TECHNICAL MEMORANDUM #3

DATE: December 5, 2019

Kittelson #: 20783
MDT #: 110591

TO: Wade Salyards, PE Montana Department of Transportation

FROM: Andy Daleiden, PE, Mark Heisinger, EIT, and Krista Purser, EIT – Kittelson & Associates, Inc.

PROJECT: Exposition Dr & 1st Ave N - Billings - NH 16-1(53)0, UPN 7908000

SUBJECT: Tier 2 Alternatives Evaluation and Screening

Introduction

This memorandum addresses the Tier 2 alternatives evaluation and screening for the Exposition Drive / 1st Avenue North intersection in Billings, MT. This report presents refined concept designs for the Tier 2 alternatives and discusses their evaluation. The information in this memorandum will be used to identify the preferred alternative that will be moved forward to the final design phase.

PROJECT AREA

Located in Yellowstone County, within the Billings city limits, the Exposition Drive / 1st Avenue North intersection is located 1.3 miles northeast of downtown Billings and just southwest of MetraPark. This intersection resides on the Camino Real International Trade Corridor that connects Canada, United States, and Mexico, and is a critical junction that provides local and regional connectivity to downtown Billings, US 87, Highway 3, and Interstate 90. Figure 1 illustrates the project location within Billings and Yellowstone County. The eastern project limits end at the Dick Johnston Bridge which crosses the Yellowstone River and provides access to Interstate 90. A Montana Rail Link (MRL) railroad facility is located to the south of the study area and runs parallel to 1st Avenue North and US 87 over the Yellowstone River.

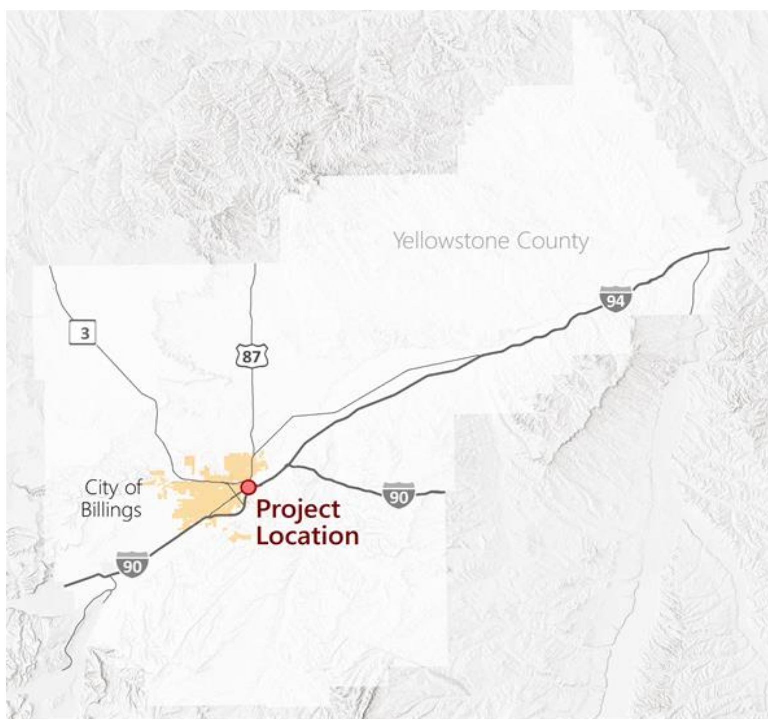


Figure 1 Project Vicinity Map

ALTERNATIVES DEVELOPMENT AND SCREENING PROCESS

The project team is applying a tiered process to developing and screening the intersection alternatives. The project team identified 16 initial options ranging from conventional intersection form to alternative intersections to grade-separated to system changes through new connections. The project team presented the 16 initial alternatives and evaluation results to the Project Advisory Committee (PAC), MDT, and Yellowstone County Commission in June, July, and August 2019. Through this discussion, the project team selected six alternatives to advance to Tier 1. The Tier 1 concepts were presented to the PAC, MDT, and local property and business owners in September 2019. Through the discussion, three alternatives were chosen to advance to Tier 2. Figure 2 illustrates the overall alternatives development and screening process for the project.

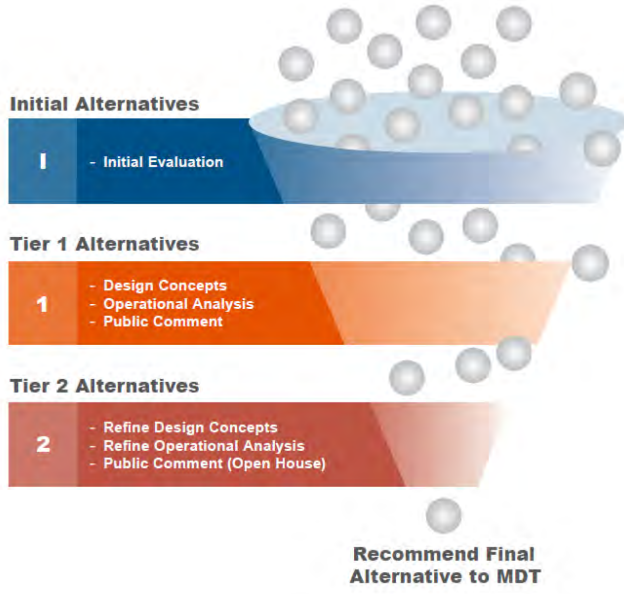


Figure 2 Alternatives Development and Screening Process

The Tier 2 alternatives will be presented to the PAC, MDT, and to the public during an Open House in December 2019. Through these discussions, the project team will choose a preferred alternative to move into final design and implementation.

Tier 2 Alternatives and Evaluation

The Tier 2 analysis evaluates 3 alternatives, shown in Figures 3 through 5. As shown, the alternatives are:

- **Alternative 1 - No-Build**
  - Existing infrastructure remains in-place.
  - Potential signal timing adjustments, but no equipment changes
- **Alternative 4 - Free Westbound Right-Turn Lane**
  - Converts existing westbound right-turn lane into a free right-turn lane and brings northbound right-turn lane through traffic signal at the Exposition Drive/1st Avenue N intersection
  - Provides 4th northbound lane on Exposition Drive between 1st Avenue N and 4th Avenue N, which becomes the right-turn lane at 6th Avenue N
  - Extends southbound left-turn lane at the Exposition Drive/1st Avenue N intersection
  - Refines intersection alignment to improve turning radii for trucks
  - Adds pedestrian crossings to east and north legs of Exposition Drive/1st Avenue N
  - Realigns pedestrian crossing on the south leg of the Exposition Drive/4th Avenue N intersection to decrease crossing distance
  - Provides pathway on both sides of Exposition Drive between 1st Avenue N and 4th Avenue N, provides sidewalks elsewhere
  - Provides pathway connection on north side of 1st Avenue N from Exposition Drive to Jim Dutcher Trail

- **Alternative 5 - Dual Westbound Right-Turn Lanes**
  - Provides second westbound right-turn lane and brings northbound right-turn lane through traffic signal at the Exposition Drive/1st Avenue N intersection
  - Extends southbound left-turn lane at the Exposition Drive/1st Avenue N intersection
  - Refines intersection alignment to improve turning radii for trucks
  - Adds pedestrian crossings to east and north legs of Exposition Drive/1st Avenue N
  - Realigns pedestrian crossing on the south leg of the Exposition Drive/4th Avenue N intersection to decrease crossing distance
  - Provides pathway on both sides of Exposition Drive between 1st Avenue N and 4th Avenue N, provides sidewalks elsewhere
  - Provides pathway connection on north side of 1st Avenue N from Exposition Drive to Jim Dutcher Trail

CONCEPT DESIGNS

The concept designs for Alternative 4 and 5 incorporated existing cadastral survey data in order to identify impacts to adjacent right-of-way and to identify potential utility conflicts. The design criteria are primarily based on guidelines set forth in the MDT Roadway Design Manual (Reference 1) and the AASHTO Greenbook (Reference 2). Some of the key assumptions that were made during the geometric design of the concepts are as follows:

- **Lane widths**
  - Travel (through) lane = 12 feet
  - Inside travel lane = 13 feet (11-foot lane + 2 foot from shoulder to face-of-curb)
  - Right-turn lane = 14 feet (12-foot lane + 2 foot from shoulder to face-of-curb)
  - Left-turn lane = 12 feet
- **Turn bay taper**
  - Single left-turn bay taper = 150 feet
  - Right-turn bay taper = 15:1 taper rate
- **Sidewalk width = 6 feet**
- **Pathway width = 12 feet**
- **Landscape buffer width = 6 feet**
- **Design vehicle = WB-62 Semitrailer Truck**

The roadway alignment was maintained in Alternatives 4 and 5 except for the westbound approach to the intersection. The alignment was modified so that the inner westbound lane feeds into the westbound left-turn lane and outer westbound lane into the westbound right-turn lane, rather than both lanes feeding westbound left-turn lanes as they do today. This modification is expected to improve the operational performance and reduce lane changes approaching the intersection.

Driveways

Alternatives 4 and 5 have impacts to the existing driveways for the properties on the south side of the intersection (along 1st Avenue North). The final configuration of these driveways will be determined through on-going discussions with MDT and the adjacent property owners. The same access configuration can be used for Alternatives 4 and 5.

LEGEND

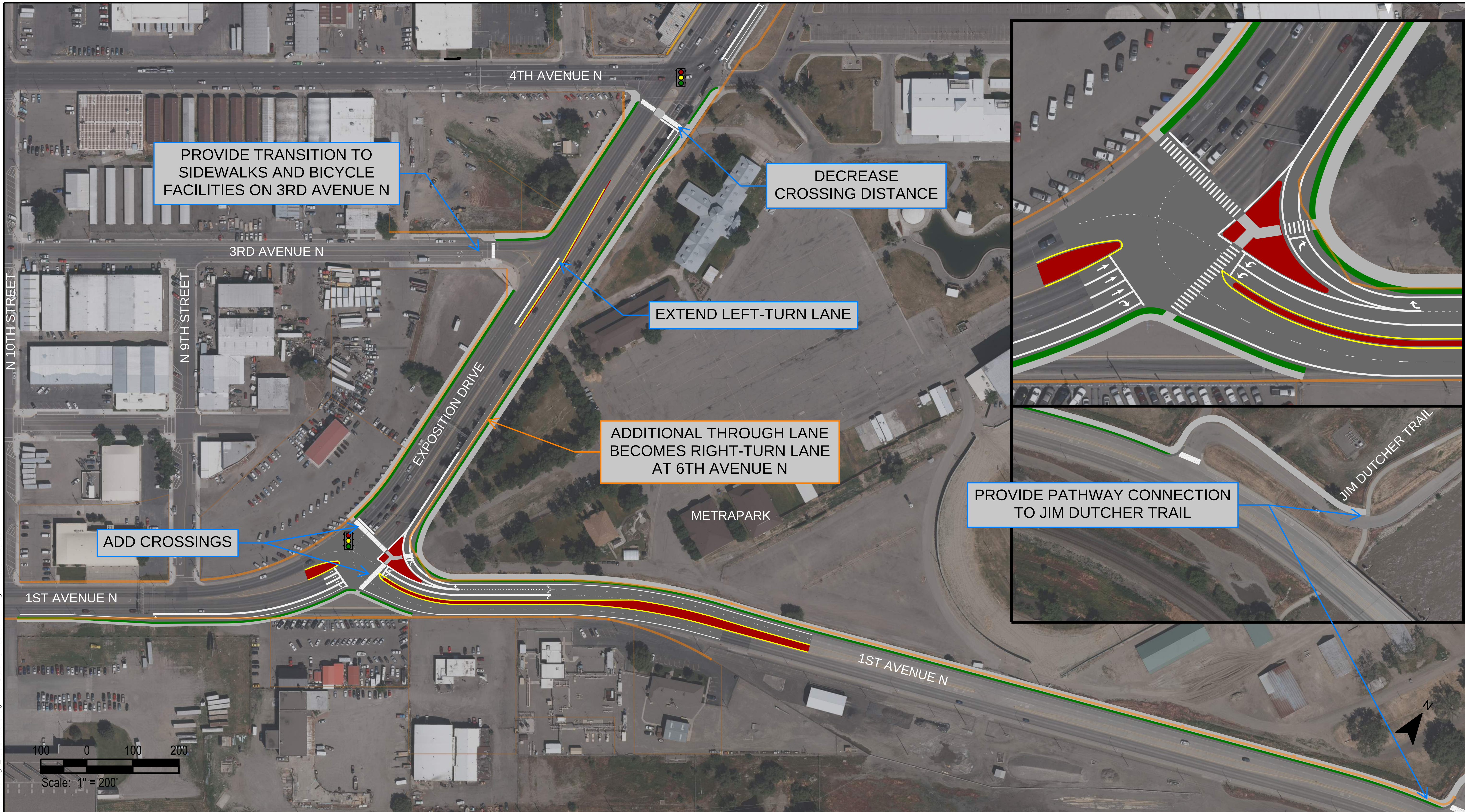
- SIDEWALK OR PATHWAY
- ROADWAY
- RIGHT-OF-WAY
- LANDSCAPING
- MEDIAN
- EXISTING TRAFFIC SIGNAL
- NEW OR MODIFIED TRAFFIC SIGNAL

VISION ZERO
zero deaths - zero serious injuries
MONTANA DEPARTMENT OF TRANSPORTATION

Alternative 1 - No-Build
Billings, Montana

Figure
3

KITTELSON & ASSOCIATES



VISION ZERO zero deaths - zero serious injuries MONTANA DEPARTMENT OF TRANSPORTATION

LEGEND

- SIDEWALK OR PATHWAY
- ROADWAY
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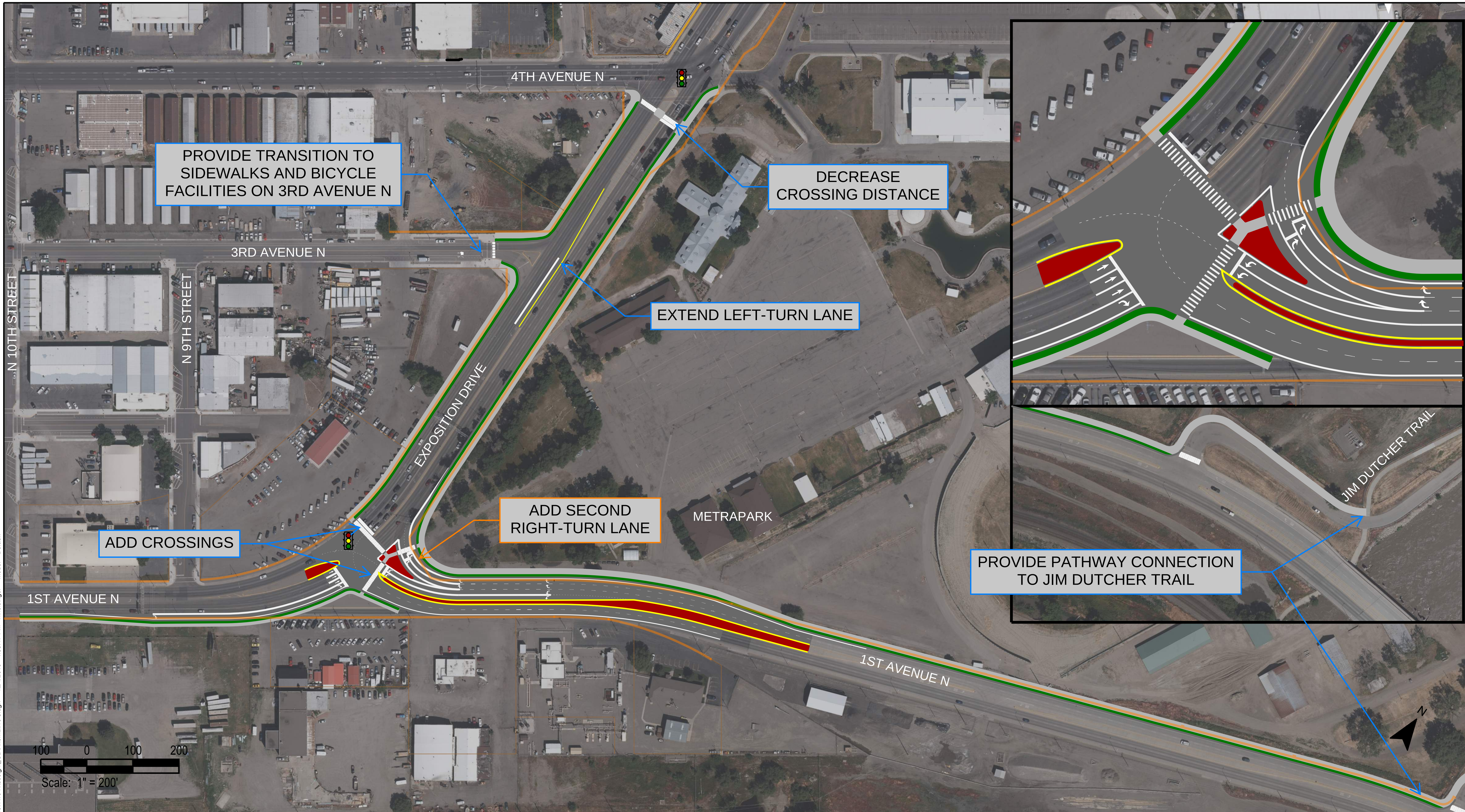
Alternative 4 - Free Westbound Right-Turn Lane
Billings, Montana

Figure
4

H:\20\20783 - Exposition Dr & 1st Ave N\design_CD\Alternative 4.dgn 12/4/2019 - 4:43:55 PM - mheisinger Model = Default

KITTELSON & ASSOCIATES



VISION ZERO
zero deaths - zero serious injuries
MONTANA DEPARTMENT OF TRANSPORTATION

LEGEND

- SIDEWALK OR PATHWAY
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- MEDIAN
- NEW OR MODIFIED TRAFFIC SIGNAL

Alternative 5 - Dual Westbound Right-Turn Lanes
Billings, Montana

Figure
5

KITTELSON & ASSOCIATES

Northbound-Right Turn Considerations

The possibility of including a second right-turn lane in the northbound direction was explored for Alternatives 4 and 5. The northbound right-turn traffic volume is projected to be 271 (AM peak hour) and 523 (PM peak hour) vehicles per hour in the year 2040. An operational analysis was conducted to determine the impacts that the second right-turn lane would have on intersection operations and the interaction of vehicle queues between the northbound through and right-turn movements. Concept designs were created for single and dual northbound right-turn lane scenarios in order to compare geometric and right-of-way impacts. The results of this analysis with draft linework are shown in Exhibit 1.

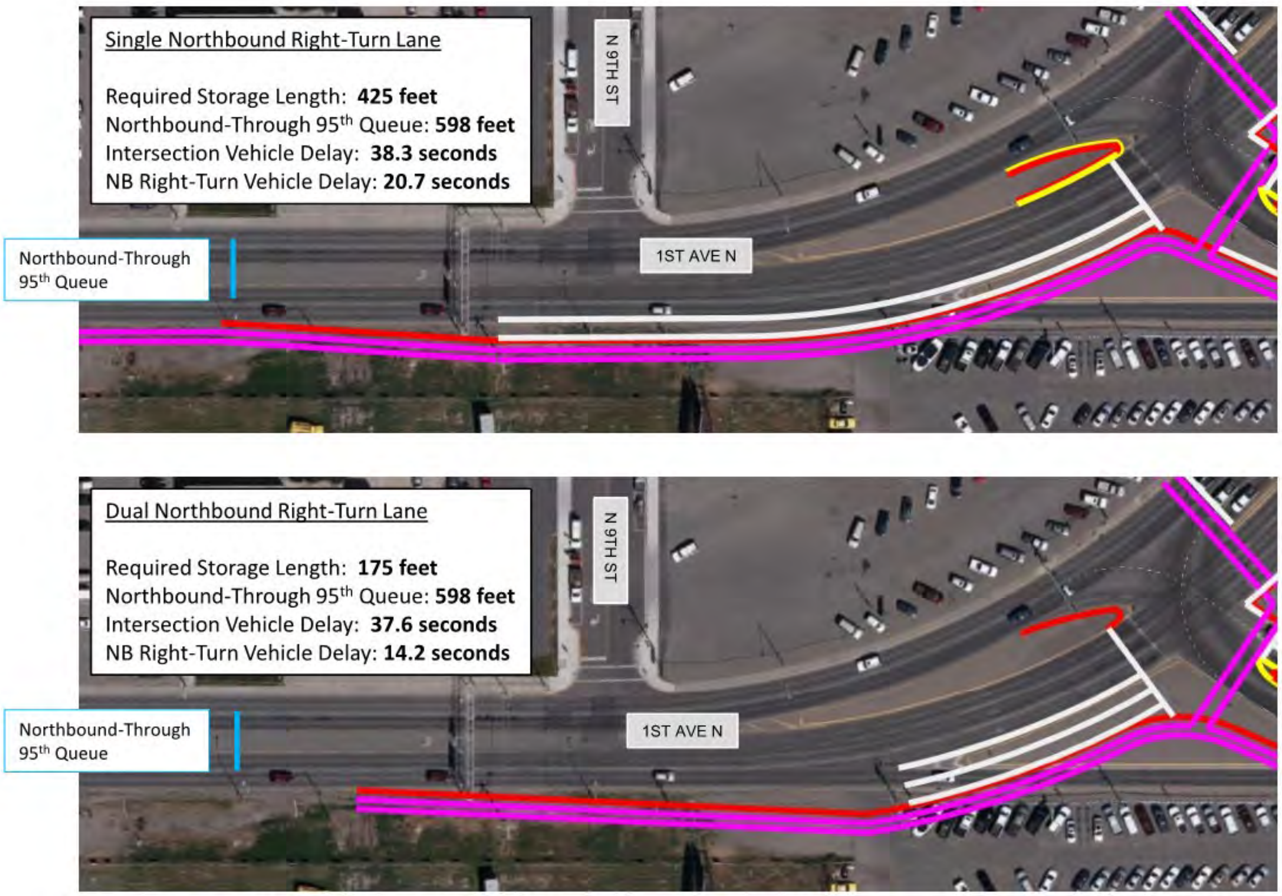

Exhibit 1 Northbound Right-Turn Lane (Single and Dual) Configurations

As shown in Exhibit 1, both configurations result in similar overall intersection vehicle delays. The 95th percentile queue for the northbound through movement is projected to extend approximately 50 feet past the end of the dual northbound right-turn taper during the weekday PM peak hour, potentially blocking traffic from accessing the turn lanes during periods of congestion. In addition, the single right-turn configuration creates a smoother transition for vehicles, as the right-turn lane taper begins and ends on the roadway tangent, before the horizontal curve. The taper for the dual right-turn lane would end on the horizontal curve. The design team recommends the single northbound right-turn lane configuration because the dual right-turn configuration provides limited operational benefits, the potential for the northbound-through queue to block the right-turn lane in the dual right-turn configuration during the peak hours, and the smoother transition into the right-turn lane that the single right-turn lane configuration provides.

COST ESTIMATES

Preliminary cost estimates for Alternatives 4 and 5 were developed based on the concept designs. The cost estimates took into account the area of roadway that would require full reconstruction, the area of roadway that would require minor reconstruction (i.e., an area that requires re-striping, but no major horizontal or vertical changes), the amount of roadway being fully excavated, and the amount of new roadway. Other key considerations include the cost of landscaping, sidewalks, and pathways, new or modified signal systems, modifications to the drainage and sewer systems, re-location of existing utilities and lighting, and design and construction management costs. A 40% contingency cost was assumed. Right-of-way costs are not included in the cost estimates. The preliminary cost estimates for Alternative 4 is $7.5 million and the cost estimate for Alternative 5 is $7.4 million. Appendix A includes the preliminary cost estimate worksheets for both alternatives.

EVALUATION RESULTS

The following describes the evaluation methodology implemented in the tiered approach. Each of the alternatives was evaluated based on the following criteria:

- **Safety Performance** – Is the alternative improving congested conditions? Are queues being reduced to reduce the potential for rear-end crashes?
- **Number of Free Right-Turns** – Are pedestrians required to cross a free right-turn lane? What's the potential for speed differentials or merging operations downstream?
- **Pedestrian Facility Quality** – What type of pedestrian facilities are provided? What's the quality of the pedestrian crossings at study area intersections?
- **Bicycle Facility Quality** – What type of bicycle facilities are provided? What's the quality of the bicycle crossings at study area intersections?
- **Traffic Operations (2040 AM/PM Peak Hour Level of Service)** – What level of service (LOS) will the intersection experience under 2040 conditions? Are queues reduced for the critical movements (e.g. westbound right-turn lane)?
    - *Future AM and PM peak hour operations worksheets are included in Appendix A and Appendix B, respectively*.
- **Traffic Operations Lifespan (After 2040) –** How long after 2040 will the intersection remain under capacity (intersection volume-to-capacity ratio of less than 1.0)?
- **Right-Of-Way Impact** – How much property is impacted?
- **Number of Properties Impacted** – How many properties are impacted?
- **Design and Construction Cost Estimates** – What's the relative cost between alternatives?

Table 1 (on the next page) compiles the evaluation results for each alternative. Alternatives 4 and 5 have similar operations in year 2040 traffic conditions and are projected to operate at under-capacity for similar lifespans in year 2040. Alternatives 4 and 5 have similar design and construction cost estimates. Pedestrian and bicycle facility quality is generally similar between the two alternatives. It should be noted that, although pedestrians are required to cross the free right-turn on Alternative 4, signal control will be provided to stop the vehicles when activated by the pedestrians.

Alternative 4 enhances access to MetraPark from Exposition Drive with the additional travel lane between 1st Avenue North and Bench Boulevard. This lane adds capacity to this segment of Exposition Drive and may function at times as an auxiliary lane for vehicles turning in MetraPark at 4th Avenue North and at Bench Boulevard.

Alternative 4 is expected to have a slightly higher area of impact on adjacent right-of-way. However, Alternatives 4 and 5 are still expected to impact the same number of parcels. Some of the key impacts to adjacent streetscape features are as follows:

- **MetraPark** – Both alternatives require the relocation or replacement of the existing MetraPark sign located on the northeast corner of the Exposition Drive/1st Avenue N intersection.
- **Streetlights** – Both alternatives likely require the relocation of streetlights on one or both sides of Exposition Drive, depending on the location of the ultimate landscape strip and sidewalks or pathways as lights could be maintained within the landscape strip.
- **Signing** – The overhead sign structures north of the Exposition Drive/1st Avenue N intersection may need to be removed and replaced, especially for Alternative 4 as the additional northbound travel lane will impact its current placement.

Next Steps

We have a public open house scheduled for December 11, 2019 and PAC meeting #3 scheduled for December 12, 2019. Based on feedback from the PAC meeting #3 and public open house, we will have further discussion with MDT and anticipate selecting a preferred alternative in January and February 2020 to move forward to the final design phase.

REFERENCES

1. Montana Department of Transportation. *Road Design Manual*. 2016.
2. American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets*. 2018.

Table 1. Alternatives Evaluation

Criteria		Safety Performance	Number of Free Right-Turns	Pedestrian Facility Quality	Bicycle Facility Quality	Traffic Operations (2040 AM/PM Peak Hour LOS[1])	Traffic Operations Lifespan (After 2040)	Right-Of-Way Impact (ft^2)	Number of Properties Impacted	Design and Construction Cost Estimates
Alternative	1	Lower	1	Lower	Lower	C/F	0 years	0	0	None
		No pedestrian or bicycle crossings provided at intersection. Volume-to-capacity ratio is 1.20 with high delay (PM). Queues are long for the westbound approach.								
	4	Medium	1	Higher	Higher	C/D	8-12 years	59,500	7	$7,500,000
		Requires crossing at free right-turn. Provides pathway connection to Jim Dutcher Trail. Volume-to-capacity ratio is 0.90 (PM). Queues are less for the westbound approach. Provides additional northbound capacity at Exposition Drive / 4th Avenue North intersection								
	5	Medium	0	Higher	Higher	C/D	8-12 years	55,000	7	$7,400,000
		Provides crossings and several multi-use path options. Provides pathway connection to Jim Dutcher Trail. Volume-to-capacity ratio is 0.90 (PM). Queues are significantly less for the westbound approach.								

[1]Level of Service – Indicates the average level of vehicle delay at an intersection. Calculated with HCM 6th Edition Methodology

Appendix A Cost Estimate Worksheets

Exposition Dr & 1st Ave N - Billings - NH 16-1(53)0, UPN 7908000

Tier 2 Cost Estimations

Alternative 4 - Free Westbound Right-Turn Lane

Montana Department of Transportation

Engineer's Estimate - Conceptual

Prepared By: Andy Daleiden, PE, Krista Purser, Mark Heisinger, Matt Ashby | *Date: November 2019*

	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Removal of Obstructions (202020055)	% of Excavation	15%	$ 246,822.25	$ 37,023.34
2	Excavation-Street (203020225)	CY	3,991	$ 20.77	$ 82,887.60
3	Special Borrow-Excavation (203020250)	CY	0	$ -	$ -
4	Excavation-Digouts (203020278)	CUYD	11,259	$ 14.56	$ 163,934.65
5	Crushed Aggregate Course (301020340)	CY	11,733	$ 23.05	$ 270,453.06
6	Plant Mix Surf GR S-3/4 (401020045)	TONS	10,127	$ 28.98	$ 293,483.85
7	Asphalt Cement PG 70-28 (402020095)	5.4% of Plant Mix	547	$ 432.53	$ 236,535.22
8	Cover Type II (409000020)	SY	23,254	$ 0.55	$ 12,789.70
9	Cold Milling - (411010000)	SY	5,830	$ 1.51	$ 8,803.30
10	Sidewalk-Concrete 6" (608010050)	SY	7,722	$ 75.54	$ 583,336.67
11	Raised Median - Decorative Concrete 6" (608010112)	SY	1,156	$ 80.98	$ 93,643.25
12	Median - Concrete Curb (609010030)	LNFT	2,700	$ 23.90	$ 64,530.00
13	Concrete Curbs, Standard Curb and Gutter (609010200)	LF	6,730	$ 33.41	$ 224,849.30
14	Landscaping	SF	33,000	$ 8.00	$ 264,000.00
15	Truncated Domes (617903255)	EACH	14	$ 1,045.89	$ 14,642.46
16	Geotextile Stabilization (622011084)	SY	17,424	$ 1.13	$ 19,689.12
17	Concrete Driveways Approaches	EACH	5	$ 1,000.00	$ 5,000.00
18	Lights - Urban	MILE	0.53	$ 175,000.00	$ 92,750.00
19	Remove Overhead Structure (619010526)	EACH	1	$ 5,806.61	$ 5,806.61
20	Reset Fence (607150125)	LNFT	3,500	$ 20.00	$ 70,000.00
21	Striping and Pavement Markings - Urban	MILE	2.06	$ 20,000.00	$ 41,227.27
				Subtotal A	**$ 2,585,385**
22	Existing Traffic Signal System Modification	LS	1	$ 50,000	$ 50,000.00
23	New Traffic Signal System	LS	1	$ 314,820	$ 314,820.00
24	New Minor Signal System	LS	0	$ 157,410	$ -
25	Prelim Signing - Urban (P61900110)	% of Subtotal A	5%	$ 2,585,385	$ 129,269.27
26	Utility Relocation (999107000)	% of Subtotal A	10%	$ 2,585,385	$ 258,538.54
27	Storm Sewer System, Complete	% of Subtotal A	25%	$ 2,585,385	$ 646,346.35
28	Mobilization	% of Subtotal A	14%	$ 2,585,385	$ 349,027.03
29	Temporary Protection & Direction of Traffic	% of Subtotal A	8%	$ 2,585,385	$ 206,830.83
30	Temporary Erosion Control (208010200)	% of Subtotal A	3%	$ 2,585,385	$ 77,561.56
				Subtotal B	**$ 2,032,394**
31	Public Utility Easement Area	% of Subtotal A & B	2%	$ 4,617,779	$ 92,400.00
32	Engineering Design	% of Subtotal A & B	10%	$ 4,617,779	$ 461,800.00
33	Construction Management	% of Subtotal A & B	10%	$ 4,617,779	$ 461,800.00
				Subtotal C	**$ 1,016,000**
				TOTAL PROJECT SUBTOTAL	**$ 5,633,779**
				Construction Costs (Subtotal A & B)	**$ 4,617,779**
				40% Contingency of Construction Costs[2]	**$ 1,847,120**
				TOTAL ESTIMATED PROJECT COST (WITH CONTINGENCY)	**$ 7,500,000**

Notes

[1]Unit Costs based on MDT Average Bid Costs, January 2018.

[2]Contingency based on MDT Cost Estimation Procedure for Highway Design Projects, November 2016.

Exposition Dr & 1st Ave N - Billings - NH 16-1(53)0, UPN 7908000

Tier 2 Cost Estimations

Alternative 5 - Dual Westbound Right-Turn Lanes

Montana Department of Transportation

Engineer's Estimate - Conceptual

Prepared By: Andy Daleiden, PE, Krista Purser, Mark Heisinger, Matt Ashby — *Date: November 2019*

	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Removal of Obstructions (202020055)	% of Excavation	15%	$ 238,986.17	$ 35,847.93
2	Excavation-Street (203020225)	CY	3,865	$ 20.77	$ 80,270.20
3	Special Borrow-Excavation (203020250)	CY	0	$ -	$ -
4	Excavation-Digouts (203020278)	CUYD	10,901	$ 14.56	$ 158,715.97
5	Crushed Aggregate Course (301020340)	CY	11,351	$ 23.05	$ 261,642.85
6	Plant Mix Surf GR S-3/4 (401020045)	TONS	9,974	$ 28.98	$ 289,055.22
7	Asphalt Cement PG 70-28 (402020095)	5.4% of Plant Mix	539	$ 432.53	$ 232,965.94
8	Cover Type II (409000020)	SY	22,903	$ 0.55	$ 12,596.71
9	Cold Milling - (411010000)	SY	6,047	$ 1.51	$ 9,130.52
10	Sidewalk-Concrete 6" (608010050)	SY	7,594	$ 75.54	$ 573,680.98
11	Raised Median - Decorative Concrete 6" (608010112)	SY	1,055	$ 80.98	$ 85,403.13
12	Concrete Curbs, Standard Curb and Gutter (609010200)	LF	6,733	$ 33.41	$ 224,949.53
13	Median - Concrete Curb (609010030)	LNFT	2,631	$ 23.90	$ 62,880.90
14	Landscaping	SF	33,000	$ 8.00	$ 264,000.00
15	Truncated Domes (617903255)	EACH	14	$ 1,045.89	$ 14,642.46
16	Geotextile Stabilization (622011084)	SY	16,856	$ 1.13	$ 19,047.73
17	Concrete Driveways Approaches	EACH	5	$ 1,000.00	$ 5,000.00
18	Lights - Urban	MILE	0.53	$175,000.00	$ 92,750.00
19	Reset Fence (607150125)	LNFT	3,500	$ 20.00	$ 70,000.00
20	Striping and Pavement Markings - Urban	MILE	2.06	$ 20,000.00	$ 41,227.27
				Subtotal A	**$ 2,533,807**
21	Existing Traffic Signal System Modification	LS	1	$ 50,000	$ 50,000.00
22	New Traffic Signal System	LS	1	$ 314,820	$ 314,820.00
23	New Minor Signal System	LS	0	$ 157,410	$ -
24	Prelim Signing - Urban (P61900110)	% of Subtotal A	5%	$ 2,533,807	$ 126,690.37
25	Utility Relocation (999107000)	% of Subtotal A	10%	$ 2,533,807	$ 253,380.73
26	Storm Sewer System, Complete	% of Subtotal A	25%	$ 2,533,807	$ 633,451.83
27	Mobilization	% of Subtotal A	14%	$ 2,533,807	$ 342,063.99
28	Temporary Protection & Direction of Traffic	% of Subtotal A	8%	$ 2,533,807	$ 202,704.59
29	Temporary Erosion Control (208010200)	% of Subtotal A	3%	$ 2,533,807	$ 76,014.22
				Subtotal B	**$ 1,999,126**
30	Public Utility Easement Area	% of Subtotal A & B	2%	$ 4,532,933	$ 90,700.00
31	Engineering Design	% of Subtotal A & B	10%	$ 4,532,933	$ 453,300.00
32	Construction Management	% of Subtotal A & B	10%	$ 4,532,933	$ 453,300.00
				Subtotal C	**$ 997,300**
				TOTAL PROJECT SUBTOTAL	**$ 5,530,233**
				Construction Costs (Subtotal A & B)	**$ 4,532,933**
				40% Contingency of Construction Costs[2]	**$ 1,813,180**
				TOTAL ESTIMATED PROJECT COST (WITH CONTINGENCY)	**$ 7,400,000**

Notes

[1]Unit Costs based on MDT Average Bid Costs, January 2018.

[2]Contingency based on MDT Cost Estimation Procedure for Highway Design Projects, November 2016.