Glenmore Trail East

Functional Planning Study Report | Executive Summary

12 July 2018

ISL Engineering and Land Services

Parsons PLUS envision more SM

Table of Contents

List of Acronyms and Abbreviations

ASP	Area Structure Plan
AT	Alberta Transportation
AADT	Annual Average Daily Traffic
CTP	Calgary Transportation Plan
DDI	Diverging Diamond Interchange
DGSS	Design Guidelines for Subdivision Servicing
EB	Eastbound
ESA	Ecological Screening Assessment
FPS	Functional Planning Study
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HGDG	Highway Geometric Design Guide
ITE	Institute of Transportation Engineers
LOS	Level of Service
LUN	Land Use Network
MAE	Multiple Account Evaluation
MDP	Municipal Development Plan
PDO	Property Damage Only
PV	Present Value
RRHPA	Ring Road and Highway Penetrators Agreement
RVC	Rocky View County
TIA	Transportation Impact Assessment
The City	City of Calgary
TUC	Transportation Utility Corridor
TZ	Transportation Zone
VPD	Vehicles Per Day
WB	Westbound
WB36	Double Trailer Transport Truck Design Vehicle
WID	Western Irrigation District

Executive Summary

E.1 Introduction

The primary objective of the study is to determine the ultimate access and land acquisition requirements along Glenmore Trail, that align with the area structure plans prepared by The City - Shepard Industrial ASP and RVC - Janet ASP and since AT prepared the Highway 560:02 study in 2007. This study was also prepared in response to existing operational and safety deficiencies associated with the corridor and the impediment these deficiencies place on planned growth within the area. The functional outcomes of the study provide improvements for the transportation network operation by reducing delays and improving capacity of the intersections within the study area. Moreover, the project recommendations will improve safety while minimizing impacts to road users, land owners, and the environment.

The recommendations of this study have been developed with a multi-jurisdictional review team which included The City of Calgary (The City), Rocky View County (RVC) and Alberta Transportation (AT).

The purpose of this report is to document the process and recommendations of the Glenmore Trail East Functional Planning Study along Glenmore Trail (Highway 560) from Stoney Trail to Rainbow Road. This report replaces the westerly 6 km of the previously proposed 17 km transportation infrastructure improvements documented in AT's 2007 Functional Planning Study for Highway 560:02 from Calgary to Highway 797.

STUDY BACKGROUND

The 2007 Highway 560 Functional Planning Study completed by AT is the approved long-term plan for the corridor. The plan calls for the upgrade of Highway 560 to a high-speed, six-lane divided highway with diamond interchanges. The 2007 Study provided no access to 100 St SE and the two originally-planned interchanges were located 400 m west of 116 St SE and along the existing alignment of Rainbow Road. Based on an updated assessment by The City, a half diamond interchange at 100 St SE was reviewed and tentatively approved by AT in 2009.

Later, based on assessment by area landowners, a Parclo A-B interchange at 116 St SE with a 100 m realignment to the west was reviewed and tentatively approved by AT in 2013. Both approvals were subject to completion of an updated functional planning study in the area, which has now been addressed by the findings of this report.

STUDY PROCESS

The functional planning study process included four phases with stakeholder and public engagement completed throughout the project. The four phases are Identify, Develop, Evaluate, and Refine and Recommend.

Phase 1: Identify

- A review of the strategic transportation context for the Glenmore Trail East corridor including the intersections with 100 St SE and 116 St SE;
- The identification of site constraints and challenges within the study area;
- The development of a comprehensive engagement plan that allowed key stakeholders and the general public to provide critical input at key study intervals to inform the study team with respect to community needs, impacts, and improvement considerations for all modes of travel;

- A review and assessment of current and future traffic conditions within the study area;
- Stakeholder workshop to identify issues, opportunities and constraints; and
- Public information session to introduce the study and establish existing conditions.

Phase 2: Develop

- The development of multiple preliminary options to take to a preliminary evaluation;
- The development of an appropriate evaluation framework to be applied to the options in order to determine a short-list of potential solutions that accommodate all modes of travel; and
- Public information session on short-term improvements for 100 St SE and long- term improvements for 100 St SE and 116 St SE.

Phase 3: Evaluate

- The completion of a Multiple Account Evaluation (MAE) process, informed by stakeholder and public engagement feedback;
- The inclusion of the Triple Bottom Line framework that considers social, economic and environmental themes in the evaluation process;
- Development of a conceptual layout at Rainbow Road to allow an evaluation of traffic and safety performance east of 116 St SE (see note below);
- The recommendation of a preferred option based on the evaluation results; and
- The documentation and summation of the evaluation process and results.

Phase 4: Refine and Recommend

- The preparation of a functional design of the recommended solution, including horizontal and vertical geometry, active transportation infrastructure, stormwater management, construction staging, right-of-way requirements, property acquisition, and implementation costs;
- The documentation of the study findings in a comprehensive report; and
- Public information session on the recommended plan and conversations with stakeholder groups.

INCLUSION OF RAINBOW ROAD INTERCHANGE

It is important to note, that due to the close spacing of the proposed interchanges from Rainbow Road to Stoney Trail, it was necessary to include Rainbow Road in the analysis in determining the overall recommended configuration for the corridor. The decision to include Rainbow Road occurred after the MAE and adoption of the DDI as the recommended plan for 100 St SE and 116 St SE.

STUDY AREA

The study area, shown in ***Figure E.1,*** consists of the Glenmore Trail corridor from Stoney Trail to about 800 m east of Rainbow Road.

FIGURE E.1: GLENMORE TRAIL EAST FUNCTIONAL PLANNING STUDY AREA

E.2 Engagement Summary

From the outset, public engagement was identified as a priority for the Glenmore Trail East Study and the project team made the commitment to engage with impacted stakeholders and the public early and often throughout the process. The engagement approach reflected and upheld the guiding principles established in The City's 2014 engage! Framework & Tools, and in the Engagement/Communications Standards for Consultants provided by Transportation Planning.

The project team developed a three-phase engagement process which provided stakeholders and the broader public with multiple opportunities to provide feedback throughout each phase of the project. The goals of the engagement process and highlights of each phase included:

- Phase 1 - Understand stakeholder and public issues:
    - Information Session (June 15, 2015) – introduced the project team, provided information about the study and discussed any issues or concerns about the proposed interchange at 100 St SE. Sixty-four people attended, and 64 comment forms were submitted, either in-person or online.
    - Issues Scoping Workshop (June 25, 2015) – Technical representatives from The City, RVC, AT and power transmission utilities (AltaLink, Alberta Electric System Operator and ENMAX) were invited to identify issues, concerns and constraints prior to concept development.
    - Scope Expanded to include 116 St SE – During the initial public consultation, stakeholders asked the project team to investigate the possibility of a full interchange at 116 St SE as well as identify possible short-term improvements to reduce congestion at the intersection.

- Phase 2 - Develop options recognising stakeholder and public identified issues:
    - Landowner Meetings (August and September of 2016) – all adjacent landowners – seven groups in total – were invited to review the preliminary interchange options. Landowners were most interested in minimizing right-of-way requirements, providing a full interchange at 100 St SE and keeping 116 St SE on the current alignment.
    - Information Session (November 16, 2016) – held to gather feedback on the short-term improvements at 100 St SE and the proposed interchange options for 100 St SE and 116 St SE. Eighty-three per cent of respondents' feedback indicated that the proposed short-term improvements at 100 St SE would improve traffic flow and responses varied for which interchange configuration (diamond or diverging diamond) was best suited for 100 St SE and 116 St SE.
- Phase 3 - Recommend a plan that considered stakeholder and public input:
    - Information Session (April 24, 2018) – held at the HeatherGlen Golf Course (and online from April 24 – May 4, 2018). Received 30 feedback comments and 61 people attended the Information Session. Over 80% of participants felt their input was used to develop the study recommendations, and that they were provided with enough information and opportunity to effectively share their feedback throughout the project.

E.3 Existing Conditions

Glenmore Trail – AT controlled Glenmore Trail, is currently a two-lane paved Skeletal Road with posted speed limit of 80 km/h approximately 550 m west of 116 St SE and 100 km/h to the east.

100 St SE – This road is currently a two-way, two lane paved Industrial Arterial road with a posted speed of 80 km/h. South of Glenmore Trail, 100 St SE is under the jurisdiction of The City. North of Glenmore Trail, 100 St SE is under the jurisdiction of the RVC.

116 St SE – This road north of Glenmore Trail is currently a two-way, two lane paved Rural Road, under the jurisdiction of RVC. South of Glenmore Trail, 116 St SE is currently a two-lane unpaved Rural Local Road with a posted speed of 80 km/h, providing access to a small number of rural residences.

Rainbow Road – Under the jurisdiction of the RVC, Rainbow Road is a two-lane paved Rural Local road with a posted speed of 80km/h.

INTERCHANGE AND INTERSECTION SPACING

The distance between the Stoney Trail interchange centreline and the centreline of the 100 St SE intersection is 2,200 m. The spacing between the intersections located within the study corridor are shown in ***Table E.1***.

TABLE E.1: INTERSECTION SPACING

INTERSECTION SEGMENTS	DISTANCE (M)
Stoney Trail SE – 100 St. SE	2,200
100 St. SE – 116 St. SE	1,600
116 St. SE – Rainbow Rd	1,600
Rainbow Road – Hwy 791	4,900

EXISTING TRAFFIC CONDITIONS

Traffic congestion at the existing intersection of 100 St SE forms part of the justification for this study. A level of service assessment and safety review was conducted for the 100 St SE and Glenmore Trail intersection to identify deficiencies and to determine possible short and long-term solutions. It is noted that a similar short-term assessment of 116 St SE or Rainbow Road was not within the scope of the study, due to the longer-term nature of the planning at those locations. ***Figure E.2*** and ***Figure E.3*** show the existing traffic volumes and truck volumes for the AM and PM peak hours as provided by The City. The LOS analysis results summary for the AM and PM peak hours follow in ***Table E.2***.

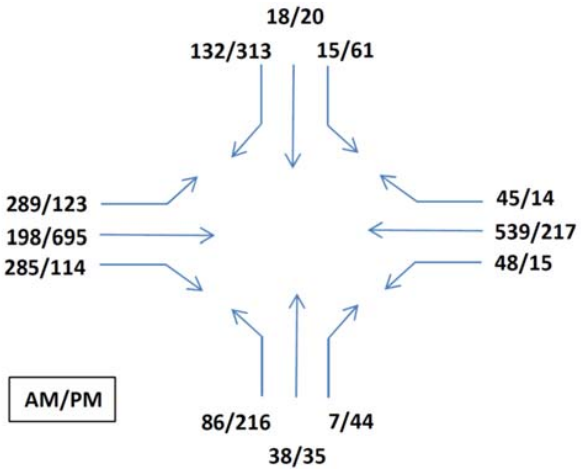


FIGURE E.2: 100 ST SE - ALL VEHICLE VOLUMES

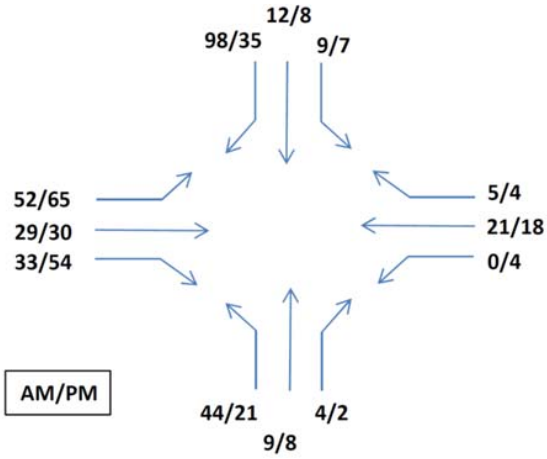


FIGURE E.3: 100 ST SE - HEAVY VEHICLE VOLUMES

TABLE E.2: 100 ST SE - SYNCHRO ANALYSIS SUMMARY (2015 AM AND PM PEAK HOURS)

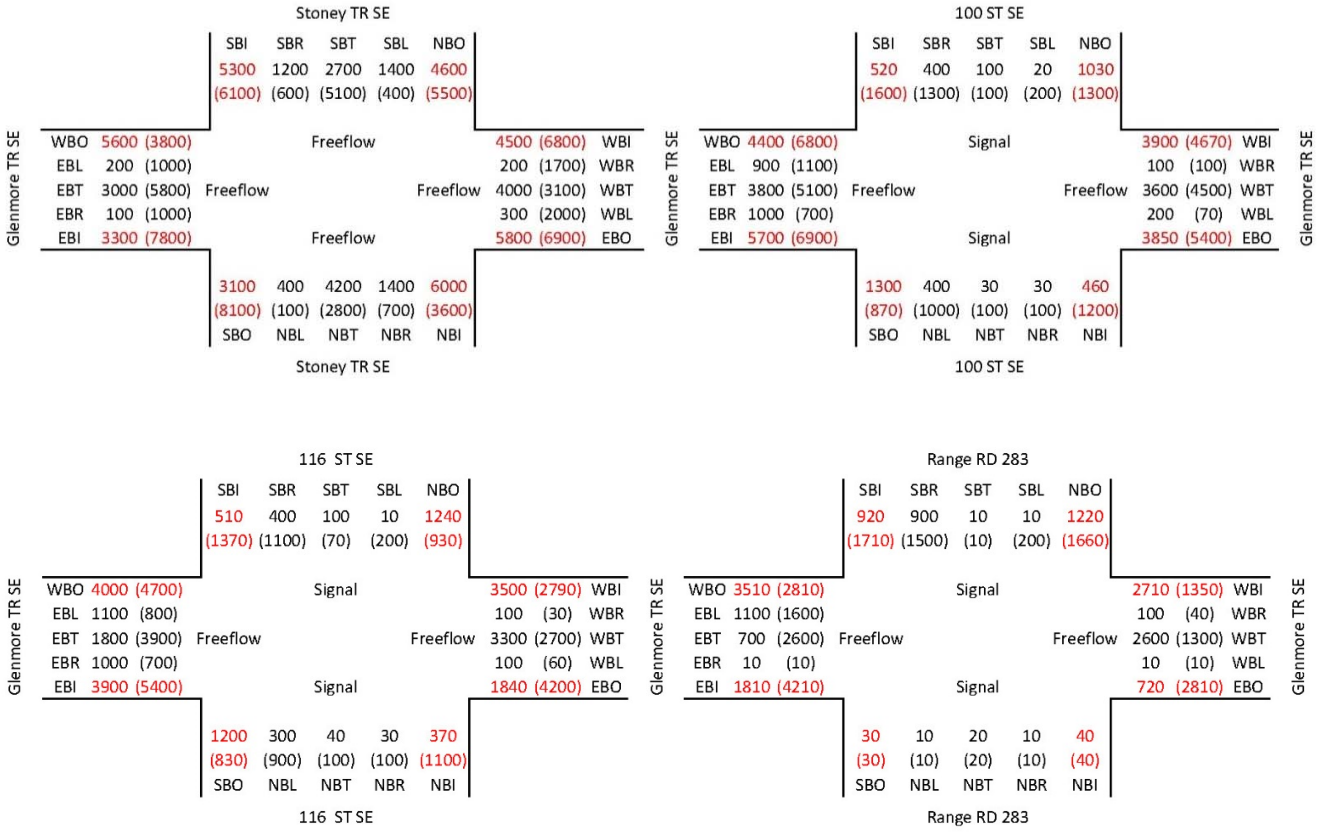
AM						PM				
MOVEMENT	DELAY (S)	V/C	LOS	LOS APPROACH		MOVEMENT	DELAY (S)	V/C	LOS	LOS APPROACH
EBL	294.5	1.55	F			EBL	52.4	0.81	D	
EBT	19.8	0.26	B	F		EBT	125.3	1.17	F	F
EBR	3.4	0.44	A			EBR	6.9	0.3	A	
WBL	13.0	0.1	B			WBL	23.3	0.2	C	
WBT	51.0	0.91	D	D		WBT	42.0	0.65	D	D
WBR	-	-	-			WBR	-	-	-	
NBL	113.8	0.89	F			NBL	56.2	0.76	E	
NBT	57.1	0.29	E	F		NBT	35.4	0.15	D	D
NBR	0.4	0.05	A			NBR	1.7	0.15	A	
SBL	-	-	-			SBL	-	-	-	
SBT	66.3	0.41	E	C		SBT	52.9	0.51	D	C
SBR	19.4	0.65	B			SBR	12.7	0.71	B	
Intersection	76.3	-	E	-		Intersection	64.5	-	E	-

EXISTING SAFETY REVIEW

The historic collision data provided by AT for the intersection of 100 St SE and Glenmore Trail was reviewed for the 5-year period between 2008 and 2012. The data includes incidents occurring at the intersection and within 400 m of Glenmore Trail. A total of seven collisions were reported within the study area over the analysis period, all of which were property damage only (PDO) incidents with no fatal or injury collisions reported. The data provided by AT indicated that the study site has a collision rate of 91.08 collisions per 100 MVKM.

E.4 Future Traffic Conditions

The future traffic volumes were developed using the 2039 traffic forecast provided by The City as a base and adjusted based on the anticipated land uses, population and employment from reference reports including approved Area Structure Plans (ASP) in both Calgary (Shepard Industrial ASP - 2013) and RVC (Janet ASP – 2014). Hence, the design traffic was developed for a full build out of the lands identified by The City and RVC for future development and not for a specific design year. The future design traffic volumes are shown in ***Figure E.4***.



NOTES

- Traffic Volumes less than 100 are rounded to the nearest 10
- Traffic Volumes larger than 100 are rounded to the nearest 100
- AM (PM) - Brackets designate PM volumes
- Red figures indicate volumes entering or exiting the intersection

FIGURE E.4: FULL BUILD-OUT DESIGN TRAFFIC VOLUMES

E.5 Option Development

Strategic options to improve the Glenmore Trail were developed considering a range of engineering, traffic, safety and cost aspects. The options were focussed on 100 St SE and 116 St SE and did not include Rainbow Road as the functional planning updates for the latter pertained primarily to ramp / weaving analysis. The basic option arrangements were developed using design features including:

- Provision of a single exit from the mainline for each interchange; and
- Full movement interchanges considered at each junction.

INITIAL OPTIONS AND CORRIDOR OPTION SCREENING

An initial corridor option screening was undertaken to better understand what lane configurations between interchanges would best support weaving operations along Glenmore Trail between Stoney Trail and Rainbow Road. Seven corridor options were developed and evaluated using a VISSIM microsimulation model.

- Option 1: Diamond interchanges with single lane on ramps;
- Option 2: Diamond interchanges with westbound dual lane on ramps;
- Option 3: Diamond interchanges with basketweave to Stoney Trail;
- Option 4: Loop ramp at 100 St SE and diamond interchanges at 116 St SE and Rainbow Road;
- Option 5: Loop ramp at 100 St SE with lane away and diamond interchanges at 116 St SE and Rainbow Road;
- Option 6: Loop ramp at 100 St SE with a basketweave and diamond interchanges at 116 St SE and Rainbow Road;
- Option 7: Diamond interchange at 100 St SE and Rainbow Road and Parclo A-B at 116 Street.

The following findings were observed from the VISSIM analysis:

- Option 2, Option 3, and Option 7 showed very similar weaving operations between interchanges and these three options performed the best among the seven corridor options;
- The corridor operates best with dual westbound entrance ramps;
- The corridor operates best with dual westbound exit ramps;
- The corridor operates best with single eastbound entrance ramps;
- The corridor operates best with dual eastbound exit ramps;
- Diamond interchanges operate best with the above entrance and exit ramp laning;
- Westbound Glenmore Trail operates best with two auxiliary lanes;
- A basketweave improves the westbound weaving operation between 100 St SE and Stoney Trail; and
- Option 7 operates well, however, the weaving distance between 100 St SE and 116 St SE is the shortest with a Parclo A-B at 116 St SE.

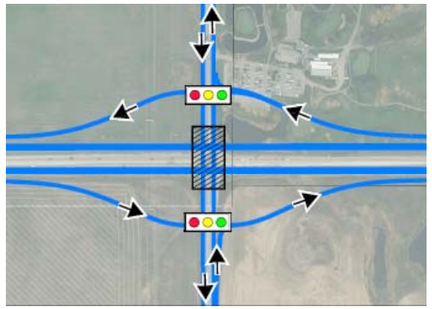
SECOND ROUND OF OPTION DEVELOPMENT AND SCREENING

Different types of interchange options were reviewed in greater detail. Six options were developed for 100 St SE, and three options were developed for 116 St SE. The options developed during this stage and the design features of each option are illustrated in ***Figure E.5*** and ***Figure E.6***.

OPTION A: DO NOTHING (BASE CASE)

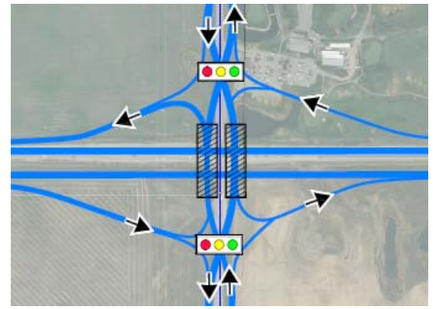
- The status quo assumes a “do-nothing” scenario, includes no changes to the study area and its intersections and no alteration to the surrounding network. This option represents the Base Case.

OPTION B - FULL DIAMOND INTERCHANGE



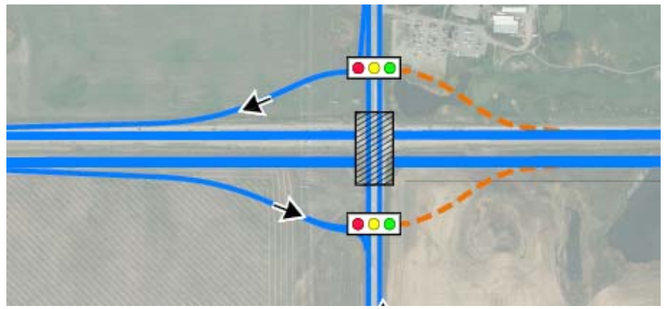
- Full movements are provided at this interchange.
- High loads can use the same ramps as the general traffic to navigate the interchange.
- Minimum desirable weaving distance is provided between adjacent interchanges.

OPTION C - DIVERGING DIAMOND INTERCHANGE



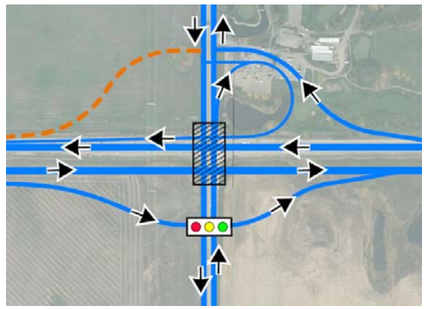
- Full movements are provided at this interchange.
- This option involves traffic along 100 St SE “crossing sides at grade” to create free-flow left turns through the interchange.
- High loads can use the same ramps as the general traffic to approach the interchange junctions. However, unique intersections will be required to allow high load movements to pass through.
- Minimum desirable weaving distance is provided between adjacent interchanges.

OPTION D - HALF DIAMOND INTERCHANGE



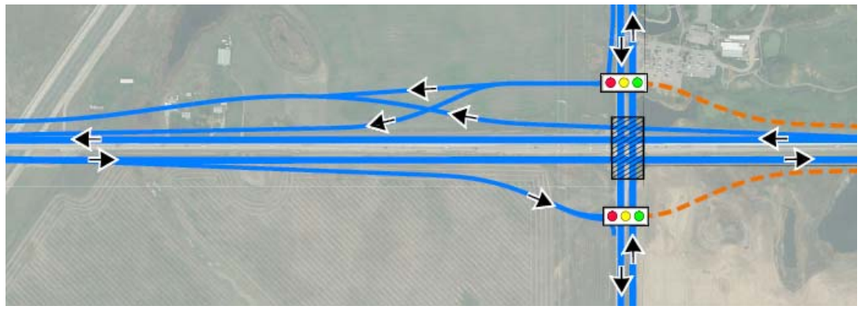
- Access provided to and from the west side only (City of Calgary side).
- Additional ramps are required on the east side to accommodate high load movement through the interchange. These ramps will not be available for use to general traffic.
- Limiting access at 100 St SE forces EB traffic to other access points.

OPTION E - HALF PARCLO HALF DIAMOND INTERCHANGE



- Full movements are provided at this interchange.
- High loads can use the same ramps as the general traffic to navigate the interchange.
- Minimum desirable weaving distance is provided between adjacent interchanges.
- This option has the largest impact on the HeatherGlen golf course.
- Alternative to this option would be to provide a separate ramp for the southbound to westbound movement, to remove conflict with the northbound to westbound movement as these two movements have very high volumes.

SUB OPTION - BASKET WEAVE CONNECTION TO STONEY TRAIL



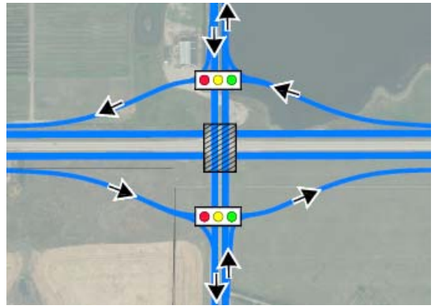
- Minimum desirable weaving distance has provided between adjacent interchanges in the eastbound direction.
- The basketweave will grade separate the entrance ramp from 100 St SE and the exit ramp to Stoney Trail thereby eliminating any potential weaving issues between these two interchanges.
- Compatible with all options and can be implemented at later stages.

FIGURE E.5: INTERCHANGE OPTIONS FOR 100 ST SE

OPTION A – DO NOTHING (BASE CASE)

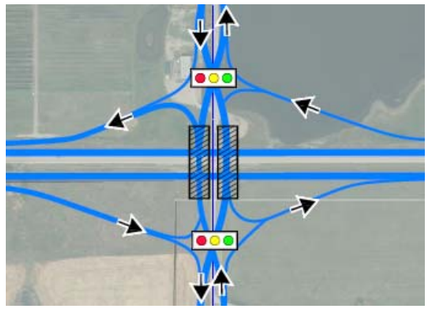
- The status quo assumes a 'do-nothing' scenario, includes no changes to the study area and its intersections and no alteration to the surrounding network. This option represents the Base Case.

OPTION B - FULL DIAMOND INTERCHANGE



- Full movements are provided at this interchange.
- High loads can use the same ramps as the general traffic to navigate the interchange.
- Minimum desirable weaving distance is provided between adjacent interchanges.

OPTION C – DIVERGING DIAMOND INTERCHANGE



- Full movements are provided at this interchange.
- More wetland impacted than full diamond.
- This option involves traffic along 116 St SE "crossing sides at grade" to create free-flow left turns through the interchange.
- High loads can use the same ramps as the general traffic to approach the interchange junctions. However, unique intersections will be required to allow high load movements to pass through.
- Minimum desirable weaving distance is provided between adjacent interchanges.

FIGURE E.6: INTERCHANGE OPTIONS FOR 116 ST SE

A total of six criteria were selected to screen the second round of options. The six criteria are traffic capacity, property impacts, weaving analysis, accessibility, wetland impacts and utility impacts. The ratings from the application of these criteria with respect to each initial option have been summarized in ***Table E.3*** and ***Table E.4*** for the 100 St SE options and the 116 St SE options. The lower scoring options were screened out from further consideration.

TABLE E.3: 100 ST SE INITIAL OPTIONS SCREENING

	OPTION A – DO NOTHING (BASE CASE)	OPTION B - FULL DIAMOND INTERCHANGE	OPTION C - DIVERGING DIAMOND INTERCHANGE	OPTION D - HALF DIAMOND INTERCHANGE	OPTION E - HALF PARCLO HALF DIAMOND INTERCHANGE	SUB OPTION - BASKETWEAVE CONNECTION TO STONEY TRAIL
Traffic Capacity	×	✓	✓	×	×	✓
Property Impacts	✓	×	×	×	×	×
Weaving Analysis	✓	✓	✓	✓	✓	✓
Accessibility	✓	✓	✓	×	×	×
Wetland Impacts	✓	×	×	✓	×	✓
Utility Impacts	✓	×	×	×	×	×
Recommendation		✓✓✓ More favourable	✓✓✓ More favourable			✓✓✓ More favourable

TABLE E.4: 116 ST SE INITIAL OPTIONS SCREENING

	OPTION A- DO NOTHING (BASE CASE)	OPTION B - FULL DIAMOND INTERCHANGE	OPTION C – DIVERGING DIAMOND INTERCHANGE
Traffic Capacity	×	✓	✓
Property Impacts	✓	×	×
Weaving Analysis	✓	✓	✓
Accessibility	✓	✓	✓
Wet Land Impacts	✓	×	×
Utility Impacts	✓	×	×
Recommendation		✓✓✓ More favourable	✓✓✓ More favourable

RECOMMENDATIONS FOR SHORT-LISTED OPTIONS

Based on the screening evaluation, the short-listed options included either a full diamond interchange or a diverging diamond interchange (DDI) for both 100 St SE and 116 St SE. It was also recommended to further evaluate the sub-option of a basketweave connection from 100 St SE to Stoney Trail.

E.6 Option Evaluation and Summary

The short-listed options were further evaluated using a Multiple Account Evaluation (MAE) process. The MAE was created with reference to The City's Triple Bottom Line framework which considers social, environmental and economic aspects in the evaluation process. It was determined that both the conventional diamond interchange and diverging diamond interchange options require a similar footprint and have comparable traffic performance and overall project costs. The overall evaluation results are summarized in ***Table E.5.*** with the key differences described below.

TABLE E.5: DIAMOND VS DDI SUMMARY

TBL	ISSUE	INDICATOR	DIAMOND	DDI
Economic	Financial	Operating and maintenance costs / efforts	✓	
		Utility relocation costs	=	=
		Present value of project cost	✓	✓
	Transportation	High load access	✓	
		Heavy vehicle usability		✓
		Accommodates Transit	✓	
		Accommodates cycling and walking		✓
		Travel time savings		✓
		Traffic safety		✓
		Reduction in traffic congestion and improved capacity		✓
	Feasibility and Deliverability	Constructability		✓
		Staging opportunity	=	=
Social	Community Impacts	Accessibility to network	=	=
		Visual aesthetics	=	=
		Construction impact to residences and businesses	=	=
		Private property impacts	✓	
		Land consumption	✓	
	Stakeholders	Public acceptability	=	=
Environ-mental	Environmental	Impacts on indigenous species, removal of habitat	✓	
	Cultural Heritage	Impact on historical sites	✓	
	Pollution	Impact on air quality	=	=

Conventional diamond interchange was evaluated favourably on the financial, community and environmental aspects, due to:

- Lower construction cost;
- Less property impact; and
- Less environmental impact.

Diverging diamond interchange was evaluated favorably on the transportation aspect, due to:

- Better accommodation of heavy vehicles;
- Better accommodation of transit, cycling and walking;
- Shorter travel time; and
- Higher capacity.

Based on the results of the evaluation, no option clearly out-performs the other. The adoption of either option will meet the requirements of the functional planning study.

As the footprint of the conventional diamond can be fully encompassed within the footprint of the DDI, selecting the DDI layout over the diamond will allow the flexibility of adopting either layout in the future, therefore allowing the interchange to be adapted to best suit the needs of the surrounding land build-out. Given the purpose of the study is to preserve the corridor for future requirements, a project decision was made to progress the DDI option to a full functional plan design.

Although the DDI requires modestly more acquired land, it has a significantly smaller footprint than the 2007 Highway 560 Functional Plan (rural-style diamond interchange), therefore reducing the overall impacts to the surrounding properties and wetlands. The additional land required for the DDI compared to the diamond interchange has the significant benefit of ensuring full flexibility for the interchange to be adapted to future needs, which is a key consideration at this stage of planning, given that build-out of the area is likely on a 30+ year time horizon.

E.7 Recommended Plan

The recommended plan for Glenmore Trail East includes interchanges at 100 St SE, 116 St SE, and Rainbow Road. The key components and features of the recommended plan include:

- Glenmore Trail ultimately widened to a six-lane divided skeletal freeway (note that the initial stage twinning requirement for Glenmore Trail is to be determined by a future study).
- 100 St SE, 116 St SE, and Rainbow Road upgraded to four lane urban arterial streets;
- Diverging diamond interchanges at 100 St SE, 116 St SE, and Rainbow Road;
- An option to include basketweave ramp structures in the westbound direction between 100 St and Stoney Trail;
- New grade separated pedestrian and cycling crossings of Glenmore Trail at 100 St SE, 116 St SE, and Rainbow Road, as part of the interchanges.

Figures E.7 to ***E.9*** show the recommended plan for the 100 St SE, 116 St SE, and Rainbow Road interchanges. ***Figure E.10*** shows the recommended plan with the optional basketweave.

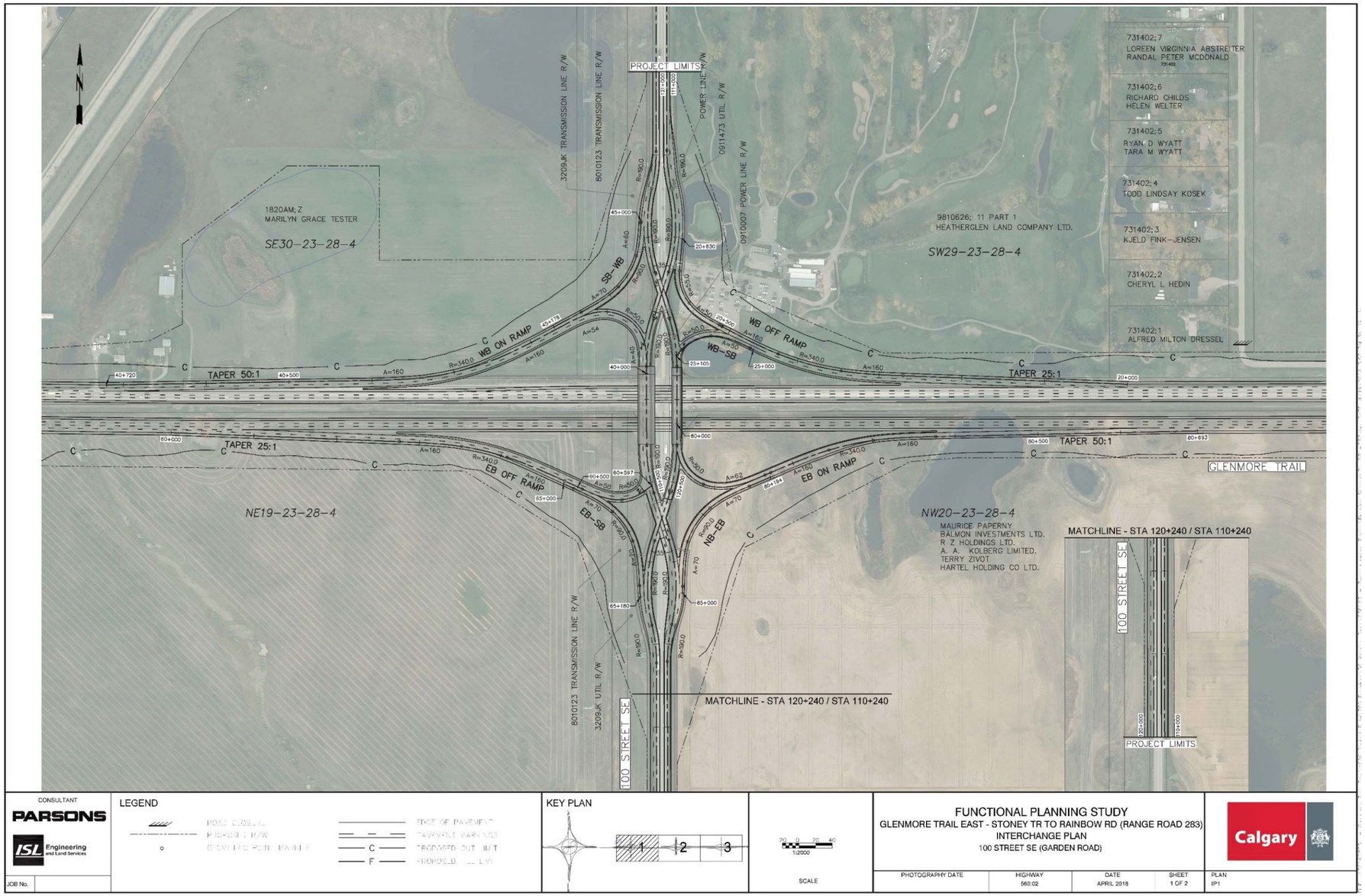


FIGURE E.7: RECOMMENDED PLAN - 100 ST SE

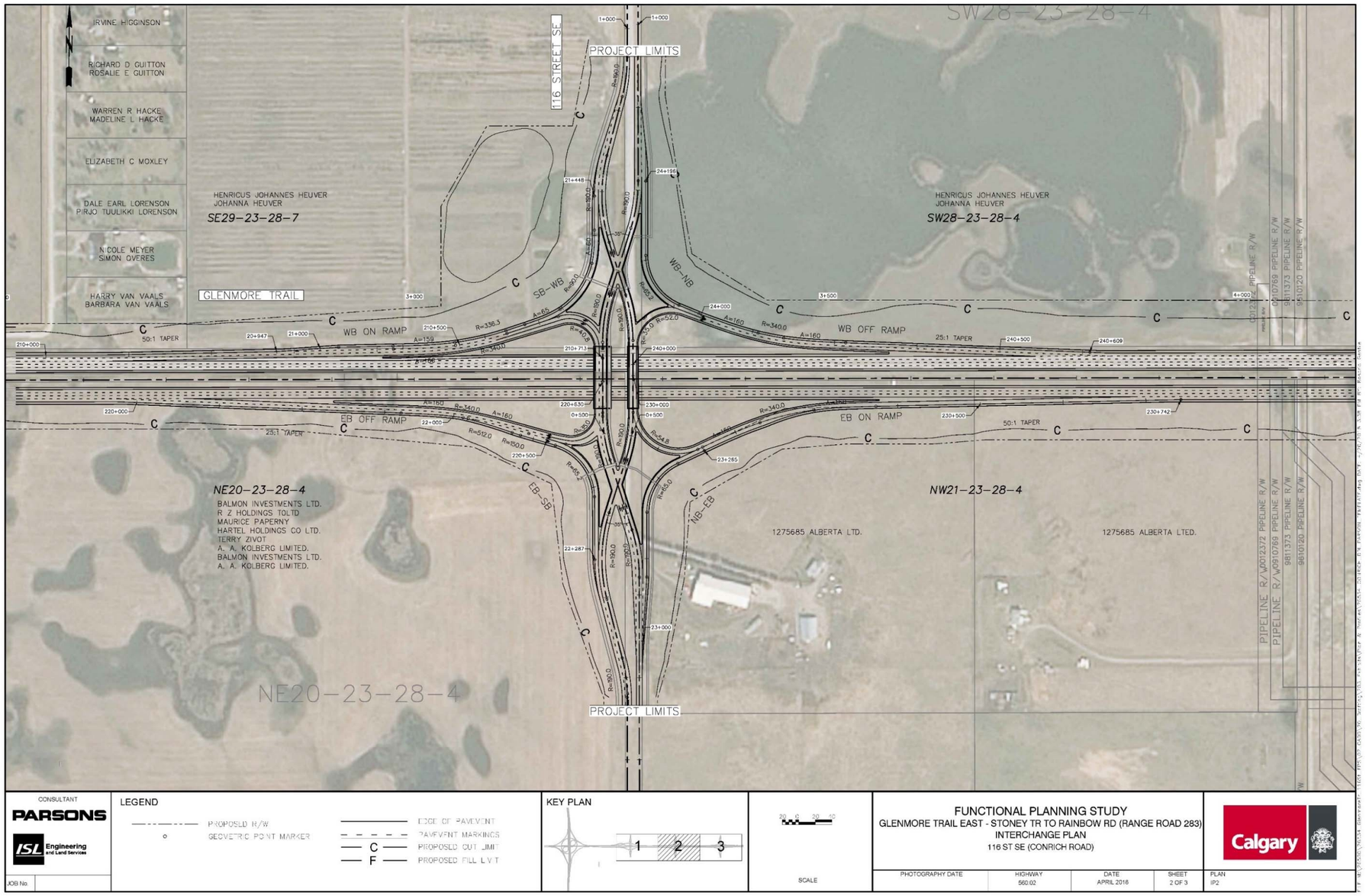


FIGURE E.8: RECOMMENDED PLAN - 116 ST SE

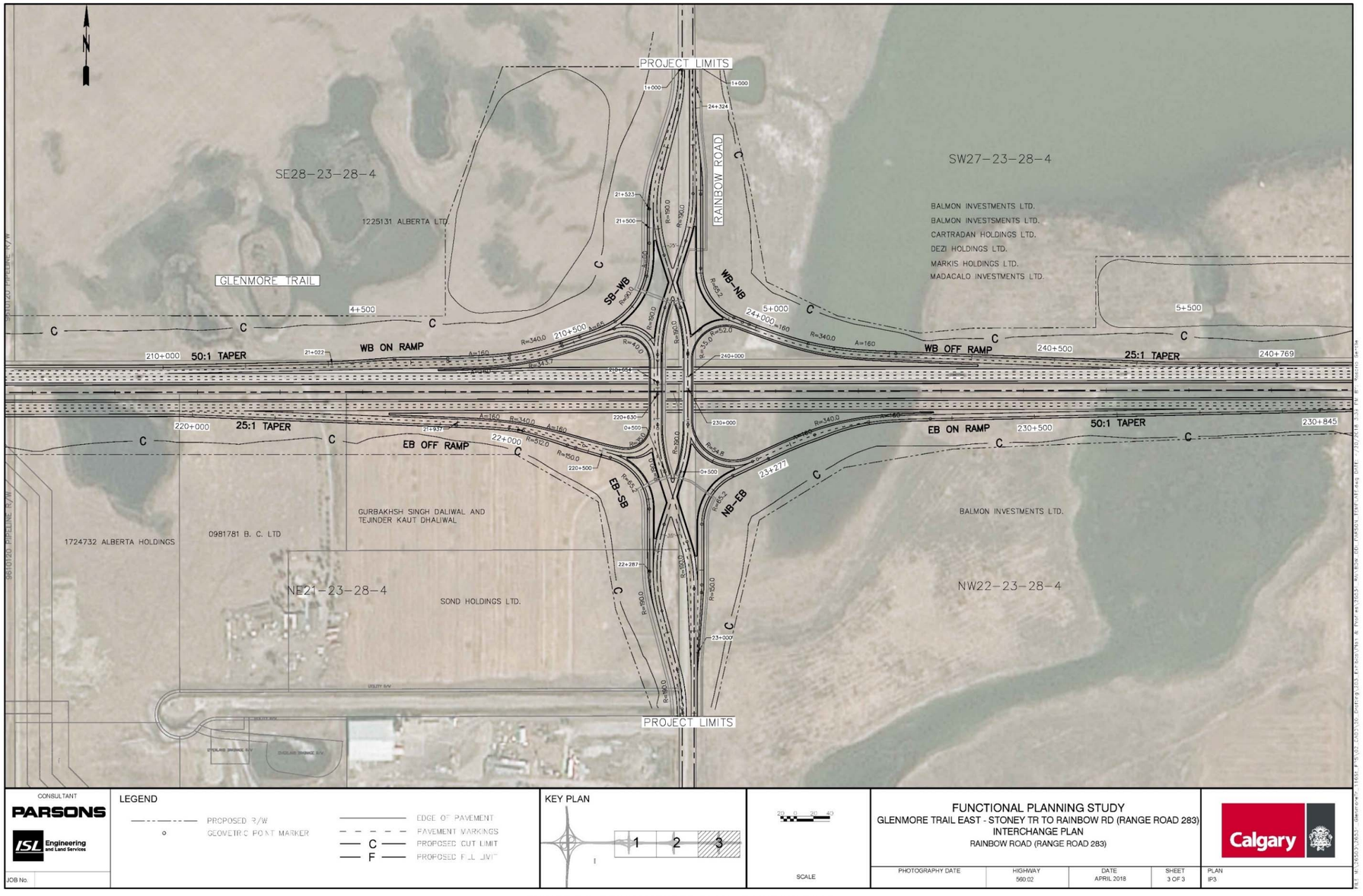


FIGURE E.9: RECOMMENDED PLAN –RAINBOW ROAD

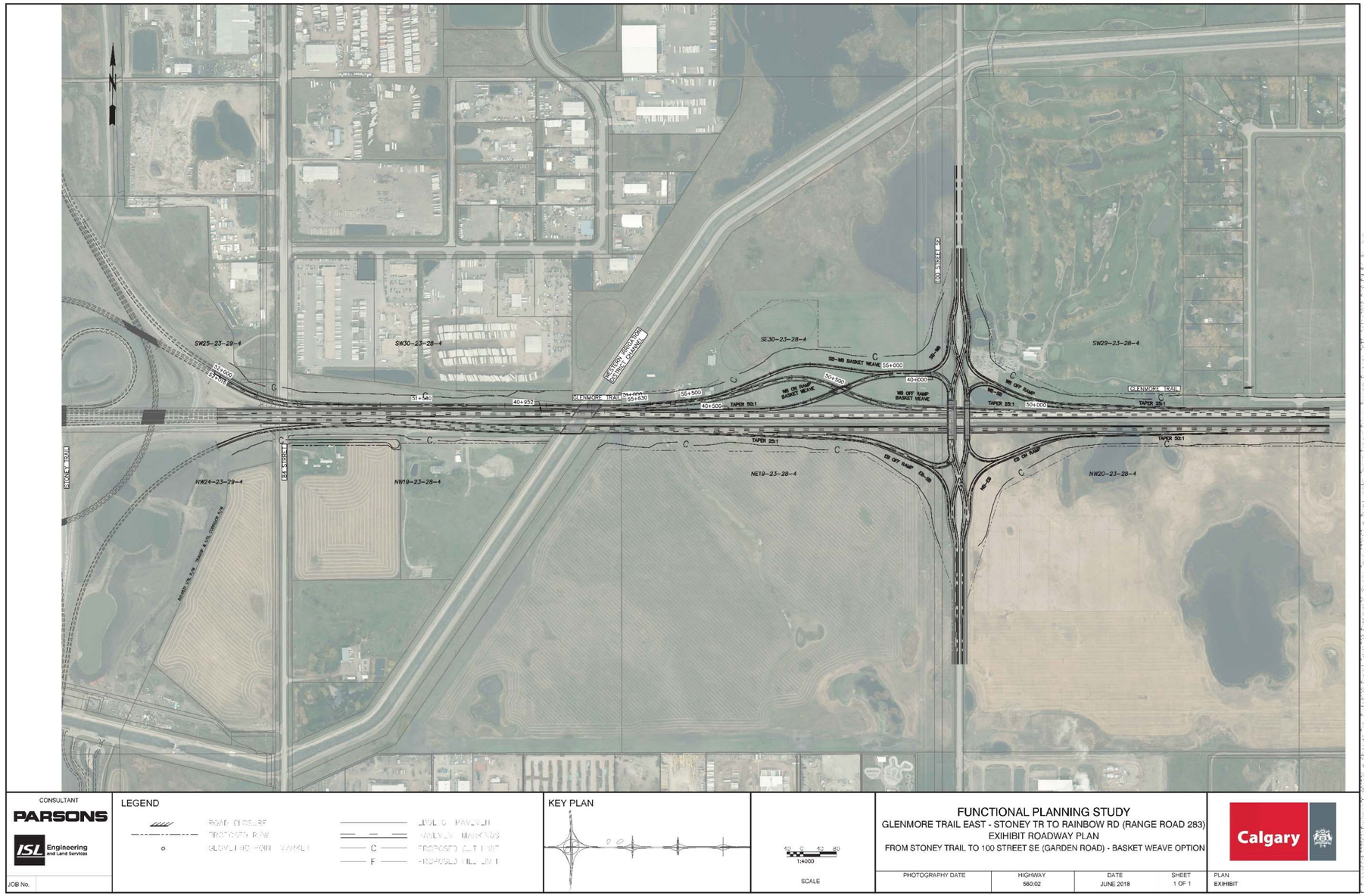


FIGURE E.10: RECOMMENDED PLAN - BASKETWEAVE OPTION

FEATURES OF THE RECOMMENDED PLAN

The following sections summarize the key components of the recommended functional plan.

Pedestrian and Cycling Facilities

The recommended plan includes a 3 m multi-use pathway along the west side and 2 m sidewalk along the east side of the northbound bridges on 100 St SE, 116 St SE and Rainbow Road. As the multi-use pathway and sidewalk approach the interchange at Glenmore Trail, they are channelized into the inside of the west structure, into a single multi-use pathway. This is consistent with typical practice for a DDI interchange.

Property Acquisition

The property requirements from the Highway 560 Functional Planning Study completed by AT in 2007 have been re-evaluated given that the recommended DDI require less property than the 2007 plan. The updated land requirements were calculated based on the areas needed to build the road network and interchange and provisions for additional stormwater ponds.

The assessment process identified a number of properties that, based on current drawings, require partial acquisition. However, with refinements to the alignment, acquisition of these properties may be avoided. The assessment also identified one potential property where full acquisition might be required due to impacts to several structures on the property. A summary of the potential property impacts for each interchange is provided in ***Table E.6***.

TABLE E.6: SUMMARY OF TOTAL POTENTIAL PROPERTY IMPACTS

OPTION	PLAN REF #	LOT NO. (LINC #)	AREA (HA)	FULL/PARTIAL	NOTES
Stoney Trail to 100 St SE	1	30984653	0.48	Partial	
	2 and 3	18104083	2.94	Partial	
	4	N/A	0.57	Partial	Service road
	5	18104091	10.10	Partial	
100 St SE	6	33448499	8.26	Partial to full	
	7	19956085 and 33448481	4.15	Partial	
	8	33448507	7.82	Partial	
	9	19955260	1.71	Partial	Same parcel as #12
	10	23862089	1.97	Partial	Includes service road to the east
116 St SE	11	30931604	7.53	Full	
	12	19955260	7.72	Partial	Same parcel as #9
	13	21608393	5.90	Partial	
	14	27711720	5.00	Partial	
	15	27424407	2.49	Partial	

OPTION	PLAN REF #	LOT NO. (LINC #)	AREA (HA)	FULL/PARTIAL	NOTES
Rainbow Rd	16	17196791	12.33	Partial	
	17	36715614 and 36715622	2.96	Partial	
	18	36372886	4.39	Partial	
	19	36715648	1.25	Partial	
	20	21593050	8.13	Partial	
	21	21607528	7.62	Partial	
	22	27355727	0.75	Partial	

COST ESTIMATES

Preliminary Cost Estimates—as defined in AT Engineering Consulting Guidelines for Highway, Bridge, and Water Projects Volume 1 - Design and Tender (2011)—were developed for each of the recommended segments along Glenmore Trail. The estimates do not include property acquisition.

The estimates, including a -40% and +75% variance, are provided in ***Table E.7***. The resulting preliminary cost estimates are an opinion of probable costs and should be refined further during the detailed design phase.

TABLE E.7: ORDER OF MAGNITUDE COST ESTIMATES

SEGMENT	UPGRADES	COST ESTIMATES (2017 $)			
		TOTAL	COMBINED	-40% VARIANCE	+75% VARIANCE
Stoney Trail to east of 100 St SE	• Upgrade existing roadway to six lanes divided cross section on Glenmore Trail • Upgrade existing 100 St SE to four lane cross section • New signals at Glenmore Trail / 100 St SE • Intersection upgrade	$68,650,000	**$151,150,000**	*$92,700,000*	*$264,510,000*
	• Construct diverging diamond interchange and ramps • Construct auxiliary lanes on Glenmore Trail	$63,300,000			
	Additional upgrades: • Basket weave between Stoney Trail and 100 St SE	$19,200,000			
East of 100 St SE to east of 116 St SE	• Upgrade existing roadway to six lane divided cross section on Glenmore Trail • Upgrade existing 100 St SE to four lane cross section • Install traffic signals at Glenmore Trail / 116 St SE • Upgrade at-grade Intersection	$31,322,000	**$86,105,000**	*$51,665,000*	*$150,700,000*
	Additional upgrades: • Construct diverging diamond interchange and ramps • Construct auxiliary lanes on Glenmore Trail	$54,800,000			
East of 116 St SE to east of Rainbow Road	• Upgrade existing roadway to six lane divided cross section on Glenmore Trail • Upgrade existing Rainbow Road to four lane cross section • Install traffic signals at Glenmore Trail / Rainbow Road • Upgrade at-grade Intersection	$32,370,000	**$89,800,000**	*$53,855,000*	*$157,080,000*
	Additional upgrades: • Construct diverging diamond interchange and ramps • Construct auxiliary lanes on Glenmore Trail	$57,400,000			

BENEFIT COST ANALYSIS

A benefit cost analysis based on vehicle delay cost was performed independently for the recommended 100 St SE, 116 St SE and Rainbow Road interchange configurations. The analysis was conducted over a 30 year period with implementation assumed to begin in 2037. The present value (PV) delay costs and construction costs were calculated and a benefit cost ratio determined based on the following general assumptions:

- Base case for benefit cost analysis includes widening on Glenmore Trail to six lanes, but retains an at-grade intersection;
- Forecasted traffic for the base case six-lane corridor associated with the 2039 land use assumptions;
- 30 year analysis period;
- Construction beginning in 2037 with a duration of two years;
- 4% internal discount rate;
- 2.5% annual traffic growth rate;
- Only travel time savings (reduction in existing delays) were assessed as benefits;
- Average value of time (blended between autos and trucks) of $35.74; and
- Property acquisition costs were not included in the calculation.

The results of the analysis indicated the following:

- 100 St SE DDI with the basketweave — 10.98 B/C Ratio (>3 year payback period)
- 116 St SE DDI — 8.44 B/C Ratio (>4 year payback period)
- Rainbow Road DDI — 7.93 B/C Ratio (> 5 year payback period)

As mentioned, only travel time benefits were included in the analysis. The inclusion of other elements such as vehicle operating cost savings, safety benefits, and salvage value should be included in future traffic analysis. However, future benefit cost analysis should also include deriving more accurate traffic forecasts for the base case where the above assumptions can be refined.

E.8 Construction Staging

The four distinct construction stages for delivering the recommended plan were identified and these are described below.

Stage 1 – Short-Term Improvements at Glenmore Trail East and 100 St SE

As a result of feedback received from the public engagement early during the planning study, a focussed analysis was conducted to fully explore the scope of any short-term improvements that could provide immediate benefits to the intersection of Glenmore Trail East and 100 St SE. ***Figure E.11*** shows the extent of the short-term improvement scope. The short-term improvements for 100 St SE are summarized below:

- Additional westbound through lane on Glenmore Trail;
- Additional eastbound through lane on Glenmore Trail;
- Additional northbound left turn lane added for a total of two left turn lanes;

- Add dedicated protected southbound left turn lane;
- Add protected southbound right turn slip-lane;
- Provide longer acceleration length for northbound traffic from 100 St SE merging onto eastbound traffic on Glenmore Trail;
- Provide longer acceleration length for southbound traffic from 100 St SE merging onto westbound traffic on Glenmore Trail;
- Improve westbound right turn lane with increase deceleration length; and
- Improve eastbound right turn slip-lane with longer deceleration length.

With a 30% contingency, 15% Engineering fee/testing fee and 10% mobilization, the total construction cost is estimated at $4.7 million.

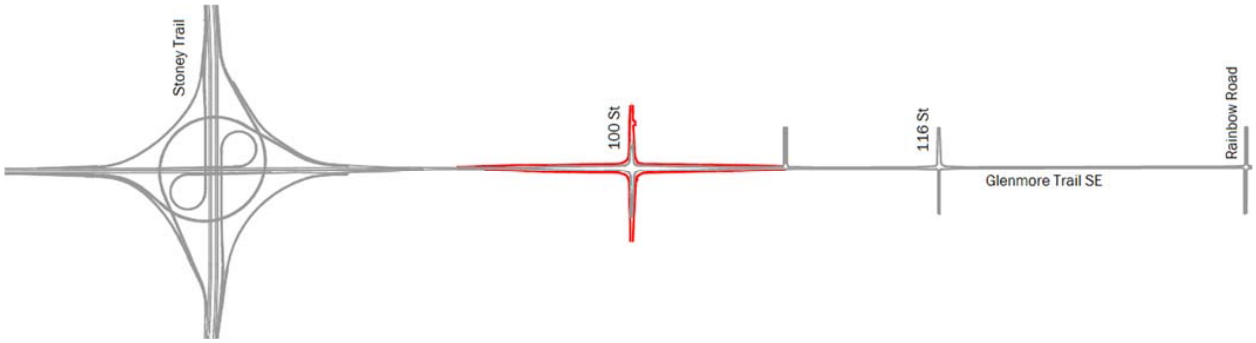


FIGURE E.11: SHORT-TERM IMPROVEMENTS AROUND 100 ST SE

Stage 2 – Glenmore Trail Twinning

Glenmore Trail east of Stoney Trail is classified as a Service Classification Level 3 highway. In the event that twinning is warranted for Glenmore Trail, it will involve the twinning of Glenmore Trail to the south, to accommodate a minimum of two lanes of traffic in either direction and include a new bridge across the Western Irrigation Canal. Refer to ***Figure E.12***. The timing of upgrading the Glenmore Trail from four lanes to six lanes will be determined in the future stage of the design based on traffic studies.

FIGURE E.12: ADDITIONAL EASTBOUND LANES AND TWINNING OF GLENMORE TRAIL

Stage 3 – Grade Separation

As land is developed, traffic demand will increase resulting in the at-grade intersections reaching capacity. Future traffic analysis along Glenmore Trail will be required to determine the timing in which the intersection(s) will require grade separation. Stage 3 could extend over a number of years with each intersection grade-separated individually or grouped together as determined by traffic demand. New ramps and bridges are required to grade separate across Glenmore Trail. ***Figure E.13*** shows the grade separation of Glenmore Trail at 100 St SE, 116 St SE and Rainbow Road. This study identified a series of temporary roads that may be required to build the bridges and ramps to minimize disruption to traffic during construction.

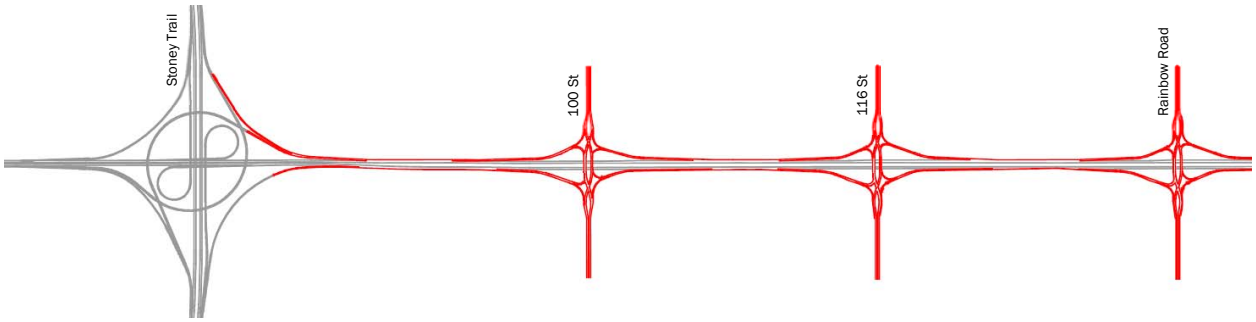


FIGURE E.13: GRADE SEPARATION OF GLENMORE TRAIL

Stage 4 – Westbound Basketweave

A westbound basketweave was proposed as a long-term solution to address potential weaving problems due to the close proximity of Stoney Trail to 100 St SE. Refer to ***Figure E.14***. If the traffic review carried out in the previous stage warrants the need for a basketweave, the basketweave can be constructed at this stage. All property acquisitions and utility relocations should have occurred during Stage 3. Hence, there should be minimal temporary traffic diversion required during construction.

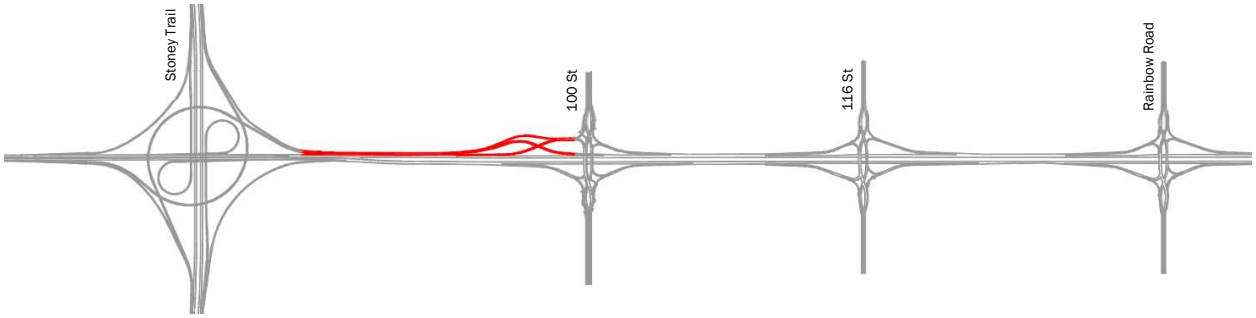
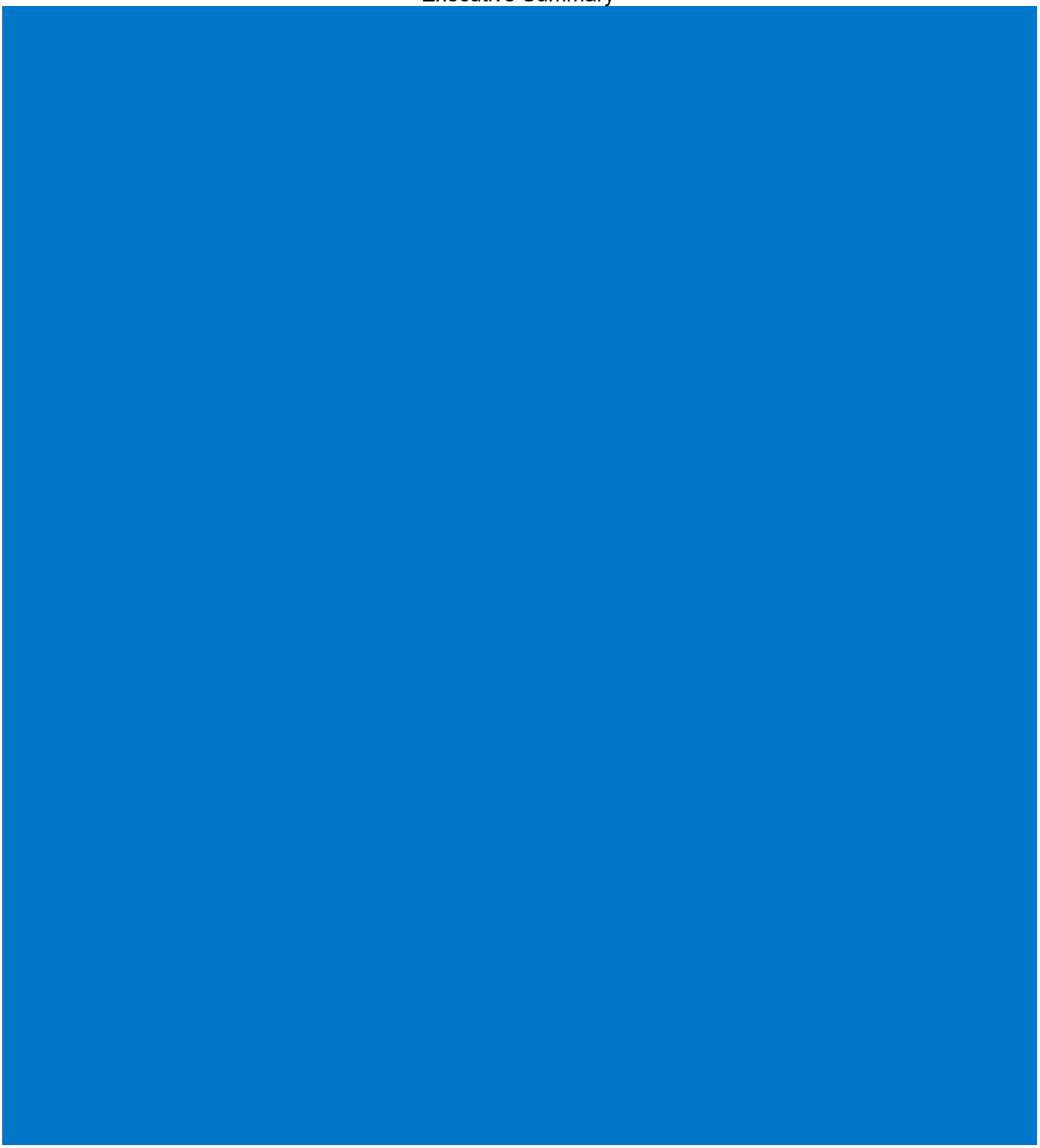


FIGURE E.14: BASKETWEAVE FROM 100 ST SE TO STONEY TRAIL

E.9 Conclusion

A comprehensive functional planning process was completed for 100 St SE, 116 St SE and Rainbow Road interchanges along Glenmore Trail under the guidance of the Technical Review Committee. Options were developed and evaluated for the study area. Three diverging diamond interchanges are recommended as the optimum interchange configuration for the junctions at 100 St SE, 116 St SE and Rainbow Road along Glenmore Trail. The recommended plan includes an option to include a basketweave structure in the westbound direction between 100 St SE and Stoney Trail to address potential weaving problems.



PARSONS

ISL Engineering and Land Services

318 11 Ave SE
Calgary, AB T2G 0Y2

P: 403. 303.1719
W: www.parsons.com