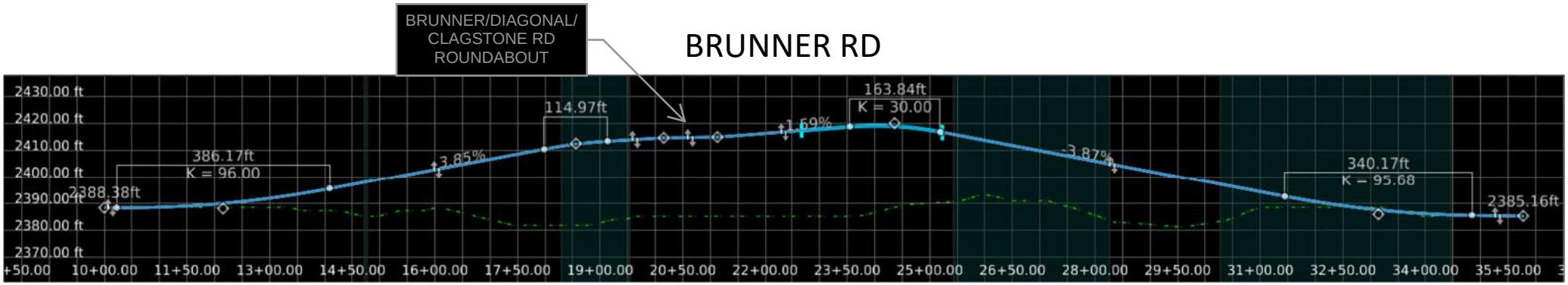


Appendix D – Alternative #2 Exhibits

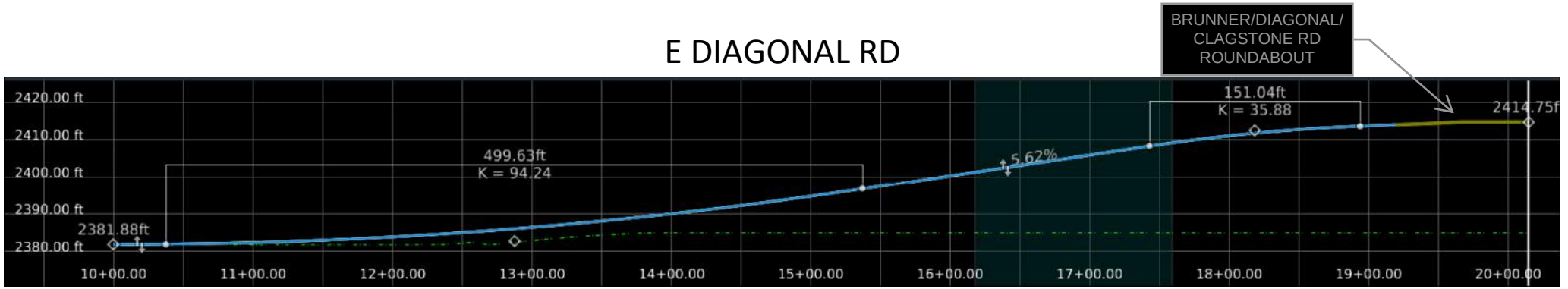

Alternative 2:
Roundabout
N CLAGSTONE RD
BRUNNER RD
BRIDGE
SKEW = 75°
BRUNNER RD
E DIAGONAL RD


Microsoft
Bing

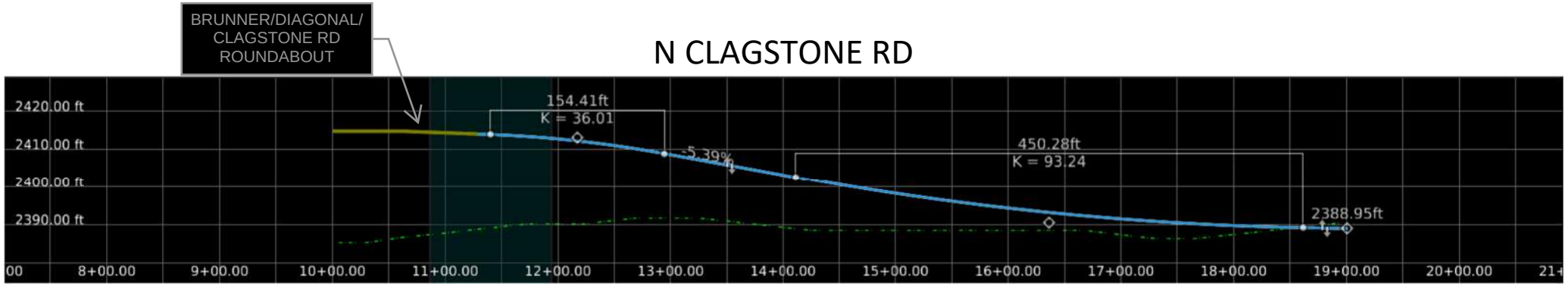
BRUNNER RD



E DIAGONAL RD

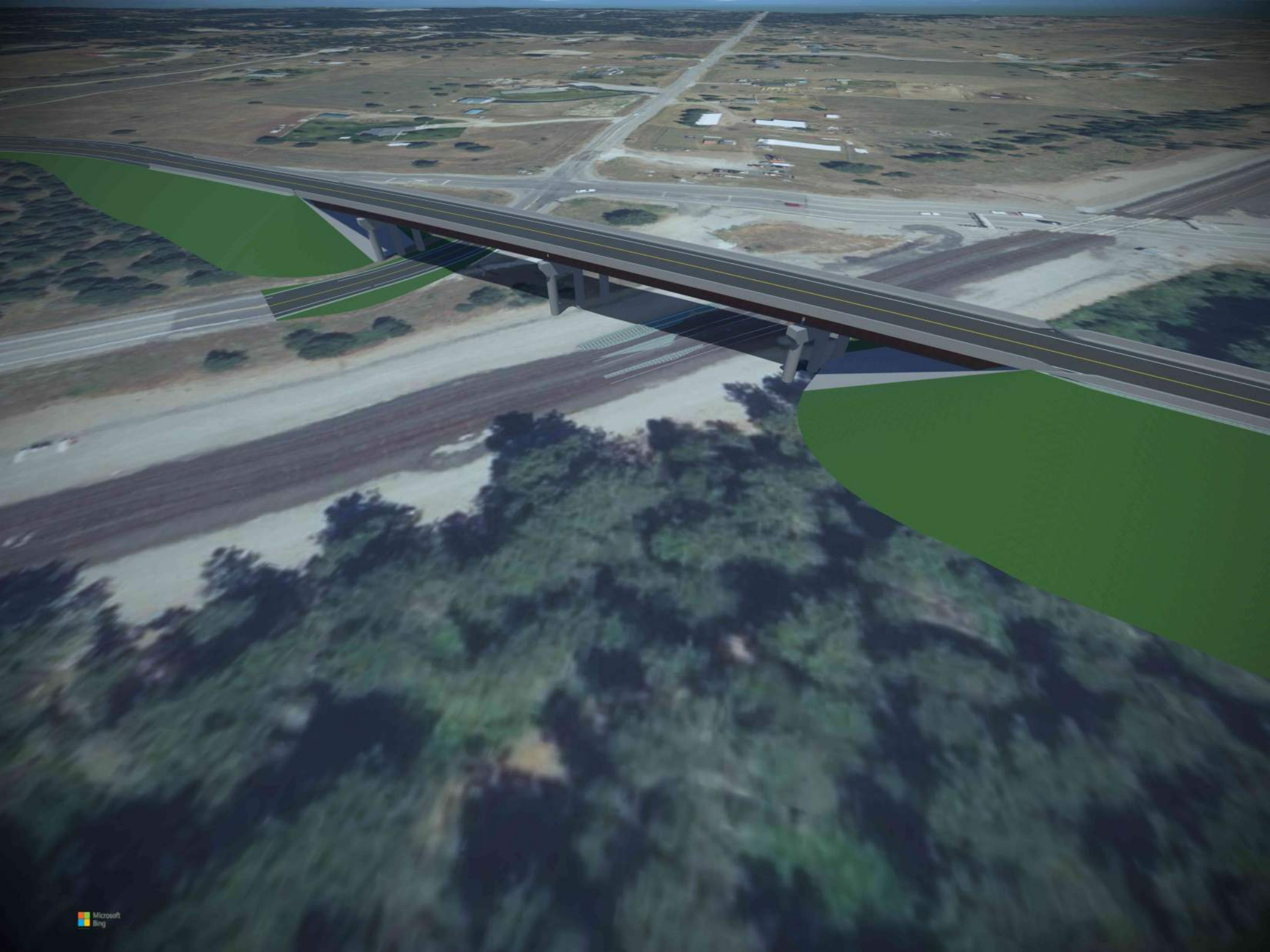


N CLAGSTONE RD



Appendix E – Alternative #3 Exhibits


Alternative 3:
Jug Handle
BRUNNER RD
JUGHANDLE RD
BRIDGE
SKEW = 75°
BRUNNER RD
E DIAGONAL RD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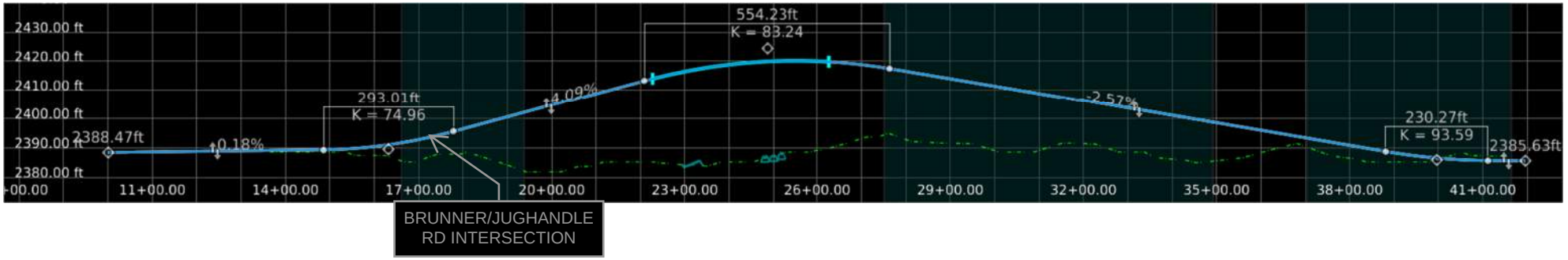
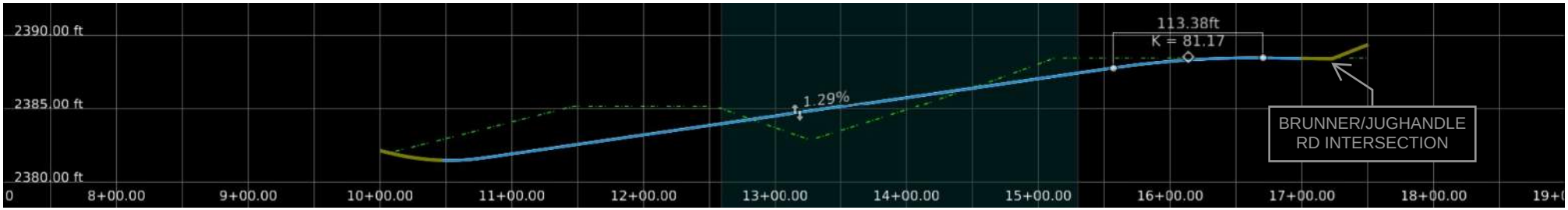
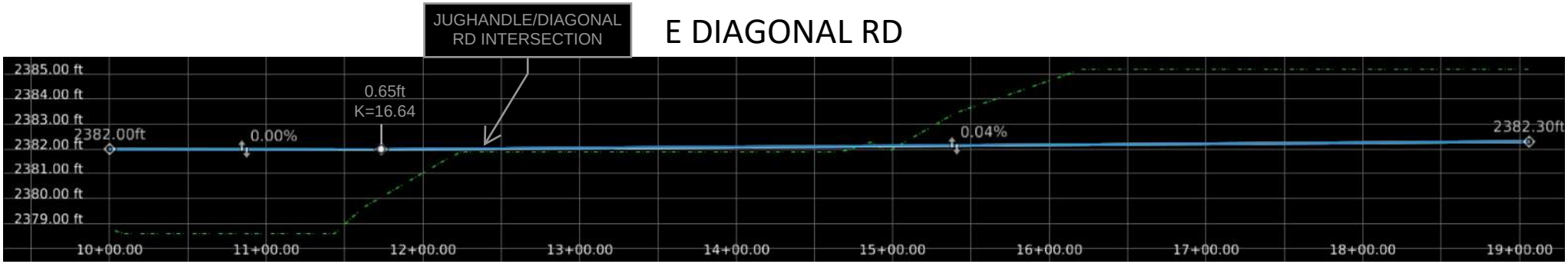
BRUNNER RD



JUGHANDLE RD

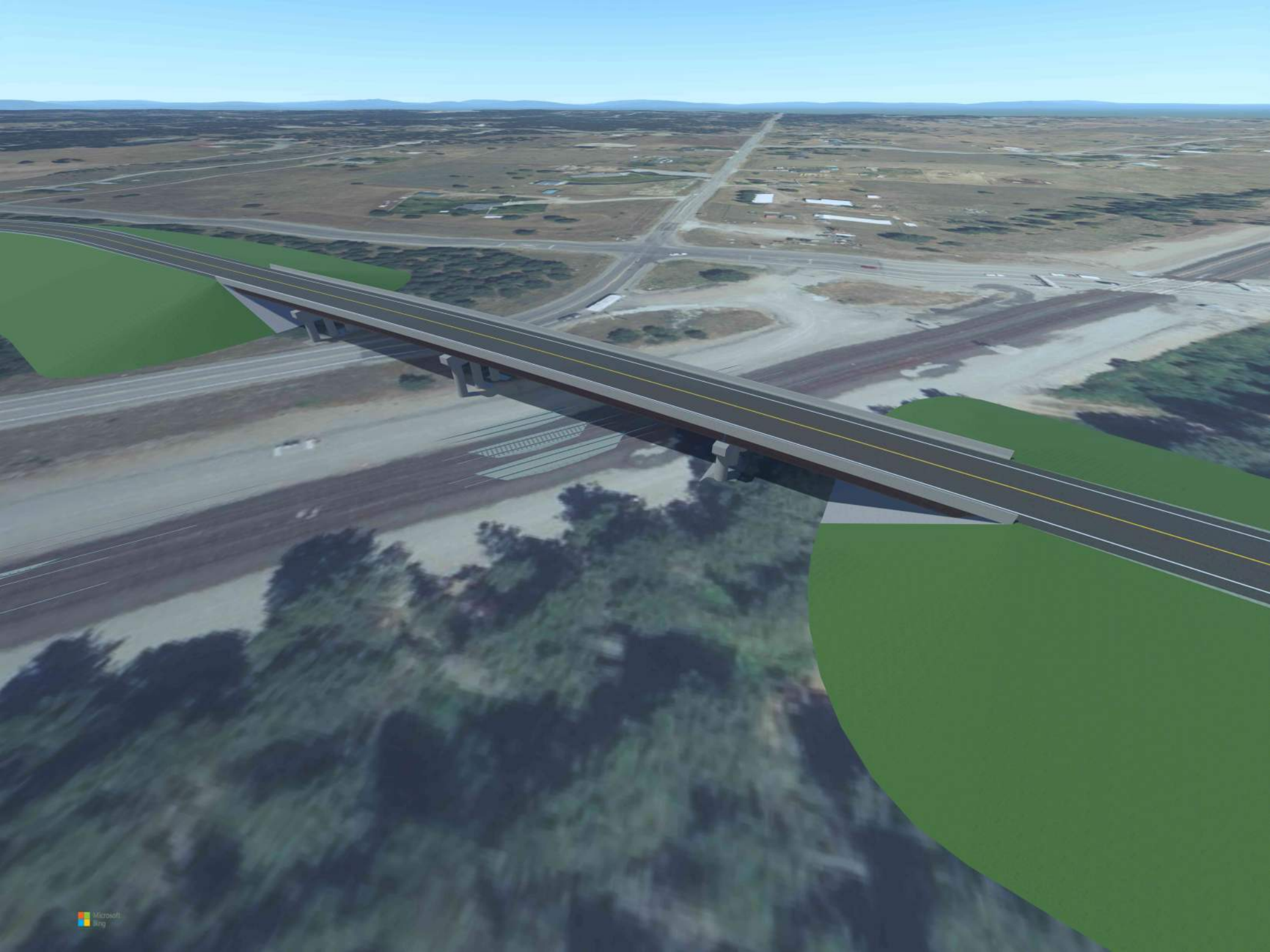


E DIAGONAL RD

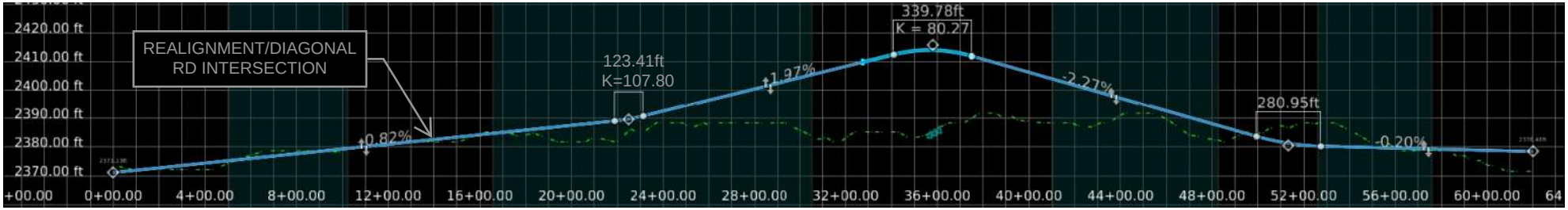


Appendix F – Alternative #4 Exhibits

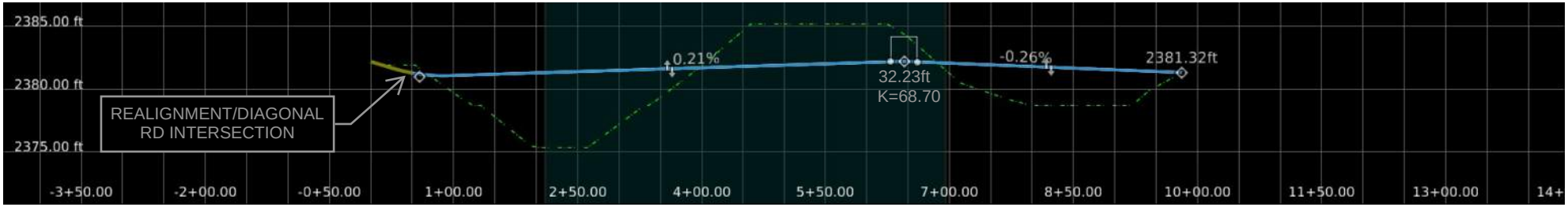

Alternative 4:
Realignment
REALIGNMENT RD
E DIAGONAL RD
BRIDGE
SKEW = 75°
REALIGNMENT RD



REALIGNMENT RD



E DIAGONAL RD



Appendix G –Cost Estimates

BRUNNER ROAD; BNSF RAIL SEPARATION				ALT 1: UNDERPASS		ALT 2: ROUND. W/ OVERPASS		ALT 3: JUGHANDLE W/ OVERPASS		ALT 4: BRUNNER/DIAGONAL REALIGN	
ITEM NO.	ITEM	UNIT COST	UNIT	QTY	TOTAL COST	QTY	TOTAL COST	QTY	TOTAL COST	QTY	TOTAL COST
205-005A	EXCAVATION	$ 20.00	CY	102,000	$ 2,040,000.00	1,900	$ 38,000.00	2,200	$ 44,000.00	12,900	$ 258,000.00
205-040A	GRANULAR BORROW	$ 17.00	CY	17,000	$ 289,000.00	180,000	$ 3,060,000.00	96,000	$ 1,632,000.00	110,000	$ 1,870,000.00
301-005A	GRANULAR SUBBASE	$ 20.00	TON	13,400	$ 268,000.00	10,400	$ 208,000.00	12,900	$ 258,000.00	15,000	$ 300,000.00
303-022A	3/4" AGGREGATE TYPE B FOR BASE	$ 25.00	TON	4,700	$ 117,500.00	3,600	$ 90,000.00	4,500	$ 112,500.00	5,200	$ 130,000.00
405-435A	SUPERPAVE HMA PAVEMENT INCLUDING ASPHALT & ADDITIVES CLASS SP-3	$ 110.00	TON	4,800	$ 528,000.00	3,700	$ 407,000.00	4,700	$ 517,000.00	5,400	$ 594,000.00
612-150A	CONCRETE BARRIER	$ 105.00	FT	400	$ 42,000.00	5,400	$ 567,000.00	3,400	$ 357,000.00	900	$ 94,500.00
Roadway Construction Total					**$ 3,284,500.00**		**$ 4,370,000.00**		**$ 2,920,500.00**		**$ 3,246,500.00**
Railway Bridge and Wall Construction Total		$ 9,000.00	FT	360	$ 3,240,000.00						
Bridge and Wall Construction Total		$ 400.00	SF			9,510	$ 3,804,000.00	13,820	$ 5,528,000.00	15,940	$ 6,376,000.00
Railway Shoo-fly					$5,000,000.00						
Contruction Total					**$ 11,524,500.00**		**$ 8,174,000.00**		**$ 8,448,500.00**		**$ 9,622,500.00**
Roadway Mobilization (10%)					$ 328,450.00		$ 437,000.00		$ 292,050.00		$ 324,650.00
Bridge Mobilization (10%)					$ 324,000.00		$ 380,400.00		$ 552,800.00		$ 637,600.00
Contingencies (35%)					$ 4,261,932.50		$ 3,146,990.00		$ 3,252,672.50		$ 3,704,662.50
Total with Mobilization					**$ 12,176,950.00**		**$ 8,991,400.00**		**$ 9,293,350.00**		**$ 10,584,750.00**
Construction Engineering (10%)					$ 1,217,695.00		$ 899,140.00		$ 929,335.00		$ 1,058,475.00
Design Engineering (12%)					$ 1,461,234.00		$ 1,078,968.00		$ 1,115,202.00		$ 1,270,170.00
Total with Mobilization, Construction Engineering, Design Engineering, & Contingencies					**$ 19,117,811.50**		**$ 14,116,498.00**		**$ 14,590,559.50**		**$ 16,618,057.50**
Right of Way		$ 52,000.00	AC	15	$ 780,000.00	9	$ 468,000.00	14	$ 728,000.00	20	$ 1,040,000.00
Anticipated Project Costs					**$ 19,897,811.50**		**$ 14,584,498.00**		**$ 15,318,559.50**		**$ 17,658,057.50**

Bridge Length	262.2'	Bridge Length	399.1'	Bridge Length	435.2'		
Bridge Width	32.0'	Bridge Width	32.0'	Bridge Width	32.0'		
Bridge Deck Width	34.6'	Bridge Deck Width	34.6'	Bridge Deck Width	34.6'		
Asphalt Bridge	8390.4	Asphalt Bridge	12771.2	Asphalt Bridge	13927.36		
Bridge Deck	9072.12	Bridge Deck	13808.86	Bridge Deck	15058.958		
ROW Impacts	9 owners	ROW Impacts	5 owners	ROW Impacts	5 owners	ROW Impacts	6 owners

Appendix H –Engineering Alternatives Analysis Matrix

Brunner Rd at BNSF Crossing; East to West

Alternatives Analysis Matrix

9/13/2023

		ALTERNATIVES											
		Alternative #1 Underpass			Alternative #2 Roundabout w/ Overpass			Alternative #3 Jughandle w/ Overpass			Alternative #4 Brunner/Diagonal Realignment w/ Overpass		
CRITERIA	**Weight**	**Quantified**	**Simple Scoring**	**Weighted Score**	**Quantified**	**Simple Scoring**	**Weighted Score**	**Quantified**	**Simple Scoring**	**Weighted Score**	**Quantified**	**Simple Scoring**	**Weighted Score**
R/W Impacts (acres)	7	15	3	21	9	7	49	14	5	35	20	1	7
Constructability	10	Difficult	4	40	Good	7	70	Good	7	70	Good	8	80
Traffic Operations	5	Good	8	40	Best	9	45	Negative	7	35	Negative	3	15
Safety	10	Best	9	90	Best	9	90	Good	8	80	Good	9	90
Construction Cost	10	$19,898,000	1	10	$14,585,000	5	50	$ 15,319,000	4	40	$ 17,659,000	3	30
Long Term Maintenance	5	Best	10	50	Good	5	25	Good	5	25	Good	5	25
Railroad Acceptance	5	Negative	0	0	Acceptable	10	50	Acceptable	10	50	Acceptable	10	50
Total Score (High is Best)				**251**			**379**			**335**			**297**

WEIGHT:	7 To 10	Most Important	7-10 Points = Favorable
	4 to 6	Moderately Important	4-6 Points = Neutral
	1 To 3	Least Important	1-3 Points = Unfavorable

Appendix I –Right-of-Way Need Lines

Alt 1 Right-of-Way Impact: 14.3 ac.

RIGHT OF WAY TAKE SHAPE

BRUNNER RD.

CLAGSTONE RD.

DIAGONAL RD.

N

Microsoft Bing

Alt 2 Right-of-Way Impact: 9.0 ac.

RIGHT OF WAY TAKE SHAPE

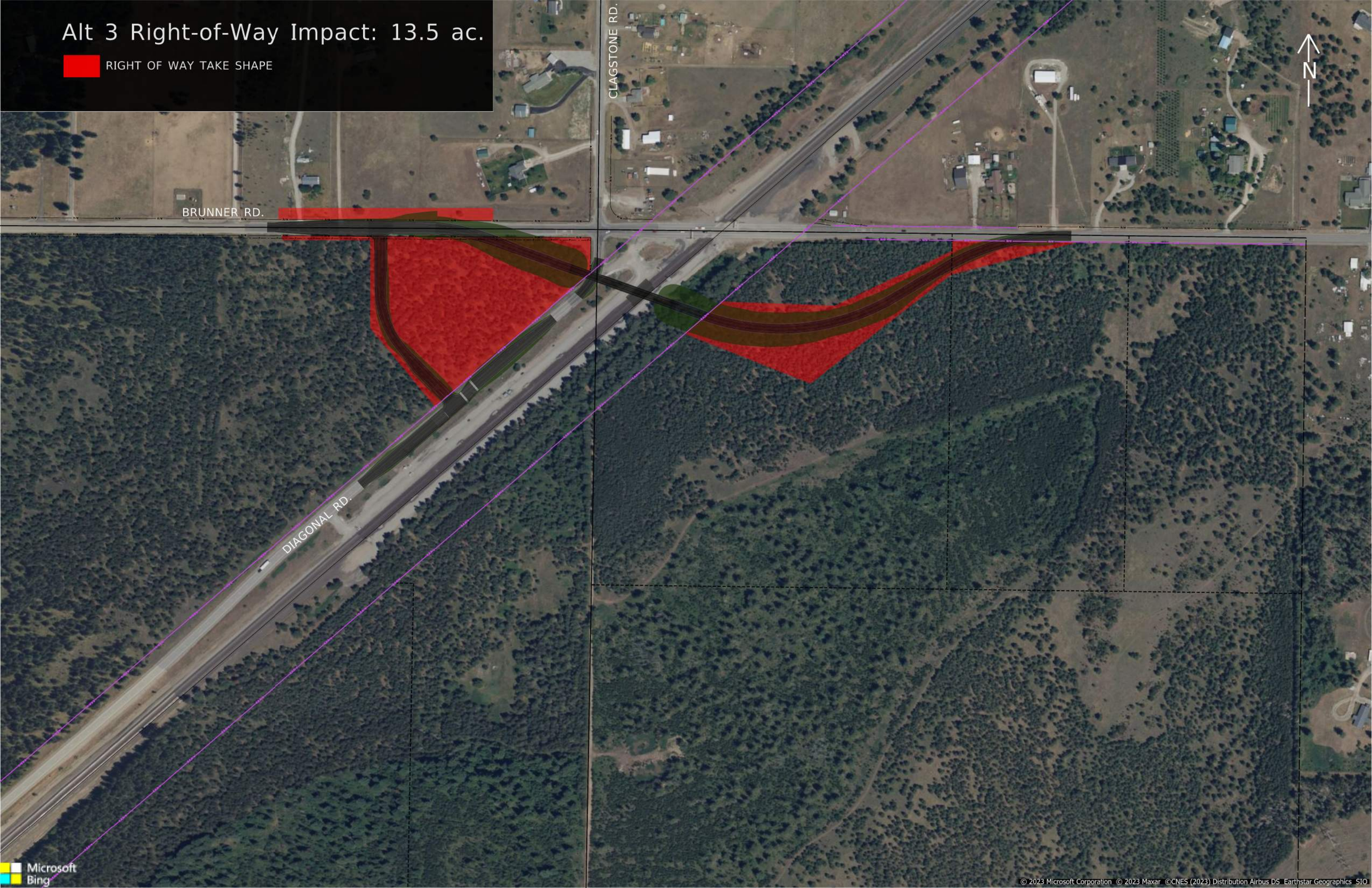
BRUNNER RD.

CLAGSTONE RD.

DIAGONAL RD.

N

Microsoft Bing


Alt 3 Right-of-Way Impact: 13.5 ac.
RIGHT OF WAY TAKE SHAPE
BRUNNER RD.
CLAGSTONE RD.
DIAGONAL RD.
N
Microsoft Bing
© 2023 Microsoft Corporation © 2023 Maxar ©CNES (2023) Distribution Airbus DS Earthstar Geographics SIO

Alt 4 Right-of-Way Impact: 19.5 ac.

RIGHT OF WAY TAKE SHAPE

BRUNNER RD.

CLAGSTONE RD.

DIAGONAL RD.

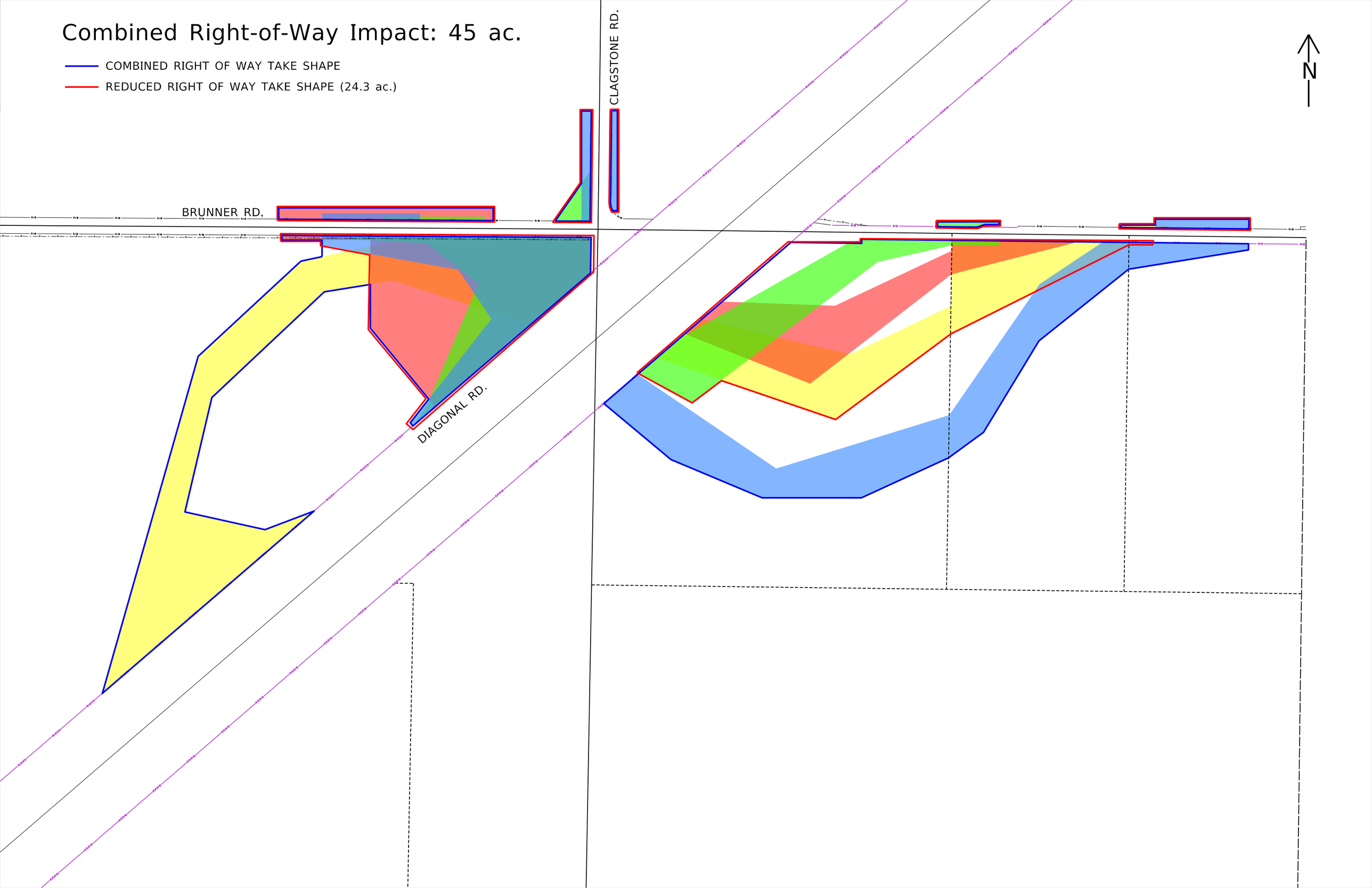
N

Microsoft Bing

Combined Right-of-Way Impact: 45 ac.

COMBINED RIGHT OF WAY TAKE SHAPE

REDUCED RIGHT OF WAY TAKE SHAPE (24.3 ac.)



Appendix J –Traffic Memo

Brunner Road at Diagonal Road
Traffic Impact Study Tech Memo

Prepared for the

Lakes Highway District, Kootenai County, Idaho

August 1, 2023

DEA Project No. LAHD0000-0014

DAVID EVANS AND ASSOCIATES INC.

663 W. Canfield Avenue
Coeur d'Alene, ID 83815

INTRODUCTION

The DEA team was selected to evaluate and design a grade-separation structure on Brunner Road at the Burlington Northern Santa Fe Railway (BNSF) crossing next to Diagonal Road in order to eliminate the existing at-grade intersection. This memo analyzes the traffic operational results for the five alternative alignments for the Brunner Road and Diagonal Road intersection as it relates to the grade-separation. The five alternatives are as follows:

1. Alternative 1, realignment of Brunner and Diagonal Roads with an underpass at the BNSF crossing.
2. Alternative 2, realignment of Brunner and Diagonal Roads while constructing an overpass at the BNSF crossing with a roundabout west of the railway.
3. Alternative 3, realignment of Brunner and Diagonal Roads with a jughandle west of the railway and an overpass at the BNSF railway.
4. Alternative 4, realignment of Brunner and Diagonal Roads with an overpass at the BNSF crossing.
5. Alternative 5, no-build alternative.

EXISTING CONDITIONS

The following section describes the transportation network in proximity to the proposed project including classified roadway network and existing traffic counts. An operational analysis is performed using the existing traffic counts to provide pre-project baseline conditions to be compared against in the following section.

Street Network

A description of the primary roadways and intersection within the study area is included below.

Brunner Road is currently an east-west two-lane major collector west and east of the project site. The posted speed limit is 50 mph.

Diagonal Road is currently a north-south two-lane major collector south of the site. The posted speed limit is 50 mph. Approaching the intersection there is a 15 mph warning sign due to a curve just before the stop sign.

Clagstone Road is a north-south two-lane local road north of the site. The posted speed limit is 50 mph.

#1 Brunner Road / Clagstone Road-Diagonal Road is an unsignalized intersection with stop control on the Clagstone Road/Diagonal Road approaches. Red flashing beacons exist on the minor approaches. All approaches consist of a single shared left/through/right lane. The posted speed limit is 50 mph for the North Brunner Road approaches, while 15 mph for the Diagonal Road and 50 mph Clagstone Road approaches.

Existing Turning Movement Counts

Turning movement counts were collected at the study intersection during the PM peak hour specifically for this project on Tuesday, June 13th, 2023. Peak Hour Traffic was determined as 4:15 to 5:15 PM. **Figure 1** shows pm peak hour turning movements.

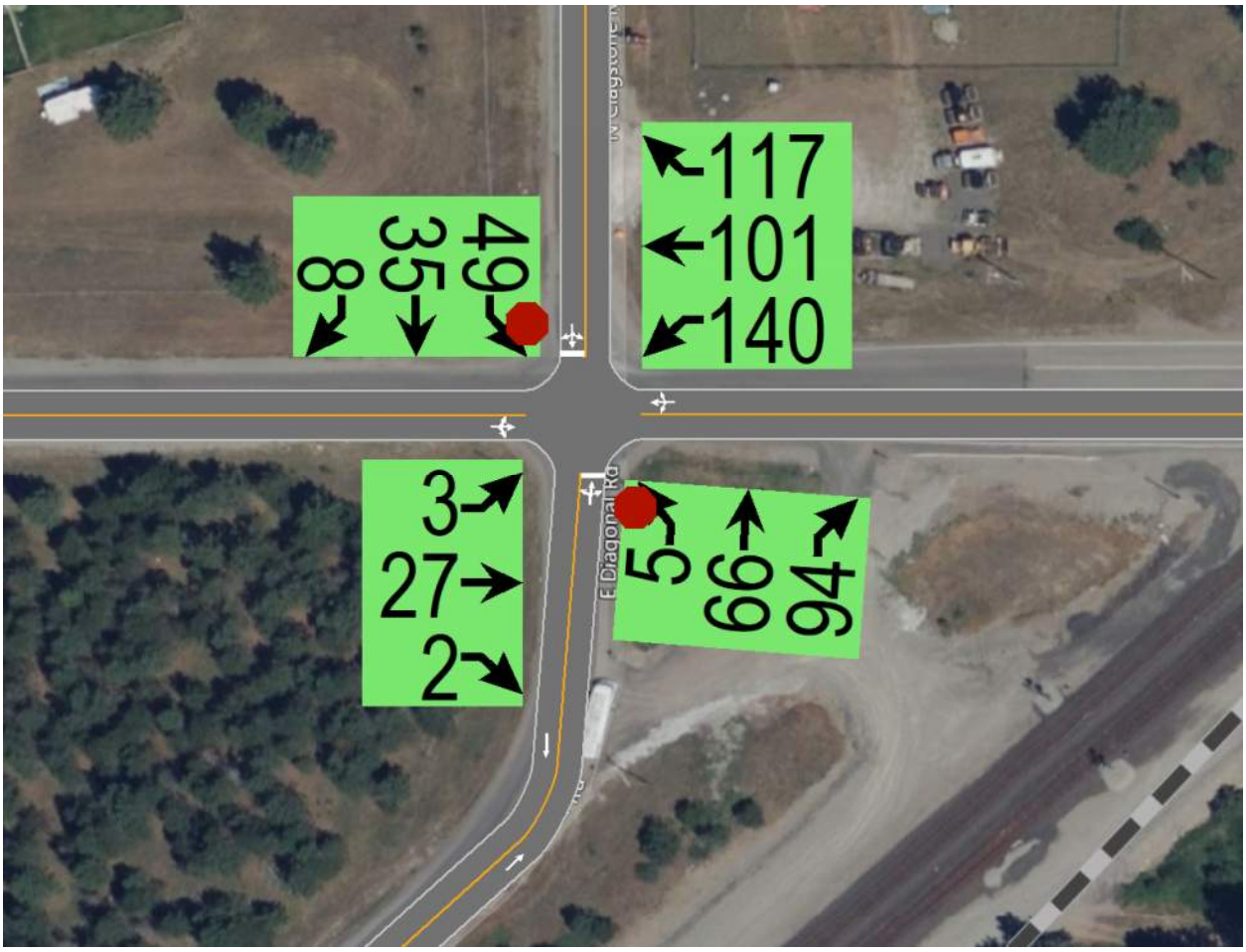


Figure 1. Existing PM Peak Hour Traffic Volumes

Level of Service Thresholds

Level of service (LOS) is a qualifiable premise developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles afforded to drivers who utilize the roadway network. It has been defined by the Transportation Research Board in the Highway Capacity Manual, which quantifies level of service into a range from "A" indicating little, if any, vehicle delay, to "F" indicating significant vehicle delay and congestion that may lead to system breakdown due to traffic volumes exceeding capacity. For signalized and stop-controlled intersections, LOS is calculated using methodology from the HCM 6th Edition. For roundabout intersections, LOS is calculated using the HCM2000 methodology. Each LOS corresponds to a range of delay and worsens as delay increases.

Figure 2 describes each LOS and range of delay for signalized and unsignalized intersections.

Current agency guidelines require intersections to operate at LOS D or better during the peak periods. Transportation improvements may be required to mitigate conditions created by development that cause level of service to drop below these established thresholds.

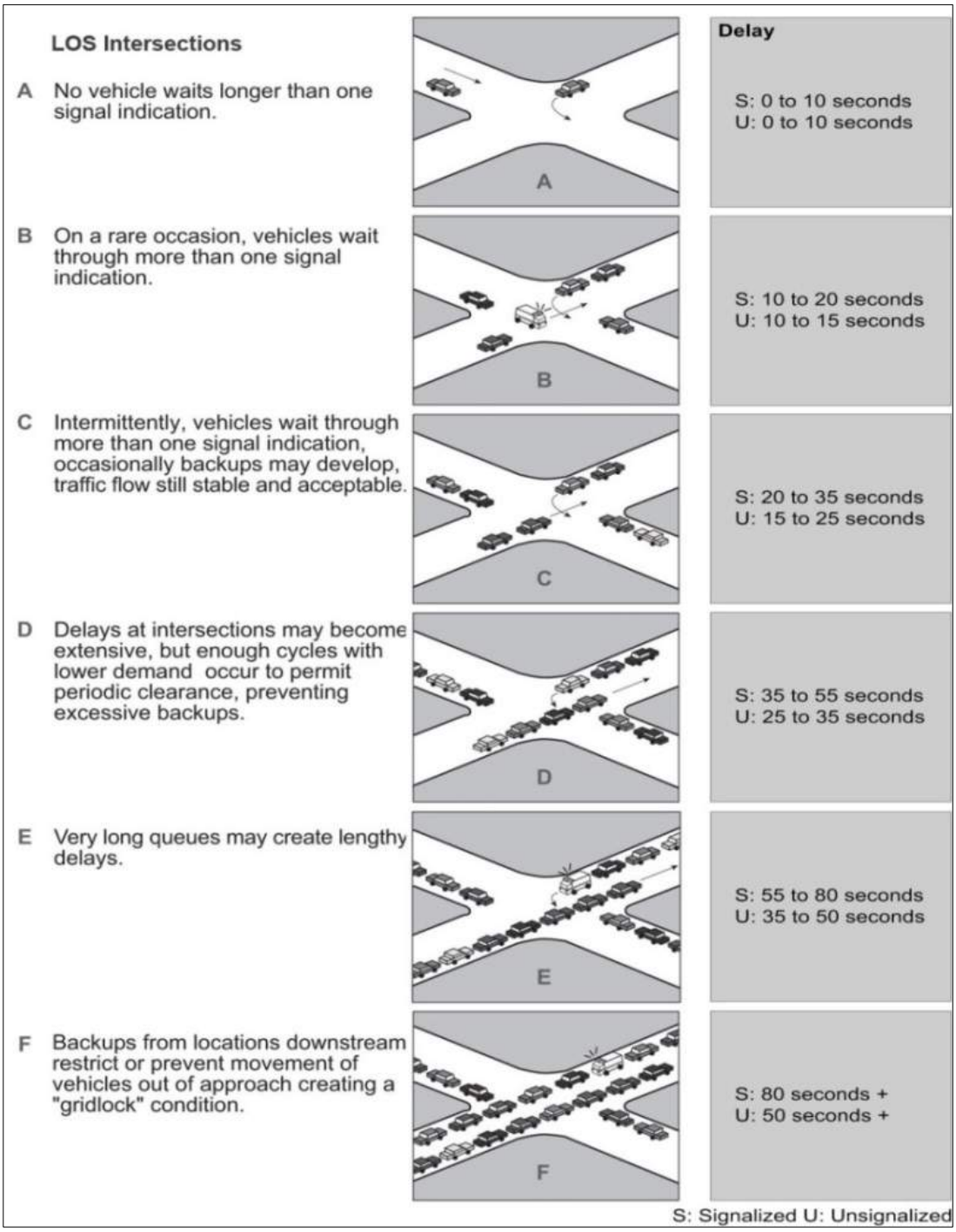


Figure 2. Level of Service Criteria

Existing operations for weekday PM peak hours were evaluated using existing traffic counts as documented earlier in this memo. Synchro and Sidra analysis worksheets are provided in **Appendix A**. As shown in **Figure 1,** the intersection of Brunner Road at Diagonal Road is currently operating at Level of Service C, with the southbound left/through/right turn movement operating at 19.4 second delay with volume well within capacity (0.29). KMPO model volumes were requested and obtained. Upon analyzing the volumes as shown in the model, it was determined the existing modeled projections were less than half of existing pm peak hour volumes collected as part of this analysis. As noted in an email from Ali Marienau on July 13, 2023, KMPO was not able to resolve the discrepancies in this area between existing ground counts and the model results in their last round of calibration.

To project future background traffic volumes, the annual growth rate for the area was identified. The City of Athol Transportation Plan, September 2019 and the KMPO Metropolitan Transportation Plan, May 2020 were utilized in determining the annual growth rate. Documents were accessed February 2023 from the following locations:

http://www.cityofathol.us/documents/City%20of%20Athol%20-%20Transportation%20Plan%2009-10-2019.pdf

https://www.kmpo.net/wp-content/uploads/2020/04/KMPO-Section-4-2020-FINAL-3-18-20.pdf

The average growth rate was determined to be 2%. The existing traffic turn movement volumes were combined with the 2% annual growth rate, compounded annually for 22 years to estimate background growth for Year 2045 No Build Background Conditions and are shown in **Figure 3**.

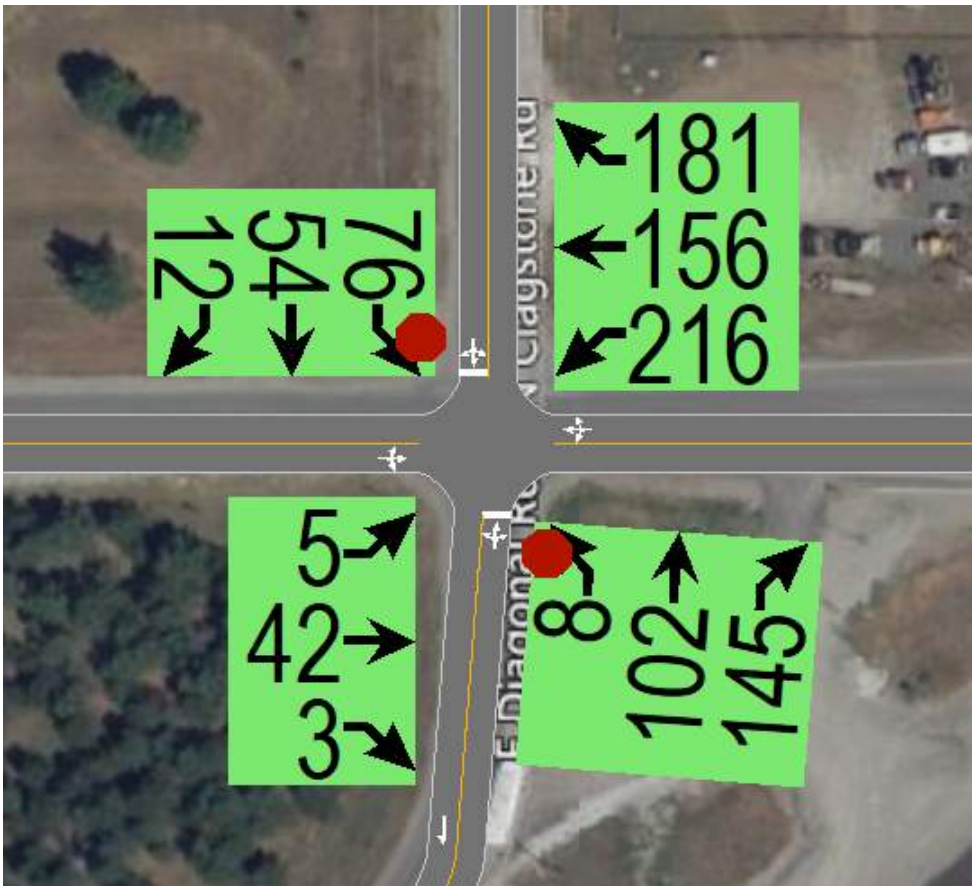


Figure 3. 2045 Background (NO BUILD) PM Peak Volumes

Table 1. Intersection Operations PM Peak Hour
Brunner Road and Clagstone/Diagonal Road

INTERSECTION	Control Type	Int. LOS	Int. Delay (seconds)	Critical Movement		
				MVMT	Delay (s)	V/C
2023 PM PEAK HOUR						
Brunner Rd. / Clagstone/Diagonal Rd.	TWSC	C	7.9	SB LTR	19.4	0.29
2045 PM NO BUILD PEAK HOUR – ALT 5						
Brunner Rd. / Clagstone/Diagonal Rd.	TWSC	**F**	28.2	SB LTR	**129.3**	**1.00**
2045 PM BUILD PEAK HOUR – ALT 1						
Brunner Rd. / Clagstone/Diagonal Rd.	TWSC	**F**	24.6	SB LTR	**109.2**	**0.94**
	AWSC	C	32.5	WB LTR	32.5	0.86
2045 PM BUILD PEAK HOUR – ALT 2						
Brunner Rd. / Clagstone/Diagonal Rd	RAB	A	6.6	SB LTR	8.9	0.16
2045 PM BUILD PEAK HOUR – ALT 3						
Brunner Rd. / Diagonal Rd.	TWSC	D	7.1	NBL	28.6	0.13
Diagonal Rd. / Jughandle	TWSC	C	9.0	SBL	20.3	0.47
2045 PM BUILD PEAK HOUR – ALT 4						
Brunner Rd. / Clagstone/Diagonal Rd.	TWSC	C	2.8	EBL	17.0	0.02
Diagonal Rd. / Brunner Rd. Re-Route	TWSC	**E**	6.5	WBL	**40.4**	0.38

As shown in **Table 1**, the intersection is anticipated to operate at **LOS F** under Year 2045 Background (No Build) pm peak hour conditions. The southbound left/through/right movement is anticipated to operate with **129.3** second delay **(LOS F**) with volume at capacity **(1.00).**

Each of the alternatives, 1, 2, 3, and 4 were analyzed for year 2045. The following paragraphs describe the analysis for each alternative.

For Alternative 1, the intersection of Brunner at Diagonal-Clagstone roads will be shifted south and slightly east with and underpass at the BNSF railroad. Assuming left turn pockets along Brunner Road with stop control at Diagonal and Clagstone, the intersection is anticipated to operate at **LOS F**. The southbound left/through/right movement is operating at **LOS F** with an average delay of **109.2** seconds, with volume nearing capacity **(0.94)**. Assuming All Way Stop

Control the intersection will operate at LOS C with the westbound left/through/right operating at LOS C, with a delay of 32.5 seconds and volume to capacity of 0.86. Figure 4 shows the alternative alignment and PM Peak Hour turning movement volumes.

Figure 4. 2045 Alternative 1 PM Peak Volumes

Alternative 2, a proposed single lane roundabout (RAB) near the current intersection location, presented the best results regarding level of service, delay, volume to capacity and queuing impact. The intersection is anticipated to operate at LOS A, with a delay of 6.6 seconds and volume to capacity of 0.16. Furthermore, westbound 95th percentile back of queuing is anticipated to be a maximum of 88.' All other approaches are anticipated to have queuing of 50' or less. See **Table 1** for results. It should be noted that this alternative will have the lowest cost as well as minimal right of way impact due to not shifting away from the current intersection location. The at-grade railroad intersection will be converted to an overpass. **Figure 5** shows the Alternative 2 2045 turning movement volumes.

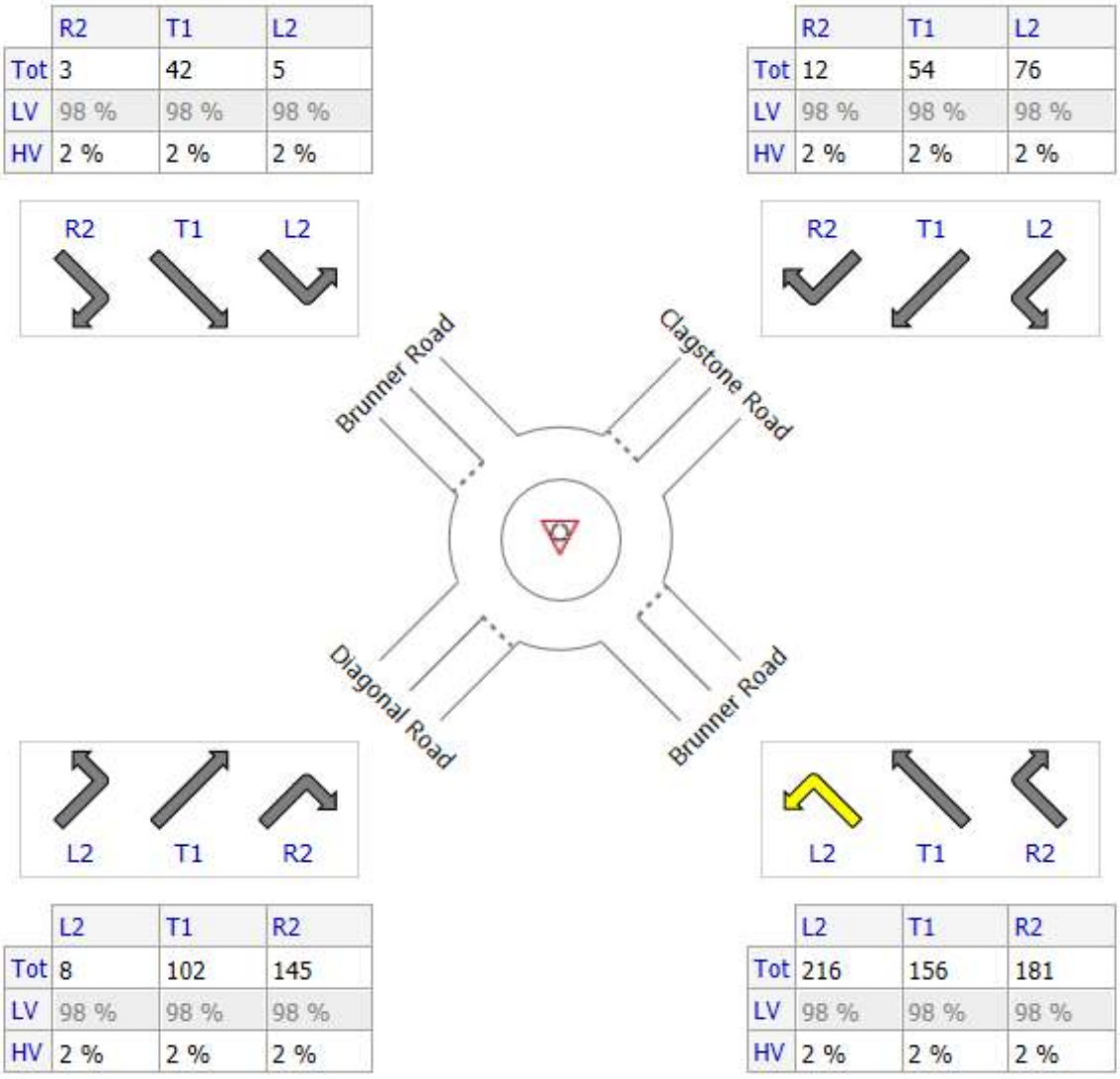


Figure 5. 2045 Alternative 2 PM Peak Volumes

Alternative 3, removes the Brunner Road and Diagonal Road intersection by creating a "jughandle." Diagonal Road would continue north on the existing alignment, but a new "jughangle" road would connect Diagonal and Brunner to the west of the existing intersection. Brunner Road would be shifted south with a bridge over Diagonal Road and the railroad.

The northbound left turn movement at the intersection of the new "jughandle" road and Brunner Road intersection is anticipated to operate at 28.6 seconds/LOS D under year 2045 Build pm peak hour conditions. It should be noted if additional development were to occur west of the intersection, this movement is subject to becoming deficient. The Diagonal Road at the "jughandle" intersection (south) is anticipated to operate at LOS A. The southbound left turn from

the “jughandle” to Diagonal Road is anticipated to operate at LOS C with a delay of 20.3 seconds. See Figure 6 for the alternative alignment and turning movement volumes.

Figure 6. 2045 Alternative 3 PM Peak Volumes

Alternative 4 creates the most out of direction travel for those heading east/west on Brunner Road. East of the existing at-grade railroad crossing, Brunner Road will shift south in order to cross over the railway and Diagonal Road at a ninety degree angle with a bridge. Brunner Road will then curve south, tying into Diagonal Road at a new intersection (see **Figure 7**).

The westbound left turn from Diagonal onto Diagonal at the new Diagonal Road/Brunner Connection intersection is anticipated to operate at **LOS E**, with a delay of **40.4** seconds. The original Diagonal/Clagstone Road at Brunner Road intersection will no longer have an east leg and is anticipated to operate at LOS A, with a delay of 2.8 seconds. Alternative 4 is anticipated to be the highest cost of all alternatives, with the most significant right of way impact of all alternatives. The bridge and roadway lengths will be the longest as well.

Figure 7. 2045 Alternative 4 PM Peak Volumes

CONCLUSIONS AND RECOMMENDATIONS

The DEA team was selected to evaluate and design a grade-separation structure on Brunner Road at the Burlington Northern Santa Fe Railway (BNSF) crossing next to Diagonal Road in order to eliminate the existing at-grade intersection. This memo analyzes the traffic operational results for the five alternative alignments for the Brunner Road and Diagonal Road intersection as it relates to the grade-separation. The results for all scenarios are as follows:

The intersection of Brunner Road at Diagonal Road is currently operating at Level of Service C, with the southbound left/through/right turn movement operating at 19.4 second delay with volume well within capacity (0.29).

The Brunner Road at Diagonal Road intersection is anticipated to operate at **LOS F** under Year 2045 Background (No Build) pm peak hour conditions. The southbound left/through/right movement is anticipated to operate with **129.3** second delay **(LOS F**) with volume at capacity **(1.00).**

For Alternative 1, the Brunner Road at Diagonal Road intersection is anticipated to operate at **LOS F**. The southbound left/through/right movement is operating at **LOS F** with an average delay of **109.2** seconds, with volume nearing capacity **(0.94)**. Assuming All Way Stop Control the intersection will operate at LOS C with the westbound left/through/right operating at LOS C, with a delay of 32.5 seconds and volume to capacity of 0.86. It should be noted that queuing is heavier under this scenario than the other alternatives.

Alternative 2, a proposed single lane roundabout (RAB), provided the best results regarding level of service, delay, volume to capacity and queuing impact. The intersection is anticipated to operate at LOS A, with a delay of 6.6 seconds and volume to capacity of 0.16. The westbound 95th percentile back of queuing is anticipated to be a maximum of 88'. All other approaches are anticipated to have queuing of 50' or less during Year 2045 Alt 2. Build Conditions. This alternative is anticipated to have the shortest bridge, the lowest cost as well as minimal right of way impact.

In Alternative 3, northbound left turn movement at the "jughandle" intersection with Brunner Road is anticipated to operate at 28.6 seconds/LOS D under year 2045 Build pm peak hour conditions. It should be noted that if additional development were to occur west of the intersection, this movement/intersection level of service/delay is subject to becoming deficient.

For Alternative 4, the westbound left turn from Diagonal Road onto Diagonal Road at the new Diagonal Road/Brunner Road Connection is anticipated to operate at **LOS E**, with a delay of **40.4** seconds. Alternative 4 is anticipated to be the highest cost of all alternatives, with the most significant right of way impacts. The bridge and roadway lengths will be the longest as well.

Appendix A – Synchro and Sidra Output Sheets

Existing Conditions – Weekday PM Peak Hour

Intersection	
Int Delay, s/veh	7.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	3	27	2	140	101	117	5	66	94	49	35	8
Future Vol, veh/h	3	27	2	140	101	117	5	66	94	49	35	8
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	3	29	2	152	110	127	5	72	102	53	38	9

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	237	0	0	31	0	0	537	577	30	601	515	174
Stage 1	-	-	-	-	-	-	36	36	-	478	478	-
Stage 2	-	-	-	-	-	-	501	541	-	123	37	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1330	-	-	1582	-	-	455	427	1044	412	464	869
Stage 1	-	-	-	-	-	-	980	865	-	568	556	-
Stage 2	-	-	-	-	-	-	552	521	-	881	864	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1330	-	-	1582	-	-	383	378	1044	290	411	869
Mov Cap-2 Maneuver	-	-	-	-	-	-	383	378	-	290	411	-
Stage 1	-	-	-	-	-	-	978	863	-	567	494	-
Stage 2	-	-	-	-	-	-	448	463	-	727	862	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.7	2.9	13.7	19.4
HCM LOS			B	C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	594	1330	-	-	1582	-	-	349
HCM Lane V/C Ratio	0.302	0.002	-	-	0.096	-	-	0.287
HCM Control Delay (s)	13.7	7.7	0	-	7.5	0	-	19.4
HCM Lane LOS	B	A	A	-	A	A	-	C
HCM 95th %tile Q(veh)	1.3	0	-	-	0.3	-	-	1.2

Future Background (2045) No Build Conditions – Weekday PM Peak Hour

Intersection	
Int Delay, s/veh	28.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	5	42	3	216	156	181	8	102	145	76	54	12
Future Vol, veh/h	5	42	3	216	156	181	8	102	145	76	54	12
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	46	3	235	170	197	9	111	158	83	59	13

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	367	0	0	49	0	0	833	895	48	931	798	269
Stage 1	-	-	-	-	-	-	58	58	-	739	739	-
Stage 2	-	-	-	-	-	-	775	837	-	192	59	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1192	-	-	1558	-	-	288	280	1021	247	319	770
Stage 1	-	-	-	-	-	-	954	847	-	409	424	-
Stage 2	-	-	-	-	-	-	391	382	-	810	846	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1192	-	-	1558	-	-	199	225	1021	110	256	770
Mov Cap-2 Maneuver	-	-	-	-	-	-	199	225	-	110	256	-
Stage 1	-	-	-	-	-	-	950	844	-	407	341	-
Stage 2	-	-	-	-	-	-	256	308	-	593	843	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.8	3	31.8	129.3
HCM LOS			D	F

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	401	1192	-	-	1558	-	-	155
HCM Lane V/C Ratio	0.691	0.005	-	-	0.151	-	-	0.996
HCM Control Delay (s)	31.8	8	0	-	7.7	0	-	129.3
HCM Lane LOS	D	A	A	-	A	A	-	F
HCM 95th %tile Q(veh)	5.1	0	-	-	0.5	-	-	7.6

Alternative 1 (2045) Build Conditions – Weekday PM Peak Hour

Intersection	
Int Delay, s/veh	24.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	5	42	3	216	156	181	8	102	145	76	54	12
Future Vol, veh/h	5	42	3	216	156	181	8	102	145	76	54	12
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	0	-	-	200	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	46	3	235	170	197	9	111	158	83	59	13

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	367	0	0	49	0	0	833	895	48	931	798	269
Stage 1	-	-	-	-	-	-	58	58	-	739	739	-
Stage 2	-	-	-	-	-	-	775	837	-	192	59	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1192	-	-	1558	-	-	288	280	1021	247	319	770
Stage 1	-	-	-	-	-	-	954	847	-	409	424	-
Stage 2	-	-	-	-	-	-	391	382	-	810	846	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1192	-	-	1558	-	-	209	237	1021	118	270	770
Mov Cap-2 Maneuver	-	-	-	-	-	-	209	237	-	118	270	-
Stage 1	-	-	-	-	-	-	950	844	-	407	360	-
Stage 2	-	-	-	-	-	-	273	324	-	592	843	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0.8	3	29	109.2
HCM LOS			D	F

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	418	1192	-	-	1558	-	-	165
HCM Lane V/C Ratio	0.663	0.005	-	-	0.151	-	-	0.935
HCM Control Delay (s)	29	8	-	-	7.7	-	-	109.2
HCM Lane LOS	D	A	-	-	A	-	-	F
HCM 95th %tile Q(veh)	4.7	0	-	-	0.5	-	-	7

Intersection	
Intersection Delay, s/veh	23.5
Intersection LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	5	42	3	216	156	181	8	102	145	76	54	12
Future Vol, veh/h	5	42	3	216	156	181	8	102	145	76	54	12
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	5	46	3	235	170	197	9	111	158	83	59	13
Number of Lanes	0	1	0	0	1	0	0	1	0	0	1	0

Approach	EB	WB	NB	SB
Opposing Approach	WB	EB	SB	NB
Opposing Lanes	1	1	1	1
Conflicting Approach Left	SB	NB	EB	WB
Conflicting Lanes Left	1	1	1	1
Conflicting Approach Right	NB	SB	WB	EB
Conflicting Lanes Right	1	1	1	1
HCM Control Delay	10	32.5	13.2	11.8
HCM LOS	A	D	B	B

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	3%	10%	39%	54%
Vol Thru, %	40%	84%	28%	38%
Vol Right, %	57%	6%	33%	8%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	255	50	553	142
LT Vol	8	5	216	76
Through Vol	102	42	156	54
RT Vol	145	3	181	12
Lane Flow Rate	277	54	601	154
Geometry Grp	1	1	1	1
Degree of Util (X)	0.439	0.094	0.867	0.271
Departure Headway (Hd)	5.708	6.223	5.19	6.32
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	626	571	697	565
Service Time	3.781	4.317	3.242	4.404
HCM Lane V/C Ratio	0.442	0.095	0.862	0.273
HCM Control Delay	13.2	10	32.5	11.8
HCM Lane LOS	B	A	D	B
HCM 95th-tile Q	2.2	0.3	10.3	1.1

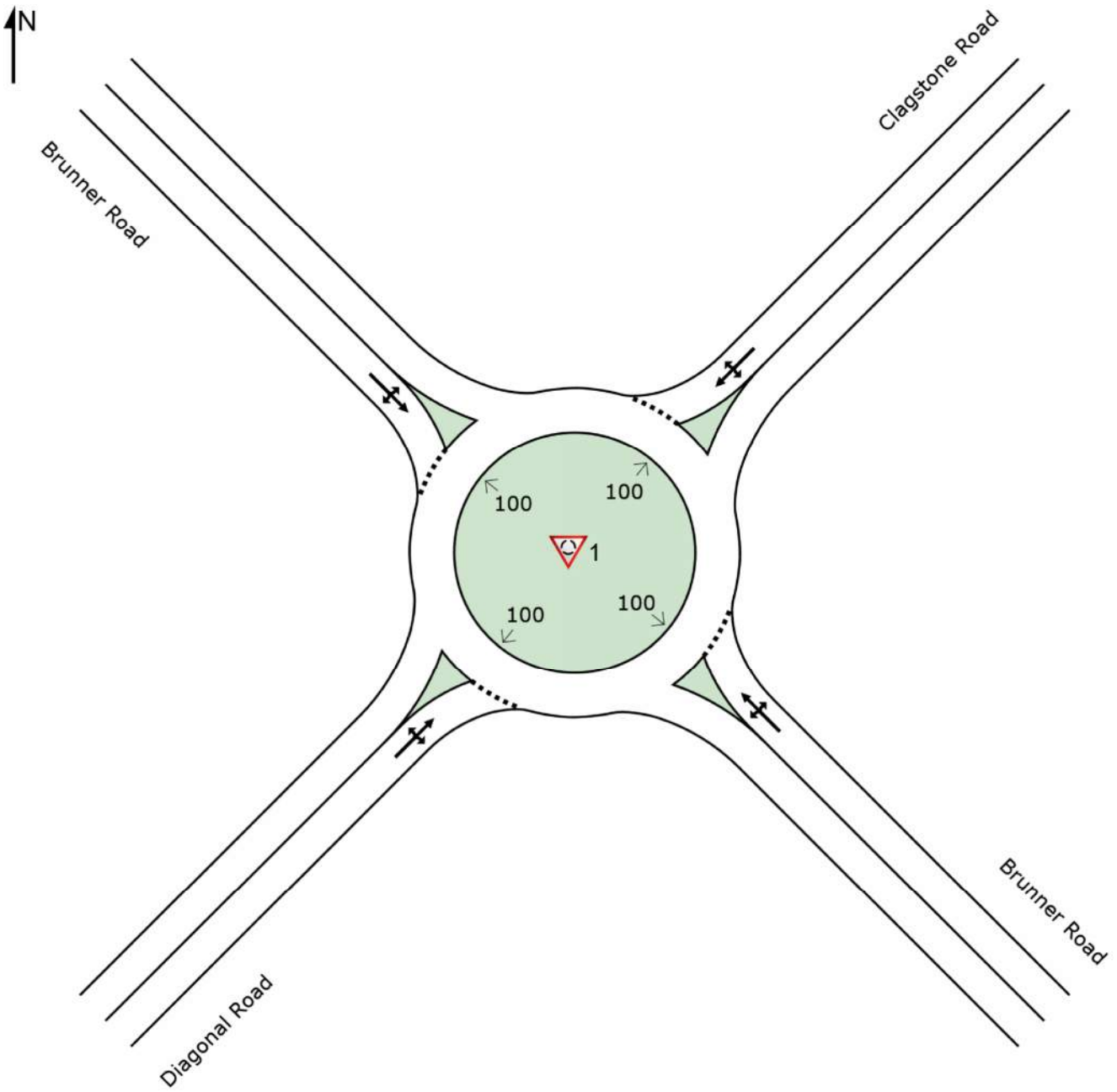
Alternative 2 (2045) Build Conditions – Weekday PM Peak Hour

SITE LAYOUT

Site: 1 [Year 2045 Background Conditions PM - Brunner - Clagstone - NE-SW (Site Folder: General)]

Brunner / Clagstone roundabout
2023 Existing PM Peak Hour
Alternative 2
Site Category: (None)
Roundabout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 1 [Year 2045 Background Conditions PM - Brunner - Clagstone - NE-SW (Site Folder: General)]

Brunner / Clagstone roundabout
2023 Existing PM Peak Hour
Alternative 2
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] ft	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed mph
SouthEast: Brunner Road														
3x	L2	216	2.0	235	2.0	0.492	10.6	LOS B	3.5	88.3	0.40	0.57	0.40	35.8
8x	T1	156	2.0	170	2.0	0.492	4.7	LOS A	3.5	88.3	0.40	0.57	0.40	35.8
18x	R2	181	2.0	197	2.0	0.492	4.7	LOS A	3.5	88.3	0.40	0.57	0.40	34.7
Approach		553	2.0	601	2.0	0.492	7.0	LOS A	3.5	88.3	0.40	0.57	0.40	35.4
NorthEast: Clagstone Road														
1x	L2	76	2.0	83	2.0	0.157	11.7	LOS B	0.8	20.9	0.52	0.67	0.52	35.1
6x	T1	54	2.0	59	2.0	0.157	5.7	LOS A	0.8	20.9	0.52	0.67	0.52	35.0
16x	R2	12	2.0	13	2.0	0.157	5.8	LOS A	0.8	20.9	0.52	0.67	0.52	34.0
Approach		142	2.0	154	2.0	0.157	8.9	LOS A	0.8	20.9	0.52	0.67	0.52	34.9
NorthWest: Brunner Road														
7x	L2	5	2.0	5	2.0	0.053	11.3	LOS B	0.2	6.3	0.45	0.53	0.45	36.3
4x	T1	42	2.0	46	2.0	0.053	5.4	LOS A	0.2	6.3	0.45	0.53	0.45	36.3
14x	R2	3	2.0	3	2.0	0.053	5.4	LOS A	0.2	6.3	0.45	0.53	0.45	35.2
Approach		50	2.0	54	2.0	0.053	6.0	LOS A	0.2	6.3	0.45	0.53	0.45	36.2
SouthWest: Diagonal Road														
5x	L2	8	2.0	9	2.0	0.229	10.4	LOS B	1.2	30.4	0.31	0.48	0.31	37.2
2x	T1	102	2.0	111	2.0	0.229	4.4	LOS A	1.2	30.4	0.31	0.48	0.31	37.1
12x	R2	145	2.0	158	2.0	0.229	4.5	LOS A	1.2	30.4	0.31	0.48	0.31	35.9
Approach		255	2.0	277	2.0	0.229	4.7	LOS A	1.2	30.4	0.31	0.48	0.31	36.4
All Vehicles		1000	2.0	1087	2.0	0.492	6.6	LOS A	3.5	88.3	0.40	0.56	0.40	35.6

Site Level of Service (LOS) Method: Delay & Degree of Saturation (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
Intersection and Approach LOS values are based on average delay for all movements (v/c not used).
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: HCM Queue Formula.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Alternative 3 (2045) Build Conditions – Weekday PM Peak Hour

Intersection	
Int Delay, s/veh	7.1

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	42	8	397	156	20	221
Future Vol, veh/h	42	8	397	156	20	221
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	100	100	-	100	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	46	9	432	170	22	240

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	55	0	1080	46
Stage 1	-	-	-	-	46	-
Stage 2	-	-	-	-	1034	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1550	-	241	1023
Stage 1	-	-	-	-	976	-
Stage 2	-	-	-	-	343	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1550	-	174	1023
Mov Cap-2 Maneuver	-	-	-	-	174	-
Stage 1	-	-	-	-	976	-
Stage 2	-	-	-	-	247	-

Approach	EB	WB	NB
HCM Control Delay, s	0	5.9	11.2
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	NBLn2	EBT	EBR	WBL	WBT
Capacity (veh/h)	174	1023	-	-	1550	-
HCM Lane V/C Ratio	0.125	0.235	-	-	0.278	-
HCM Control Delay (s)	28.6	9.6	-	-	8.2	-
HCM Lane LOS	D	A	-	-	A	-
HCM 95th %tile Q(veh)	0.4	0.9	-	-	1.1	-

Intersection	
Int Delay, s/veh	9

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations						
Traffic Vol, veh/h	186	219	153	102	54	88
Future Vol, veh/h	186	219	153	102	54	88
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	100	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	202	238	166	111	59	96

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	550	107	155	0	-	0
Stage 1	107	-	-	-	-	-
Stage 2	443	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	496	947	1425	-	-	-
Stage 1	917	-	-	-	-	-
Stage 2	647	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	434	947	1425	-	-	-
Mov Cap-2 Maneuver	434	-	-	-	-	-
Stage 1	803	-	-	-	-	-
Stage 2	647	-	-	-	-	-

Approach	SB	NE	SW
HCM Control Delay, s	14.8	4.7	0
HCM LOS	B		

Minor Lane/Major Mvmt	NEL	NET	SBLn1	SBLn2	SWT	SWR
Capacity (veh/h)	1425	-	434	947	-	-
HCM Lane V/C Ratio	0.117	-	0.466	0.251	-	-
HCM Control Delay (s)	7.9	0	20.3	10.1	-	-
HCM Lane LOS	A	A	C	B	-	-
HCM 95th %tile Q(veh)	0.4	-	2.4	1	-	-

Alternative 4 (2045) Build Conditions – Weekday PM Peak Hour

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	5	45	164	283	130	12
Future Vol, veh/h	5	45	164	283	130	12
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	100	100	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	49	178	308	141	13

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	812	148	154	0	-	0
Stage 1	148	-	-	-	-	-
Stage 2	664	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	348	899	1426	-	-	-
Stage 1	880	-	-	-	-	-
Stage 2	512	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	305	899	1426	-	-	-
Mov Cap-2 Maneuver	305	-	-	-	-	-
Stage 1	770	-	-	-	-	-
Stage 2	512	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	10	2.9	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1426	-	305	899	-	-
HCM Lane V/C Ratio	0.125	-	0.018	0.054	-	-
HCM Control Delay (s)	7.9	-	17	9.2	-	-
HCM Lane LOS	A	-	C	A	-	-
HCM 95th %tile Q(veh)	0.4	-	0.1	0.2	-	-

Intersection	
Int Delay, s/veh	6.5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	57	118	145	110	337	216
Future Vol, veh/h	57	118	145	110	337	216
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	100	-	200	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	62	128	158	120	366	235

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1125	158	0	0	278	0
Stage 1	158	-	-	-	-	-
Stage 2	967	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	227	887	-	-	1285	-
Stage 1	871	-	-	-	-	-
Stage 2	369	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	162	887	-	-	1285	-
Mov Cap-2 Maneuver	162	-	-	-	-	-
Stage 1	871	-	-	-	-	-
Stage 2	264	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	19.7	0	5.4
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	162	887	1285	-
HCM Lane V/C Ratio	-	-	0.382	0.145	0.285	-
HCM Control Delay (s)	-	-	40.4	9.7	8.9	-
HCM Lane LOS	-	-	E	A	A	-
HCM 95th %tile Q(veh)	-	-	1.6	0.5	1.2	-