BILLINGS AIRPORT ROAD & MAIN STREET Concept

TECHNICAL MEMORANDUM #3A

Date: November 27, 2015

Project #: 18460

To: Wade Salyards, PE
Montana Department of Transportation

From: Brett Korporaal and Andy Daleiden, PE

Project: Airport Road/Main Street – Billings, CM 1099(102), UPN 8718000

Subject: Tier I: Evaluation and Screening of Initial Alternatives

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This technical memorandum summarizes the Tier I evaluation and screening of the initial alternatives that were developed for the Airport Road and Main Street intersection in Billings, MT and presented in Technical Memorandum (TM) #2 and at the PAC Meeting #1. We performed a fatal flaw analysis to determine and eliminate alternatives. The fatal flaw analysis evaluated the initial twenty alternatives against three evaluation criteria, which are presented below along with the methodology used in the evaluation.

Traffic Operations - Does the alternative accommodate the future year 2040 critical volumes?

An operational analysis was performed for the twenty initial alternatives included in TM #2 using CAP-X and Synchro 8 traffic analysis software tools. This memorandum documents the Highway Capacity Manual (HCM) operations for each alternative under year 2040 traffic conditions during the weekday a.m. and p.m. peak hours. The operational analysis included the following assumptions: year 2040 traffic volumes as presented in TM #1 during the weekday a.m. and p.m. peak hours, optimized signal timings, and a peak hour factor of 1.0 (given the 20-year planning horizon). All other assumptions presented in TM #1 were maintained for this analysis. Attachments A and B includes the year 2040 traffic conditions operational analysis for all of the alternatives during the weekday a.m. and p.m. peak hours, respectively.

In the future conditions operations analysis, we identified an operational benefit at the Airport Road/Main Street intersection by adding a southbound right-turn lane and providing either dual or triple eastbound left-turn lanes with protected left-turn phasing. With this in mind, we analyzed these improvements as standalone alternatives (2B, 2C, 2D, and 2E), as well as included the southbound right-turn lane and one of the eastbound left-turn lane improvements with the other alternatives being considered.

Alternatives that were projected to operate at a LOS E or better and an intersection volume-to-capacity ratio of less than or equal to 1.10 during both the weekday a.m. and p.m. peak periods were

considered operationally acceptable. All other alternatives were dismissed based on the operational criteria, except for Alternatives 2D and 2E as they are considered low cost alternatives and could be considered potential near-term improvements.

Table 1 (shown on the next page) presents the operations results for the initial alternatives under year 2040 traffic conditions during the weekday a.m. and p.m. peak hours. The operational analysis evaluated the study intersections impacted by each alternative. However, for purposes of the fatal flaw analysis, the operational results were presented for the critical intersections, which include Airport Road/Main Street and Aronson Avenue/Main Street for most of the alternatives. A few of the alternatives create new intersections or have significant changes to the existing intersections and those operational results are included in Table 1.

As shown in Table 1, the alternatives with northbound left-turns and unsignalized traffic control at the intersection of Aronson Avenue and Main Street are projected to operate at LOS F and a v/c ratio of greater than 1.0. To meet the future traffic demand, the Aronson Avenue and Main Street intersection will need to be signalized or the northbound left-turns will need to be rerouted and accommodated at another intersection.

As shown in Table 1, the following alternatives are projected to operate at a LOS E or better and an intersection volume-to-capacity ratio of less than or equal to 1.10 under year 2040 traffic conditions:

- Alternative 2D – Dual Eastbound Left-Turn Lanes and Signal Phasing Modification (*Note: This alternative has a LOS F and v/c of 1.22 during the weekday p.m. peak, but is a low-cost alternative and should be considered for further evaluation or as a potential near-term improvement.*)
- Alternative 2E – Triple Eastbound Left-Turn Lanes (*Note: This alternative has a v/c of 1.11 during the weekday p.m. peak, but is a lower cost alternative and should be considered for further evaluation or as a potential near-term improvement.*)
- Alternative 3B – Signalized Southwest Quadrant
- Alternative 3C – Signalized Southwest Quadrant (Signal at Swords Lane)
- Alternative 4B - Signalized Southwest Quadrant (One-Way Eastbound Airport Road)
- Alternative 5A – Median U-Turn (North-South)
- Alternative 5B – Partial Displaced Left-Turn (Southwest Quadrant)
- Alternative 6A – Eastbound Left Flyover
- Alternative 6B – Loop Ramp in Southeast Quadrant

As this study moves forward into Tier 2, the study alternatives should consider capacity improvements at the Lake Elmo Drive/Main Street intersection, as it is projected to be over capacity in the year 2040 future conditions. Potential improvement strategies include extending the

eastbound right-turn lane, adding a second eastbound right-turn lane (*v/c projected to be equal to 1.0 or less with improvement in place during both time periods*), and extending the northbound left-turn lane. Given the close proximity of this intersection to the Airport Road/Main Street intersection, these improvements provide an operational benefit (e.g. reduce queues and improve coordination by adding more green time to Main Street) to Main Street corridor.

Table 1. Initial Alternatives - Year 2040 Traffic Conditions, Weekday AM and PM Peak Hour

Alternative Strategy	Alternative #	Intersection	AM PEAK HOUR			PM PEAK HOUR		
			LOS	Delay	v/c ratio	LOS	Delay	v/c ratio
No Build	1	Lake Elmo Dr/Main St	F	88.2	1.30	C	31.5	1.07
		Airport Rd/Main St	F	148.1	1.27	F	146.1	1.33
		Aronson Ave/Main St	F	>80.0	1.73	F	>80.0	0.80
Conventional Intersection	2A	Airport Rd/Main St	F	126.1	1.22	F	146.1	1.27
	2B	Airport Rd/Main St	F	84.0	1.11	F	143.9	1.31
	2C	Airport Rd/Main St	E	68.3	1.05	E	112.7	1.21
	2D	**Airport Rd/Main St**	**E**	**55.6**	**1.05**	**F**	**115.1**	**1.22**
	2E	**Airport Rd/Main St**	**D**	**45.5**	**1.00**	**E**	**77.1**	**1.11**
Quadrant Intersection	3A	Airport Rd/Main St	D	39.9	0.98	F	89.0	1.16
		Aronson Ave/Main St	F	>80.0	>2.00	F	>80.0	>2.00
	3B	**Airport Rd/Main St**	**C**	**29.3**	**0.93**	**E**	**68.3**	**1.10**
		Aronson Ave/Main St	**B**	**12.0**	**0.87**	**B**	**10.0**	**0.76**
	3C	**Airport Rd/Swords Ln**	**D**	**45.0**	**0.58**	**D**	**45.5**	**0.75**
		Airport Rd/Main St	**B**	**11.4**	**0.82**	**B**	**17.5**	**0.91**
		Aronson Ave/Main St	**D**	**43.6**	**1.04**	**E**	**58.7**	**1.07**
	3D	Airport Rd/Aronson Ave	B	17.1	0.35	C	23.3	0.49
		Airport Rd/Main St	C	18.0	0.90	F	125.0	1.28
		Aronson Ave/Main St	C	18.5	0.47	F	>200.0	>2.00
One-Way Intersection or Couplet	4A	Airport Rd/Main St	C	22.2	0.85	C	34.0	0.97
		Aronson Ave/Main St	F	>80.0	>2.00	F	>80.0	0.80
	4B	**Airport Rd/Main St**	**B**	**10.8**	**0.82**	**C**	**25.1**	**0.92**
		Aronson Ave/Main St	**B**	**13.1**	**0.88**	**B**	**11.2**	**0.74**
	4C	Airport Rd/Main St	D	48.8	1.02	F	103.3	1.12
		Aronson Ave/Main St	B	12.4	0.92	A	6.9	0.75
	4D	Airport Rd/Main St	D	49.2	1.07	D	54.6	1.11
		Aronson Ave/Main St	B	14.5	0.86	F	82.3	1.12
Alternative Intersection (High-Volume)	**5A**	**Airport Rd/Main St**	**C**	**34.8**	**0.93**	**E**	**60.0**	**1.06**
		Aronson Ave/Main St	**B**	**12.2**	**0.88**	**B**	**14.3**	**0.77**
	5B	**Airport Rd/Main St**	**D**	**44.3**	**0.93**	**E**	**60.8**	**1.06**
		Aronson Ave/Main St	**B**	**11.5**	**0.87**	**A**	**9.4**	**0.74**
	5C	Airport Rd/Main St	F	-	>4.00	F	-	>4.00
Grade Separated	**6A**	**Airport Rd/Main St**	**E**	**70.8**	**1.08**	**C**	**33.2**	**0.99**
	6B	**Airport Rd/Main St**	**A**	**-**	**-**	**A**	**-**	**-**
		Aronson Ave/Main St	**B**	**-**	**-**	**C**	**-**	**-**
	6C	Airport Rd/Main St	A	-	-	A	-	-
		Airport Rd/Bench Blvd	F	92.5	1.07	F	96.8	1.05

Note: Gray shading and **bold text** represent an alternative with LOS E or better and a v/c ratio of less than or equal to 1.10.

Environmental - Does the alternative have a significant impact to an environmental resource or topographical constraint?

Based on the environmental scan presented in TM #1, an evaluation was performed to identify if any of the alternatives would have a major impact to any of the 4(f) sites, historical properties, or floodplain areas. The alternative was considered a fatal flaw if it impacted an environmental element (e.g. new structure would be located on or near the environmental element). According to MDT, there is a historical resource (e.g. rock shelter and pictographs) located in the southeast quadrant of the Airport Road and Main Street intersection. The alternatives that included new structures and connections in this quadrant were considered a fatal flaw due to this environmental resource.

We also performed an assessment of the alternatives in relationship to the surrounding topography. The northeast quadrant includes Alkali Creek and a significant grade change sloping away from the intersection, which becomes a challenge for any alternatives using this quadrant. The southeast quadrant has a significant grade change sloping away from the intersection, which becomes a challenge for any alternatives using this quadrant. Alternatives were dismissed based on an alternative requiring new structure in the southeast and northeast quadrants of the Airport Road and Main Street intersection. Table 2 summarizes the alternatives eliminated based on the environmental criteria.

Project Advisory Committee - Was the alternative dismissed at the PAC Meeting #1?

At our PAC Meeting #1, we asked the PAC about any of the alternatives being a fatal flaw from an agency perspective. At that time, Alternatives 3C and 5C were identified as fatal flaws. Alternative 3C was considered to be fatally flawed due to the addition of a new signal on Airport Road in close proximity to the Airport Road/Main Street intersection. Alternative 5C was considered to be fatally flawed due to an operational deficiency and impacts to signal progression on Main Street with a multilane roundabout.

Tier I – Evaluation and Screening of Alternatives

Table 2 summarizes the screening of the alternatives based on the operations, environmental, and PAC criteria.

Table 2. Tier I – Evaluation and Screening of Alternatives

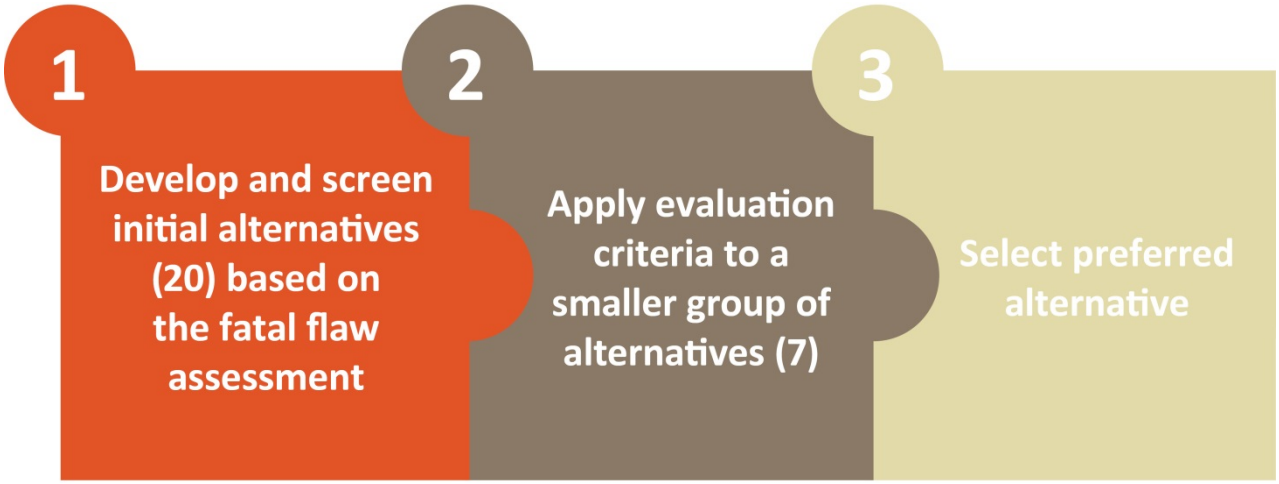
No.	Alternative	Fatal Flaw Criteria			
		Oper-ations	Environ-mental	PAC	Why?
1	No-Build	X	-	-	▪ Does not address critical traffic volumes.
2A	Operational Strategies	X	-	-	▪ Modifications to signal timing does not address critical traffic volumes. ▪ Strategies should be considered with other alternatives.
2B	Add Southbound Right-Turn Lane	X	-	-	▪ Provides operational benefit, but does not fully address critical traffic volumes. ▪ Strategy should be considered with other alternatives.
2C	Eastbound Approach Lane Reconfiguration	X	-	-	▪ Does not address critical traffic volumes.
2D	Dual Eastbound Left-Turn Lanes and Signal Phasing Modification	-	-	-	▪ Provides operational benefit, but does not fully address critical traffic volumes. ▪ Strategy should be considered with other alternatives. ▪ Recommended for Tier II evaluation.
2E	Triple Eastbound Left-Turn Lanes	-	-	-	▪ Provides operational benefit, but does not fully address critical traffic volumes. ▪ Strategy should be considered with other alternatives. ▪ Recommended for Tier II evaluation.
3A	Unsignalized Southwest Quadrant	X	-		▪ Does not address critical traffic volumes at Aronson Avenue.
3B	Signalized Southwest Quadrant	-	-	-	▪ Recommended for Tier II evaluation.
3C	Signalized Southwest Quadrant (Signal at Swords Lane)	-	-	X	▪ Dismissed by PAC due to new signal too close to the existing interchange.
3D	Signalized Southeast Quadrant	X	X	-	▪ Significant environmental impacts.
4A	Airport Road One-Way Eastbound	X	-	-	▪ Does not address critical traffic volumes.
4B	Signalize Southwest Quadrant - Removal of Northbound Left-Turns and One-Way Eastbound Airport Road	-	-	-	▪ Recommended for Tier II evaluation.
4C	One-Way Couplet (Westbound - Aronson Avenue)	X	-	-	▪ Does not address critical traffic volumes.
4D	One-Way Couplet (Eastbound - Aronson Avenue)	X	-	-	▪ Does not address critical traffic volumes.
5A	Median U-Turn (MUT) - North/South	-	-	-	▪ Recommended for Tier II evaluation.
5B	Partial Displaced Left-Turn (DLT) – Southwest Quadrant	-	-	-	▪ Recommended for Tier II evaluation.
5C	Multilane Roundabout	X	-	X	▪ Does not address critical traffic volumes. ▪ Dismissed by PAC due to operational deficiency and impacts to signal progression.
6A	Eastbound Left Flyover at Airport Road/Main Street	-	X	-	▪ Significant impacts to Main Street, alignment, and signal at Lake Elmo Drive
6B	Loop Ramp in Southeast Quadrant	-	X	-	▪ Significant environmental impacts.
6C	Airport Road Overpass to Bench Boulevard	X	X	-	▪ Does not address critical traffic volumes. ▪ Significant environmental impacts.

Based on the Tier I screening shown In Table 2, we recommend carrying forward six alternatives (highlighted in gray shading) and the no build alternative to the Tier II evaluation for further consideration and refinement.

Recommendations and Next Steps

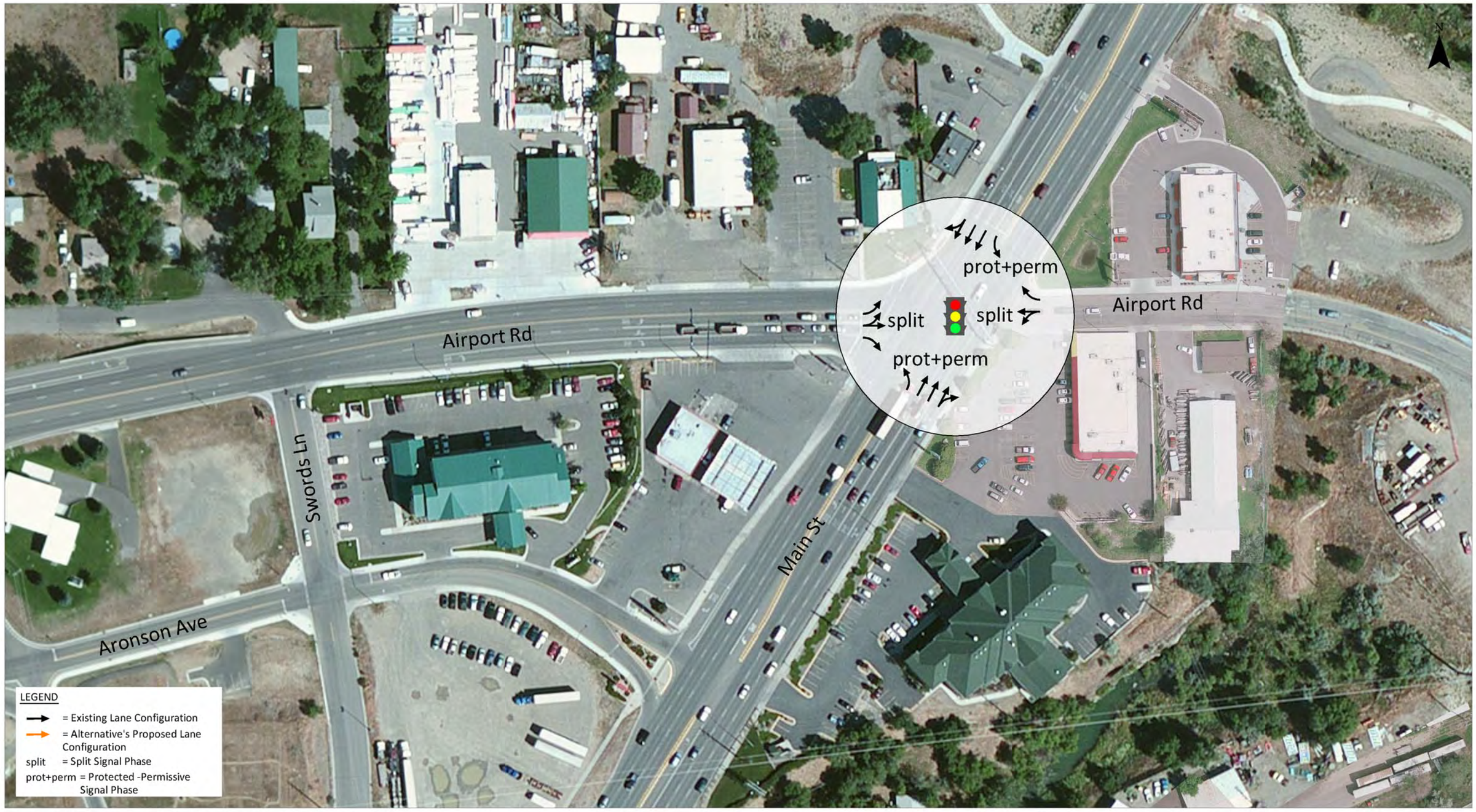
It is recommended that Alternatives 1, 2D, 2E, 3B, 4B, 5A, and 5B be carried forward into the Tier II evaluation for further consideration and refinement. The process for further refinement is outlined in Exhibit 1. Figures 1 through 7 provide a high-level schematic of the recommended alternatives, including lane configurations and call-outs at the critical intersections. Additionally, improvement strategies at the Lake Elmo Drive/Main Street intersection, such as extending the eastbound right-turn lane, adding a second eastbound right-turn lane, and/or extending the northbound left-turn lane are recommended for consideration with the alternatives in Tier II.

Exhibit 1. Tiered Approach to Alternatives Evaluation



Under Tier II, the seven alternatives will be further refined into concept designs and evaluated based on the detailed evaluation criteria presented in TM #2. The Tier II evaluation will be summarized in TM #3B and presented to the PAC in December 2015.

If you have any questions, please contact Andy Daleiden via email at adaleiden@kittelson.com or by phone at 208.338.2683.



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BILLINGS AIRPORT ROAD & MAIN STREET Concept

ALTERNATIVE 1 - NO BUILD
TIER I: EVALUATION AND SCREENING OF INITIAL ALTERNATIVES
BILLINGS, MONTANA

SCALE: 1" = 100'
0 100' 200'

FIGURE
1

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

H:\profile\18480 - Airport Road & Main Street - Billings\dwgs\figs\18480_Alternatives.dwg - Mar 22, 2016 - 2:16pm - bkoopsal - Layout Tab: Alt 1

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BILLINGS AIRPORT ROAD & MAIN STREET Concept

ALTERNATIVE 2D - DUAL EASTBOUND LEFT-TURN LANES AND SIGNAL PHASING MODIFICATION
TIER I: EVALUATION AND SCREENING OF INITIAL ALTERNATIVES
BILLINGS, MONTANA

SCALE: 1" = 100'

0 100' 200'

FIGURE 2

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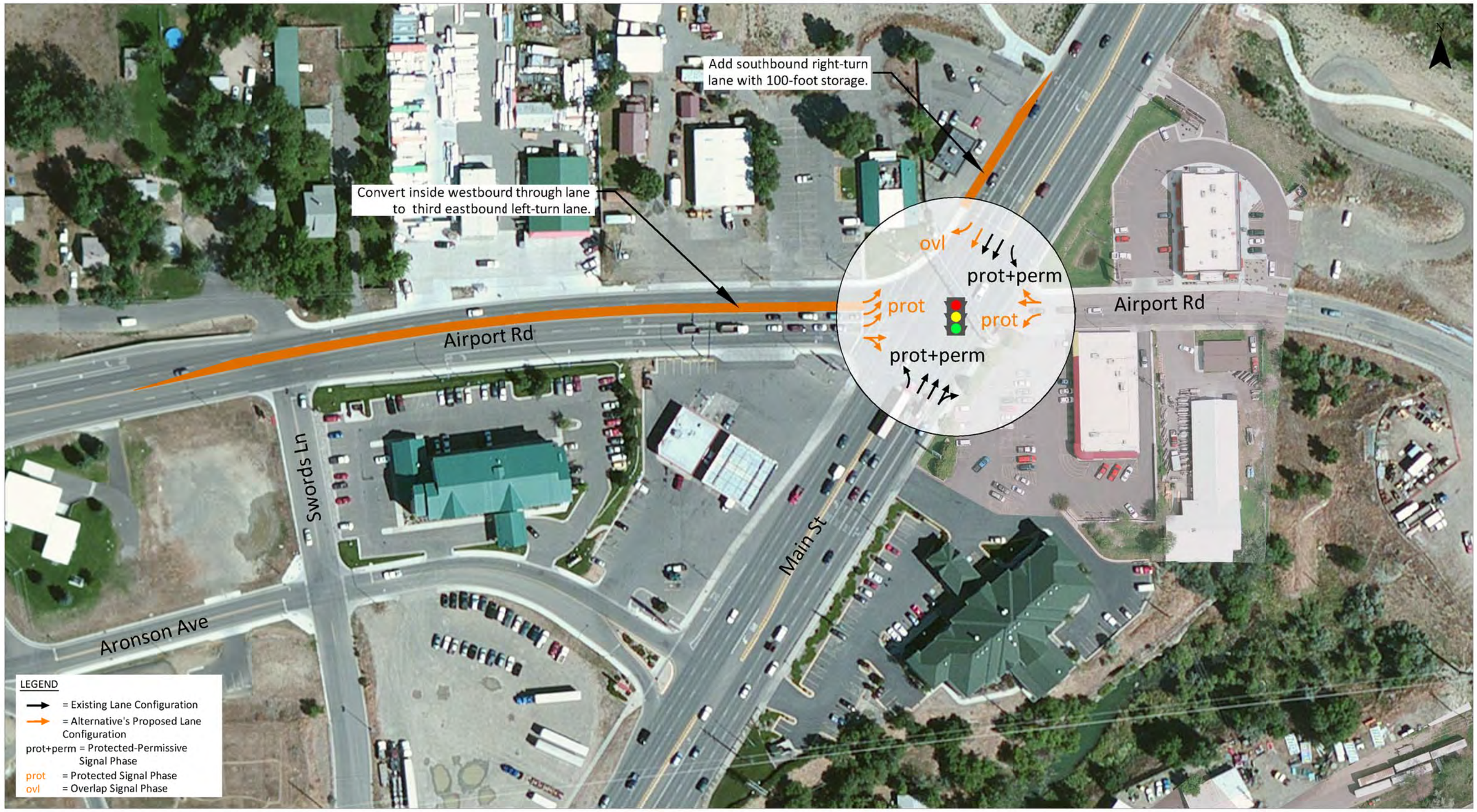
TRANSPORTATION ENGINEERING/PLANNING



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BILLINGS AIRPORT ROAD & MAIN STREET Concept

ALTERNATIVE 2E - TRIPLE EASTBOUND LEFT-TURN LANES
TIER I: EVALUATION AND SCREENING OF INITIAL ALTERNATIVES
BILLINGS, MONTANA

SCALE: 1" = 100'

0 100' 200'

FIGURE 3

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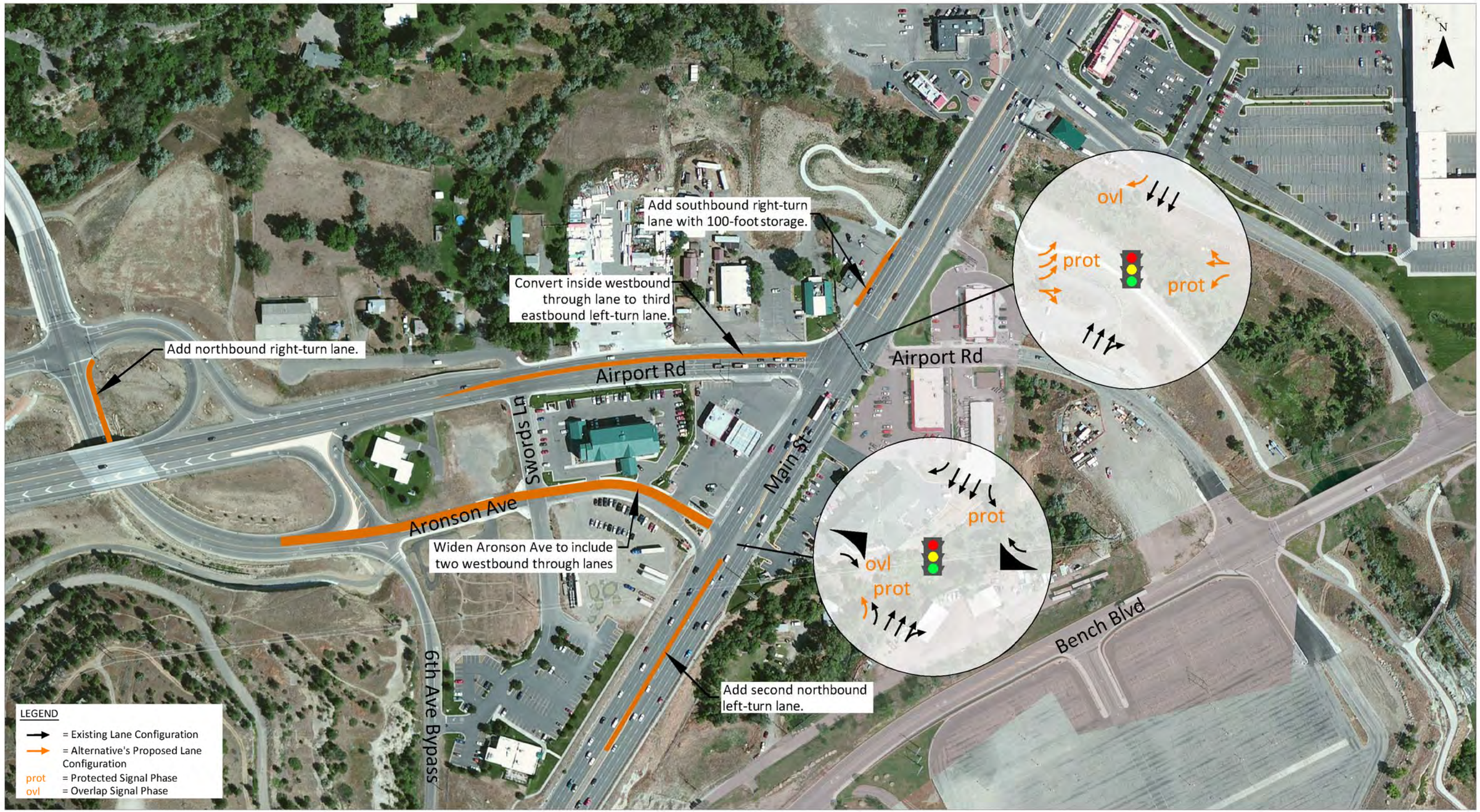

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BILLINGS AIRPORT ROAD & MAIN STREET Concept

ALTERNATIVE 3B - SIGNALIZED SOUTHWEST QUADRANT
TIER I: EVALUATION AND SCREENING OF INITIAL ALTERNATIVES
BILLINGS, MONTANA

SCALE: 1" = 200'
0 200' 400'

FIGURE 4

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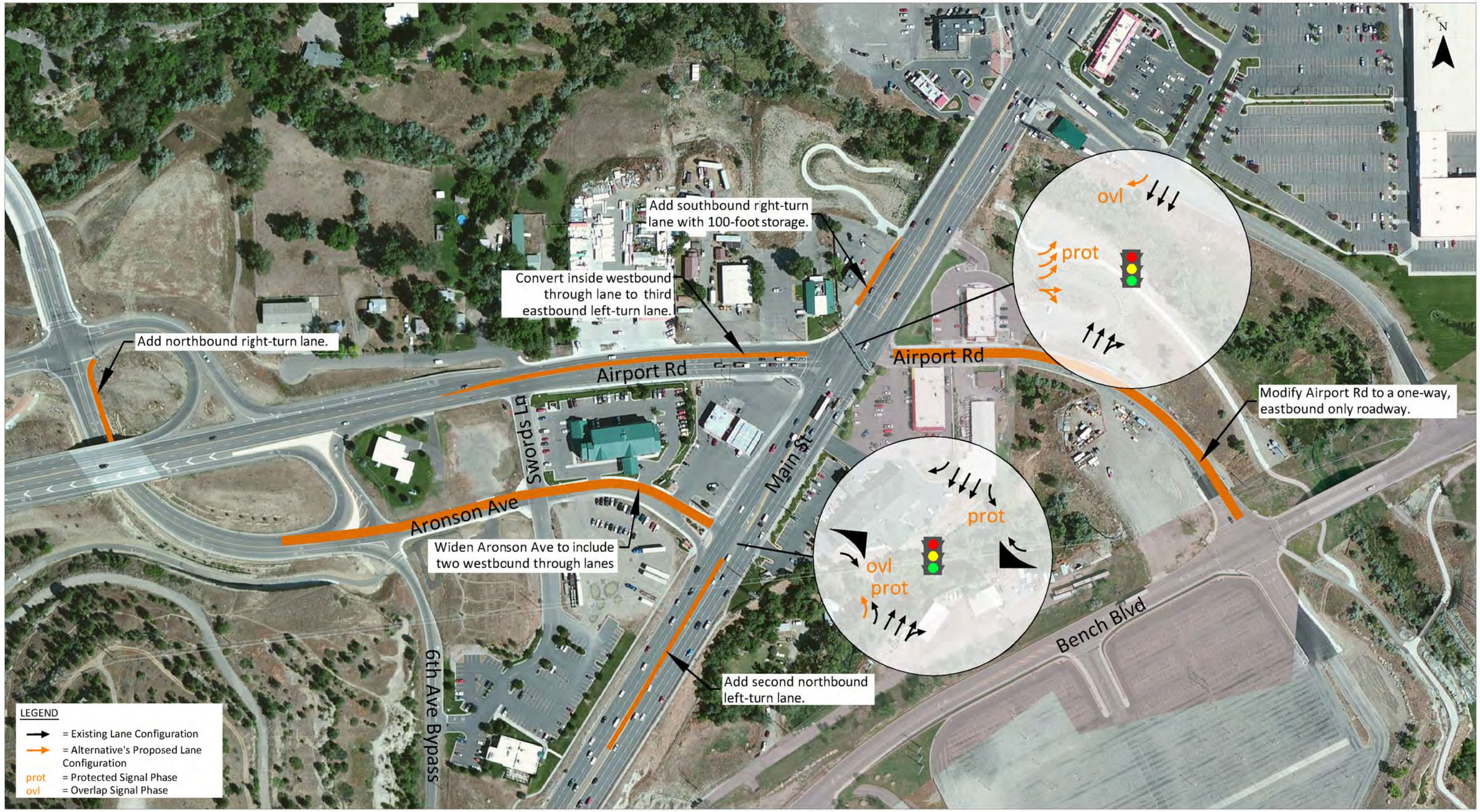

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BILLINGS AIRPORT ROAD & MAIN STREET Concept

ALTERNATIVE 4B - SIGNALIZED SOUTHWEST QUADRANT (ONE-WAY EASTBOUND ALKALI CREEK RD)
TIER I: EVALUATION AND SCREENING OF INITIAL ALTERNATIVES
BILLINGS, MONTANA

SCALE: 1" = 200'
0 200' 400'

FIGURE 5

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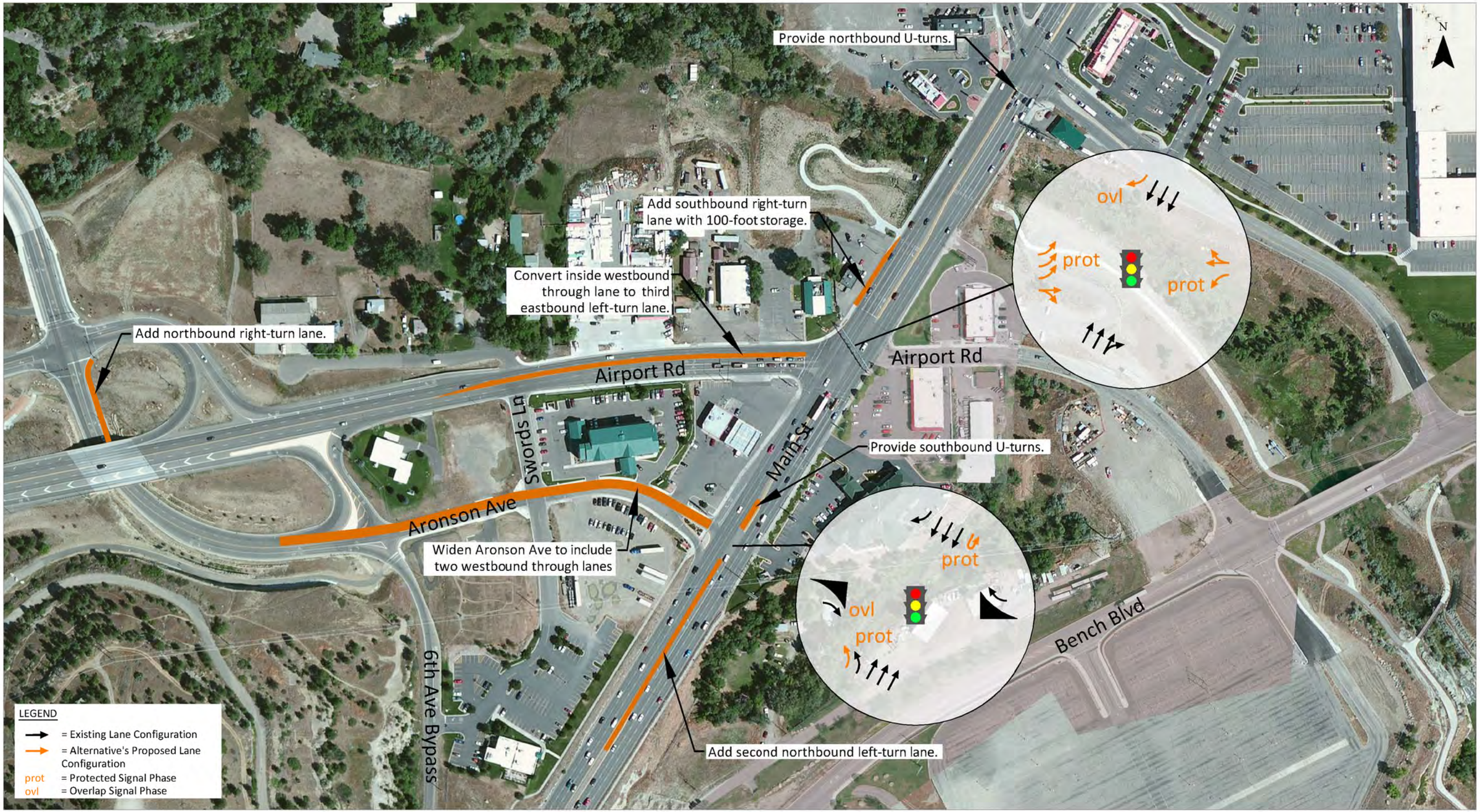

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ALTERNATIVE 5A - MEDIAN U-TURN (NORTH AND SOUTH)
TIER I: EVALUATION AND SCREENING OF INITIAL ALTERNATIVES
BILLINGS, MONTANA

SCALE: 1" = 200'
0 200' 400'

FIGURE 6

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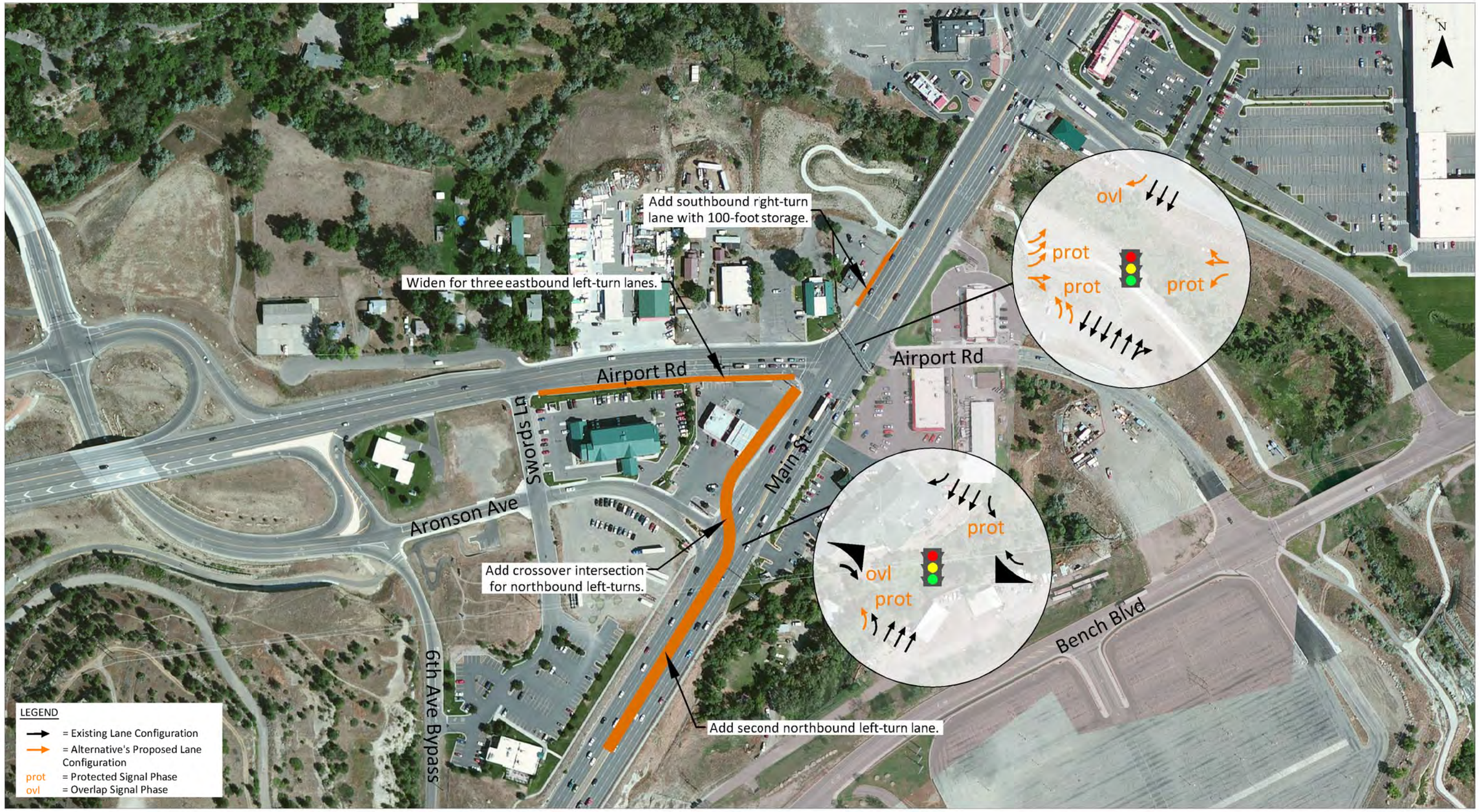

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ALTERNATIVE 5B - PARTIAL DISPLACED LEFT-TURN (SOUTHWEST QUADRANT)
TIER I: EVALUATION AND SCREENING OF INITIAL ALTERNATIVES
BILLINGS, MONTANA

SCALE: 1" = 200'
0 200' 400'

FIGURE 7

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Attachment A Alternatives Operational Analysis - Year 2040 Traffic Conditions, Weekday AM Peak Hour

Attachment B Alternatives Operational Analysis - Year 2040 Traffic Conditions, Weekday PM Peak Hour