

EXECUTIVE SUMMARY

1. Introduction

A safety review of the Highway 2:15 (Deerfoot Trail) corridor was commissioned by Alberta Transportation in conjunction with the City of Calgary (City). The review was conducted in accordance with the Transportation Association of Canada's (TAC) Canadian Guide to In-Service Road Safety Reviews (2004), which defines a safety review as an in-depth engineering study of an existing road using road safety principles with the purpose of identifying cost-effective countermeasures that would improve road safety and operations for all users.

Highway 2, also known as Deerfoot Trail within the city, is the major north-south freeway. Highway 2 is part of the CANAMEX Trade Corridor that extends north to Alaska and south to the United States and Mexico. The scope of this review encompasses a 50 kilometre section extending from the Okotoks interchange at the south review limits to the north city limits.

Alberta Transportation has jurisdiction over Deerfoot Trail and is responsible for its maintenance. The maintenance function is currently conducted under contract by Carmacks Enterprises Ltd. The Calgary Police Service (CPS), Calgary Fire Department, Calgary EMS, and 9-1-1 services are responsible for policing and emergency response within the city limits. South of the city limits, the R.C.M.P (Okotoks Detachment), the local Sheriff's department, Okotoks Fire Department and Foothills Regional EMS are responsible for policing and emergency response.

In recent years, rapid population growth and economic prosperity have contributed to increased traffic levels throughout the city highway network and placed particular pressure on Deerfoot Trail and its interchanges. As part of Alberta Transportation and the City's commitment to providing safe and efficient roadway operations, this multi-phase safety review was initiated.

Alberta Transportation is currently in the process of constructing the northwest and northeast portions of the Calgary Ring Road, and planning the southeast portion. It is anticipated that upon completion, the Ring Road will alleviate some of the congestion on Deerfoot Trail. This review is focused on improving safety within the existing right-of-way over the next three years.

2. Objectives and Phases

The objectives of the Deerfoot Trail Safety Review, the project phasing and the current progress are summarized in FIGURE ES.1.

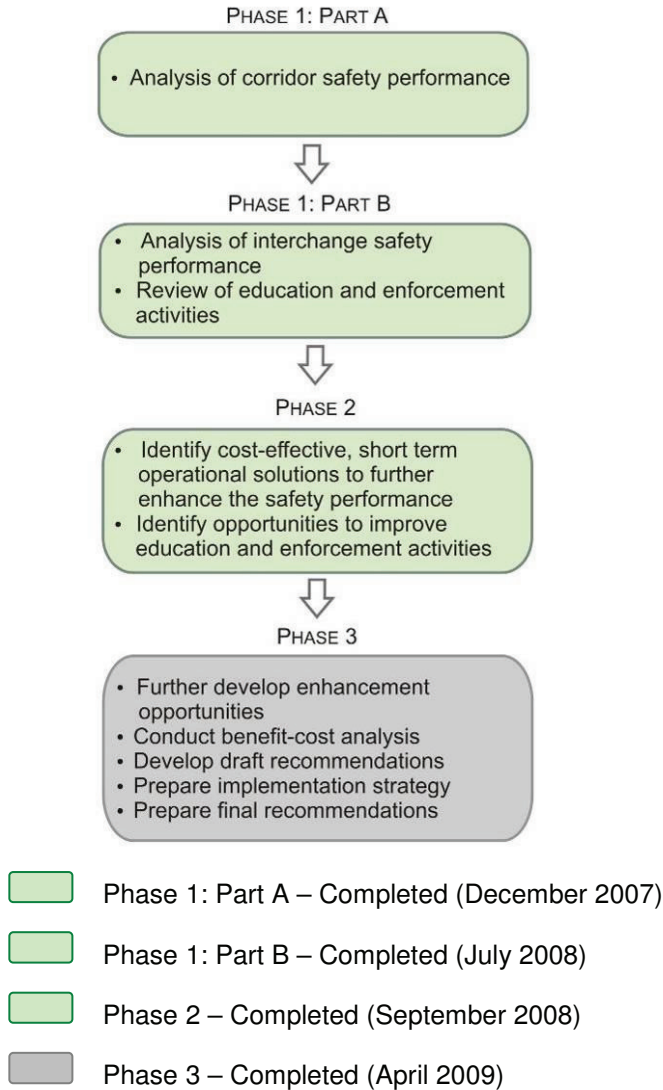


FIGURE ES.1 SAFETY REVIEW PHASES

Phase 1 involved data analysis and identification of crash trends and potential safety issues. Phase 2 identified potential enhancement opportunities for these issues and other issues identified at the outset of the review. Phase 3 involved further development of the more favourable enhancement opportunities, an economic evaluation, and the preparation of an implementation strategy and monitoring plan.

3. Further Development of Phase 2 Enhancement Opportunities

Ramp Metering

Ramp meters are traffic signals installed on freeway ramps to provide gaps for traffic entering the freeway. Applications in the United States and elsewhere have reported significant collision reductions. Candidate locations for ramp metering were identified in Phase 2 in order to address the high proportion of congestion-related collisions at critical locations. In Phase 3, these were further investigated, and in consultation with the Province and City, three sites were selected and modelled using TSIS-CORSIM and Synchro 7.0 software:

- Southland Drive southbound on-ramp;
- 11 Street southbound on-ramp; and,
- 17 Avenue northbound on-ramp.

The TSIS-CORSIM results were found to better represent the overall conditions, and were used as the basis of the recommendations. The modelling exercise also took into account the impacts at the adjacent intersections and roadways. The operational performance was described in terms of the average speed increase for the mainline and the overall average speed change (including the ramps and adjacent intersections). The results revealed that ramp metering would be beneficial at Southland Drive and 11 Street southbound on-ramps. The results are summarized in TABLE ES.1.

TABLE ES.1 SUMMARY OF RAMP METER MODEL RESULTS**

RAMP METERING LOCATION	MAINLINE AVERAGE SPEED CHANGE (%)	OVERALL AVERAGE SPEED CHANGE (%)	COLLISION REDUCTION (%) *
Southland Drive	47	6	15 – 50%
11 Street	4	-9	
Southland Drive & 11 Street	9	-2	
Southland Drive & 11 Street With 15 Percent Diversion	31	4	

* Percent of total crashes on mainline and ramps

**Note: Speed change percentage values based on comparison to condition with no ramp metering, with the exception of the case with 15 percent diversion which is a comparison between Southland Drive metered only and both Southland Drive & 11 Street metered.

The initial cost of the ramp metering deployment has been approximated at \$300,000, with annual maintenance costs of \$10,000. These locations may now proceed to detailed design, including micro-simulation.

Guide Signing

The Phase 2 report identified a number of potential enhancements to the quality, effectiveness and consistency of the guide signs provided along Deerfoot Trail. Phase 3 proceeded to develop a specific plan for upgrading all the signs in both directions. A systematic priority rating method was developed to prioritize the improvements. A summary of the general recommendations is provided in TABLE ES.2, and the specific plans for each set of signs are provided in the APPENDIX C of this report.

TABLE ES.2 GENERAL RECOMMENDATIONS FOR GUIDE SIGNS

General Issue with Existing Signs	Suggested Improvements
<ul style="list-style-type: none"> ▪ Too many locations identified on Destination Distance Signs. 	<ul style="list-style-type: none"> ▪ Limit the number of locations to three. The exceptions are when four destinations are required to sign the next two interchanges. <i>For example, 24 St E / Douglasdale Blvd and Anderson Rd / Bow Bottom Tr are consecutive interchange exits in the southbound direction; therefore all four locations are shown</i>
<ul style="list-style-type: none"> ▪ Potential confusion related to the quadrant reference for intersecting roads. <i>For example, current guide sign indicates "130 Ave. SE".</i> 	<ul style="list-style-type: none"> ▪ Preference is to only identify "N" or "S" for east-west streets, and to identify "E" and "W" for north-south streets. <i>For example, indicate "130 Ave. S" and "11 St. E"</i>
<ul style="list-style-type: none"> ▪ Simplify guidance when an intersecting road accommodates travel in two directions. 	<ul style="list-style-type: none"> ▪ Remove reference of "EAST / WEST" or "NORTH / SOUTH" when a motorist can choose to head in either travel direction upon exiting the mainline.
<ul style="list-style-type: none"> ▪ Inconsistency in the placement of arrow on Exit Directional Signs. 	<ul style="list-style-type: none"> ▪ Consistent placement on bottom of the sign and centred vertically ▪ Use of "down" arrow on exit approach, "upward right" arrow at exit itself ▪ Arrow should be in yellow portion of sign for "Exit Only" exits
<ul style="list-style-type: none"> ▪ Exit Only tabs missing at some exits 	<ul style="list-style-type: none"> ▪ Provide Exit Only tabs to mitigate the risk of "last minute" lane changes
<ul style="list-style-type: none"> ▪ Wayfinding for the City Centre may be inconspicuous 	<ul style="list-style-type: none"> ▪ Provide a custom sign symbol for City Centre ▪ Determine preferred route (Macleod Tr at northbound fork, 17 Ave S / Blackfoot Tr when northbound on Deerfoot Tr, Memorial Dr when southbound on Deerfoot Tr)
<ul style="list-style-type: none"> ▪ Wayfinding for Airport is inconsistent 	<ul style="list-style-type: none"> ▪ Use Major Airport symbol ▪ Use arrow instead of orienting airplane symbol ▪ Use 96 Ave N as preferred route

In summary, while the current signs are adequate in identifying the intersecting roads; however, several improvements should be considered to enhance signing uniformity and consistency, particularly along the oldest north part of the corridor (between Peigan Trail and Country Hills Boulevard).

Other Enhancement Opportunities

Several other enhancement opportunities raised during Phase 2 were further developed in Phase 3:

- Feasibility of bus-only shoulders;
- Additional camera locations;
- Curve warning and delineation;
- Slippery Conditions Ahead Warning Signs (Glenmore Trail – Peigan Trail)
- Enhancements to gore areas;
- Review of roadside hazards;
- Incident management; and,
- Queue detection and signal optimization.

These opportunities are discussed in Section 5.0 of this report, and the recommendations are summarized in FIGURE ES.2.

4. Recommended Education and Enforcement Strategies

The Phase 2 report identified opportunities to further expand on the current public education and traffic enforcement activities to change driver behaviour and to support the proposed infrastructure changes.

The main strategies to enhance current efforts in education and enforcement are:

- Strengthen the Links Between Enforcement and Education Programs
- Establish Deerfoot Trail's Reputation as a Continuously Enforced Corridor
- Review Public Education Signage
- Reduce Congestion-Related Risks Through Travel Demand Management and Education
- Conduct Evaluations of Education and Enforcement Activities

As part of the recommendation to strengthen the link between education, enforcement and engineering initiatives, specific suggestions include developing a special Deerfoot Trail Safety Task Force or expanding the reach of the Traffic Engineering / Calgary Police Service committee (familiarily known as Ops/Cops), and considering the development of a dedicated patrol and enforcement unit on Deerfoot Trail, based on successful models elsewhere.

As part of the movement to establish Deerfoot Trail's reputation as a continuously enforced corridor and to better impact driver behaviour, it is recommended that the automated enforcement program be expanded to include a greater emphasis on permanent fixed speed enforcement, supported by the necessary education and possible lowering of violation thresholds for ticketing. The ability to enforce the speed limit using fixed cameras may require changes to legislation. Candidate pilot locations where the highest number of injury collisions was encountered are provided in this report.

5. Economic Evaluation of Enhancements

A benefit-cost analysis of the proposed Deerfoot Trail mainline and interchange enhancements was undertaken to assist in identifying the most promising enhancement opportunities. A customized method reflecting the evaluation methods used at each agency was prepared separately for the mainline and the interchange enhancements. The life cycle of each enhancement was determined and the benefits and costs (over each life cycle) were estimated for each enhancement. The benefits were evaluated in three areas:

- a) Safety;
- b) Operational; and
- c) Environmental.

The costs were high-level estimates separated into capital costs, operational and maintenance costs. Unit costs provided by the Province were used for this purpose.

For the mainline recommendations, the benefits of each proposed enhancement were compared to the cost of implementing them based on a customized version of the Internal Rate of Return (IRR) method used by Alberta Transportation, incorporating the three major evaluation criteria. Operational and environmental benefits are also expected to be incurred with most of the safety improvements.

For the interchanges, the benefits were primarily related to safety, with minimal operational or environmental implications. The method was based on a risk assessment developed by Opus, consisting of both demonstrated and potential collision risk (frequency plus severity). The cost effectiveness was expressed as a benefit-cost ratio (BCR).

The results of the evaluation indicated that the majority of the mainline enhancements met the minimum of IRR > 3% and the majority of the interchange enhancements met the minimum BCR of 1:1 (improvement pays for itself over its life). Enhancements that did not meet these criteria were excluded from the recommendations. The economic evaluation results are described in detail in this report and appendices.

6. Implementation Strategy

An implementation strategy was devised that would clearly prioritize the recommendations and suggest an agency to lead the design and implementation of each. Time frames for implementation were categorized into:

- *Immediate* (can likely be implemented as part of regular operations or maintenance);
- *Short Term* (within 3 years, to reflect business and the planning/construction cycle – may include capital cost items); and
- *Long Term* (more significant costs, extensive planning required, expansion of short-term pilot projects, ongoing activities).

For each recommendation, a lead agency is nominated for the purpose of leading the initiative. For some of the new initiatives, including ramp metering and queue detection, joint leadership is recommended. Funding of the improvements or cost-sharing will need to be discussed among the agencies involved. The recommended implementation strategy is summarized in FIGURE ES.2 for interchange recommendations and FIGURE ES.3 for mainline recommendations.

Immediate

The immediate improvements are low-cost and high benefit-cost items. These are summarized in Section 9.3 of this report and details are provided in the Phase 2 report. The interchange recommendations are expected to cost a combined \$215,000 and result in a benefit-cost of 30:1 over the life of the improvements. Implementing all of the immediate mainline recommendations is expected to cost approximately \$240,000.

Discussions and further study of the recommended pilot projects should also commence as soon as possible, including incident management, ramp metering and enforcement and education. For ramp metering, the detailed design of the ramp metering installations, including the micro-simulation, should be commenced to confirm the appropriateness of the candidate locations.

Short Term (within 3 years)

Short-term recommendations include the guide signing upgrades (starting with the high-priority items), incident management strategies (including piloting incident investigation sites and providing/enhancing towing and patrolling services) and ramp metering installations pending the favourable outcome of micro-simulation and detailed design. The remainder of the interchange recommendations can also be implemented during this period, as they are relatively low capital cost items.

The short term interchange improvements are expected to cost approximately \$930,000 in total, and result in a benefit-cost of 7:1 over the life of the improvements. The total cost of the short term mainline recommendations is approximately \$4.3M.

Long Term (after 3 years)

Following a detailed evaluation of the first three years of improvements, some of the mainline recommendations can be revisited or expanded. After three years, the Southeast Ring Road is also expected to be in place. The need for any further safety and operational enhancements should be determined by taking into account the changes in traffic patterns on Deerfoot Trail that result from the Ring Road completion.

7. Monitoring and Evaluation Strategy

A monitoring and evaluation plan was developed to assess the effectiveness of the implemented recommendations. This plan is described in Section 10 and includes the evaluation criteria, methodology, and data requirements.

The primary criteria (measure of effectiveness) will be collision reduction, based on collision frequency or the risk method developed by Opus. For the mainline enhancements in particular, other measures can be used to supplement collisions, particularly if sample sizes are low, location coding of collisions is unclear or collision data will not be available in a timely fashion due to the lapse in collision reporting and processing. The monitoring plan identifies appropriate measures for each category of the mainline enhancements. In addition to changes in collision frequency, rate and severity, it will be particularly important for the ramp metering and queue detection programs to measure delays and queues, and for the speed enforcement campaigns to measure changes in speed.

It is recommended that the effectiveness of the enhancements be formally evaluated:

- *Within one year:* one full year following the immediate enhancements. This is expected to provide a preliminary indication of the effectiveness; and again
- *Within four years:* one full year following the implementation of the “short-term” enhancements to be implemented within the first three years. This timing is also appropriate given that it will occur after the scheduled construction of the Southeast Ring Road.

The four-year evaluation can be conducted as part of an updated *Deerfoot Trail Safety Review*. The recommended evaluation schedule is summarized in TABLE ES.3.

TABLE ES.3 INTERCHANGE MONITORING AND EVALUATION SCHEDULE

“Before” Period	Implementation and Monitoring of Immediate Enhancements	One-Year Evaluation	Implementation and Monitoring of Short-Term Enhancements	Four-Year Evaluation
2006-2008	2009	2010	2010-2012	2013

8. Summary and Next Steps

The *Highway 2:15 (Deerfoot Trail) Safety Review*, jointly commissioned by Alberta Transportation and the City of Calgary, provides a significant opportunity for enhancing traffic safety and operations on Alberta's most heavily travelled corridor. This three-phase review, culminating with the *Phase 3 Report: Recommendations*, presents 69 recommendations for engineering enhancements along the Deerfoot Trail mainline, at five major interchanges (at 32 Avenue N, 16 Avenue N, Memorial Drive, 17 Avenue S and Glenmore Trail S), and for enhanced traffic enforcement and public education.

A total of 40 recommendations for the mainline of Deerfoot Trail are brought forward for implementation over the next three years, at a cost of approximately \$5,500,000. 29 additional enhancements are recommended at the five interchanges over the next three years, at a cost of approximately \$1,150,000. Both the interchange and mainline recommendations are expected to yield significant safety benefits, and in some cases additional operational and environmental benefits.

The recommendations in this report include several innovative programs which have been successfully implemented in other large municipalities, including the ramp metering application. The feasibility and benefits of these programs have been investigated during this review. Successful pilot projects can lead to more widespread application.

The immediate next steps will involve coordination between Alberta Transportation, the City of Calgary and their partner agencies, in responding to the recommendations and gaining the necessary approvals and resources. This will be followed by the implementation of the immediate enhancements, and planning towards the implementation of the short-term recommendations.

Continued cooperation will help to ensure that safety is held in high priority on this critical link in Alberta's transportation network.

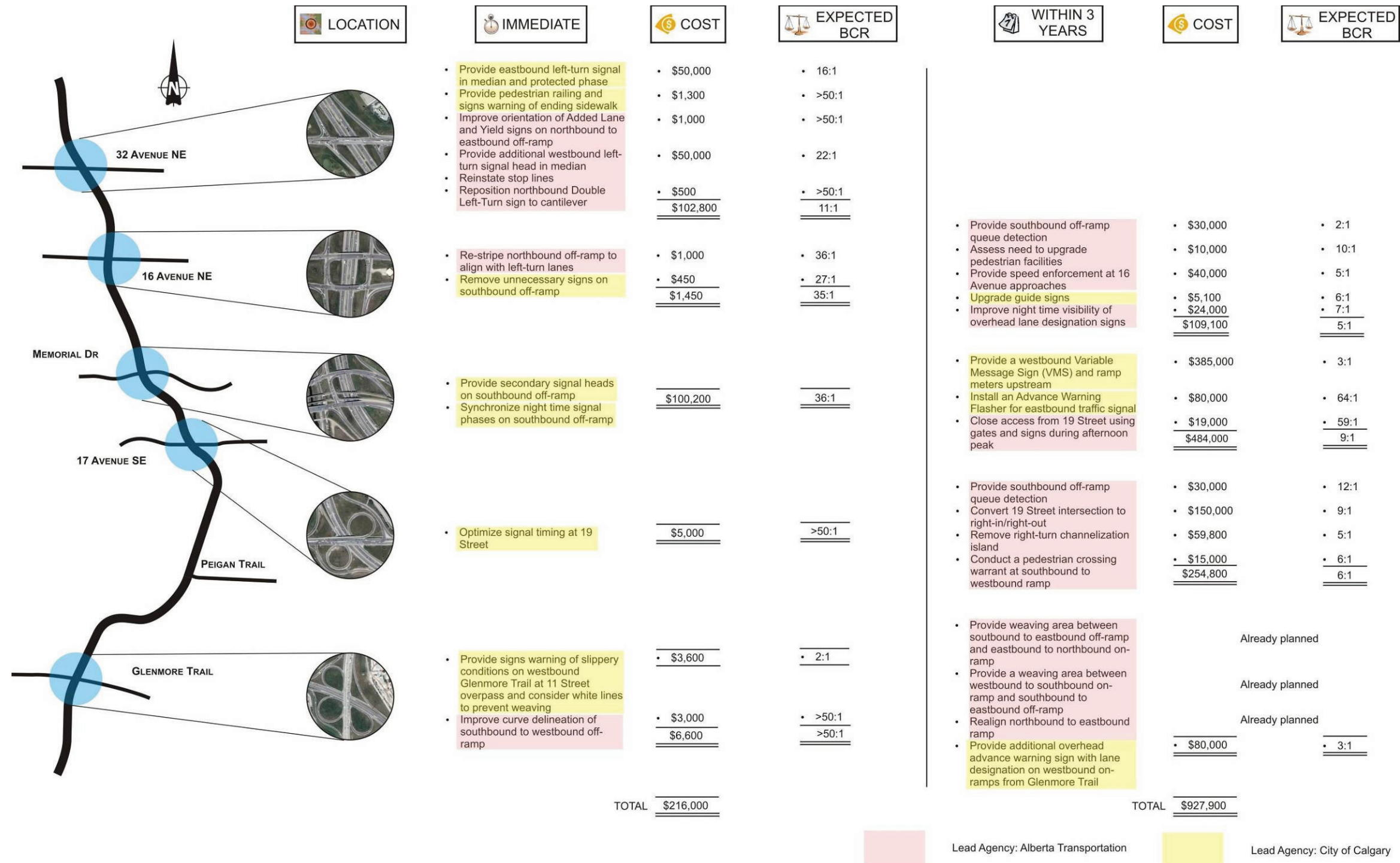


FIGURE ES.2 SUMMARY OF INTERCHANGE IMPLEMENTATION STRATEGY

HIGHWAY 2:15 – DEERFOOT TRAIL CORRIDOR SAFETY REVIEW, PHASE 3
ALBERTA TRANSPORTATION AND THE CITY OF CALGARY










CATEGORY	LEAD AGENCY	IMMEDIATE	COST	WITHIN 3 YEARS	COST	>3 YEARS OR ONGOING
 Freeway Guide Signs	Alberta Transportation	<ul style="list-style-type: none"> Detailed design of guide signs and supports Improve sign visibility Remove destination signs with guide sign appearance 		<ul style="list-style-type: none"> Upgrade <i>High Priority</i> signs as described in Section 4 and Appendix C 	\$3.2M	<ul style="list-style-type: none"> Upgrade <i>Medium Priority</i>, then <i>Low Priority</i> signs as described in Section 4 and Appendix C
 Pavement Marking and Delineation	Alberta Transportation	<ul style="list-style-type: none"> Provide additional delineator posts and improve pavement markings at highway exit gore areas 	\$130,000	<ul style="list-style-type: none"> Provide delineators (reflectors) on concrete barriers along Calf Robe Bridge and adjacent curves to the north and south 	\$75,000	<ul style="list-style-type: none"> Ongoing Basis: Use rural pavement arrow design in AT's Pavement Marking Guide Revisit need for High Friction Pavement on Calf Robe Bridge approaches
 Ramp Metering	Alberta Transportation and City of Calgary	<ul style="list-style-type: none"> Detailed design including micro-simulation 	\$100,000	<ul style="list-style-type: none"> Implement ramp metering at Southland Drive and 11 Street Evaluate results on an ongoing basis, and review need for changes resulting from completion of Northeast Ring Road 	\$200,000	<ul style="list-style-type: none"> Implement ramp metering at other locations if successful, and based on traffic conditions following the Southeast Ring Road
 Speed Management	Alberta Transportation	<ul style="list-style-type: none"> Curve warnings at curve south of Calf Robe Bridge and curve warning supplemented with 95 km/h advisory speed limit at northbound curve under 17 Avenue overpass Remove/relocate Slippery Conditions Ahead signs near Calf Robe Bridge 	\$10,000			
 Incident Management	City of Calgary	<ul style="list-style-type: none"> Expand "Take it Off the Road" campaign 		<ul style="list-style-type: none"> 6 pan-tilt-zoom (PTZ) cameras between Douglasdale Blvd and Beddington Trail Consider public-private towing contract Provide two stationed patrols during peak hours as pilot project Develop Quick Clearance Legislation Adopt photogrammetry method Pilot an incident investigation site at northbound off-ramp to Peigan Trail 	\$300,000 \$50,000 \$350,000	<ul style="list-style-type: none"> 5 pan-tilt-zoom (PTZ) cameras between Douglasdale Blvd and Beddington Trail Revisit benefits of providing 12 additional cameras between Douglasdale Blvd and Beddington Trail Evaluate stationed patrols and incident investigation site. Expand if successful Consider providing instant tow dispatch along selected freeway links
 Queue Detection	Alberta Transportation and City of Calgary			<ul style="list-style-type: none"> Utilize queue detection technologies combined with signal optimization to eliminate queue tails 	\$180,000	
 Education and Enforcement	Calgary Police Service	<ul style="list-style-type: none"> Consider expanding Ops/Cops Committee scope to include marketing and communication professionals 		<ul style="list-style-type: none"> Provide fixed speed camera enforcement Lower threshold for ticketing speed violations Provide TDM Education towards reducing Congestion-Related Risks Create dedicated enforcement unit Remove/Replace Educational Signs; Enforce/Remove Regulatory Signs Deploy educational campaigns on, improperly secured loads, cyclists/pedestrians using freeway, and quick clearance 	\$240,000	<p>ON AN ONGOING BASIS:</p> <ul style="list-style-type: none"> Increase education and enforcement: <ul style="list-style-type: none"> Against speeds too high for road conditions Targeting top three behaviours (besides speeding) contributing to collisions Conduct regular evaluations of Education and Enforcement activities
 Roadside Hazards	Alberta Transportation	<ul style="list-style-type: none"> Remove, relocate or protect roadside hazards verified within clear zone 		<ul style="list-style-type: none"> Conduct detailed walk-through to identify other roadside hazards 	\$50,000	
 Bus-Only Shoulders	City of Calgary	<ul style="list-style-type: none"> Address issues identified in report, and discuss with Transit 		<ul style="list-style-type: none"> Pilot use of bus-only shoulders along northbound Deerfoot Trail between Anderson Rd on- and off-ramps 	\$7,000	<ul style="list-style-type: none"> Evaluate pilot application, and review feasibility of widening shoulders at other locations if successful
			TOTAL \$240,000		TOTAL \$4.3M	

FIGURE ES.3 SUMMARY OF CORRIDOR WIDE IMPLEMENTATION STRATEGY