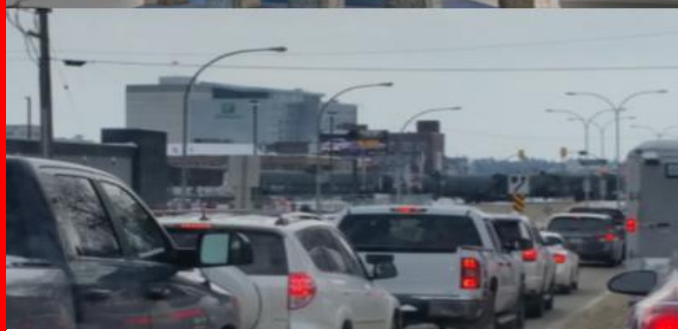
Attachment 2



Rail Relocation versus Grade Separation

City of Saskatoon

February 19, 2018

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Executive Summary

The City of Saskatoon (City) faces a problem not without precedent; it is a desirable place to live, visit, and do business, yet one that is bisected by a legacy railway network that today generates unintended consequences in terms of safety, quality of life, productivity losses, and environmental impacts. In the future, as railway and vehicle traffic grows and trains become longer, these “externalities” will only compound.

Saskatoon’s residents and visitors are increasingly delayed by Canadian Pacific (CP) and Canadian National (CN) freight trains that pass through level crossings throughout the city. This delays motorists and pedestrians, increases the risk of accidents, causes congestion at adjoining intersections, restricts access to businesses and residences, increases vehicle emissions and operating cost, and may delay emergency services response times. In order to determine the most viable and cost effective means of mitigating railway impacts on its citizens, the City requested a cost-benefit analysis (CBA) be conducted on viable options. HDR was engaged to conduct this analysis.

Solutions may include the partial or full grade-separation of one or both of the railway lines, and/or relocation of one or both of the railway lines and respective rail yards outside of the city core. In order to inform the decision making process, an in-depth analysis was conducted comparing public benefits relative to costs for the following alternatives:

- Base (no-build) case: Existing at-grade crossings remain at-grade, mainline tracks and yards remain at their current alignment and locations;
- Alternative 1: Grade separate of one or more of the existing CP or CN at-grade crossings (CP/CN Grade Separate);
- Alternative 2: Elevate the CP mainline over the existing roadway network (CP Elevate);
- Alternative 3: Lower the CP mainline below the existing roadway network (CP Trench); or,
- Alternative 4: Relocate of the CP mainline and Sutherland yard outside of city limits (CP Relocate).

For each alternative, a cost-benefit analysis (CBA) was conducted. This included the following:

Grade Separation Options (Alternatives 1-3)

1) At each at-grade crossing under consideration, conduct field investigations to determine viable grade separation options including:
    a. Road over rail (road overpass);
    b. Road under rail (road underpass);
    c. Rail over road (rail overpass - elevated rail);
    d. Rail under road (rail underpass - rail trench);
2) For each option, conduct preliminary engineering to estimate construction cost;
3) For each option, estimate the economic, environmental, and social benefits of grade separation including (but not limited to):
    a. Travel time savings to motorists;
    b. Vehicle operating cost savings;
    c. Reduced vehicle emissions; and,
    d. Improved safety;
4) Compare benefits to costs; calculate financial metrics such as cost-benefit ratio (CBR)[1] and net present value (NPV)[2].

CP Mainline and Yard Relocation Options (Alternative 4)

1) Conduct desktop and field investigations to determine viable routes outside of city limits for CP mainline and yard relocation;
2) Engage CP for feedback regarding route selection and, based on this feedback, conduct preliminary engineering to estimate construction cost;
3) Estimate the economic, environmental, and social benefits of CP mainline and yard relocation including (but not limited to):
    a. Travel time savings to motorists;
    b. Vehicle operating cost savings;
    c. Reduced vehicle emissions;
    d. Improved safety;
    e. Land value capture of existing CP right-of-way within city limits; and,
    f. Property price appreciation for properties adjacent to the CP right-of-way.
4) Compare benefits to costs; calculate financial metrics such as cost-benefit ratio (CBR) and net present value (NPV).

[1] Cost-benefit ratio (CBR) is an indicator which attempts to summarize the overall societal value for money of a project. A value greater than 1 indicates the quantified benefits of completing a project outweigh the costs.

[2] Net present value (NPV) represents the monetized value of benefits less costs discounted to present day terms. A positive NPV indicates that the project's benefits outweigh the costs over the duration of the analysis period.

Though it's work with the Railway Working Group (RWG), 5 CP and 4 CN at-grade crossings were selected for separations as alternative 1. Table 1 provides a summary of undiscounted[3] cost and benefit estimates by option.

Table 1: Summary of Total Costs and Benefits by Alternative, Millions of 2017 Dollars.

Alternative	Total Costs	Total Benefits	Cost-Benefit Ratio	Net Benefits
Alt. 1 – CP Grade Separate	$233.6 M	$153.2	0.66	($80.3)
Alt. 1 – CN Grade Separate	$140.8 M	$64.8	0.46	($76.1)
Alt. 2 – CP Elevate	$208.4 M	$100.9	0.48	($107.6)
Alt. 3 – CP Trench	$591.4 M	$196.4	0.33	($395.0)
Alt. 4 – CP Relocate	$589.7 M	$392.1	0.66	($197.6)

In order to reflect the time preference of current over future consumption, Table 2 provides a summary of discounted cost and benefit estimates by option utilizing a 10 percent discount rate recommended by Transport Canada[4].

Table 2: Summary of Discounted Costs and Benefits by Alternative, Millions of 2017 Dollars.

Alternative	Present Value of Costs	Present Value of Benefits	Cost-Benefit Ratio	Net Present Value
Alt. 1 – CP Grade Separate	$180.8 M	$22.8	0.13	($157.9)
Alt. 1 – CN Grade Separate	$109.0 M	$9.50	0.09	($99.5)
Alt. 2 – CP Elevate	$136.2 M	$12.5	0.09	($123.7)
Alt. 3 – CP Trench	$375.8 M	$19.6	0.05	($356.2)
Alt. 4 – CP Relocate	$385.3 M	$86.5	0.22	($298.8)

Table 3 provides results for each of the nine proposed grade separations separately.

[3] Discounting reflects society's general preference for the present as well as broader inter-generational concerns. It refers to the rate at which society is willing to trade present for future consumption and presents future costs and benefits in present terms.

[4] Transport Canada. "National Trade Corridors Fund (NTCF) Applicant's Guide – Comprehensive Project Proposal."

Table 3: Summary of Discounted Costs and Benefits by Location, Millions of 2017 Dollars.

Grade Crossing Location	Undiscounted			Discounted @ 10 Percent		
	Total Costs	Total Benefits	Cost-Benefit Ratio	Present Value of Costs	Present Value of Benefits	Cost-Benefit Ratio
25 St E / Idlywyd	$61.1 M	$48.4 M	0.79	$47.3 M	$6.34 M	0.13
22 St W	$48.0 M	$46.5 M	0.97	$37.2 M	$7.61 M	0.20
3 Ave N	$68.9 M	$20.1 M	0.29	$53.3 M	$3.59 M	0.07
Preston Ave N	$26.5 M	$23.3 M	0.88	$20.5 M	$3.60 M	0.18
Central Ave	$29.1 M	$14.9 M	0.51	$22.5 M	$1.67 M	0.07
33 St W	$44.7 M	$14.4 M	0.32	$34.6 M	$2.39 M	0.07
Marquis Dr	$23.1 M	$13.7 M	0.59	$17.8 M	$1.23 M	0.07
11 St W	$43.7 M	$19.9 M	0.46	$33.8 M	$3.02 M	0.09
51 St	$29.4 M	$16.8 M	0.57	$22.7 M	$2.86 M	0.13

Based on results of the analysis, from a pure monetary point of view, no options prove viable.

In addition to the monetized benefits summarized above, the proposed alternatives further provide intangible benefits that are difficult to quantify including improved emergency response times, access to community services and facilities, and neighborhood aesthetics and cohesiveness.

Emergency Response Times

Crossings along key emergency response routes will experience both improved emergency response times and reliability due to the elimination of congestion and delay at grade crossings. Secondary route selection will no longer be required due to trains occupying level crossings and emergency services will be able to utilize shorter improved routes.

Access to Community Services and Facilities

The elimination of congestion and delay at grade crossings will improve access to schools, places of worship, healthcare facilities, community service providers, and other public institutions.

Neighbourhood Aesthetics and Cohesiveness

The proposed alternatives allow the opportunity for context-sensitive design of structure and walls that aligns with the surrounding neighbourhoods and existing buildings, thereby improving overall neighborhood aesthetics. Eliminating congestion provides neighbourhoods with enhanced cohesiveness and connectivity resulting in improved quality of life.

1 Introduction

The City of Saskatoon (City) faces a problem not without precedent; it is a desirable place to live, visit, and do business, yet one that is bisected by a legacy railway network that today generates unintended consequences in terms of safety, quality of life, productivity losses, and environmental impacts. In the future, as railway and vehicle traffic grows and trains become longer, these "externalities" will only compound.

Saskatoon's residents and visitors are increasingly delayed by Canadian Pacific (CP) and Canadian National (CN) freight trains that pass through level crossings throughout the city. This delays motorists and pedestrians, increases the risk of accidents, causes congestion at adjoining intersections, restricts access to businesses and residences, increases vehicle emissions and operating cost, and may delay emergency services response times.

Through its work with the Railway Working Group (RWG), the City initially identified nine locations where grade separation was deemed a priority. However, it was also recognized that other options may prove more favourable such the full relocation of CP and/or CN mainline and yard infrastructure outside of city limits. In order to determine the most viable and cost effective means of mitigating railway impacts on its citizens, the City requested a cost-benefit analysis (CBA) be conducted on viable options.

The following options were identified for consideration:

- Base (no-build) case: Existing at-grade crossings remain at-grade, mainline tracks and yards remain at their current alignment and locations;
- Alternative 1: Grade separate of one or more of the existing CP or CN at-grade crossings (CP/CN Grade Separate);
- Alternative 2: Elevate the CP mainline over the existing roadway network (CP Elevate);
- Alternative 3: Lower the CP mainline below the existing roadway network (CP Trench); or,
- Alternative 4: Relocate of the CP mainline and Sutherland yard outside of city limits (CP Relocate).

For each alternative, a cost-benefit analysis (CBA) was conducted. This included the following:

Grade Separation Options (Alternatives 1-3)

1) At each at-grade crossing under consideration, conduct field investigations to determine viable grade separation options including:
    a. Road over rail (road overpass);
    b. Road under rail (road underpass);
    c. Rail over road (rail overpass - elevated rail);
    d. Rail under road (rail underpass - rail trench);
2) For each option, conduct preliminary engineering to estimate construction cost;
3) For each option, estimate the economic, environmental, and social benefits of grade separation including (but not limited to):
    a. Travel time savings to motorists;
    b. Vehicle operating cost savings;
    c. Reduced vehicle emissions; and,
    d. Improved safety;
4) Compare benefits to costs; calculate financial metrics such as cost-benefit ratio (CBR) and net present value (NPV).

CP Mainline and Yard Relocation Options (Alternative 4)

1) Conduct desktop and field investigations to determine viable routes outside of city limits for CP mainline and yard relocation;
2) Engage CP for feedback regarding route selection and, based on this feedback, conduct preliminary engineering to estimate construction cost;
3) Estimate the economic, environmental, and social benefits of CP mainline and yard relocation including (but not limited to):
    a. Travel time savings to motorists;
    b. Vehicle operating cost savings;
    c. Reduced vehicle emissions;
    d. Improvement to safety;
    e. Land value capture of existing CP right-of-way within city limits; and,
    f. Property price appreciation for properties adjacent to the CP right-of-way.
4) Compare benefits to costs; calculate financial metrics such as cost-benefit ratio (CBR) and net present value (NPV).

The remainder of the report is structured as follows:

- Section 2 provides methodology, summary of project costs, input values, and results of the CBA;
- Section 3 summarizes grade separation concepts along with construction cost estimates for each at-grade crossing considered;
- Section 4 provides concepts for the CP elevation and trench options. Construction cost estimates for each are also provided; and

- Section 5 outlines four separate CP mainline relocation options along with a construction cost estimate for a single **preferred** option.

All construction cost estimates provided herein are considered are Class 5. As per the Association for the Advancement of Cost Engineering (AACE), the level of accuracy for this estimate (considering track, earthwork, retaining wall, roadway, bridge, and utilities) ranges from -50% to +100%.[5]

[5] Advancement of Cost Engineering. "Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries. "2016.

2 Cost-Benefit Analysis

CBA is a conceptual framework that quantifies in monetary terms as many of the costs and benefits of a project as possible. Benefits are broadly defined; they represent the extent to which people impacted by the project are made better-off, as measured by their own willingness-to-pay. In other words, central to CBA is the idea that people are best able to judge what is "good" for them, what improves their well-being or welfare. CBA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some groups within society are made worse-off. A project or proposal would be rated positively if the benefits to some are large enough to compensate the losses of others. Finally, CBA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life-cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

2.1 Methodology

The specific methodology developed for this analysis was developed using the above CBA principles and is consistent with the published Transport Canada guidelines[6]. In particular, the methodology involves:

- Establishing existing and future conditions under the Base Case and Alternative scenarios;
- Assessing benefits with respect to each of the key project objectives;
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement; and,
- Discounting future benefits and costs with the real discount rate as recommended by Transport Canada (10 percent).

Options were compared primarily based on the CBA results. Benefits were estimated based on improvements to social welfare including travel time savings, vehicle operating cost savings, reduced vehicle emissions, and improvement to safety. The analysis assumed no net benefits to CP in terms of capacity or operating cost improvements. Grade separation benefits are largely dependent on both current and future vehicle and train volumes. Relocation benefits further incorporate opportunities for redevelopment of existing CP right-of-way and property value appreciation adjacent to CP right-of-way.

[6] Transport Canada. "National Trade Corridors Fund (NTCF) Applicant's Guide – Comprehensive Project Proposal."

In many cases, grade separation necessitates road closures and restricted access to businesses. These business impacts vary depending on the type of business, nature of the access restriction and mitigation measures put in place. The scope of this analysis precludes estimates of foregone business opportunities to be conducted.

2.2 Project Costs

Construction cost estimates for each of the 9 grade separation locations under consideration is provided in Table 4.

Table 4: Summary of Construction Cost Estimates, Grade Separation. Millions of 2017 Dollars.

Grade Separation Location	Grade Separation Type	Bridge Cost	Roadway Work Cost	Railway Work Cost	Other Costs*	Contingency (30%)	Total Costs
Canadian Pacific Railway (CP)							
25th St E / Idlywyd	Road Underpass	$6.2 M	$29.7 M	$2.1 M	$9.0 M	$14.1 M	**$61.1 M**
22nd St W	Road Underpass	$6.3 M	$21.6 M	$2.1 M	$6.9 M	$11.1 M	**$48.0 M**
3rd Ave N	Road Overpass with Interchange	$10.4 M	$25.9 M	$0.3 M	$16.4 M	$15.9 M	**$68.9 M**
Preston Ave	Road Overpass	$2.7 M	$12.8 M	$0.8 M	$4.1 M	$6.1 M	**$26.5 M**
Central Ave	Road Overpass	$5.7 M	$11.8 M	$0.4 M	$4.5 M	$6.7 M	**$29.1 M**
Total		**$31.3 M**	**$101.8 M**	**$5.7 M**	**$40.9 M**	**$53.9 M**	**$233.6 M**
Canadian National Railway (CN)							
33rd St W	Rail Overpass	$5.9 M	$1.4 M	$20.9 M	$6.2 M	$10.3 M	**$44.7 M**
Marquis Drive	Road Overpass	$2.5 M	$10.9 M	$0.8 M	$3.6 M	$5.3 M	**$23.1 M**
11th St W	Road Overpass	$9.7 M	$16.6 M	$0.6 M	$6.7 M	$10.1 M	**$43.7 M**
51st St W	Road Overpass	$4.1 M	$13.2 M	$0.8 M	$4.5 M	$6.8 M	**$29.4 M**
Total		**$22.2 M**	**$42.1 M**	**$23.1 M**	**$21.0 M**	**$32.5 M**	**$140.9 M**

** Other costs include environmental, mobilization, right-of-way, and engineering costs*

As per the Association for the Advancement of Cost Engineering (AACE), the level of accuracy for the cost estimates estimate (considering track, earthwork, retaining wall, roadway, bridge, and utilities) ranges from -50% to +100%.[7] An underpass typically costs more than an overpass since overpasses may avoid permanent utility relocation and temporary rail relocation which is often required when an underpass is proposed.

[7] Advancement of Cost Engineering. "Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries. "2016. https://web.aacei.org/docs/default-source/toc/toc_18r-97.pdf?sfvrsn=4

Table 5 provides capital cost estimates by alternative. Additional detail may be found in Sections 3 to 5.

Table 5: Summary of Capital Cost Estimates, by Alternative. Millions of 2017 Dollars.

Alternative	Total Costs	Present Value of Costs	Construction Period (Years)	Description
Alt. 1 – CP Grade Separate	$233.6 M	$180.8 M	2	Grade separate 5 crossings (25th St, 22nd St, 3rd Ave, Preston Ave, Central Ave.)
Alt. 1 – CN Grade Separate	$140.9 M	$109.0 M	2	Grade separate 4 crossings (33rd St, Marquis Drive, 11th St, 51st St)
Alt. 2 – CP Elevate	$208.4 M	$136.2 M	6	Allows grade separation of 8 crossings (Avenue P S, 20 St W, Avenue H S, 22nd St W, Avenue C N, Idylwyld Dr, 3rd Avenue N, 7 Avenue N)
Alt. 3 – CP Trench	$591.4 M	$375.8 M	7	Allows grade separation of 6 crossings (Avenue P S, 20 St W, Avenue H S, 22nd St W, Avenue C N, Idylwyld Dr)
Alt. 4 – CP Relocate	$589.7 M	$385.3 M	6	Eliminates all at-grade crossings along the CP mainline

2.3 Benefit Estimation

In estimating benefits for each alternative, the benefit categories considered are summarized by Table 6.

Table 6: Benefit Categories Considered, by Alternative

Benefit Category	Alternative			
	1	2	3	4
Travel Time Savings	✓	✓	✓	✓
Vehicle Operating Cost Savings	✓	✓	✓	✓
Reduced Vehicle Emissions	✓	✓	✓	✓
Improved Safety	✓	✓	✓	✓
Pavement Maintenance Costs	✓	✓	✓	✓
Residual Value of Assets	-	-	-	✓
Economic Value of Land	-	-	-	✓
Property Price Appreciation	-	-	-	✓

Specific methodologies and assumptions used to estimate individual benefit categories are provided below.

2.3.1 Travel Time Savings

Travel time savings, in hours, between the Base and the Alternative cases were estimated based on average annual daily traffic (AADT) forecasts derived from the City's historical

traffic counts and regional travel demand model (TDM)[8]. The model estimates AADT under various population growth scenarios which were then translated to an AADT forecast for each crossing. Data regarding current daily train counts and railway design speeds for both CN and CP was obtained through railroad reporting required under Grade Crossing Regulations[9]. Under the regulations, railroads must provide the following information regarding pubic grade crossings:

1) Exact location of the public grade crossing;
2) Number of tracks that cross the public grade crossing;
3) Average annual train movements;
4) Railway design speed;
5) Type of warning system at the public grade crossing;
6) Information regarding whether a *Stop* sign is installed on the same post as the *Railway Crossing* sign; and
7) Information regarding whether train whistling is required on approach to the public grade crossing.

The calculations, in tandem with the assumptions provided in Table 7 were performed as follows:

1) Determine the *probability of delay* which is a function train frequency, speed, length, and gate lead and lad time;
2) Derive the amount of *vehicles impacted by delay* by multiplying AADT and the *probability of delay*;
3) Calculate *vehicle delay time* by multiplying the amount of *vehicles impacted by delay* with the amount of time it takes for a train to clear the crossing; and
4) Multiply *vehicle delay time* by average vehicle occupancy and the value of time by vehicle type to obtain the estimate for travel time savings.

Detour Impacts

Similarly, the additional travel time due to construction detours were calculated based on assumed average distance of detour and average vehicle detour speed. The steps used to estimate detour impacts are summarized below:

8) Derive the *additional vehicle travel time* by using AADT, average detour distance, and average vehicle detour speed; and
9) Multiply the *additional vehicle travel time* by average vehicle occupancy and the value of time by vehicle type to obtain the estimate of detour impacts.

[8] Travel Demand Model results provided estimates under 300,000 (300K), 400,000 (400k), and 500,000 (500k) population scenarios. Each scenario is attributed to a future calendar year based on City projections.

[9] Government of Canada, Grade Crossing Regulations (SOR/2014-25).

Table 7: Assumptions Used in the Estimation of Travel Time Savings

Variable Name	Unit	Value	Source
Average Auto Occupancy	people/vehicle	1.65	Natural Resources Canada Canadian Vehicle Survey 2009 Summary Report
Value of Time for Automobile Driver and Passenger	$/hour	$17.4	Statistics Canada 2011 Census (2016 Census information not yet available), calculated as half of implied wage in Saskatoon, using average salary of population above 15 years old working full time divided by average working week (35 hrs)
Value of Time for Truck Driver	$/hour	$28.7	Calculated based on average weekly wages including overtime for Transportation and Warehouse sector for Saskatoon, assuming a 35 hour work week; CANSIM Table 281-0063, 2017$

2.3.2 Vehicle Operating Cost Savings

Out-of-pocket vehicle operating cost savings accrue from decreased vehicle wait times and idling while additional costs accrue due to detours at time of construction. The out-of-pocket cost savings were monetized based on the change in delay time and associated fuel and oil used while idling, offset by additional vehicle kilometers traveled (VKT) due to construction detours. Table 8 provides the assumptions used to estimate vehicle operating cost savings while the steps used to derive estimates are as follows:

1) Multiply *vehicle delay time*, determined previously, by the motor oil consumption factor at idle (by vehicle type) to obtain estimates for *motor oil consumed at idle*;
2) Multiply *vehicle delay time* by the vehicle fuel used at idle (by vehicle type) to obtain estimates for both *gasoline and diesel consumed at idle*; and
3) Multiply motor oil, gasoline, and diesel consumed by respective costs to obtain the estimate for vehicle operating cost savings.

Detour Impacts

Vehicle operating cost impacts due to detours are estimated in a similar fashion.

1) Determine the *additional vehicle kilometres traveled (VKT)* by using AADT, average detour distance, and the average detour speed;
2) Multiply the *additional VKT* by factors motor oil consumption while driving (by vehicle type) to obtain estimates for *motor oil consumed*;
3) Multiply the *additional VKT* by average fuel economy by vehicle type to derive estimates for *gasoline and diesel consumed*; and
4) Multiply the estimates of motor oil, gasoline, and diesel consumption by respective costs to obtain the estimate of detour impacts.

Table 8: Assumptions Used in the Estimation of Vehicle Operating Costs

Variable Name	Unit	Value	Source
Average Truck Fuel Economy	litres/km	0.36	Natural Resources Canada Canadian Vehicle Survey 2009 Summary Report
Average Auto Fuel Economy	litres/km	0.11	Natural Resources Canada Canadian Vehicle Survey 2009 Summary Report
Vehicle Fuel Burned at Idle - Automobile	litres/hour	1.50	Calculated based on National Resources Canada assumptions: over an idle time of 10 minutes, 0.25 litres of fuel wasted in 3 L engine size
Vehicle Diesel Burned at Idle - Truck	litres/hour	3.00	Value stated in text in National Resources Canada: Highway trucking: Idling gets you nowhere!, 2015.
Motor Oil Consumption at Idle - Auto	litres/hour	0.03	Based on US DOT: HERS-ST Highway Economic Requirements System (2002) oil consumption of 1.38qt/1000 miles and assuming that "One hour of idle time is equal to approximately 25 miles of driving" (Ford Motor Company, 2011), converted to litres/hr
Motor Oil Consumption at Idle - Truck	litres/hour	0.03	Based on US DOT: HERS-ST Highway Economic Requirements System (2002) oil consumption of 1.38qt/1000 miles and assuming that "One hour of idle time is equal to approximately 25 miles of driving" (Ford Motor Company, 2011), converted to litres/hr
Motor Oil Consumption, Driving - Auto	litres/km	0.001	Based on US DOT: HERS-ST Highway Economic Requirements System (2002) oil consumption of 1.38qt/1000 miles, converted to litres/km
Motor Oil Consumption, Driving - Truck	litres/km	0.001	Based on US DOT: HERS-ST Highway Economic Requirements System (2002) oil consumption of 1.38qt/1000 miles, converted to litres/km
Cost of Motor Oil - Automobile	$/litre	$4.74	BC Ministry of Transportation: Default Values for Cost-Benefit Analysis in British Columbia 2012
Cost of Motor Oil - Truck	$/litre	$4.74	BC Ministry of Transportation: Default Values for Cost-Benefit Analysis in British Columbia 2012
Gasoline Retail Price	2017$/gallon	$0.66	Statistics Canada, net of taxes. Table 326-0009 - Average retail prices for gasoline and fuel oil, by urban centre, monthly. Forecasted based on 2016-2050 average annual growth obtained from the U.S. EIA Annual Energy Outlook 2017.
Average Yearly Increase in Gasoline Retail Price	%	1.26%	Average Annual Growth Rate Calculated.
Diesel Retail Price	2017$/gallon	$0.73	Statistics Canada, net of taxes. Table 326-0009 - Average retail prices for gasoline and fuel oil, by urban centre, monthly. Forecasted based on 2016-2050 average annual growth obtained from the U.S. EIA Annual Energy Outlook 2017.
Average Yearly Increase in Diesel Retail Price	%	1.74%	Average Annual Growth Rate Calculated.

2.3.3 Reduced Vehicle Emissions

Reduced vehicle emissions, in tonnes by pollutant type, are realized through a reduction in idling and delay time and partially offset due to additional vehicle kilometers traveled (VKT) due to construction detours. The assumptions used to monetize emission costs are provided in Table 9 below.

1) Multiply *vehicle delay time*, determined previously, by the emission factors at idle by pollutant type (CO_2, NOx, VOC, PM, and Sox) to obtain *tonnes of pollutants by type at idle*; and
2) Multiply *tonnes of pollutants by type at idle* by respective monetary values to obtain the monetized estimate for reduced vehicle emissions.

Detour Impacts

Emission impacts due to construction detours are estimated in a similar fashion to vehicle operating cost impacts.

1) Multiply *additional vehicle kilometres traveled (VKT)*, determined previously, by emission factors per kilometer traveled (by pollutant type) to obtain tonnes of pollutants by type; and
2) Multiply *tonnes of pollutants by type* by respective monetary values to obtain the monetized estimate for detour impacts.

Table 9: Assumptions Used in the Estimation of Emission Costs

Variable Name	Unit	Value	Source
CO_2 per litre of Fuel Burned at Idle - Highway Vehicles	grams /hour	3,079	MOVES Average Annual Emissions Factors for Idling, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in CO_2 Emission Rate	%	0.96%	Average Annual Growth Rate Calculated
NOx per litre of Fuel Burned at Idle - Highway Vehicles	grams /hour	3.48	MOVES Average Annual Emissions Factors for Idling, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in NOx Emission Rate	%	4.12%	Average Annual Growth Rate Calculated
VOC per litre of Fuel Burned at Idle - Highway Vehicles	grams /hour	0.81	MOVES Average Annual Emissions Factors for Idling, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in VOC Emission Rate	%	5.23%	Average Annual Growth Rate Calculated
PM per litre of Fuel Burned at Idle - Highway Vehicles	grams /hour	0.188	MOVES Average Annual Emissions Factors for Idling,

Variable Name	Unit	Value	Source
			Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in PM Emission Rate	%	5.17%	Average Annual Growth Rate Calculated
SOx per litre of Fuel Burned at Idle - Highway Vehicles	grams /hour	0.022	MOVES Average Annual Emissions Factors for Idling, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in SOx Emission Rate	%	0.87%	Average Annual Growth Rate Calculated
CO_2 per KM Travelled, Weighted Average	grams /KM	253.0	MOVES Weighted Average Annual Emissions Factors, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in CO_2 Emission Rate	%	1.31%	Average Annual Growth Rate Calculated
NOx per KM Travelled, Weighted Average	grams /KM	0.2453	MOVES Weighted Average Annual Emissions Factors, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in NOx Emission Rate	%	5.65%	Average Annual Growth Rate Calculated
VOC per KM Travelled, Weighted Average	grams /KM	0.0377	MOVES Weighted Average Annual Emissions Factors, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in VOC Emission Rate	%	6.34%	Average Annual Growth Rate Calculated
PM per KM Travelled, Weighted Average	grams /KM	0.0097	MOVES Weighted Average Annual Emissions Factors, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in PM Emission Rate	%	4.51%	Average Annual Growth Rate Calculated
SOx per KM Travelled, Weighted Average	grams /KM	0.0017	MOVES Weighted Average Annual Emissions Factors, Using US National Default Fleet Mix of Highway Vehicles
Average Annual Decrease in SOx Emission Rate	%	1.25%	Average Annual Growth Rate Calculated
CO_2 Cost per Tonne	2017$ /tonne	$45.0	Technical Update to Environment and Climate Change Canada's Social Cost of Greenhouse Gas Estimates, Environment and Climate Change Canada, March 2016.
Average Annual Increase in CO_2 Costs	%	1.55%	Average Annual Growth Rate Calculated
NOx Cost per Tonne	2017$ /tonne	$4,831	Transport Canada Estimating the Full Costs of Transport in Canada, August 2008
VOC Cost per Tonne	2017$ /tonne	$588	

Variable Name	Unit	Value	Source
PM Cost per Tonne	2017$ /tonne	$17,004	
SOx Cost per Tonne	2017$ /tonne	$5,344	

2.3.4 Improved Safety and Avoided Accident Costs

The number and severity of collisions for each of the 9 at-grade crossing under consideration were derived using the U.S. Federal Rail Administration (FRA) collision prediction formulae taking into account the crossing-specific information. The FRA Collision Prediction model[10] requires data on the crossing type (urban or rural), warning device, type of road and area under consideration, number of trains at the crossing, and other crossing-specific information obtained from both CP and CN. Table 10 provides the assumptions used to estimate safety benefits while a brief summary of calculation steps are as follows:

1) Derive the *expected number of fatalities, injuries, and PDO accidents* by using the FRA collision prediction model; and
2) Multiply the expected number of fatalities, injuries, and PDO accidents respective costs by collision severity to obtain estimates of avoided accident costs.

Detour Impacts

Collisions resulting from construction detours were estimated based on Saskatchewan factors per million vehicle miles travelled obtained from Transport Canada. The estimated methodology used follows the following steps:

1) Derive the *expected number of fatalities, injuries, and PDO accidents* by multiplying the *additional vehicle kilometres traveled (VKT)*, determined previously, by respective collision rates per VKT; and
2) Multiply the *expected number of fatalities, injuries, and PDO accidents* respective costs by collision severity to obtain estimates of avoided accident costs.

[10] The U.S FRA collision prediction model provides the expected number of collisions, by severity, for each grade crossing considered. The model takes into account train lengths and speeds, traffic at the crossing, number of tracks and roadway lanes, and type of warning device to name a few.

Table 10: Assumptions Used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Value of Statistical Life	$/fatality	$7,573,661	Policy Horizons Canada, 2007 $
Average Cost per Injury Victim	$/injury	$80,492	Collision Costs Study prepared for the Capital Region Intersection Safety Partnership by Paul de Leur, February 2010
Average Cost per PDO Victim	$/PDO	$13,283	Collision Costs Study prepared for the Capital Region Intersection Safety Partnership by Paul de Leur, February 2010
Fatalities per Million VMT	events/million VKT	0.0095	Transport Canada, rates for Saskatchewan 2014
Injuries per Million VMT	events/million VKT	0.423	Transport Canada, rates for Saskatchewan 2014
PDO per Million VMT	events/million VKT	0.846	Calculated based on the assumption that 2 vehicles involved in accidents, based on injuries per million VKT

2.3.5 Pavement Maintenance Costs

Pavement maintenance costs accrue from additional vehicle kilometers traveled (VKT) due to detours at time of construction. The additional VKT, determined previously, is multiplied by pavement damage costs by vehicle type to obtain monetary estimates. The assumptions used to monetize pavement maintenance costs are provided in Table 11.

Table 11: Assumptions Used in the Estimation of Pavement Maintenance Costs

Variable Name	Unit	Value	Source
Pavement Maintenance Costs - Auto	$/km	$0.001	US DOT 2016 Guidance, Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000. Converted to USD $/km from USD $/mi, and inflated from 2000 to 2017 USD$, before being converted to CAD$ using 2017 average exchange rate
Pavement Maintenance Costs - Truck	$/km	$0.29	

2.3.6 Residual Value of Assets

The residual value of assets is calculated using straight-line depreciation and an estimated average track life of 35 years. The net book value at the end of the study period is added as a benefit stream in the final year. The benefit was estimated by multiplying the capital costs by the ratio of service life remaining to the estimate service life. This benefit only accrued to CP elevation, CP trench, and CP relocation alternatives as they are placed in service later and thus do not reach the end of their useful life by 2055. Table 12 provides the assumptions used to estimate residual value.

Table 12: Assumptions Used in the Estimation of Residual Value

Variable Name	Unit	CP Elevate	CP Trench	CP Relocate	Source
Study End Year	year	2055	2055	2055	HDR Assumption
Estimated Asset Service Life	years	35	35	35	HDR assumption based on industry standard
CBA Benefit Period	years	31	30	31	HDR Assumption
Service Life Remaining	years	4	5	4	HDR Calculation
Capital Costs	2017$	$208,440,414	$591,444,526	$589,689,637	HDR Calculation
Residual Value in 2055	2017$	$67,393,101	$23,821,762	$84,492,075	HDR Calculation

2.3.7 Economic Value of Land

The economic value of the CP mainline and Sutherland yard right-of-way was calculated for the rail relocation option based on land area for the railway yard, as well as the main and spur lines obtained through GIS review. Estimates per acre were multiplied by land area to derive monetary values. The assumptions used to estimate the economic value of land are provided by Table 13 below.

Table 13: Assumptions Used in the Estimation of the Economic Value of Land

Variable Name	Unit	Value	Source
Main Line and Spur Line, Land Size	acres	180	HDR GIS review
Railway Yard, Land Size	acres	109	HDR GIS review
Main Line and Spur Line, Land Value	$/acre	$300,000	Property appraisal of City owned South Caswell site of $1M per acre. Discounted by 70% to factor more limited use of linear right-of-way
Railway Yard, Land Value	$/acre	$500,000	Property appraisal of City owned South Caswell site of $1M per acre. Discounted by 50% to factor relative distance from downtown core

2.3.8 Property Price Appreciation

The price impacts on residential and commercial property values adjacent to CP right-of-way were estimated for the rail relocation option only. Market value for impacted properties was obtained from the City and was estimated to appreciate 5% due to reduced noise and improved community cohesion arising from rail relocation[11]. Property price

[11] The construction of infrastructure with accompanying noise or aesthetics implications such as roadways, rail, and power transmission lines have shown to have anywhere from a 1% to 10% impact on property values with more significant impacts observed in dense urban environments. Five percent was selected as a reasonable estimate to assess potential impacts from the relocation while remaining conservative in approach.

appreciation was estimated by multiplying the market value of properties by the estimated appreciation rate. Table 14 provides a summary of the assumptions used to estimate property price appreciation.

Table 14: Assumptions Used in the Estimation of Property Price Appreciation

Variable Name	Unit	Value	Source
Assessed Residential and Commercial Property Value	2017$	$184,159,600	City of Saskatoon
Property Price Appreciation	%	5.0%	HDR Real Estate Group. Based on literature review findings of 1% - 10% property value impact due to noise, power line aesthetics etc.

2.4 Road and Rail Traffic Projections

The Cost-Benefit Analysis measures benefits against costs throughout a 35 year period of analysis which ends in year 2055. The benefits period (the number of years during which benefits occur) varies by alternative due to different time periods required for design, engineering, environmental assessments, and construction. Table 15 below provides a breakdown of the evaluation period by alternative.

Table 15: Summary of Evaluation Period, by Alternative

Alternative	Construction Start	In-Service	Total Benefit Period (Years)	Total Evaluation Period (Years)
Alt. 1 – CN/CP Grade Separate	2020	2021	34	35
Alt. 2 – CP Elevate	2021	2025	31	35
Alt. 3 – CP Trench	2021	2026	30	35
Alt. 4 – CP Relocate	2021	2025	31	35

All monetized benefits and costs are estimated in 2017 dollars with future dollars discounted using a 10 percent real discount rate[12] as recommended by Transport Canada. The analysis makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. The following section provides details with respect to the demand projections that drive the project impacts including trains per day, average annual daily traffic (AADT), freight train speeds, and detour distances.

[12] The real discount rate is typically applied to estimates made in constant dollars in order to remove the effect of inflation.

2.4.1 Roadway Delay Projections

Assumptions

AADT forecasts are based on Saskatoon's Regional Travel Demand Model (TDM) which was performed under three population scenarios. TDM traffic projections are provided in Table 16 while general assumptions are provided in Table 17. Common assumptions include train lengths of 7,000 feet and a gate lead/lag time of 36 seconds, based on industry standard.

Table 16: Regional Travel Demand Model Results

Roadway	300K (Year 2021)	400K (2032)	500K (2041)
11th St W	19,830	27,180	32,540
Dundonald Ave Ramp	4,480	4,600	6,110
22nd St W	35,950	35,870	38,650
Idylwyld Dr & 25th St	38,120	38,790	43,340
3rd Ave N	33,800	34,370	40,010
51st St	30,700	31,780	33,850
Marquis Dr	22,040	24,270	38,900
Preston Ave	29,220	28,930	44,920
Central Ave	18,790	18,180	26,750
33rd St W	25,160	27,780	29,950

Table 17: Assumptions Used in the Estimation of Roadway Delay Projections

Grade Crossing Location	AADT		Construction Detour Distance (km)	Detour Speed (km/h)	Train Speed (mph)
	2017	2035	Build Case	Build Case	Build/No-Build
Alt. 1 – CP Crossings					
Idylwyld Dr	30,361	40,251	0.46	50	15
22 St W	32,754	36,774	0.24	50	15
3 Ave N	18,188	36,156	0.05	50	30
Preston Ave N	19,428	33,500	0.08	50	30
Central Ave	11,135	20,678	0.35	50	30
Sum of Alt. 1 – CP Crossings	**111,866**	**167,359**	**1.18**	**-**	**-**
Alt. 1 – CN Crossings					
33 St	23,215	28,485	0.00	50	30
Marquis Dr	6,727	28,403	0.24	50	40
11 St W	23,500	33,917	0.00	50	30
51 St	28,411	32,456	0.00	50	30
Sum of Alt. 1 – CN Crossings	**81,853**	**123,261**	**0.24**	**-**	**-**
Sum of Alt. 2 – CP Elevate Crossings	104,623	150,216	0.16	50	16
Sum of Alt. 3 – CP Trench Crossings	87,962	114,061	0.16	50	16
Sum of Alt. 4 – CP Relocate Crossings	178,818	276,187	n/a	n/a	25

Projections

Values were interpolated between the data points in order to obtain annual estimates. AADT after year 2041 were grown at the 2032-2041 average annual growth rate. Table 18 and Table 19 provide summaries of roadway delay projections.

Table 18: Roadway Delay Projections (1 of 2)

Grade Crossing Location	2025		2035	
	Total Vehicle Hours of Delay - Autos	Total Vehicle Hours of Delay - Trucks	Total Vehicle Hours of Delay - Autos	Total Vehicle Hours of Delay - Trucks
Alt. 1 – CP Crossings				
Idylwyld Dr	29,237	3,799	33,005	4,289
22 St W	27,376	3,557	30,153	3,918
3 Ave N	7,863	1,022	8,995	1,169
Preston Ave N	6,732	875	8,334	1,083
Central Ave	4,293	558	5,144	668
Sum of Alt. 1 – CP Crossings	75,501	9,811	85,631	11,127
Alt. 1 – CN Crossings				
33 St	6,031	784	8,220	1,068
Marquis Dr	3,345	435	5,195	675
11 St W	6,929	900	10,722	1,393
51 St	7,189	934	9,366	1,217
Sum of Alt. 1 – CN Crossings	23,494	3,053	33,503	4,353
Sum of Alt. 2 – CP Elevate Crossings	62,582	8,132	80,988	10,524
Sum of Alt. 3 – CP Trench Crossings	67,597	8,784	83,319	10,826
Sum of Alt. 4 – CP Relocate Crossings	74,004	9,616	98,927	12,854

Table 19: Roadway Delay Projections (2 of 2)

Grade Crossing Location	2045		2055	
	Total Vehicle Hours of Delay - Autos	Total Vehicle Hours of Delay - Trucks	Total Vehicle Hours of Delay - Autos	Total Vehicle Hours of Delay - Trucks
Alt. 1 – CP Crossings				
Idylwyld Dr	41,275	5,363	53,441	6,944
22 St W	36,220	4,706	45,044	5,853
3 Ave N	11,774	1,530	15,955	2,073
Preston Ave N	15,024	1,952	28,039	3,643
Central Ave	8,735	1,135	15,357	1,996
Sum of Alt. 1 – CP Crossings	113,028	14,686	157,836	20,509
Alt. 1 – CN Crossings				
33 St	11,650	1,514	17,225	2,238
Marquis Dr	11,439	1,486	26,277	3,414
11 St W	17,025	2,212	28,324	3,680
51 St	13,097	1,702	19,105	2,482
Sum of Alt. 1 – CN Crossings	53,211	6,914	90,931	11,814
Sum of Alt. 2 – CP Elevate Crossings	104,638	13,597	137,053	17,809

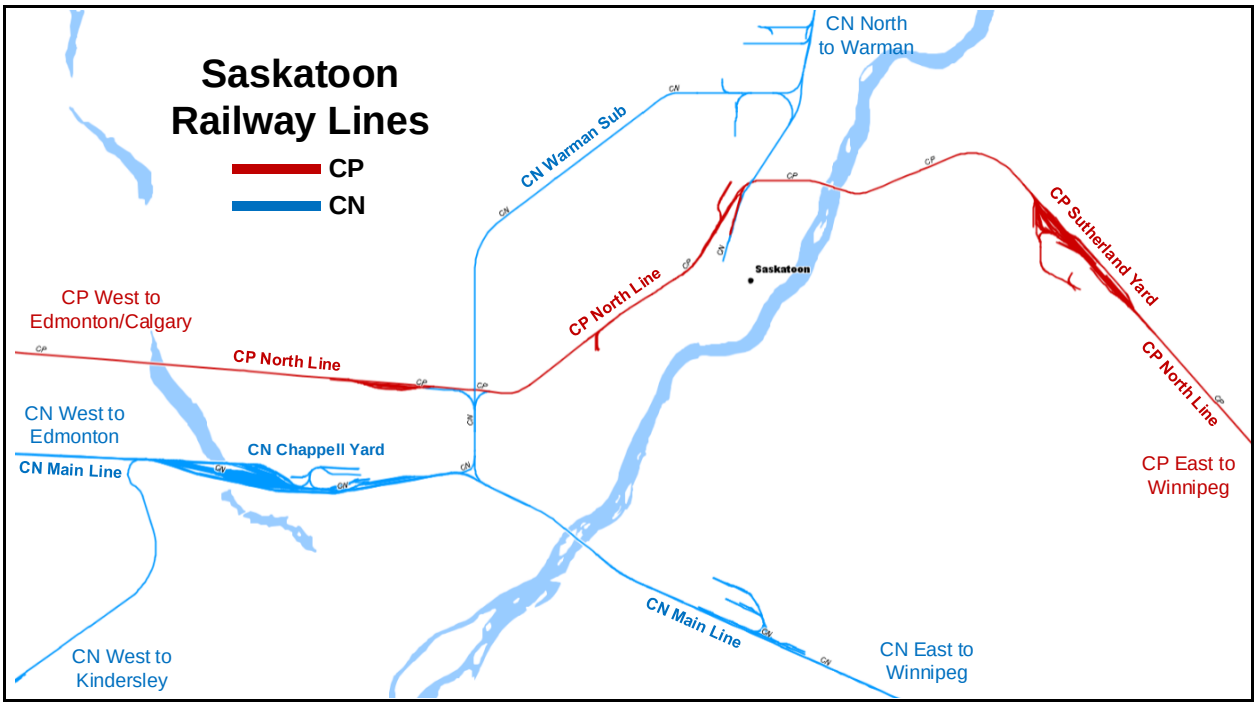
Grade Crossing Location	2045		2055	
	Total Vehicle Hours of Delay - Autos	Total Vehicle Hours of Delay - Trucks	Total Vehicle Hours of Delay - Autos	Total Vehicle Hours of Delay - Trucks
Sum of Alt. 3 – CP Trench Crossings	103,826	13,491	132,246	17,184
Sum of Alt. 4 – CP Relocate Crossings	129,940	16,884	170,834	22,198

2.4.2 Railway Traffic Projections

The projected growth of railway traffic through the City is required in order to evaluate the long term economic impact of rail delays and lost labour productivity to various businesses in the Saskatoon Region. In order to understand the forecasted impacts on identified crossings throughout the City, separate rail traffic forecasts were developed for the following two rail corridors:

- **Canadian Pacific Railway (CP) North Line:** Consists of CP's east-west secondary mainline through the City. The North Line encompasses both CP's Sutherland Subdivision to the east of the former CP Saskatoon station on Idylwyld Drive and CP's Wilkie Subdivision to the west of Idylwyld Drive.
- **Canadian National Railway (CN) Warman Subdivision:** Consists of CN's north-south route through the City. The Warman Subdivision acts as a north-south connection between CN's east-west secondary mainline at Warman and CN's primary east-west mainline at Chappell Yard on the southwest side of Saskatoon.

Figure 1: Railway Lines Through Saskatoon



Source: RAC Online Atlas 2018

Forecasts of rail traffic were projected to the year 2055 to determine the relative long term impacts of rail traffic through the City. It should be noted that rail traffic forecasting is subject to a multitude of factors including, but not limited to; economic growth, operating decisions (such as train length and traffic routing), and market competitiveness between rail carriers. Rail traffic volumes through Saskatoon have varied considerably over the past few years, primarily driven by the variability in crude oil by rail shipments. Although many commodities have specific long term shipping patterns that can be predictable, other commodities (like crude oil) can vary drastically dependent on market conditions. Market dynamics can shift drastically, new markets or shipping options open up (like pipelines), and long term export destinations can change for commodities produced in Western Canada.

Each forecast was broken down into the various train types operated over the CP and CN corridors. These train types may be commodity based or service based. The following sections provide a brief description of each train type including the anticipated annual growth factors for each commodity or train service. Where appropriate, an overview of train length is included for context, as well as any other factors that could affect the growth factors of each train type.

Merchandise

Both CN and CP currently operate scheduled merchandise trains on their respective corridors. Merchandise primarily consists of mixed carload traffic, but may include Automotive or Intermodal traffic in the long term forecasts. Currently, each railway is operating a scheduled train per day in each direction, plus occasional additional trains when required based on volumes.

It is assumed CP's current merchandise train volume is sufficient to handle growth until sometime between 2020 and 2025. At that point, an additional pair of merchandise trains may be re-routed to CP's North Line to accommodate additional growth. CP previously routed a pair of intermodal trains on the North Line, but those trains are currently operating between Edmonton and Winnipeg via Calgary on CP's primary mainline. It is assumed those trains will eventually shift back to the North Line through Saskatoon to accommodate traffic growth and reduce overall operating miles / transit time on this specific train pair.

CN's existing merchandise trains on the Warman Sub handle carload traffic to/from the west, including industrial locations such as Edmonton, Lloydminster, and North Battleford. With significant carload growth anticipated out of this service region, an aggressive 5% yearly growth factor was applied to CN's merchandise train volumes through the entire forecast period.

Table 20: CP North Line Merchandise Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Merchandise	2.0	2.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Table 21: CN Warman Sub Merchandise Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Merchandise	2.0	2.3	3.0	3.8	4.8	6.1	7.7	9.8	12.4

Grain

Grain traffic through Saskatoon includes bulk unit trains handling cereals, pulses, and oil seed products. Depending on volumes and market requirements, both railways may handle grain traffic in their existing merchandise trains as well. The forecasted volumes for grain trains on both railways includes returning grain empties as well.

CP's traditional model for grain trains operated between 100 and 112 cars in length (up to 7,000 feet long including locomotives). As a growth and efficiency initiative, CP is now working with their grain customers across Western Canada to accommodate grain trains up to 8,500 feet in length including locomotives. If volumes were to stay constant, CP's actual grain train counts would decrease through Saskatoon as they convert grain customers to the larger model. However, the larger train model will likely result in greater

efficiencies and may attract new volumes and potential new build opportunities on CP's lines. As such, a 5% yearly growth factor was applied to CP grain traffic between 2018 and 2022 to account for this strategy. Thereafter, a more modest 2% growth factor was utilized to account for yield increases in grain production until 2030.

CN currently handles manifest traffic east of Warman on their existing grain trains, so some growth is expected going forward regardless of CP's expansion strategy in Western Canada. The CN grain forecast also anticipates an increase of 0.3 trains per day (TPD) in 2018 to account for Grains Connect new Maymont terminal northwest of Saskatoon. Thereafter a conservative 2% growth factor was utilized to account for yield increases in grain production until 2030.

Table 22: CP North Line Grain Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Grain	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Table 23: CN Warman Sub Grain Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Grain	2.2	2.7	2.9	3.2	3.5	3.9	4.3	4.7	5.2

Potash

Although both CN and CP handle significant potash volumes on their east-west routes through the City, CN does not currently handle potash trains on the Warman Sub at this time. Any small volume potash moves would be handled in CN's existing merchandise train service.

CP has several options for routing potash trains out of the mines in Northern Saskatchewan depending on ultimate destination and operating considerations (crews, corridor capacity, mechanical inspection locations, etc…). Current potash train volumes are mostly loaded potash trains from the mines immediately around Saskatoon destined for Vancouver BC. CP does have routing flexibility to send these potash volumes down their Lanigan Subdivision to Regina and CP's mainline if required. It's anticipated that long term export growth will increase the loaded potash train volumes on CP. In addition, it is anticipated that more empty trains will be routed on the North Line through Saskatoon to balance the train flows. Considering both of those conditions, a 5% growth factor was applied to potash train volumes through the City.

The potash traffic forecast was conservative and did not anticipate any new build potash mines contributing to growth on either corridor. It's possible that additional volumes could be added to either of the corridors if the proposed BHP Jansen mine is completed east of Saskatoon. With a projected output of 8 million tons of potash per year, this mine could potentially add an additional 2+ trains per day to either of the corridors to account for both

loads and empties moving between Jansen and the proposed port facility in Fraser Surrey Docks (Vancouver). At this time, it is unknown if CP would route these BHP potash volumes through Saskatoon or Regina. If CN were to secure the new potash business, it is probable that the traffic could move on the Warman Subdivision travelling between CN's secondary mainline at Warman and their primary mainline in Saskatoon.

Table 24: CP North Line Potash Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Potash	0.5	0.6	0.7	0.9	1.2	1.5	1.9	2.5	3.2

Crude Oil

Volumes of crude oil moving by rail may present the largest degree of uncertainty in these forecasts. During the peak of 2014/2015, both CN and CP were moving considerable crude by rail volumes through the City. The significant decline in oil prices led to steep decline in oil volumes after the peak, but they are now on the rebound, primarily being driven by lack of pipeline capacity to markets.

CP has multiple options for routing crude oil from Northern Alberta origins to destinations in the east and US Midwest. Typically, the shortest route mileage would be utilized, routing these trains through Saskatoon to ultimate destination. However, other factors influence crude oil train routing including existing crew bases, corridor capacity, and resource balancing. This creates a large degree of uncertainty in forecasting crude oil train volumes going forward. A conservative approach was taken to account for terminal facilities directly located on or along CP's North Line, like U.S. Development Group at Hardisty AB, and Plains Marketing at Kerrobert SK. Only a portion of volumes out of the Edmonton area are accounted for in the volumes as some of that volume may route via Calgary and CP's mainline. To account for lack of pipeline capacity, the forecast grew quickly from 1.5 TPD currently to 4.0 TPD by 2019 (2 loads & 2 empties daily). After that time, the forecast was shown flat through to 2030 as it is anticipated that additional pipeline capacity will have come online.

Similar to CP, CN has multiple routes to handle crude oil from the Edmonton area towards Eastern and US markets. Emphasis was on forecasting volumes from facilities along CN's secondary mainline west of Warman, like Altex Energy's Lashburn SK facility. Again, crude oil volumes are anticipated to ramp up quickly from 0.5 TPD currently, to an anticipated 1.5 TPD by 2019. Like the CP forecast, the CN volumes are held constant through 2030 with anticipation that pipeline capacity is created.

It should be noted that crude by rail volumes could continue to grow post 2019 if sufficient pipeline capacity is not created for crude oil produced in Western Canada. The cancellation of the TransCanada's Energy East pipeline project has created the near term requirement for increased rail shipments. In the long term, other pipeline projects like

TransCanada's Keystone XL and Kinder Morgan's Trans Mountain expansion will dictate how much crude oil moves by rail.

Table 25: CP North Line Crude Oil Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Crude Oil	1.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0

Table 26: CN Warman Sub Crude Oil Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Crude Oil	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Interchange

Interchange volumes represent rail traffic that different rail carriers exchange between each other. Within the City, both CN and CP interchange with each other on a regular basis. In addition, CN also receives interchanges from the Carleton Trail Railway (CTRW). The CTRW operates between Prince Albert SK and Saskatoon SK, utilizing CN's Warman Subdivision between Warman and CN's Chappell Yard.

Currently CN and CP share the responsibilities for interchanging traffic between themselves with each carrier handling operations between CP's Sutherland Yard and CN's Chappell Yard for a portion of the year. Current interchange is handled 3 times per week in both directions, representing a weighted average of 0.9 TPD across both the CN and CP corridors. There is significant capacity for growth on these transfers and it is not currently anticipated that these interchanges will grow unless there is a drastic change in interchange opportunities.

The CTRW interchanges with CN at Chappell Yard on average of 2-3 times per week. This represents 4-6 trains per week operating over the CN Warman Sub, or approximately 0.7 TPD on a weighted average. Much like the CN-CP interchange, the CTRW currently has room for growth on its interchange trains and no significant growth is anticipated through the forecasted period to 2030. It's possible that new customer development on CTRW could change that future state – but no known major projects were considered as part of this forecast.

Table 27: CP North Line Interchange Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
CN-CP I/C	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Table 28: CN Warman Sub Interchange Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
CTRW I/C	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
CN-CP I/C	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Other

Other traffic represents small volume train movements on the corridor not already accounted for in the forecasts above. It may include such traffic as inbound fertilizers, frac sand, pipe trains, dimensional shipment trains, and work trains required by each of the railways.

With the expectation that CP would double its merchandise trains on their North Line at some time in the future, it is anticipated that the vast majority of this "other" traffic would be handled in CP's existing merchandise trains operating on the corridor. A placeholder of 0.1 TPD was utilized throughout the forecast to account for work trains and the odd occasional unit train of other commodities being handled by CP.

A different approach was utilized for CN's other train traffic. It is anticipated that CN's growth on the Warman Subdivision will grow at essentially the same rate as its merchandise traffic but that they will have insufficient room on their merchandise trains to handle the new business. As such, a similar 5% annual growth rate was applied to their other train forecast. A primary driver of this category will likely be inbound fertilizer shipments to various locations along the CN secondary mainline through Warman.

Table 29: CP North Line Other Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 30: CN Warman Sub Other Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Other	0.5	0.6	0.7	0.9	1.2	1.5	1.9	2.5	3.2

Local Industry

Local Industry jobs, sometimes referred to as assignments by the railways, make up the final portion of train movements in each forecast. A slightly different approach was utilized in each forecast based on how both railroads currently service their local customers in the Saskatoon area.

CP currently services customers on both the East and West sides of Saskatoon out of their Sutherland Yard. Service may be scheduled for certain days, or could be on a demand basis depending on the customer type. The potash mines typically receive on demand service as their shipments between unit trains (export volumes) and local trains (domestic volumes) can vary considerably throughout the year and dependent on market conditions. As such, it is anticipated that CP's local industry jobs will increase over time with overall traffic growth. A conservative 2% annual growth factor was utilized to account for this increase.

CN doesn't not service any potash mines off the Warman Subdivision, hence their local industry jobs are more consistent in nature. They primarily service carload customers located at various industries on the North side of Saskatoon. The current assignment is operated more or less daily out and back on the Warman Subdivision. At this time, it is anticipated that this assignment will be sufficient to handle increased growth at all of these customers through the forecasted period to 2030. Any new customer facilities, or significant customer expansions may increase the requirement for more service, but none are noted at this time.

Table 31: CP North Line Local Industry Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Local Industry	1.1	1.2	1.3	1.5	1.7	2.0	2.3	2.7	3.1

Table 32: CN Warman Sub Local Industry Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Local Industry	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Summary of Rail Traffic Forecast

The above traffic forecasts are summarized in the tables below for both the CP North Line and CN Warman Subdivision. With Saskatoon being located on key Western Canadian routes for both railways, there is a high probability that traffic growth will materialize, including opportunities that were not considered in this preliminary forecast. With the exception of crude oil (which has significant market dynamics), these forecasts represent a conservative view on projected rail volumes, anticipated growth trends, and potential rail routing options. Table 33 and Table 34 summarize, by train type, forecasted trains per day while Table 35 provides projections by grade crossing location.

Table 33: CP North Line Overall Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Merchandise	2.0	2.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Grain	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Potash	0.5	0.6	0.7	0.9	1.2	1.5	1.9	2.5	3.2
Crude Oil	1.5	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
CN-CP Interchange	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Other	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Mainline	**5.5**	**8.1**	**10.4**	**10.6**	**10.9**	**11.2**	**11.6**	**12.2**	**12.9**
Local Industry	1.1	1.2	1.3	1.5	1.7	2.0	2.3	2.7	3.1
Total Including Local	**6.6**	**9.3**	**11.7**	**12.1**	**12.6**	**13.2**	**13.9**	**14.8**	**15.9**

Table 34: CN Warman Sub Overall Train Forecast, Trains per Day

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Merchandise	2.0	2.3	3.0	3.8	4.8	6.1	7.7	9.8	12.4
Grain	2.2	2.7	2.9	3.2	3.5	3.9	4.3	4.7	5.2
Crude Oil	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
CTRW Interchange	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
CN-CP Interchange	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Other	0.5	0.6	0.7	0.9	1.2	1.5	1.9	2.5	3.2

Train Type	Current	2020	2025	2030	2035	2040	2045	2050	2055
Total Mainline	**6.8**	**8.6**	**9.7**	**11.0**	**12.6**	**14.6**	**17.0**	**20.1**	**23.9**
Local Industry	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total Including Local	**8.8**	**10.6**	**11.7**	**13.0**	**14.6**	**16.6**	**19.0**	**22.1**	**25.9**

Table 35: Railway Traffic Projections, by Grade Crossing Location, Trains per Year

Grade Crossing Location	2025	2035	2045	2055
Alt. 1 – CP Crossings				
Idylwyld Dr	4,271	4,595	5,080	5,814
22 St W	4,271	4,595	5,080	5,814
3 Ave N	4,271	4,595	5,080	5,814
Preston Ave N	4,271	4,595	5,080	5,814
Central Ave	4,271	4,595	5,080	5,814
Alt. 1 – CN Crossings				
33 St	4,271	5,330	6,948	9,449
Marquis Dr	4,271	5,330	6,948	9,449
11 St W	4,271	5,330	6,948	9,449
51 St	4,271	5,330	6,948	9,449
Alt. 2 – CP Elevate Crossings	4,271	4,595	5,080	5,814
Alt. 3 – CP Trench Crossings	4,271	4,595	5,080	5,814
Alt. 4 – CP Relocate Crossings	4,549	4,890	5,371	6,068

2.5 Comparative Results of Options

The tables below summarize the benefits and costs of each option in addition to key financial metrics including the net present value (NPV), cost-benefit Ratio (CBR), internal rate of return (IRR)[13], and discounted payback period (DPP)[14]. Both undiscounted and discounted results are presented.

Table 36: Summary of the Cost-Benefit Analysis, Undiscounted. Millions of 2017 Dollars.

Options	Total Benefits	Total Costs	Net Benefits	CBR	IRR	Payback
Alt. 1 – CN/CP Grade Separate						
25 St E / Idylwyld	$48.4 M	$61.1 M	-$12.7 M	0.79	-1.1%	n/a
22 St W	$46.5 M	$48.0 M	-$1.5 M	0.97	-0.2%	n/a
3 Ave N	$20.1 M	$68.9 M	-$48.8 M	0.29	-5.4%	n/a
Preston Ave N	$23.3 M	$26.5 M	-$3.2 M	0.88	-0.6%	n/a
Central Ave	$14.9 M	$29.1 M	-$14.1 M	0.51	-2.8%	n/a
33 St W	$14 M	$44.7 M	-$30.3 M	0.32	-4.8%	n/a
Marquis Dr	$13.7 M	$23.1 M	-$9.4 M	0.59	-2.1%	n/a
11 St W	$19.9 M	$43.7 M	-$23.8 M	0.46	-3.4%	n/a
51 St	$16.8 M	$29.4 M	-$12.6 M	0.57	-2.5%	n/a

[13] Internal rate of return (IRR) is a metric that measures the profitable of potential projects and represents the rate at which net present value (NPV) would equal zero. Generally speaking, projects with a high IRR are more desirable to undertake.

[14] The discounted payback period (DPP) is a metric that provides the number of years required to a project to recover its initial expenditures by discounting future cash flows. In general, projects with a DPP that is less than their target period is desirable for implementation.

Options	Total Benefits	Total Costs	Net Benefits	CBR	IRR	Payback
Alt. 2 – CP Elevate	**$100.9 M**	**$208.4 M**	**-$107.6 M**	**0.48**	**-2.9%**	**n/a**
Alt. 3 – CP Trench	**$196.4 M**	**$591.4 M**	**-$395.0 M**	**0.33**	**-4.0%**	**n/a**
Alt. 4 – CP Relocate	**$392.1 M**	**$589.7 M**	**-$197.6 M**	**0.66**	**-2.2%**	**n/a**

Table 37: Summary of the Cost-Benefit Analysis, Discounted at 10%. Millions of 2017 Dollars.

Options	Present Value of Benefits	Present Value of Costs	NPV	CBR	IRR	DPP
Alt. 1 – CN/CP Grade Separate						
25 St E / Idylwyld	$6.3 M	$47.3 M	-$41.0 M	0.13	-1.1%	n/a
22 St W	$7.6 M	$37.2 M	-$29.6 M	0.20	-0.2%	n/a
3 Ave N	$3.6 M	$53.3 M	-$49.7 M	0.07	-5.4%	n/a
Preston Ave N	$3.6 M	$20.5 M	-$16.9 M	0.18	-0.6%	n/a
Central Ave	$1.7 M	$22.5 M	-$20.8 M	0.07	-2.8%	n/a
33 St W	$2.4 M	$34.6 M	-$32.2 M	0.07	-4.8%	n/a
Marquis Dr	$1.2 M	$17.8 M	-$16.6 M	0.07	-2.1%	n/a
11 St W	$3.0 M	$33.8 M	-$30.8 M	0.09	-3.4%	n/a
51 St	$2.9 M	$22.7 M	-$19.9 M	0.13	-2.5%	n/a
Alt. 2 – CP Elevate	**$12.5 M**	**$136.2 M**	**-$123.7 M**	**0.09**	**-2.9%**	**n/a**
Alt. 3 – CP Trench	**$19.6 M**	**$375.8 M**	**-$356.2 M**	**0.05**	**-4.0%**	**n/a**
Alt. 4 – CP Relocate	**$86.5 M**	**$385.3 M**	**-$298.8 M**	**0.22**	**-2.2%**	**n/a**

The following tables summarize results by benefit category.

Table 38: Summary of the Cost-Benefit Analysis, by Benefit Category. Undiscounted, Millions of 2017 Dollars.

Benefit Categories	Alt. 1 – CP Grade Separate	Alt. 1 – CN Grade Separate	Alt. 1 – All CN & CP Crossings	Alt. 2 – CP Elevate	Alt. 3 – CP Trench	Alt. 4 – CP Relocate
Travel Time Savings	$123.6	$46.4	$170.0	$64.81	$90.60	$117.10
Vehicle Operating Cost Savings	$5.22	$2.72	$7.95	($2.74)	$3.31	$7.15
Reduced Vehicle Emissions	$0.45	$0.25	$0.70	($0.17)	$0.32	$0.65
Improved Safety	$24.40	$15.43	$39.83	$17.42	$18.48	$76.25
Pavement Maintenance Costs	($0.43)	($0.05)	($0.48)	($2.25)	($0.77)	$0.00
Residual Value of Assets	$0.00	$0.00	$0.00	$23.82	$84.49	$73.23
Economic Value of Land	-	-	-	-	-	$108.50
Property Price Appreciation	-	-	-	-	-	$9.21
Total Benefits	$153.2	$64.8	$218.0	$100.9	$196.4	$392.1
Capital Costs	($233.6)	($140.8)	($374.4)	($208.4)	($591.4)	($589.7)

Benefit Categories	Alt. 1 – CP Grade Separate	Alt. 1 – CN Grade Separate	Alt. 1 – All CN & CP Crossings	Alt. 2 – CP Elevate	Alt. 3 – CP Trench	Alt. 4 – CP Relocate
Net Benefits	**($80.3)**	**($76.1)**	**($156.4)**	**($107.6)**	**($395.0)**	**($197.6)**
Cost-Benefit Ratio	**0.66**	**0.46**	**0.58**	**0.48**	**0.33**	**0.66**

Table 39: Summary of the Cost-Benefit Analysis, by Benefit Category. Discounted at 10%, Millions of 2017 Dollars.

Benefit Categories	Alt. 1 – CP Grade Separate	Alt. 1 – CN Grade Separate	Alt. 1 – All CN & CP Crossings	Alt. 2 – CP Elevate	Alt. 3 – CP Trench	Alt. 4 – CP Relocate
Travel Time Savings	$18.84	$6.42	$25.25	$9.53	$13.90	$15.13
Vehicle Operating Cost Savings	$0.10	$0.27	$0.37	($0.58)	$0.24	$0.84
Reduced Vehicle Emissions	($0.01)	$0.02	$0.02	($0.05)	$0.02	$0.08
Improved Safety	$4.21	$2.83	$7.04	$3.37	$3.34	$11.16
Pavement Maintenance Costs	($0.32)	($0.04)	($0.36)	($0.42)	($0.21)	$0.00
Residual Value of Assets	$0.00	$0.00	$0.00	$0.64	$2.26	$4.40
Economic Value of Land	-	-	-	-	-	$50.62
Property Price Appreciation	-	-	-	-	-	$4.30
Total Benefits	$22.81	$9.50	$32.31	$12.48	$19.56	$86.53
Capital Costs	($180.8)	($109.0)	($289.8)	($136.2)	($375.8)	($385.3)
Net Present Value	**($157.9)**	**($99.5)**	**($257.4)**	**($123.7)**	**($356.2)**	**($298.8)**
Cost-Benefit Ratio	**0.13**	**0.09**	**0.11**	**0.09**	**0.05**	**0.22**

3 Grade Separation Concepts

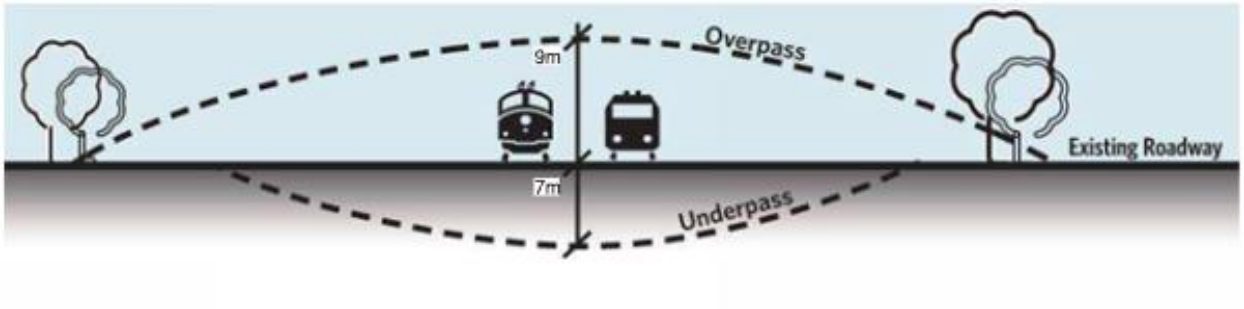
3.1 Overpass/Underpass Considerations

Cost-Benefit Analysis (CBA) requires an estimate of construction and operating costs for new facilities under evaluation. In support of the CBA for individual at-grade grossing locations, HDR developed conceptual grade separation concepts to inform cost estimation. At each of the crossing locations under consideration, an evaluation was made to determine the feasibility and practicality to design an overpass (roadway over the railroad) or an underpass (roadway passing under the railroad) solution. Specifically, the impacts considered include the following:

Preservation of Existing Roadway Conditions

In general, the construction of an underpass requires less distance to return to existing grade as compared to an overpass. An overpass typically requires 180m in each direction from the existing at-grade crossing with approximately 9m of height gain to obtain the necessary vertical clearance over the railroad. An underpass would typically impact approximately 120m each side of the existing at-grade crossing, including approximately 7m of depth to provide the necessary clearance under the railroad tracks (see Figure 2). Thus, limiting the horizontal distance required to return to existing grade may have advantages in terms of maintaining existing roadway connections. Typically, areas near the downtown core with a high concentration of business and commuter activity tend to favour construction of an underpass in order to mitigate permanent road closures and/or the development of new connections.

Figure 2: Basic Grade Separation Concept



Open Space Continuity

In general, an underpass is preferred to an overpass in terms of maintaining existing sight lines and the overall preservation of community identity. Development of an overpass may require structures that impede sightlines and generally reduce property values relative to the construction of an underpass. These impacts are expected to be more profound in areas of high population / business density nearer to the downtown core.

Pedestrian/Cyclist Experience

In general, the development of an underpass relative to an overpass provides advantages to pedestrian/cyclist modes. Pedestrian/cycling facilities associated with an underpass can be typically constructed at lower grades than that required for an overpass.

Construction Cost

In general, the construction of an overpass is less costly than the construction of an underpass. Overpasses may avoid permanent utility relocation and temporary rail relocation often required when an underpass is proposed.

3.1.1 Basis of Design

The following documents, general standards, and assumptions are utilized for the purpose of providing indicative cost estimates of grade separation alternatives:

- The City of Saskatoon Design and Development Standards Manual;
- Crime Prevention through Environmental Design Guidelines (CPTED);
- Rail Proximity Guidelines;
- American Railway Engineering and Maintenance-of-Way Association (AREMA);
- Canadian Highway Bridge Design Code (CSA S6-06);
- CP Requirements for the Design of Steel and Concrete Bridges Carrying Railway Traffic in Canada 2006;
- The City of Saskatoon Complete Streets Design and Policy Guide 2017;
- The City of Saskatoon specifications and standard drawings (file name: allspecs_and_dwgs_jan31_2017);
- 5.5 metre minimum vertical clearance from highway to low chord of a railroad overpass structure;
- 7.01 metre minimum vertical clearance from railroad track to low chord of a highway overpass bridge, extending 7.5m each side of the existing track(s);
- 7.5 metre minimum horizontal clearance from center of existing tracks to any overhead bridge substructure;
- 3.5 metre minimum roadway travel lane and 2.5 metre walkway width for arterial roads; and,
- Maximum vertical roadway grade of 5%.

Roadway features would meet current Saskatoon geometric design requirements for the specific roadway classifications, with adjustments taking into account local requirements for bicycle, pedestrian, shoulders, and curb/gutter configurations.

The existing railway skew angle is a key consideration in selecting the type of bridge at each grade separation location. For railroad structures, the skew angle is the angle measured between a line perpendicular to the center-line of bridge and the center-line of the abutments or piers. The American Railway Engineering and Maintenance-of-Way

Association (AREMA) guidelines allow for a maximum of 15 degree skew on precast concrete and box girder spans, and a 30 degree skew on steel spans and precast concrete I-girder and T-girder spans. For skewed bridges, cast-in-place concrete bridges are preferable with maximum of 60 degree skew being acceptable. Table 40 and Table 41 provide the design criteria used for a roadway underpass and overpass, respectively.

Table 40: Design Criteria - Underpass

Underpass	
Roadway Classification	• Match existing condition
Roadway Design Speed	• Match existing condition
Minimum Horizontal Curve (Design Parameter)	• 250m
Maximum Roadway Profile Grade	• 5%
Minimum "K" Value (Design Parameter)	• Crest Curve 13, Sag Curve 18
Roadway Minimum Vertical Clearance	• 5.5m
Road Right-of-Way	• Construct the proposed roadway and sidewalk within the existing road ROW. Additional right-of-way may be needed during construction
Sidewalk	• Proposed sidewalk on both sides of the road
Railway Bridge	• Two-span cast-in-place, post tensioned concrete through girder bridge (CIP/PT/TG) • Walkway is included as part of the CIP girder • Substructure consist two abutments and a mid-pier • Approach spans at both sides of the bridge
Retaining Walls	• Tie back or pile and lagging style walls with precast or cast-in-place concrete fascia, constructed from the top down to minimize excavation and the amount of ROW needed. Designed to withstand hydraulic pressure from ground water • The face of the walls may vary from standard plain concrete panels to the use of architectural form liners and color to meet the preferences of the local community. These panels or form liners are provided at both sides of the roadways with cast-in-place concrete barrier walls along the edges to allow for the sidewalk to be raised relative to the roadway profile
Utilities	• Shallow utility relocation or adjustment as needed • Water main relocation • Storm sewer and sanitary sewer relocation or pump station as applicable
Drainage	• A permanent pumping station and dewatering system for the drainage during the construction as needed. Further geotechnical investigation is required
Track Shoofly	• Temporary shoofly track would be built beside the existing track • Railway flagger needed during construction period

Underpass	
Road Detouring	• Full closure and detour to nearby roads

Table 41: Design Criteria - Overpass

Overpass	
Roadway Classification	• Match existing condition
Roadway Design Speed	• Match existing condition
Minimum Horizontal Curve (Design Parameter)	• 250m
Maximum Roadway Profile Grade	• 5%
Minimum "K" Value (Design Parameter)	• Crest Curve 13, Sag Curve 18
Roadway Minimum Vertical Clearance	• 7.01m
Road Right-of-Way	• Construct the proposed roadway and sidewalk within the existing road ROW. Additional ROW may needed during construction
Sidewalk	• Proposed sidewalk at one side of the road separate from traffic with a concrete barrier
Road Bridge	• Single-span, cast-in-place, post tensioned, concrete through girder bridge (CIP/PT/TG) • Substructure consists of two abutments • Approach spans at both sides of the bridge
Retaining Walls	• Mechanically stabilized earth (MSE) wall would be used along the roadway embankment at both sides
Utilities	• Shallow utility relocation or adjustment as needed • Overhead power/cable relocation/modification • Deep utility protection
Drainage	• Catch basin, manhole, and storm water sewer to be installed as necessary
Track Shoofly/Flagging	• No shoofly track needed • Railway flagger needed during the construction period
Road Detouring	• Full closure and detour to nearby roads

3.1.2 Basis of Estimate

Purpose and Type of Estimate

HDR prepared a Class 5 construction cost estimate for the proposed grade separations taking into account the design specifications and referenced documents, as well as the methodology described below. As per the Association for the Advancement of Cost Engineering (AACE), the level of accuracy for this estimate (considering track, earthwork, retaining wall, roadway, bridge, and utilities) ranges from -50% to +100%.[15] The limitations of these estimates is that it does not take into account, where applicable, potential accommodation costs related to detours and any associated costs to adjacent roadways. The contingency is the amount set aside to mitigate potential unforeseen and/or unpredictable circumstances.

Estimating Tools/Methodology

The conceptual grade separation drawings are developed based on the Light Detection and Ranging (LIDAR) survey provided by the City. The unit prices for each cost component are based on HDR's professional experience and knowledge as well input provided by the City based on past experience.

Assumption/Clarifications

- No ground survey, geotechnical information, and locating information was available;
- No 3D modeling has been performed;
- Cast-in-place concrete bridges are planned for all proposed roadway/railway bridges; and,
- Full roadway closures at each location during construction has been assumed in order to minimize cost. Existing adjacent roadways would be used as detour routes during the construction period.

3.1.3 Evaluation Summary

Table 42 summarizes the preferred solution to achieve grade separation and the rationale for this choice at each location.

[15] Advancement of Cost Engineering. "Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries. "2016. *https://web.aacei.org/docs/default-source/toc/toc_18r-97.pdf?sfvrsn=4*

Table 42: Evaluation Summary

Location	Preferred Solution	Justification
Idylwyld Dr @ CP	Road Underpass	This crossing is located within the downtown area of Saskatoon where street network connectivity, open space continuity, and development impacts are key selection criterion. A road underpass requires less vertical clearance and would result in less vertical deflection on Idylwyld Drive and 25th St. This would minimize road closures to only 25th St W and 24th St E, maintain improved road network connectivity, and minimize impacts to existing developments. Despite an expected higher construction cost relative to an overpass, the project team feels an underpass is the preferred option near the city core.
22 St W @ CP	Road Underpass	This crossing is located in central Saskatoon and adjacent to densely populated commercial and residential areas where street network connectivity, open space continuity, and development impacts are key selection criterion. A road underpass requires less vertical clearance and would result in less vertical deflection on 22nd St W. This would minimize road closures to Avenues E, F, G, and H, maintain improved road network connectivity, and minimize impacts to existing developments. Notwithstanding an expected higher construction cost, the project team feels an underpass is the preferred option due to the above factors.
3 Ave N @ CP	Road Overpass (Interchange)	Since 33rd St E and 3rd Ave N are major arterials, maintaining connectivity and acceptable traffic flow along both corridors are key selection criterion. A road overpass at the rail crossing with an interchange at the intersection of 33rd St E and 3rd Ave N would provide free flow along 33rd St E, maintain traffic connectivity between the two roadways, and minimize the impacts to 33rd St E and CP. An overpass interchange is of lower cost than an underpass interchange. These considerations result in an overpass interchange being the preferred option.
Preston Ave N @ CP	Road Overpass	This crossing is located adjacent to agricultural land with no nearby major developments. There are no major concerns with road network connectivity, open space continuity, and development impacts. As a result, cost is the key consideration and an overpass is the preferred option due to cost minimization.
Central Ave @ CP	Road Overpass	Since this crossing is located adjacent to commercial and residential developments, street network connectivity, development impacts, and costs are key selection criterion. The preferred option is a road overpass with service roads to maintain connectivity. The proposed overpass elevates Central Avenue above CP and provides room for two service roads (one on each side of the crossing) to pass under Central Avenue and provide access to surrounding businesses.
33 St W @ CN	Rail Overpass	This crossing is located on the east leg of the Circle Drive and 33rd St E interchange, approximately 100 metres east of the Circle Drive bridge. The bridge structure prohibits raising 33rd St W while the bridge piers and foundations restrict lowering of the road. Given both a road underpass and road overpass are not feasible, a rail overpass is the preferred solution as it would minimize impacts to both 33rd St W and Circle Drive and minimize costs relative to a rail underpass.

Location	Preferred Solution	Justification
Marquis Drive @ CN	Road Overpass	This crossing is located adjacent to industrial land with no major developments nearby and there are no major concerns with open space continuity. Both overpass and underpass options have similar impacts to street network connectivity and development impacts. Thus, an overpass is the preferred option since it would minimize cost.
11 St @ CN	Road Overpass	This crossing is located between Dundonald Avenue and Circle Drive with some nearby residential housing. While there are no major concerns with open space continuity, road network connectivity, feasibility, and cost are the major selection criterion. Since 11th St currently crosses over Circle Drive, constructing an underpass would be costly and cause significant impacts to the existing road network. The preferred solution is shifting 11th St south and constructing an overpass over CN and Circle Drive. This minimizes cost, reduces the length of bridge crossing over CN, and allows for existing 11th St to be used as a detour during construction.
51 St @ CN	Road Overpass	The crossing is located adjacent to commercial developments and there are no major concerns with open space continuity. Both overpass and underpass options have similar impacts to street network connectivity and development impacts. As a result, an overpass is the preferred option that would minimize cost.

3.2 Idylwyld Dr @ CP

3.2.1 Existing Crossing Features

The Idylwyld Drive and 25th Street E at-grade railroad crossing is located within the downtown area of Saskatoon. A single CP mainline track passes through the intersection at a 57 degree skew. Figure 3 shows the crossing area while Table 43 provides a summary of the key statistics for this crossing.

A signalized three way intersection connects 25th Street E and Idylwyld Drive. At each crossing location, both Idylwyld Drive and 25th Street E are divided roadways with raised medians. Known existing utilities include water, sanitary and storm sewers, cable, street lights, gas lines, and overhead power lines.

Figure 3: Idylwyld Drive / 25th Street E @ CP Crossing

Table 43: Idylwyld Drive / 25th Street E Crossing Key Statistics

Roadway Statistics	Railway Statistics
Idylwyld Drive	
Total 2017 AADT: 30,361	Subdivision: Sutherland
Roadway Classification: Major arterial	2017 Trains per Day: 6.6
Road Post Speed: 50 km/h	Train Speed: 15 mph
Travel Lane NB: 2, SB: 2	CP Milepost: 113.4
Pavement Width: ~ 20m	Warning System: Flashing lights, bells, and gates
Sidewalk: Both Sides	Track Angle: 57 degrees
25 Street E	
Roadway Classification: Minor Arterial	
Road Post Speed: 60 km/h	
Travel Lane EB: 2, WB: 3	
Sidewalk: Both Sides	

3.2.2 Proposed Solution

This crossing is located within the downtown area of Saskatoon where street network connectivity, open space continuity, and development impacts are critical selection criterion. A road underpass requires less vertical clearance and would result in less vertical deflection on Idylwyld Drive and 25th Street. This would minimize road closures to only 25th Street W and 24th Street E, maintain better road network connectivity, and minimize impacts to existing developments. Access to businesses on both sides of the underpass would be redirected to side streets. An underpass is less visually obstructive, provides better open space continuity, and is more user friendly to pedestrians and cyclists. Despite the higher construction cost, an Idylwyld Drive underpass is the preferred option.

The Idylwyd/25th St E intersection is proposed to be relocated to the south of the existing intersection in order to reduce the proposed bridge length. Some additional ROW would be required at the southeast corner of the existing intersection. The CP track would remain at same location and elevation however minor improvements may be addressed in the detailed design stage. The proposed structure is a single track two-span cast-in-place, post tensioned concrete through girder bridge (CIP/PT/TG), with an abutment spanning approximately 57 metres face to face. Figure 4 shows the proposed conceptual plan and profile for the underpass.

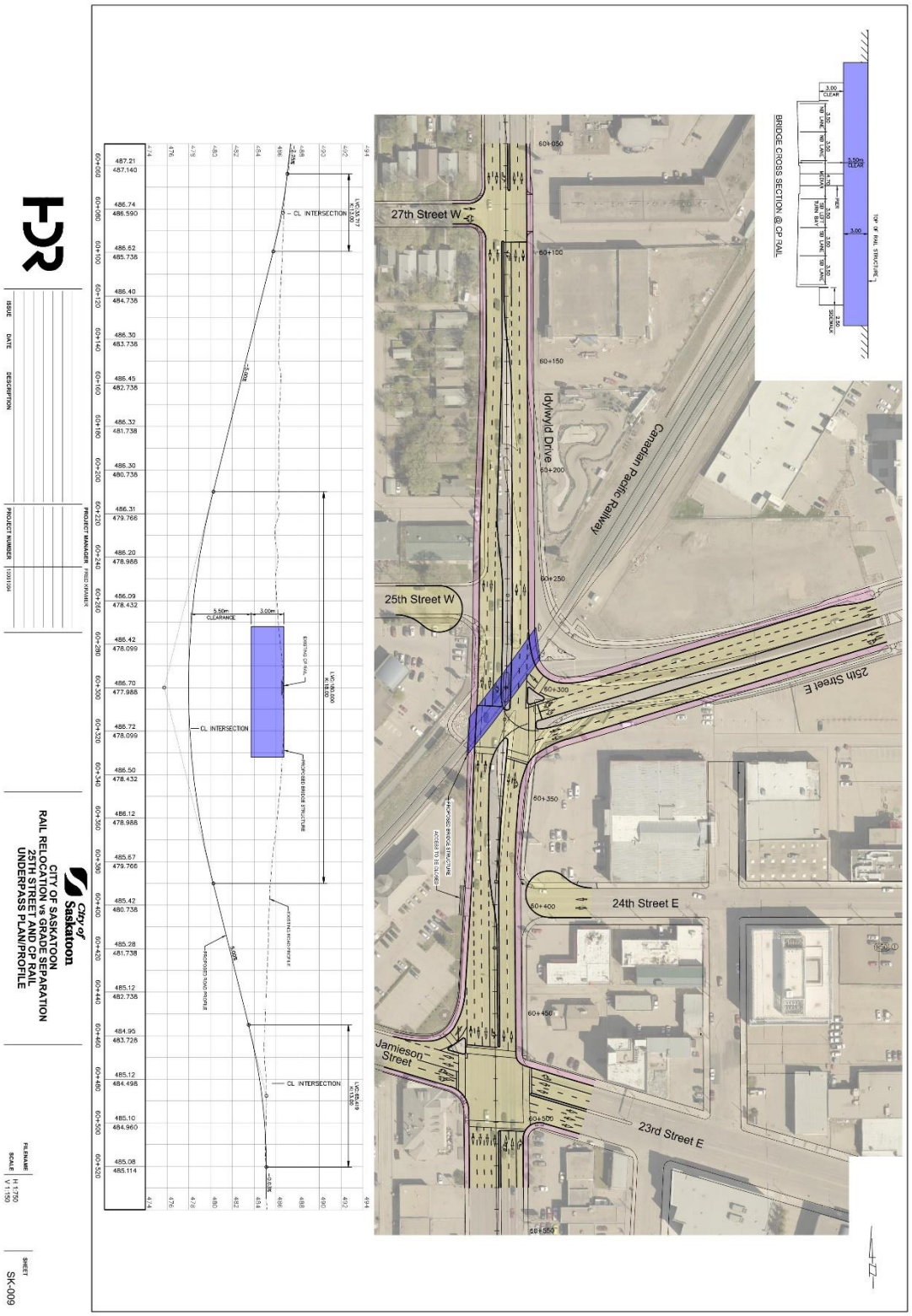


Figure 4: Proposed Conceptual Plan and Profile for Idylwyld Dr @ CP

3.2.3 Cost Estimate

The Class 5 construction cost estimate takes into account the railway bridge, roadway and railway works, utilities, and other cost components. With a 30 percent contingency, the construction cost is estimated at approximately $61.1 million (2017$). Table 44 shows the various cost components for the Idylwyld Dr / 25th street E underpass option while Appendix A provides detailed cost estimates.

Table 44: Idylwyld Drive / 25th Street E Underpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$6.18
Roadway Work	$24.7
Railway Work	$2.09
Utility Cost	$5.00
Environmental	$0.55
Mobilization	$3.85
Engineering	$4.24
Land Acquisition	$0.40
Contingency (30%)	$14.1
Total Cost (2017$)	**$61.1**

3.3 22nd Street W @ CP

3.3.1 Existing Crossing Features

The 22nd Street at-grade railroad crossing is located in central Saskatoon between Avenue F and Avenue G. A single CP mainline track crosses 22nd Street W at a 58 degree skew. Figure 5 shows the crossing area while Table 45 provides a summary of the key statistics for this crossing.

At the location of the at-grade crossing, 22nd Street W is a divided roadway with raised medians. Adjacent to the crossing are commercial and residential developments. Known existing utilities include water, sanitary and storm sewers, cable, street lights, gas lines, and overhead power lines.

Figure 5: 22nd Street W @ CP Crossing

Table 45: 22nd Street W Crossing Key Statistics

Roadway Statistics	Railway Statistics
2017 AADT: 32,754	Subdivision: Wilkie
Roadway Classification: Major arterial	2017 Trains per Day: 6.6
Road Post Speed: 50 km/h	Train Speed: 15 mph
Travel Lane EB: 3, WB: 3	CP Milepost: 0.38
Pavement Width: ~ 21m	Warning System: Flashing lights, bells, and gates
Sidewalk: Both Sides	Track Angle: 58 degrees

3.3.2 Proposed Solution

The crossing is located in central Saskatoon and adjacent to densely populated commercial and residential areas where street network connectivity, open space continuity, and development impacts are critical selection criterion. A road underpass requires less vertical clearance and would result in less vertical deflection at the 22nd Street W and Avenue I intersection. This would minimize road closures to Avenues E, F, G, and H, maintain improved road network connectivity, and minimize impacts to existing developments. An underpass is less visually obstructive, more user friendly to pedestrians and cyclists, and provides better open space continuity. Despite the higher construction cost, a 22nd Street W underpass is the preferred option.

Access to businesses on both sides of the underpass would be redirected to side streets and CP track would remain at the same location and elevation with minor improvements able to be addressed at the detailed design stage. The proposed structure is a single track two-span cast-in-place, post tensioned concrete through girder bridge (CIP/PT/TG), with an abutment of approximately 56 metres in length. Figure 6 shows the proposed conceptual plan and profile for the underpass.

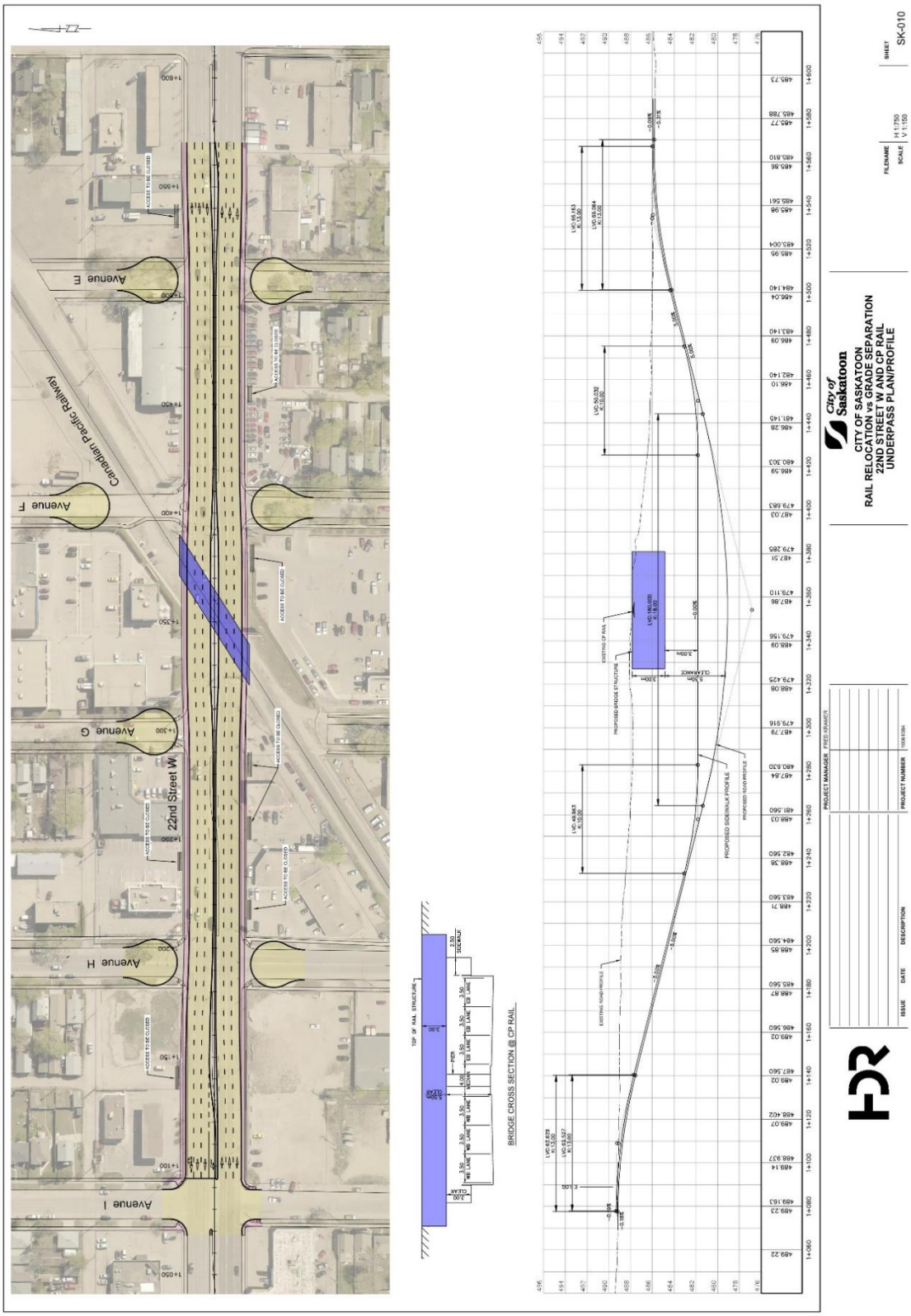


Figure 6: Proposed Conceptual Plan and Profile for 22nd Street W @ CP

3.3.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. Taking into account a 30 percent contingency, the construction cost is estimated at approximately $48.0 million (2017$). Table 46 summarizes the various cost components while Appendix A provides detailed cost estimates.

Table 46: 22nd Street W Underpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$6.32
Roadway Work	$18.1
Railway Work	$2.09
Utility	$3.50
Environmental	$0.55
Mobilization	$3.05
Engineering	$3.36
Contingency (30%)	$11.1
Total Cost (2017$)	**$48.0**

3.4 3rd Avenue N @ CP

3.4.1 Existing Crossing Features

The 3rd Avenue N at-grade railroad crossing is located at the intersection with 33rd Street E, where 3rd Avenue transitions into Warman Road. A single CP mainline track crosses the 3rd Avenue N at a 19 degree skew. Figure 7 shows the crossing area and Table 47 provides a summary of the key statistics for this crossing.

At the location of the at-grade crossing, 3rd Avenue N is a divided roadway with raised medians. Adjacent to the crossing are some commercial and industrial developments. Known existing utilities include water, sanitary and storm sewers, cable, street lights, gas lines, and overhead power lines.

Figure 7: 3rd Avenue N @ CP Crossing

Table 47: 3rd Avenue N Crossing Key Statistics

Roadway	Railway
2017 AADT: 18,188	Subdivision: Sutherland
Roadway Classification: Major arterial	2017 Trains per Day: 6.6
Road Post Speed: 50 km/h	Train Speed: 30 mph
Travel Lane NB:4, SB: 2	CP Milepost: 112.52
Pavement Width: ~ 21m	Warning System: Flashing lights, bells, and gates
Sidewalk: Both Sides	Track Angle: 19 degrees

3.4.2 Proposed Solution

This crossing is located at the junction of two major arterial roads. Maintaining road network connectivity, acceptable traffic flow, and cost minimization are the key selection criterion. A rail overpass or underpass would be prohibitive due to the rail junction 100 metres west of the crossing. An interchange, however, would provide free flow along 33rd Street, maintain traffic connectivity between the two roadways, eliminate congestion, and minimize impacts to 33rd Street E and CP. Thus, the proposed crossing solution is an interchange at the intersection of 33rd Street E and 3rd Avenue N, with 3rd Avenue N traversing over 33rd Street E and the CP crossing. It should be noted that there may be increased traffic realized in adjacent neighborhoods, potentially resulting in increased noise and travel time along adjacent roadways.

Residential and businesses access adjacent to the interchange would be redirected to side streets. 33rd Street would maintain the same vertical profile with slight adjustments to the horizontal alignment and cross-section. The CP track would remain at same location and elevation with minor improvements able to be addressed in the detailed design stage. The proposed bridge structure is 5 lanes divided with one walkway and spans approximately 35 metres over 33rd Street and 11 metres over the CP track. Figure 8 and Figure 9 show the proposed conceptual plan and profile for the interchange.

Figure 8: Proposed Conceptual Plan and Profile for 3rd Avenue N @ CP

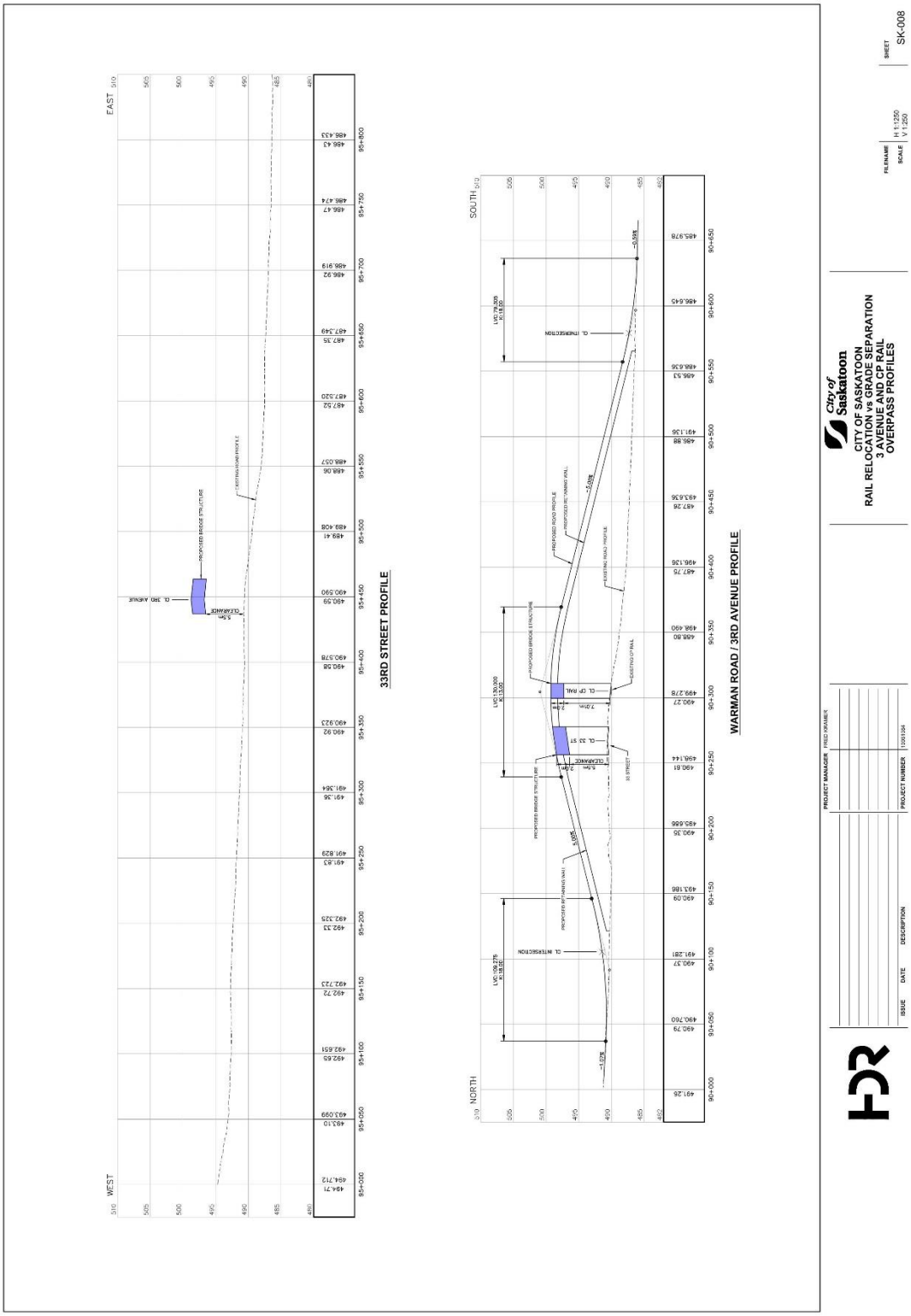


Figure 9: Proposed Conceptual Plan and Profile for 3rd Avenue N @ CP

3.4.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. With a 30 percent contingency, the estimated construction cost is approximately $68.9 million (2017$). Table 48 summarizes the various cost components while Appendix A provides detailed cost estimates.

Table 48: 3rd Avenue N Interchange Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$10.4
Roadway Work	$22.9
Railway Work	$0.32
Utility	$3.00
Environmental	$0.60
Mobilization	$3.72
Engineering	$4.09
Land Acquisition	$8.00
Contingency (30%)	$15.9
Total Cost (2017$)	**$68.9**

3.5 Preston Avenue N @ CP

3.5.1 Existing Crossing Features

The Preston Avenue N at-grade railroad crossing is located in the University of Saskatchewan Management Area within the City. A single CP mainline track crosses Preston Avenue N at a 23 degree skew.

Figure 10 shows the crossing area and Table 49 provides a summary of the key statistics for this crossing. At the location of the at-grade crossing, Preston Avenue N is a divided roadway with raised medians. Known existing utilities include water, sanitary and storm sewers, cable, street lights, gas lines, and overhead power lines.

Figure 10: Preston Avenue N @ CP Crossing

Table 49: Preston Avenue N Crossing Key Statistics

Roadway	Railway
2017 AADT: 19,428	Subdivision: Sutherland
Roadway Classification: Major arterial	2017 Trains per Day: 6.6
Road Post Speed: 60 km/h	Train Speed: 30 mph
Travel Lane NB: 2, SB: 2	CP Milepost: 110.95
Pavement Width: ~ 15m	Warning System: Flashing lights, bells, and gates
Sidewalk: Both Sides	Track Angle: 23 degrees

3.5.2 Proposed Solution

The crossing is located adjacent to agricultural land with no major developments nearby and there are no major concerns regarding road network connectivity, open space continuity, and development impacts. Thus, cost is the major selection criteria. A Preston Avenue N overpass would minimize impacts to underground utilities and is priced lower than an underpass.

The CP track would remain at the same location and elevation and minor improvements may be addressed at the detailed design stage. The proposed structure is 4 lanes divided with one walkway and spans approximately 30 metres. Figure 11 shows the proposed conceptual plan and profile for the overpass.

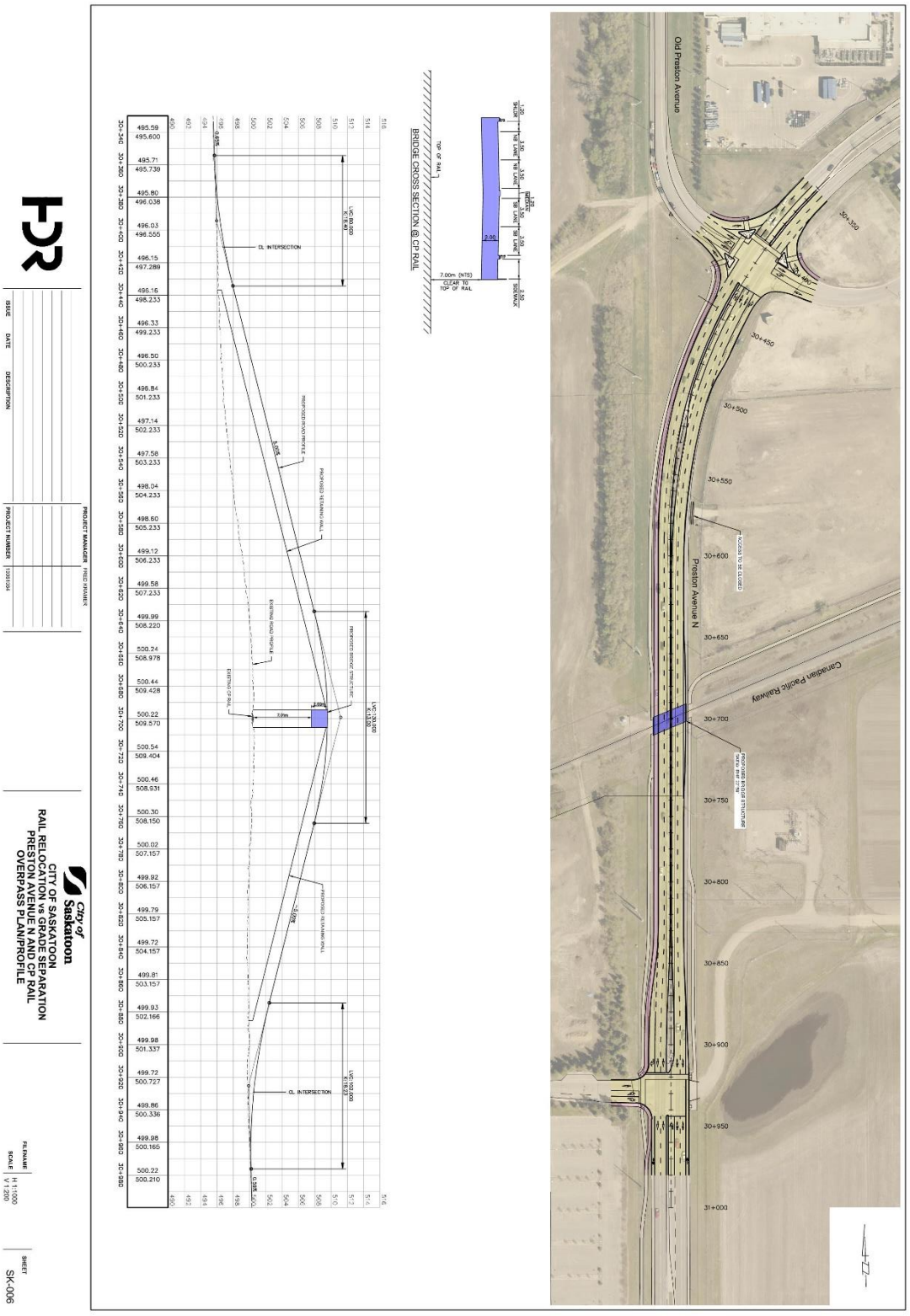


Figure 11: Proposed Conceptual Plan and Profile for Preston Avenue N @ CP

3.5.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. With a 30 percent contingency, the estimated construction cost is approximately $26.5 million (2017$). Table 50 summarizes the various cost components while Appendix A provides detailed cost estimates.

Table 50: Preston Avenue N Overpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$2.69
Roadway Work	$10.8
Railway Work	$0.76
Utility	$2.00
Environmental	$0.55
Mobilization	$1.68
Engineering	$1.85
Contingency (30%)	$6.11
Total Cost (2017$)	**$26.5**

3.6 Central Avenue @ CP

3.6.1 Existing Crossing Features

The Central Avenue at-grade railroad crossing is located between 112 Street and Gray Avenue. A twin CP Railway track crosses Central Avenue at a 48 degree skew. Figure 12 shows the crossing area and Table 51 provides a summary of the key statistics for this crossing.

At the location of the at-grade crossing, Central Avenue is a 4 lane roadway with sidewalks on both sides. Adjacent to the crossing are commercial and residential developments. Known existing utilities include water, sanitary and storm sewers, cable, street lights, gas lines, and overhead power lines.

Figure 12: Central Avenue @ CP Crossing

Table 51: Central Avenue Crossing Key Statistics

Roadway	Railway
2017 AADT: 11,135	Subdivision: Sutherland
Roadway Classification: Major arterial	2017 Trains per Day: 6.6
Road Post Speed: 50 km/h	Train Speed: 30 mph
Travel Lane NB: 2, SB: 2	CP Milepost: 109.78
Pavement Width: ~ 14m	Warning System: Flashing lights, bells, and gates
Sidewalk: Both Sides	Track Angle: 48 degrees

3.6.2 Proposed Solution

Since this crossing is located adjacent to commercial and residential developments, Street network connectivity, development impacts, and cost minimization are key selection criterion. An overpass at this location would minimize cost as well as impacts to underground utilities. Access to businesses at both side of the roadway underpass will be maintained though the addition of two service roads and three bridge structures. The proposed crossing solution at this location is an overpass with Central Avenue traversing over the railroad.

The CP Railway track would remain at same location and elevation and minor improvements may be addressed at the detailed design stage. The proposed structure is 2 lanes with 1 walkway and spans approximately 35 metres. The number of lanes on Central Avenue at the crossing is reduced from 4 lanes to 2 lanes to reduce the cost of the overpass. This lane reduction is not anticipated to have significant impact on traffic operation since the overpass would provide free flow and Central Avenue on either side of the overpass is currently only 2 lanes.

Two service roads are proposed with one on each side of the overpass. These services roads would provide access to businesses adjacent to the rail crossing. Two additional structures would need to be constructed for Central Avenue to cross over the proposed service roads. Figure 13 shows the proposed conceptual plan and profile for the overpass.

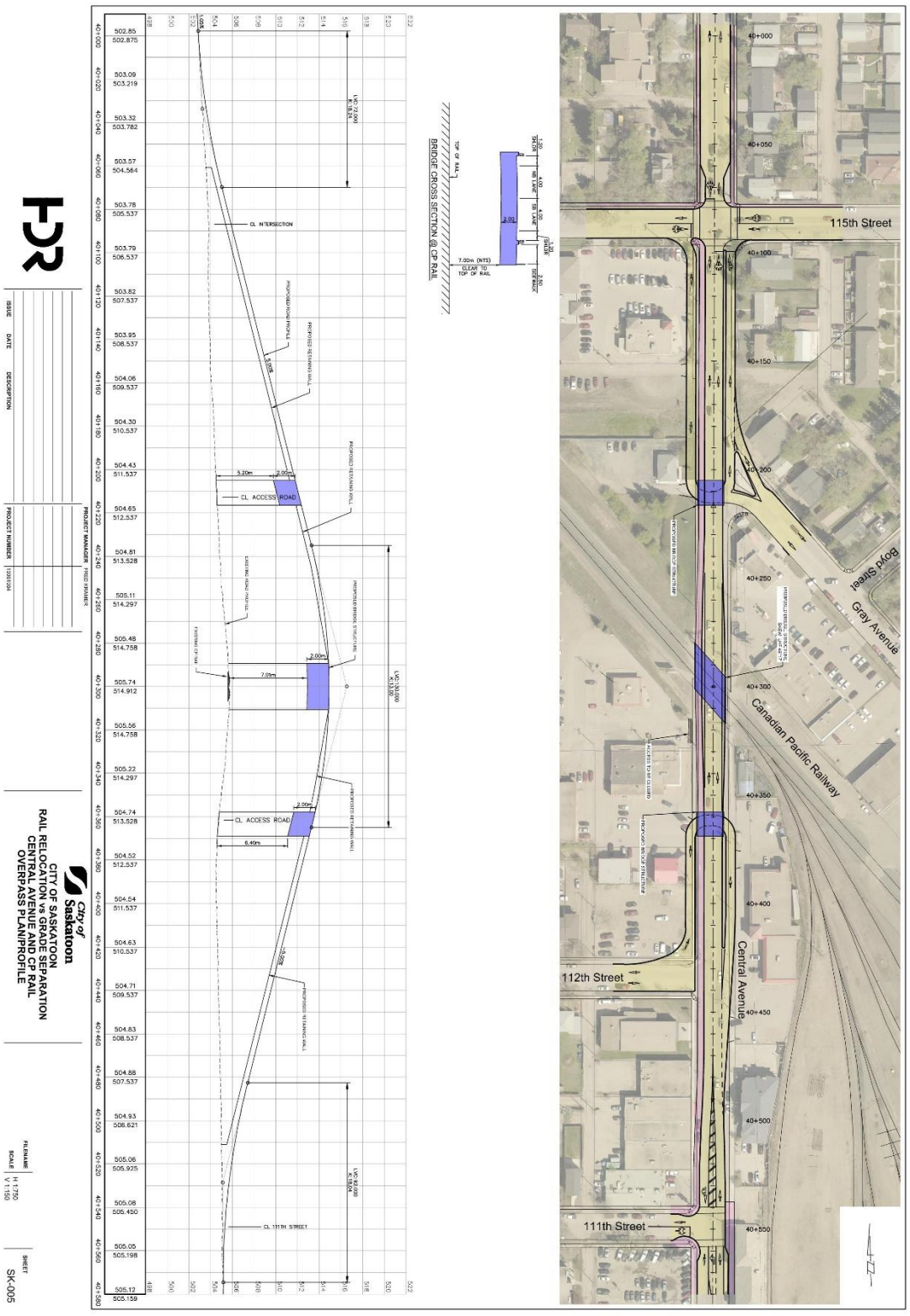


Figure 13: Proposed Conceptual Plan and Profile for Central Avenue @ CP

3.6.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. Taking into account a 30 percent contingency, the construction cost is estimated at approximately $29.1 million (2017$). Table 52 summarizes the various cost components while Appendix A provides detailed cost estimates.

Table 52: Central Avenue Overpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$5.72
Roadway Work	$10.3
Railway Work	$0.37
Utility	$1.50
Environmental	$0.55
Mobilization	$1.85
Engineering	$2.03
Contingency (30%)	$6.71
Total Cost (2017$)	**$29.1**

3.7 33rd Street W @ CN

3.7.1 Existing Crossing Features

The 33rd Street W at-grade railroad crossing is located east of the Circle Drive and 33rd Street W interchange, approximately 100 metres east of the Circle Drive Bridge. A single CN mainline track crosses 33rd Street W east of the Circle Drive ramps at a 53 degree skew. Figure 14 shows the crossing area and Table 53 provides a summary of the key statistics for this crossing.

At the location of the at-grade crossing, 33rd Street W is 4 lane roadway with sidewalks on both sides. Known existing utilities include water, storm sewers, street lights, gas lines, and overhead power lines.

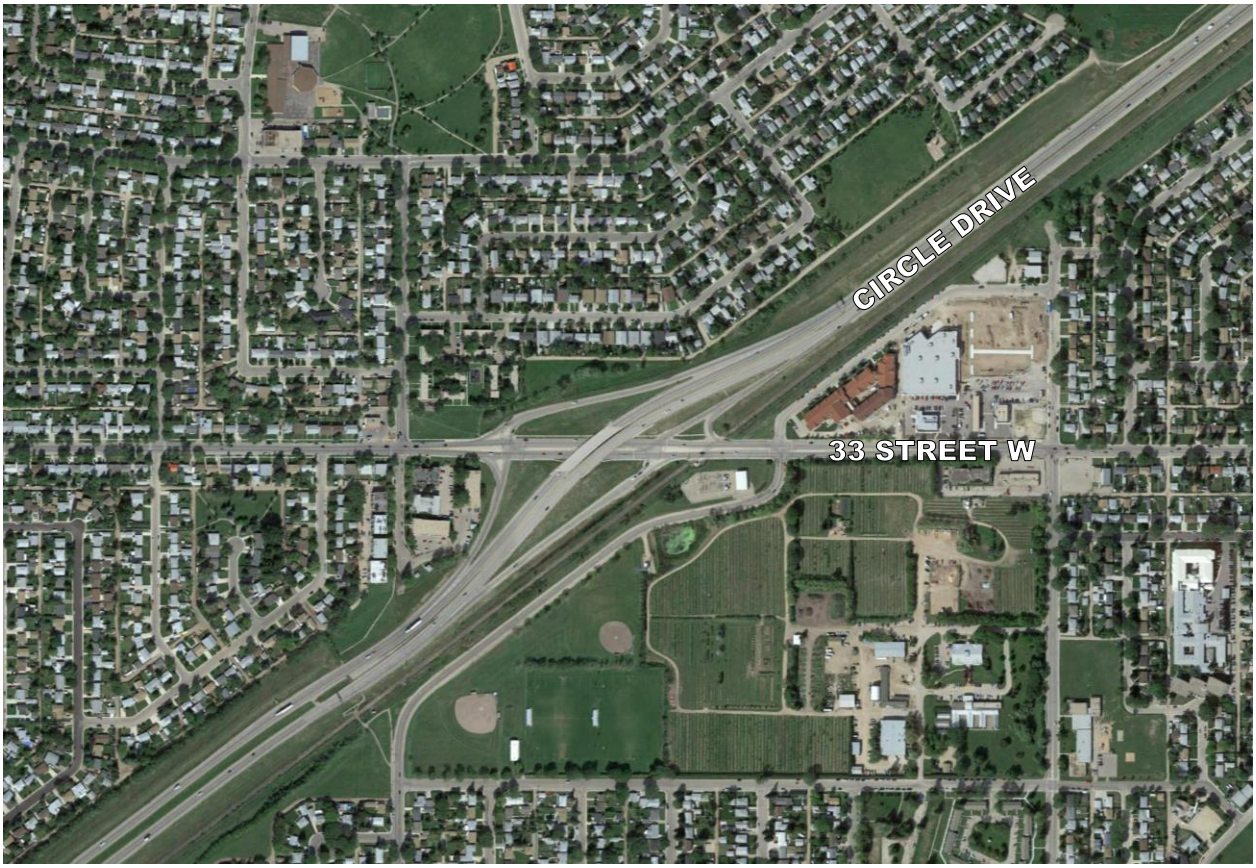


Figure 14: 33 Street W @ CN Crossing

Table 53: 33rd Street W Crossing Key Statistics

Roadway	Railway
2017 AADT: 23,215	Subdivision: Warman
Roadway Classification: Major arterial	2017 Trains per Day: 8.8
Road Post Speed: 50 km/h	Train Speed: 30 mph
Travel Lane EB: 2, WB: 2	CN Milepost: 3.07
Pavement Width: ~ 16m	Warning System: Flashing lights, bells, and gates
Sidewalk: Both Sides	Track Angle: 53 degrees

3.7.2 Proposed Solution

The Circle Drive bridge structure, located approximately 100 metres west of the crossing, prohibits raising 33rd Street W while lowering is restricted due to the bridge piers and foundations. Feasibility and cost are the main selection criterion at this location. A 33rd Street W rail overpass would minimize the impacts to 33rd Street W and Circle Drive while maintaining existing street network connectivity. The overpass further minimizes cost relative to a rail underpass.

33rd Street W would remain at the same location and elevation while the proposed rail overpass structure is a single track, two-span, cast-in-place, post tensioned concrete through girder bridge (CIP/PT/TG) with abutment spanning approximately 50 metres face

to face. Figure 15 and Figure 16 show the proposed conceptual plan and profile for the overpass.

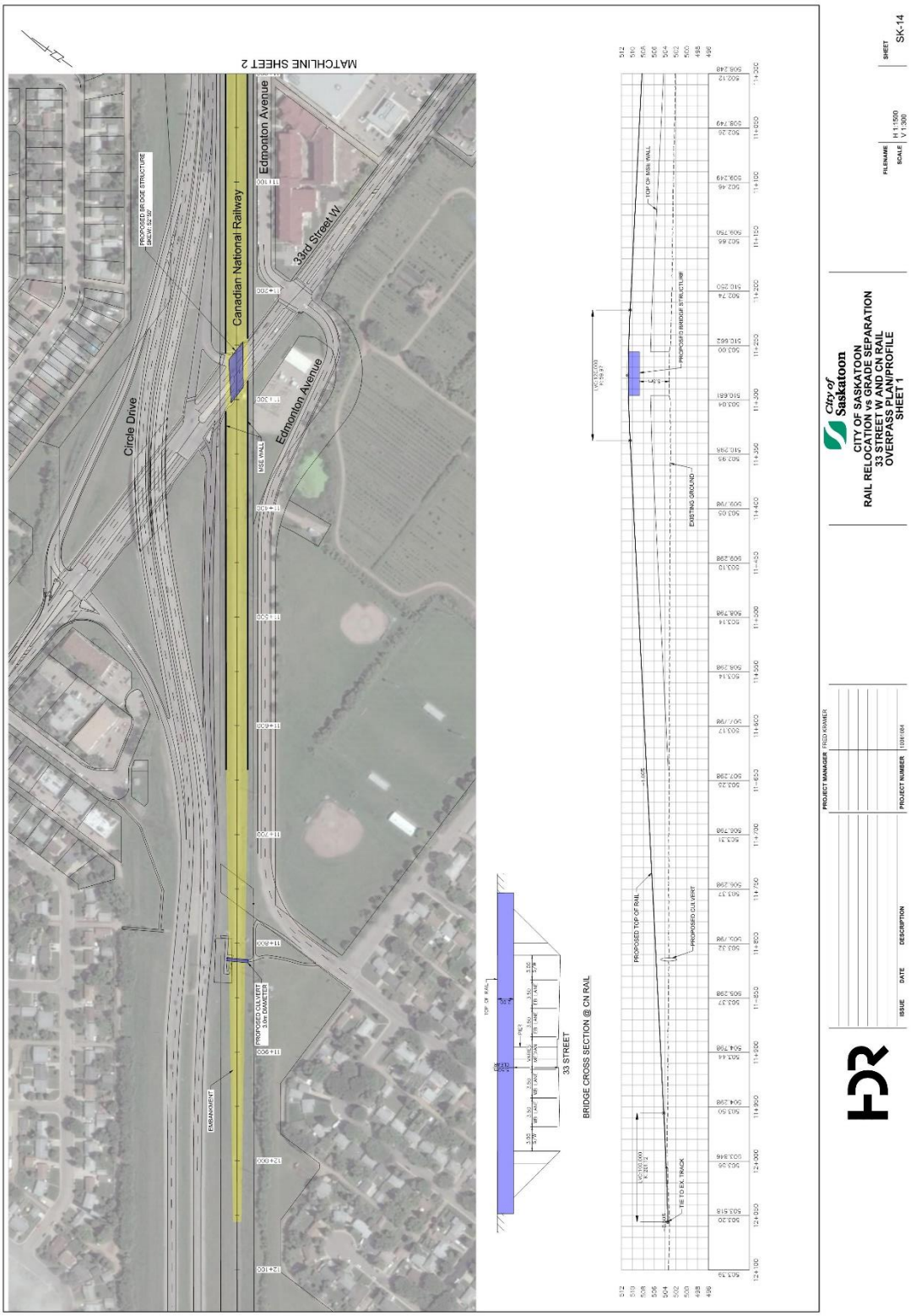


Figure 15: Proposed Conceptual Plan and Profile for 33rd Street W @ CN

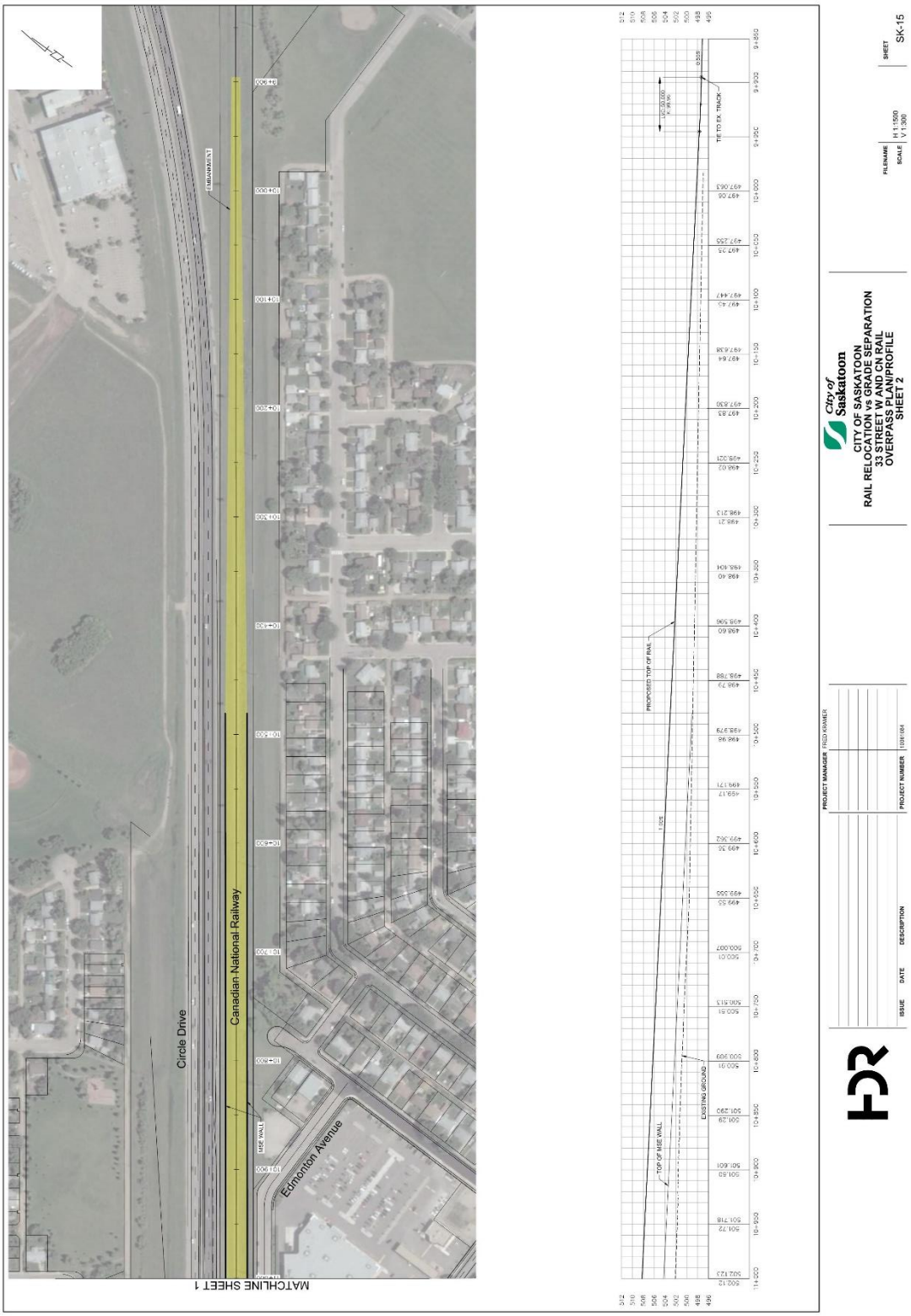


Figure 16: Proposed Conceptual Plan and Profile for 33rd Street W @ CN

3.7.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. With a 30 percent contingency, the construction cost is estimated at approximately $44.7 million (2017$). Table 54 summarizes the various cost components while Appendix A provides detailed cost estimates.

Table 54: 33rd Street W Overpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$5.87
Traffic Control	$1.36
Railway Work	$17.9
Utility	$3.00
Environmental	$0.55
Mobilization	$2.73
Engineering	$3.00
Contingency (30%)	$10.3
Total Cost (2017$)	**$44.7**

3.8 Marquis Drive @ CN

3.8.1 Existing Crossing Features

The Marquis Drive at-grade railroad crossing is located between Kochar Avenue and Arthur Rose Avenue. A single CN mainline track crosses Marquis Drive at a 9 degree skew. Figure 17 shows the crossing area and Table 55 provides a summary of the key statistics for this crossing.

At the location of the at-grade crossing, Marquis Drive is a 4 lane roadway with a pathway on the north side with industrial land adjacent to the crossing. Known existing utilities include water, sanitary and storm sewers, street lights, and overhead power lines.

With the opening of the North Commuter Parkway river crossing in 2018, a significant increase in traffic volumes is expected.

Figure 17: Marquis Drive @ CN Crossing

Table 55: Marquis Drive Crossing Key Statistics

Roadway	Railway
2017 AADT: 6,727	Subdivision: Warman
Roadway Classification: Major arterial	2017 Trains per Day: 8.8
Road Post Speed: 70 km/h	Train Speed: 40 mph
Travel Lane EB: 2, WB: 2	CN Milepost: 8.50
Pavement Width: ~ 15m	Warning System: Flashing lights, bells, and gates
Sidewalk: North Side	Track Angle: 9 degrees

3.8.2 Proposed Solution

The crossing is located adjacent to industrial land with no major developments nearby and no major concerns with open space continuity. Both overpass and underpass options have similar impacts to street network connectivity and development. For this location, cost is the key variable used for selection. An overpass would minimize impacts to underground utilities and is of lower cost than an underpass. Thus, the proposed crossing solution at this location is an overpass with Marquis Drive traversing over the railroad.

The CN track would remain at same location and elevation with minor improvements able to be addressed at the detailed design stage. The proposed structure is 4 lanes divided

with one walkway and spans approximately 30 metres. Figure 18 shows the proposed conceptual plan and profile for the overpass.

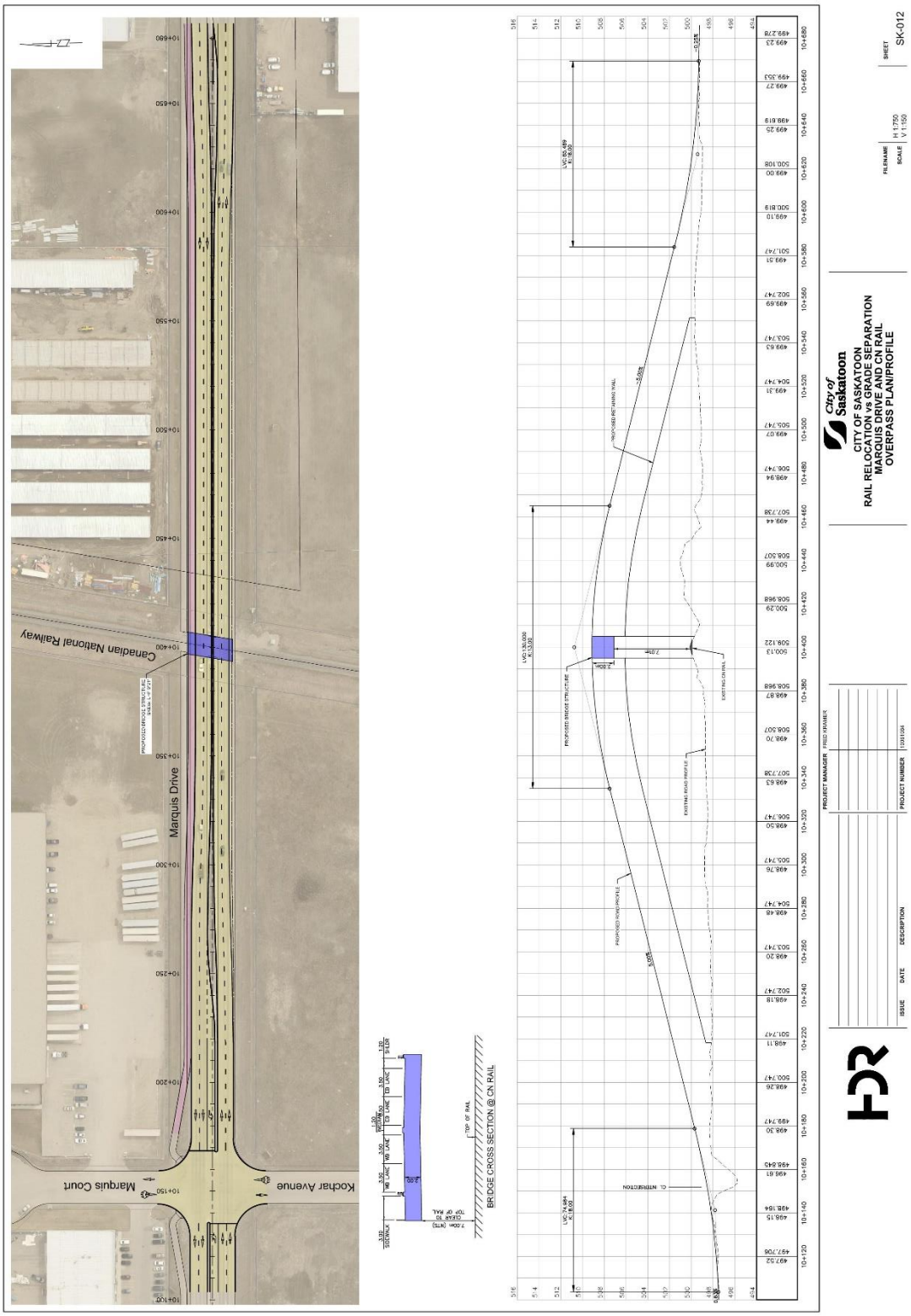


Figure 18: Proposed Conceptual Plan and Profile for Marquis Drive @ CN

3.8.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. Taking into account a 30 percent contingency, the construction cost is estimated at approximately $23.1 million (2017 $). Table 56 summarizes the various cost components and Appendix A provides detailed cost estimates.

Table 56: Marquis Drive Overpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$2.48
Roadway Work	$9.38
Railway Work	$0.76
Utility	$1.50
Environmental	$0.55
Mobilization	$1.47
Engineering	$1.61
Contingency (30%)	$5.32
Total Cost (2017$)	**$23.1**

3.9 11th Street W @ CN

3.9.1 Existing Crossing Features

The 11th Street W at-grade railroad crossing is located between Dundonald Avenue and Circle Drive. Three CN mainline tracks branch out and cross 11th Street W at varying angles. Figure 19 shows the crossing area while Table 57 provides a summary of the key statistics for this crossing.

At the location of the at-grade crossing, 11 Street W is a 6 lane roadway with raised median and sidewalks on the north side with adjacent residential housing. Known existing utilities include water, sanitary and storm sewers, cable, street lights, gas lines, and overhead power lines.

The CN Warman subdivision is orientated directly north-south at the crossing. The CN-CP interconnection crosses 11th street to the north east while the CP Vitara track crosses 11th street to the north west. Lastly, the CP Sutherland yard crosses the Dundonald southbound ramp in an east-west direction.

Figure 19: 11 Street W @ CN Crossing

Table 57: 11th Street W Crossing Key Statistics

Roadway	Railway
2017 AADT: 19,063	Subdivision: Warman
Roadway Classification: Major arterial	2017 Trains per Day: 8.8
Road Post Speed: 50 km/h	Train Speed: 30 mph
Travel Lane EB: 3, WB: 3	CN Milepost: 0.73
Pavement Width: ~ 21m	Warning System: Flashing lights, bells, and gates
Sidewalk: North Side	Track Angle: Varies

3.9.2 Proposed Solution

This crossing is located near the 11th Street bridge over Circle Drive. Since there are no major concerns with open space continuity, road network connectivity, feasibility, and cost are the major selection criteria. Given that 11th Street currently crosses over Circle Drive, constructing an underpass would be costly and cause significant impacts to the existing road network. An overpass, however, would minimize cost, maintain road network connectivity, and is more feasible.

The proposed crossing solution involves moving 11th Street W south and constructing an overpass over CN and Circle Drive This would reduce the length of the bridge crossing over CN and allow for the existing 11th Street to be used as a detour during construction. The CN tracks would remain at the same location and elevation with minor improvements possible at the detailed design stage. The proposed structure is 4 lane divided with one walkway and spans approximately 45 metres. Figure 20 shows the proposed conceptual plan and profile for the overpass. The proposed solution addresses all three CN rail crossing conflicts at 11th street as well as the elimination of the CP Sutherland subdivision crossing at the Dundonald southbound ramp by relocating the ramp to the south of 11th street.

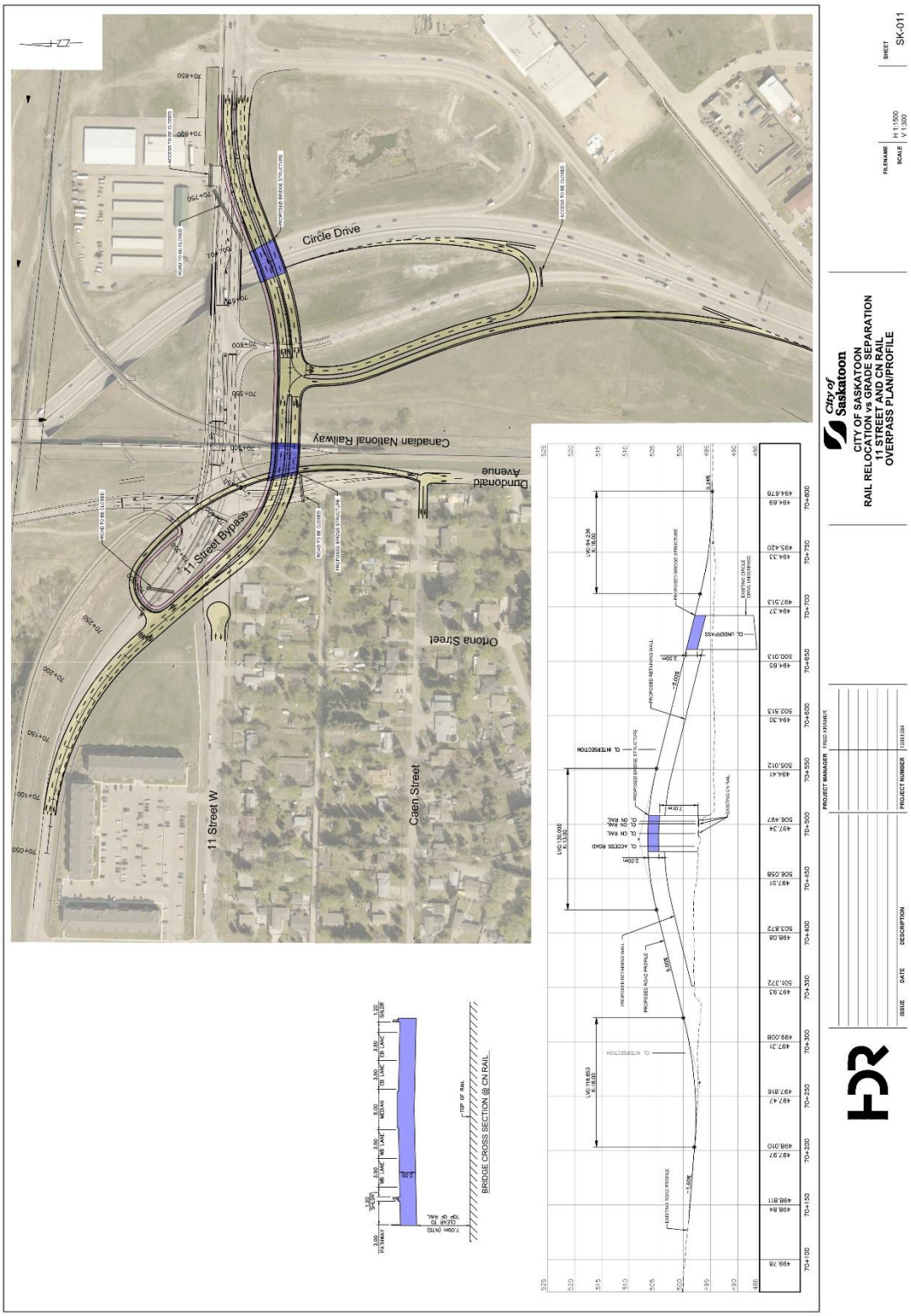


Figure 20: Proposed Conceptual Plan and Profile for 11th Street W @ CN

3.9.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. With a 30 percent contingency, the estimated construction cost is approximately $43.7 million (2017 $). Table 58 summarizes the various cost components while Appendix A provides detailed cost estimates.

Table 58: 11th Street W Overpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$9.70
Roadway Work	$14.6
Railway Work	$0.64
Utility	$2.00
Environmental	$0.55
Mobilization	$2.74
Engineering	$3.02
Land Acquisition	$0.40
Contingency (30%)	$10.1
Total Cost (2017$)	**$43.7**

3.10 51st Street @ CN

3.10.1 Existing Crossing Features

The 51st Street W at-grade railroad crossing is located between Millar Avenue and Warman Road. A single CN mainline track crosses 51st Street at an 11 degree skew. Figure 21 shows the crossing area and Table 59 provides a summary of the key statistics for this crossing.

At the location of the at-grade crossing, 51st Street is a 6 lane divided roadway with a raised median and a multi-use train/pathway on the southeast side that extends from Warman Road to the crossing location. The adjacent land is light industrial with some commercial developments. Known existing utilities include water, sanitary and storm sewers, cable, street lights, gas lines, and overhead power lines.

Figure 21: 51ST Street @ CN Crossing

Table 59: 51st Street Crossing Key Statistics

Roadway	Railway
2017 AADT: 28,411	Subdivision: Warman
Roadway Classification: Major arterial	2017 Trains per day: 8.8
Road Post Speed: 50 km/h	Train Speed: 30 mph
Travel Lane EB: 3, WB: 3	CN Milepost: 6.76
Pavement Width: ~ 20m	Warning System: Flashing lights, bells, and gates
Sidewalk: Southeast side	Track Angle: 11 degrees

3.10.2 Proposed Solution

The crossing is located adjacent to commercial developments and there are no major concerns with open space continuity. Both overpass and underpass options have similar impacts to street network connectivity and development impacts. As a result, cost is the major selection criterion. An overpass would minimize impacts to underground utilities and is priced lower than an underpass. Thus, the proposed crossing solution at this location is an overpass with 51 Street traversing over the railroad.

The CN track would remain at the same location and elevation and minor improvements may be addressed at the detailed design stage. The proposed structure is 6 lanes divided with one walkway and spans approximately 35 metres. Figure 22 shows the proposed conceptual plan and profile for the overpass.

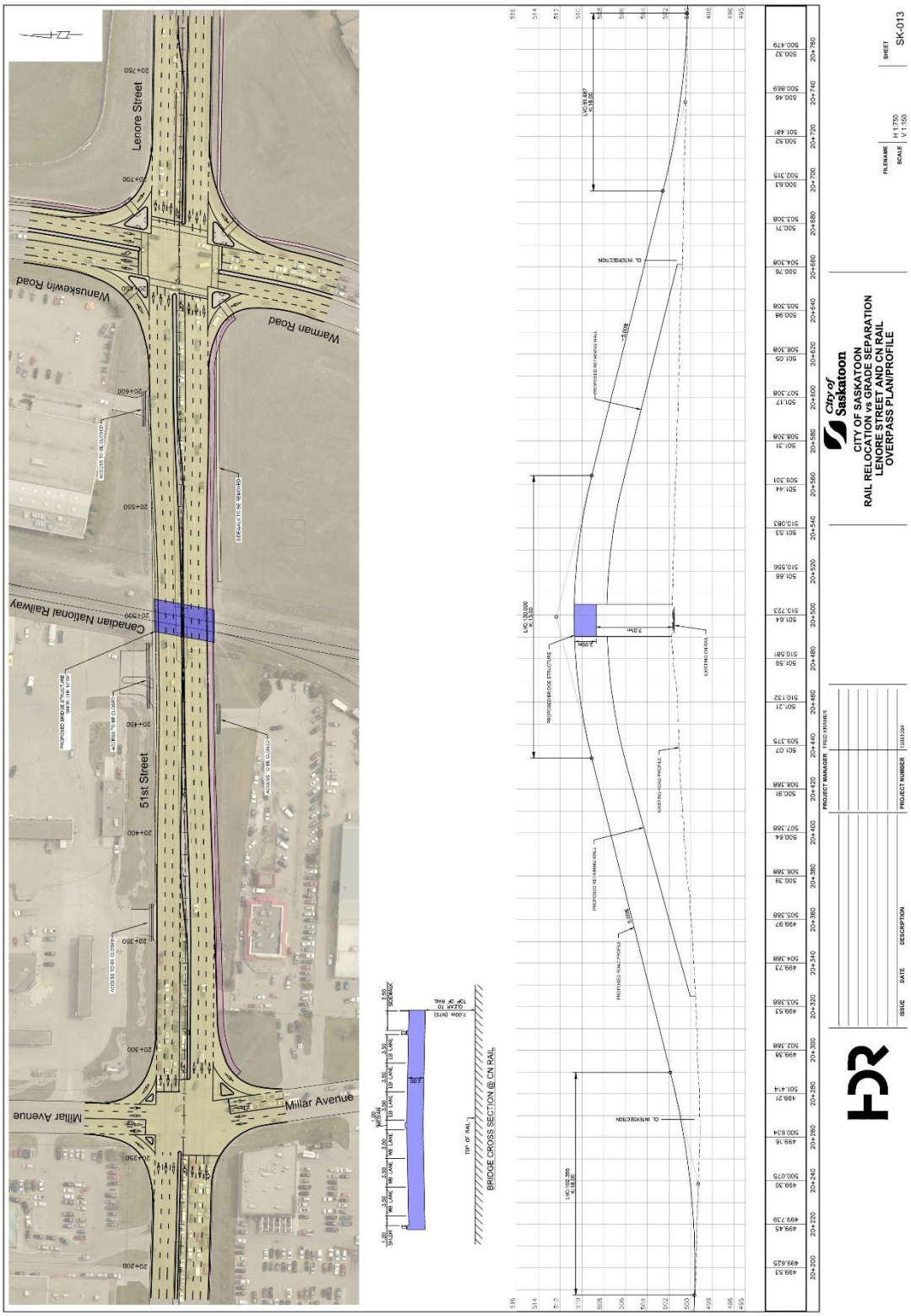


Figure 22: Proposed Conceptual Plan and Profile for 51st Street @ CN

3.10.3 Cost Estimate

The Class 5 construction cost estimate includes the railway bridge, roadway and railway works, utilities, and other cost components. Taking into account a 30 percent contingency, the construction cost estimate is approximately $29.4 million (2017$). Table 60 summarizes the various cost components while Appendix A provides detailed cost estimates.

Table 60: 51st Street Overpass Option Cost Estimate

Cost Components	Cost ($M)
Bridge	$4.11
Roadway Work	$11.7
Railway Work	$0.79
Utility	$1.50
Environmental	$0.55
Mobilization	$1.87
Engineering	$2.06
Contingency (30%)	$6.78
Total Cost (2017$)	**$29.4**

4 CP Elevation and Trench Concepts

In order to use cost-benefit analysis (CBA) to evaluate all alternatives, conceptual elevation and trench concepts were developed to inform cost estimation. Alternative 2 (CP Elevate) considered the elevation of the CP mainline over the existing roadway network, while Alternative 3 (CP Trench) considered the lowering of the CP mainline below the existing roadway network. The concepts and cost estimates are provided in Sections 4.1 and 4.2 below.

4.1 CP Elevation

4.1.1 CP Elevation Concept

Since the CP mainline track is planned to remain at the same elevation on crossing the existing South Saskatchewan River bridge, the existing track embankment needs to be raised and the 7 Avenue N rail bridge must be replaced in order to grade separate 3rd Avenue North/Warman Road without modifying the existing roadway geometry. The rail embankment could feasibly be constructed from the east of Warman Road and extend westward to Avenue W S where it would resume original grade. In order to reduce the embankment's footprint, 2 to 4 metre high mechanically stabilized earth (MSE) walls are proposed to be installed at both sides along its length. The average height of the embankment is 6 metres and would create a barrier through a significant portion of the core area. A total of nine crossings through the embankment may be constructed. All existing at-grade crossings between 7th Avenue N and Ave W S may be grade separated, funds permitting, and all the existing roads cut off by the rail line may be grade separated at a reasonable cost. The removal of the CP city center yard will allow for road network redevelopment at the north downtown area and additional rail bridges may be added as needed. Prior to construction, a parallel shoofly track would be constructed and remain in service until the new mainline track is complete. Although temporary ROW may be needed at some very tight sections, no additional permanent ROW will be required for the proposed rail embankment. Figure 23 illustrates the CP Elevation concept while the following section provides the Class 5 construction cost estimate.

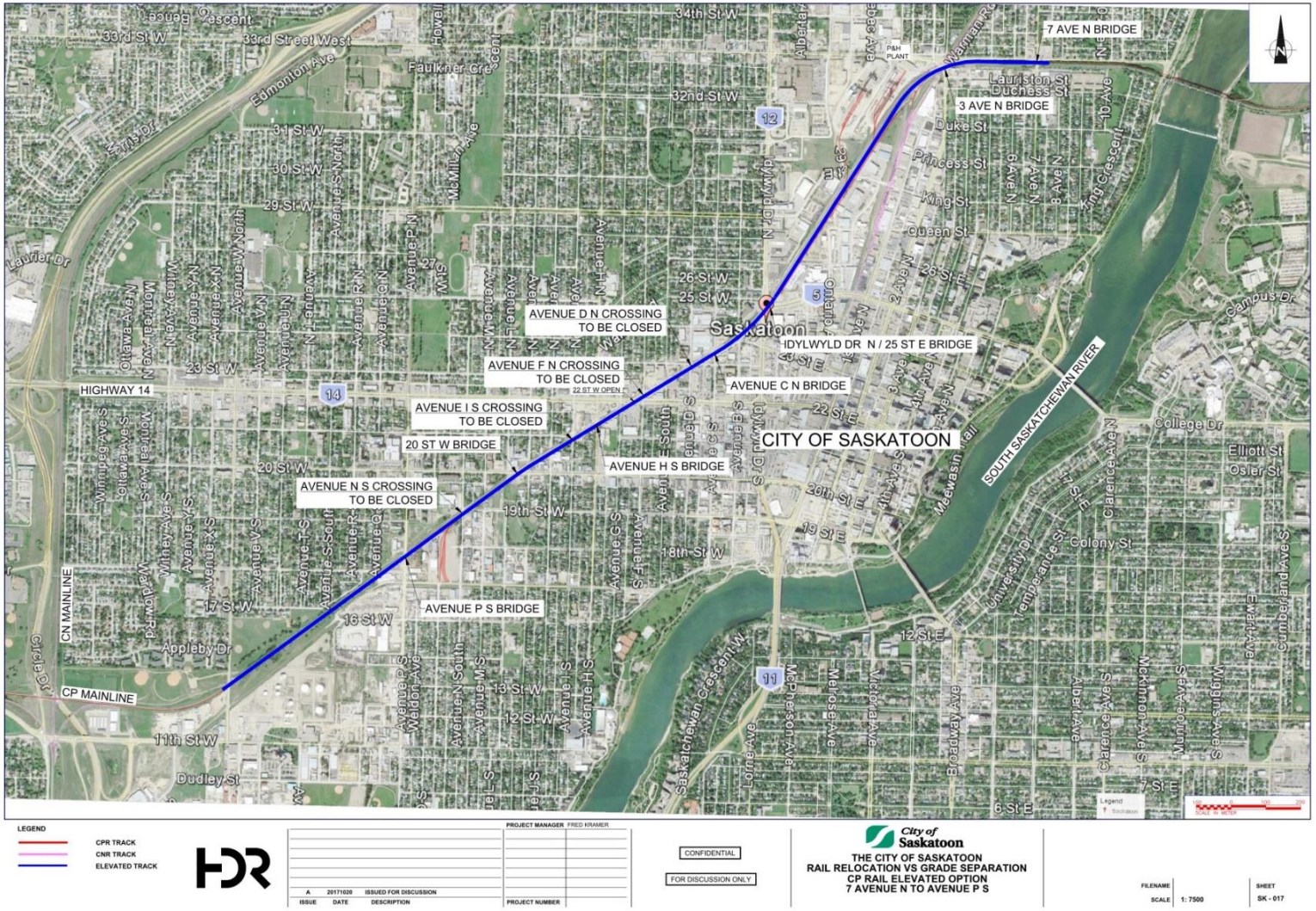


Figure 23: CP Elevation Alternative

4.1.2 CP Elevation Cost Estimate

The Class 5 construction cost estimate including the embankment, retaining walls, new mainline track, shoofly track, and 30 percent contingency is approximately $208.4 million (2017$). Table 61 summarizes the various cost components for the CP elevation alternative while Appendix A provides detailed estimates.

Table 61: CP Elevation Cost Estimate

Cost Components	Cost ($M)
Bridge	$36.9
Railroad Work	$47.1
Shoofly Track	$9.35
Drainage	$10.0
Utilities	$15.0
Environmental	$9.00
Traffic Control	$6.36
Mobilization	$12.7
Engineering	$14.0
Contingency (30%)	$48.1
Total Cost (2017$)	**$208.4**

4.2 CP Trench

4.2.1 CP Trench Concept

The rail trench could feasibly be constructed starting just west of Warman Road, passing beneath Idylwyld Drive, and returning to original grade at Avenue W S. Nine crossings above the trench could be constructed. The proposed trench would be functionally indistinguishable from the embankment option. It would be 9 metres deep with a minimum of 3 metre tall fences on either side and consist of a wide concrete pile wall which would run through a significant portion of the core area.

Construction of an adjacent temporary shoofly track along the entire length of the trench will be required temporarily during construction. Purchase/lease of a significant number of private properties would be required to construct the temporary rail line.

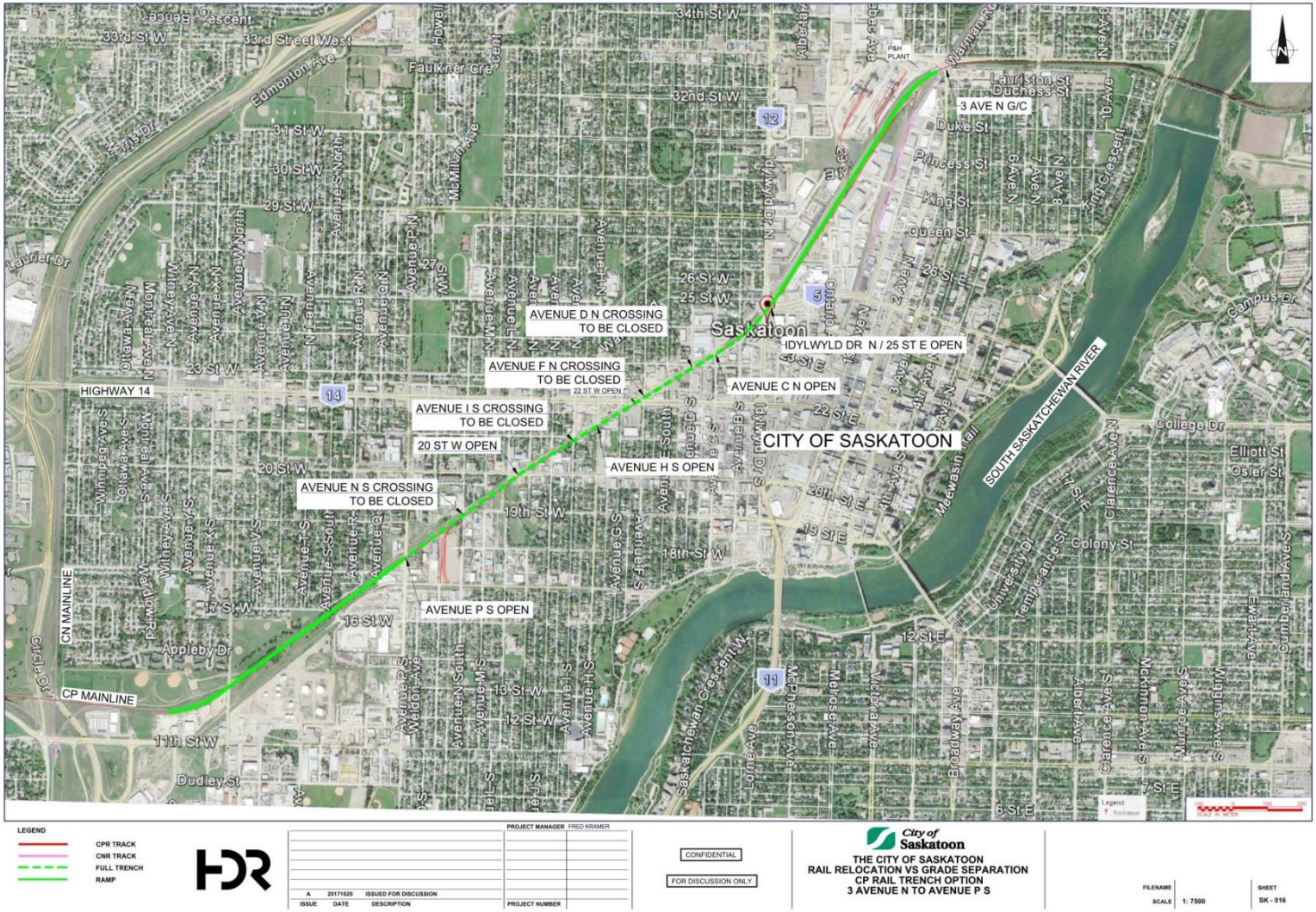


Figure 24: CP Trench Alternative

4.2.2 CP Trench Cost Estimate

The Class 5 construction cost estimated including the trench, earthwork, new mainline track and roadway bridges, utilities relocation and modification, and 30 percent contingency is approximately $591.4 million (2017$). Table 62 summarizes the various cost components for the CP trench alternative while Appendix A provides detailed estimates.

Table 62: CP Trench Cost Estimate

Cost Components	Cost ($M)
Trench	$255.1
Earthwork	$16.3
Barrier	$1.86
Dewatering and Water Treatment	$10.0
Utilities	$30.0
Drainage	$8.00
Bridge Cost	$12.5
Railroad Work	$10.1
Shoofly Track	$13.0
Environmental Costs	$11.5
Traffic Control	$9.21
Mobilization Costs	$36.8
Engineering Costs	$40.5
Contingency (30%)	$136.5
Total Cost (2017$)	**$591.4**

5 CP Mainline Relocation

Four separate rail alignment options were developed to inform the feasibility of relocating the existing CP mainline and CP owned Sutherland yard outside of the City limits. While a proposed rail yard with a similar track length of the existing CP Sutherland yard is required and a cost estimate for this yard is provided, a preferred location was not identified as this would require further CP consultation. The location of this yard will not significantly alter the cost estimate. Figure 25 provides a high-level map of each rail alignment option while an overview of key considerations is summarized by Table 63. A brief description of each option is provided in the following sections.

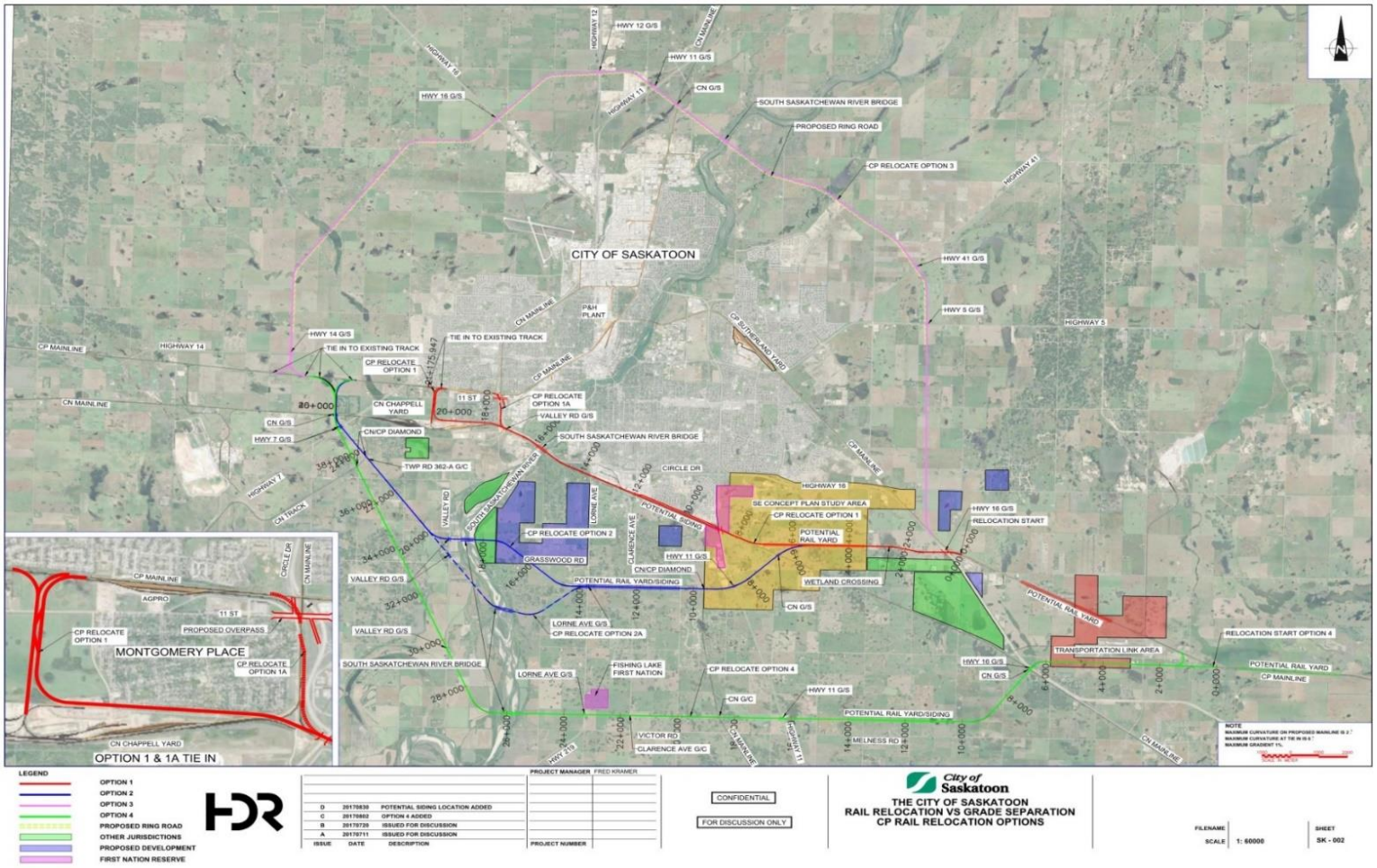


Figure 25: CP Mainline Relocation Alternative Options

Table 63: Summary of Key CP Mainline Relocation Considerations

Considerations	Option 1 - Red	Option 1A – Red Dashed	Option 2 - Blue	Option 2A – Blue Dashed	Option 3 - Pink	Option 4 - Green
ROW	ROW requires CN consent. Propose to construct 3rd mainline south of existing and provide to CN. CP to run on the most northern track	ROW requires CN consent. Propose to construct 3rd mainline south of existing and provide to CN. CP to run on most northern track	Acquire	Acquire	ROW along North Perimeter Highway. Some ROW acquisition may be required	Acquire
Length of Current Main Track (Between Connections)	27 KM	22 KM	28 KM	28 KM	30 KM	38 KM
Length of Proposed Main Track	24 KM	18 KM	28 KM	29 KM	44 KM	42 KM
South Saskatchewan River Crossing (metres)	Potential for shared use double/triple track bridge to replace existing CN (480m)	Potential for shared use double/triple track bridge to replace existing CN (480m)	New Build (450m) Single Track Bridge	New Build (500m) Single Track Bridge	New Build (300m) Single Track Bridge	New Build (700m) Single Track Bridge
CN Mainline Rail Grade Separation	none	none	4	4	1	4
Roadway Grade Separations (all are roadway bridges unless noted)	Widen 3 existing CN grade separations at Valley Road, Clarence Ave., and HWY 11 New - HWY 16	Widen 3 existing CN grade separations at Valley Road, Clarence Ave., and HWY 11 New – HWY 16	**Five New** - HWY 7, Lorne Ave. (HWY 219), HWY 11, HWY 16, Road G/S, and TWP RD 362-A	**Five New** - HWY 7, Lorne Ave. (HWY 219), HWY 11, HWY 16, Road G/S, and TWP RD 362-A	**Six New**– HWY 16 (2), HWY 5, HWY 41, HWY 11, HWY 12, and HWY 14	**Four New** - HWY 7, Lorne Av (HWY 219), HWY 11, HWY 16
At Grade Road Crossings	Same as existing	Same as existing	5-10	5-10	15-20	10-15

Considerations	Option 1 - Red	Option 1A – Red Dashed	Option 2 - Blue	Option 2A – Blue Dashed	Option 3 - Pink	Option 4 - Green
CN Impacts	Option 1 restricts access to Chappell Yard Restricts access to customers near Clarence Ave	Requires crossover to access existing CP mainline Restricts access to customers near Clarence Ave	No Impact	No Impact	No Impact	No Impact
CP Impacts	Requires joint use bridge and ROW	Requires joint use bridge and ROW	Positive Impact due to higher track speed and less on grade crossing	Positive Impact due to higher track speed and less on grade crossing	Operation cost may be increased due to increased track mile	Potential increased cost of service to Cargill, and Potash Corp Patience Lake Mine
First Nations	Close proximity to First Nations reserves	Close proximity to First Nations reserves	No Impact	No Impact	No Impact	No Impact
Public Impact	Concerns may arise due to close proximity of alignment to the City	Concerns may arise due to close proximity of alignment to the City	Rail alignment runs through SE Concept Plan Area, proposed development north of Grasswood Road, and is in close proximity to acreages in RM.	Rail alignment runs through SE Concept Plan Area and is in close proximity to acreages in RM	Likely most preferred from public point of view	Avoids RM development areas
Other Jurisdictions	No Impact	No Impact	RM Corman Park, Alignment through sensitive area near South Saskatchewan	RM Corman Park	RM Corman Park	RM Corman Park

5.1 Option 1 – CP Within Existing CN Rail Right-of-Way

Option 1 is visually shown by a red line in Figure 25. The proposed alignment begins from the existing CP mainline Sutherland Subdivision (mile 102.31, west of Freeborn Road) and heads west utilizing a proposed grade separation (highway overpass) with Highway 16/Yellowhead Highway. After approximately 7km, the alignment turns northwest running parallel with the existing CN mainline to the north and shares CN right-of-way for approximately 11km before bearing west between the CN Chappell yard and the Montgomery Place neighbourhood. The alignment crosses a new shared 3 track bridge across the South Saskatchewan River (which replaces the existing CN single track bridge) before tying back to the existing CP mainline at Wilkie Subdivision Mile 3.77. This option relies heavily on the availability of CN right-of-way and a willingness of both parties to negotiate a suitable business arrangement.

5.2 Option 2A – Corman Park, Near South of the City Limits

Option 2A is visually depicted by a blue line in Figure 25. The tie-in point to the existing CP mainline, as well as the first 6km of the proposed alignment, are the same as Option 1. After 6km, the alignment turns southwest and crosses a proposed grade separation (track overpass) with CN mainline track and Highway 11. After returning to grade, the alignment heads west crossing a proposed grade separation (highway overpass) with Highway 219/Lorne Ave before bearing southwest to avoid crossing the Riverside Estates community. The proposed alignment then crosses the South Saskatchewan River on a single track bridge and heads northwest to cross a proposed grade separation (roadway overpass) with Valley Road. While still heading northwest, the alignment crosses two further proposed grade separations (track overpass) with Highway 7 and CN mainline track as well as two proposed diamond crossings with CN branch lines. The alignment ties back to the existing CP mainline at Wilkie Subdivision (mile 5.92). This option does not significantly increase the total route miles for CP. The cost estimate for this option is summarized by Table 64 while detailed cost estimates are be found in Appendix A.

In order to provide an indicative cost, Class 5 construction cost estimates have been developed for Option 2A including the mainline track, rail yard, railway signal system, grade separation costs, and other cost components. Taking into account a 30 percent contingency, the cost is estimated at approximately $589.7 million (2017$). Table 64 summarizes the various cost components while Appendix A provides detailed estimates.

Table 64: CP Mainline Relocation Option 2A Cost Estimate

Cost Components	Cost ($M)
Mainline Track	$71.8
Rail Yard	$105.9
HWY 16 Road Overpass	$13.8
CN Mainline (Watrous Sub) Grade Separation 1	$2.20
HWY 11 Grade Separation	$5.50
CN Mainline (Craik Sub) at Grade Crossing (Diamond)	$0.80
South Saskatchewan River Bridge	$79.0
HWY 219 Road Overpass	$6.68
Valley Road Overpass	$7.27
At Grade Road Crossing	$3.20
CN Mainline (Rosetown Sub) at Grade Crossing (Diamond)	$0.80
HWY 7 Grade Separation	$8.80
CN Mainline (Watrous Sub) Grade Separation 2	$2.20
Utility Protection & Relocation	$23.0
Signal System	$12.0
Environmental	$12.0
Traffic Control	$3.00
Right-of-Way	$26.6
Mobilization	$35.8
Engineering	$39.4
Contingency (30%)	$129.9
Total Cost (2017$)	**$589.7**

5.3 Option 3 – Proposed Saskatoon Ring Road Alignment

Option 3 is visually shown by a pink line in Figure 25. The proposed alignment begins at the existing CP mainline Sutherland Subdivision (mile 102.63) then heads north running parallel with the proposed Saskatoon North Ring Road (perimeter highway) alignment while crossing two proposed grade separations with Highway 5 and Highway 41. The alignment bears west crossing the South Saskatchewan River before crossing further proposed grade separations with Highway 11, Highway 12 as well as CN mainline. After crossing Highway 12, the track continues southwest to cross proposed grade separations with Highway 16/Yellowhead Highway and Highway 14. The alignment ties back with the existing CP mainline at Wilkie Subdivision (mile 6.92). This alignment increases CP track miles by 14 km as compared to the existing CP mainline. The key benefit Option 3 presents is the avoidance of some right-of-way acquisition that other options encounter. There is potential for challenges, however, in obtaining CP concurrence due to significantly increased track miles and other considerations.

5.4 Option 4 – Corman Park, Far South of the City Limits

Option 4 is visually depicted by a green line in Figure 25. As compared to Option 2A, the proposed Option 4 alignment has been shifted further south in order to avoid some existing and future developments that are close to the city limits and limit track curvature. The alignment starts at the existing CP mainline Sutherland Subdivision (mile 96.06) and

continues west to cross the proposed Transport Link Area before heading southwest to cross a proposed grade separation (highway overpass) with Highway 16/Yellowhead Highway and CN mainline track (rail overpass). The alignment then runs parallel with Melness Road to the west and crosses the South Saskatchewan River on a single track bridge prior to turning northwest and tying back to CP mainline at the same location as Option 2A. Similar to Option 2A, two diamond crossings with CN branch lines have been planned. The new mainline track measures 42km which increases CP rail track miles by 4km as compared to the existing CP rail mainline and increases track miles by 13km relative to Option 2A.

Appendix A- Detailed Construction Cost Estimates for Grade Separation Option

Project: Saskatoon Grade Separation Study
Idylwyld Drive & 25th Street
Bridge Structure

A. Bridge Superstructure			
Cast-in-Place, Post Tensioned Concrete Through Girder Bridge (CIP/PT/TG)			
	Cost per Cubic Meter	Quantity	Cost
CIP Box Girder Concrete, Skewed	$1,900	827	$1,570,350
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	131	$679,052
	Cost per Lin. Meter		
Expansion joint	$2,800	45	$125,620
	Cost per Sq. Meter		
Waterproofing	$600	385	$231,000
	Cost per Lin. Meter		
Pedestrian Railing	$200	130	$26,000
		Subtotal	$2,632,022
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	22	$157,025
		Subtotal	$157,025
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	86	$103,313
		Subtotal	$103,313
		Superstructure Subtotal	$2,892,361
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	817	$980,610
	Cost per ton	Quantity	Cost
Reinforcing Steel	$4,500	129	$581,012
		Subtotal	$1,561,622
Foundation			
	Cost per Each	Quantity	Cost
Drilled Shaft	$97,500	9	$877,500
		Subtotal	$877,500
		Substructure Subtotal	$2,439,122
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction increase		6%	$319,888.95
Phased construction and framework increase		10%	$533,148.26
		16%	$853,037
		Total Bridge Cost	**$6,184,520**

A. Road Work			
Earthwork			
	Cost per Cubic Meter	Quantity	Cost
Excavation to Waste	$20	93300	$1,866,000
Asphalt/Concrete Removal & Dispo	$135	3700	$499,500
Engineering Fill - Walkway	$60	3600	$216,000
		Subtotal	$2,581,500
Surfacing			
	Cost per ton	Quantity	Cost
Asphalt Pavement	$170	4300	$731,000
	Cost per Cubic Meter		
Base Course	$85	2400	$204,000
Subbase Course	$75	2400	$180,000
Drainage Layer	$95	3100	$294,500
	Cost per Sq. Meter		
Sidewalk	$130	3600	$468,000
	Cost per Lin. Meter		
Curb and Gutter	$110	3800	$418,000
Traffic Barrier	$380	200	$76,000
Pedestrian and Top of Wall Railing	$200	2700	$540,000
		Subtotal	$2,911,500
Landscaping			
	Cost LS	Quantity	Cost
Art and Landscaping	$500,000	1	$500,000
		Subtotal	$500,000
Traffic Items			
	Cost LS	Quantity	Cost
Traffic and Street Light, Sign, Pavement Marking	$1,500,000	1	$1,500,000
		Subtotal	$1,500,000
Retaining Wall			
	Cost per Sq. Meter	Quantity	Cost
Retaining Wall	$1,300	7200	$9,360,000
Temporary Shoring	$900	6000	$5,400,000
		Subtotal	$14,760,000
		Civil Subtotal	$22,253,000

B. Miscellaneous			
Detouring			
	Cost LS	Quantity	Cost
Temporary at Grade Crossing and Road Work	$1,500,000	1	$1,500,000
Detour Signing and Signals	$200,000	1	$200,000
		Subtotal	$1,700,000
Utilities			
	Cost LS	Quantity	Cost
Utility adjustment	$5,000,000	1	$5,000,000
		Subtotal	$5,000,000
Drainage			
	Cost LS	Quantity	Cost
Drainage	$750,000	1	$750,000
		Subtotal	$750,000
		Miscellaneous Subtotal	$7,450,000
		Total Road Cost	**$29,703,000**

Project: Saskatoon Grade Separation Study
Idylwyld Drive & 25th Street
Railroad Work

Railroad Work				
New Track				
	Cost per Meter		Quantity	Cost
New Railway Track	1,500		120	$180,000
		Subtotal		$180,000
Train Routing During Construction				
	Cost per Meter		Quantity	Cost
Shoofly Track	1,500		800	$1,200,000
	Cost LS		Quantity	Cost
Railroad Xing and Signal	500,000		1	$500,000
		Subtotal		$1,700,000
Railroad Xing and Signal Removal				
	Cost LS		Quantity	Cost
Railroad Xing and Signal Removal	100,000		1	$100,000
		Subtotal		$100,000
Railroad Flagging				
	Cost per Days		Quantity	Cost
Flagging	1,100		100	$110,000
		Subtotal		$110,000
			Total Railroad Cost	**$2,090,000**

Project: Saskatoon Grade Separation Study
Idylwyld Drive & 25th Street
Total Cost

Subtotal Costs			
		Bridge Subtotal	$6,184,520
		Road Subtotal	$29,703,000
		Railroad Subtotal	$2,090,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$38,527,520
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$3,852,752
		Subtotal	$3,852,752
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$2,119,014
Construction Engineering		5%	$2,119,014
		Subtotal	$4,238,027
Right-of-Way			
	Cost LS	Quantity	Cost
Land Acquisition	$400,000	1	$400,000
		Subtotal	$400,000
Contingency		**% Increase**	**Cost**
Contingency		30%	$14,105,490
		Subtotal	$14,105,490
		Total Cost	**$61,123,789**

Project: Saskatoon Grade Separation Study
22nd Street
Bridge Structure

A. Bridge Superstructure			
Cast-in-Place, Post Tensioned Concrete Through Girder Bridge (CIP/PT/TG)			
	Cost per Cubic Meter	Quantity	Cost
CIP Box Girder Concrete, Skewed	$1,900	827	$1,570,350
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	131	$679,052
	Cost per Lin. Meter		
Expansion joint	$2,800	51	$142,663
	Cost per Sq. Meter		
Waterproofing	$600	385	$231,000
	Cost per Lin. Meter		
Pedestrian Railing	$200	130	$26,000
		Subtotal	$2,649,066
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	25	$178,329
		Subtotal	$178,329
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	99	$119,252
		Subtotal	$119,252
		Superstructure Subtotal	$2,946,646
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	849	$1,018,440
	Cost per ton	Quantity	Cost
Reinforcing Steel	$4,500	134	$603,425
		Subtotal	$1,621,865
Foundation			
	Cost per Each	Quantity	Cost
Drilled Shaft	$97,500	9	$877,500
		Subtotal	$877,500
		Substructure Subtotal	$2,499,365
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction increase		6%	$326,760.68
Phased construction and framework increase		10%	$544,601.13
		16%	$871,362
		Total Bridge Cost	**$6,317,373**

Project: Saskatoon Grade Separation Study
22nd Street
Road Work

A. Road Work			
Earthwork			
	Cost per Cubic Meter	Quantity	Cost
Excavation to Waste	$20	71700	$1,434,000
Asphalt/Concrete Removal & Dispc	$135	2300	$310,500
Engineering Fill - Walkway	$60	2100	$126,000
		Subtotal	$1,870,500
Surfacing			
	Cost per ton	Quantity	Cost
Asphalt Pavement	$170	3500	$595,000
	Cost per Cubic Meter		
Base Course	$85	1700	$144,500
Subbase Course	$75	1700	$127,500
Drainage Layer	$95	2200	$209,000
	Cost per Sq. Meter		
Sidewalk	$130	2100	$273,000
	Cost per Lin. Meter		
Curb and Gutter	$110	2000	$220,000
Traffic Barrier	$380	200	$76,000
Pedestrian and Top of Wall Railing	$200	2000	$400,000
		Subtotal	$2,045,000
Landscaping			
	Cost LS	Quantity	Cost
Art and Landscaping	$500,000	1	$500,000
		Subtotal	$500,000
Traffic Items			
	Cost LS	Quantity	Cost
Traffic and Street Light, Sign, Pavement Marking	$1,000,000	1	$1,000,000
		Subtotal	$1,000,000
Retaining Wall			
	Cost per Sq. Meter	Quantity	Cost
Retaining Wall	$1,300	5200	$6,760,000
Temporary Shoring	$900	4400	$3,960,000
		Subtotal	$10,720,000
		Civil Subtotal	$16,135,500

B. Miscellaneous			
Detouring			
	Cost LS	Quantity	Cost
Temporary at Grade Crossing and Road Work	$1,000,000	1	$1,000,000
Detour Signing and Signals	$200,000	1	$200,000
		Subtotal	$1,200,000
Utilities			
	Cost LS	Quantity	Cost
Utility adjustment	$3,500,000	1	$3,500,000
		Subtotal	$3,500,000
Drainage			
	Cost LS	Quantity	Cost
Drainage	$750,000	1	$750,000
		Subtotal	$750,000
		Miscellaneous Subtotal	$5,450,000
		Total Road Cost	**$21,585,500**

Project: Saskatoon Grade Separation Study
22nd Street
Railroad Work

Railroad Work				
New Track				
	Cost per Meter		Quantity	Cost
New Railway Track	1,500		120	$180,000
		Subtotal		$180,000
Train Routing During Construction				
	Cost per Meter		Quantity	Cost
Shoofly Track	1,500		800	$1,200,000
	Cost LS		Quantity	Cost
Railroad Xing and Signal	500,000		1	$500,000
		Subtotal		$1,700,000
Railroad Xing and Signal Removal				
	Cost LS		Quantity	Cost
Railroad Xing and Signal Removal	100,000		1	$100,000
		Subtotal		$100,000
Railroad Flagging				
	Cost per Days		Quantity	Cost
Flagging	1,100		100	$110,000
		Subtotal		$110,000
			Total Railroad Cost	**$2,090,000**

Project: Saskatoon Grade Separation Study
22nd Street
Total Cost

Subtotal Costs			
		Bridge Subtotal	**$6,317,373**
		Road Subtotal	**$21,585,500**
		Railroad Subtotal	**$2,090,000**
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$30,542,873
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$3,054,287
		Subtotal	$3,054,287
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$1,679,858
Construction Engineering		5%	$1,679,858
		Subtotal	$3,359,716
Contingency		**% Increase**	**Cost**
Contingency		30%	$11,087,063
		Subtotal	$11,087,063
		Total Cost	**$48,043,939**

Project: Saskatoon Grade Separation Study
3rd Ave - Warman Road
Bridge Structure over Rail

A. Bridge Superstructure			
Concrete Bridge Superstructure			
	Cost per Lin. Meter	Quantity	Cost
CIP Box Girder Concrete, Skewed	$1,900	263	$498,750
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	41	$215,670
	Cost per Lin. Meter		
Expansion joint	$2,800	70	$196,000
		Subtotal	$910,420
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	35	$245,000
		Subtotal	$245,000
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	30	$36,000
		Subtotal	$36,000
		Superstructure Subtotal	$1,191,420
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	1172	$1,406,400
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	139	$624,969
		Subtotal	$2,031,369
Foundation			
	Cost per Each	Quantity	Cost
H-Pile	$9,750	88	$858,000
		Subtotal	$858,000
		Substructure Subtotal	$2,889,369
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$244,847.34
		6%	$244,847
		Total Bridge Cost	**$4,325,636**

Project: Saskatoon Grade Separation Study
3rd Ave - Warman Road
Bridge Structure over 33rd St

A. Bridge Superstructure			
Concrete Bridge Superstructure			
	Cost per Lin. Meter	Quantity	Cost
CIP Box Girder Concrete, Straight	$1,700	460	$782,000
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	73	$377,936
	Cost per Lin. Meter		
Expansion joint	$2,800	80	$224,000
		Subtotal	$1,383,936
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	40	$280,000
		Subtotal	$280,000
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	100	$120,000
		Subtotal	$120,000
		Superstructure Subtotal	$1,783,936
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	1764	$2,116,800
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	209	$940,653
		Subtotal	$3,057,453
Foundation			
	Cost per Each	Quantity	Cost
Pipe Pile	$11,700	72	$842,400
		Subtotal	$842,400
		Substructure Subtotal	$3,899,853
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$341,027.34
		6%	$341,027
		Total Bridge Cost	**$6,024,816**

A. Road Work			
Earthwork			
	Cost per Cubic Meter	**Quantity**	**Cost**
General Fill	**$25**	**86200**	**$2,155,000**
Asphalt/Concrete Removal & Dispo	**$135**	**6400**	**$864,000**
		Subtotal	**$3,019,000**
Surfacing			
	Cost per ton	**Quantity**	**Cost**
Asphalt Pavement	$170	10000	$1,700,000
	Cost per Cubic Meter		
Base Course	$85	4800	$408,000
Subbase Course	$75	4800	$360,000
Drainage Layer	$95	6400	$608,000
	Cost per Sq. Meter		
Sidewalk	$130	4100	$533,000
	Cost per Lin. Meter		
Curb and Gutter	$110	5000	$550,000
Guide Rail	$380	400	$152,000
Pedestrian Barrier	$130	1000	$130,000
Pedestrian Railing	$200	1100	$220,000
		Subtotal	$4,661,000
Landscaping			
	Cost LS	Quantity	Cost
Art and Landscaping	$1,000,000	1	$1,000,000
		Subtotal	$1,000,000
Traffic Items			
	Cost LS	Quantity	Cost
Traffic and Street Light, Sign, Pavement Marking	$1,500,000	1	$1,500,000
		Subtotal	$1,500,000
Retaining Wall			
	Cost per Sq. Meter	Quantity	Cost
Retaining Wall	$800	13300	$10,640,000
		Subtotal	$10,640,000
		Civil Subtotal	$20,820,000

B. Miscellaneous			
Detouring			
	Cost per Lin Meter	Quantity	Cost
Temporary Roadway Detour	$1,100	1000	$1,100,000
	Cost LS		
Detour Signing and Signals	$200,000	1	$200,000
		Subtotal	$1,300,000
Utilities			
	Cost LS	Quantity	Cost
Utility adjustment	$3,000,000	1	$3,000,000
		Subtotal	$3,000,000
Drainage			
	Cost LS	Quantity	Cost
Drainage	$800,000	1	$800,000
		Subtotal	$800,000
		Miscellaneous Subtotal	$5,100,000
		Total Road Cost	**$25,920,000**

Project: Saskatoon Grade Separation Study
3rd Ave - Warman Road
Railroad Work

Railroad Work			
New Track			
	Cost per Meter	Quantity	Cost
New Railway Track	1,500	70	$105,000
		Subtotal	$105,000
Railroad Xing and Signal Removal			
	Cost LS	Quantity	Cost
Railroad Xing and Signal Removal	100,000	1	$100,000
		Subtotal	$100,000
Railroad Flagging			
	Cost per Days	Quantity	Cost
Flagging	1,100	100	$110,000
		Subtotal	$110,000
		Total Railroad Cost	**$315,000**

Project: Saskatoon Grade Separation Study
3rd Ave - Warman Road
Total Cost

Subtotal Costs			
		Bridge Subtotal	$10,350,453
		Road Subtotal	$25,920,000
		Railroad Subtotal	$315,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$100,000	1	$100,000
Environmental Site Restoration	$500,000	1	$500,000
		Subtotal	$600,000
		Unadjusted Total	$37,185,453
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$3,718,545
		Subtotal	$3,718,545
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$2,045,200
Construction Engineering		5%	$2,045,200
		Subtotal	$4,090,400
Right-of-Way			
	Cost LS	Quantity	Cost
Land Acquisition	$8,000,000	1	$8,000,000
		Subtotal	$8,000,000
Contingency		**% Increase**	**Cost**
Contingency		30%	$15,898,319
		Subtotal	$15,898,319
		Total Cost	**$68,892,717**

Project: Saskatoon Grade Separation Study
Preston Ave
Bridge Structure

A. Bridge Superstructure			
Concrete Bridge Girders			
	Cost per Lin. Meter	Quantity	Cost
Precast Prestressed I-Girders	$550	400	$220,000
	Cost per Cubic Meter		
Concrete Deck	$1,200	200	$240,000
	Cost per ton	Quantity	Cost
Reinforcing/ Prestressing Steel	5,200	32	$164,320
	Cost per Lin. Meter	Quantity	Cost
Expansion joint	$2,800	43	$120,796
		Subtotal	$745,116
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	43	$301,990
		Subtotal	$301,990
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	55	$66,483
		Subtotal	$66,483
		Superstructure Subtotal	$1,113,589
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	658	$789,060
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	52	$233,759
		Subtotal	$1,022,819
Foundation			
	Cost per Each	Quantity	Cost
H-Pile	$8,450	48	$405,600
		Subtotal	$405,600
		Substructure Subtotal	$1,428,419
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$152,520.48
		6%	$152,520
		Total Bridge Cost	**$2,694,529**

A. Road Work			
Earthwork			
	Cost per Cubic Meter	Quantity	Cost
General Fill	$25	78400	$1,960,000
Asphalt/Concrete Removal & Dispo	$135	2300	$310,500
		Subtotal	$2,270,500
Surfacing			
	Cost per ton	Quantity	Cost
Asphalt Pavement	$170	4100	$697,000
	Cost per Cubic Meter		
Base Course	$85	1900	$161,500
Subbase Course	$75	1900	$142,500
Drainage Layer	$95	2500	$237,500
	Cost per Sq. Meter		
Sidewalk	$130	2000	$260,000
	Cost per Lin. Meter		
Curb and Gutter	$110	2700	$297,000
Guide Rail	$380	200	$76,000
Pedestrian Barrier	$130	600	$78,000
Pedestrian Railing	$200	1400	$280,000
		Subtotal	$2,229,500
Landscaping			
	Cost LS	Quantity	Cost
Art and Landscaping	$300,000	1	$300,000
		Subtotal	$300,000
Traffic Items			
	Cost LS	Quantity	Cost
Traffic and Street Light, Sign, Pavement Marking	$1,000,000	1	$1,000,000
		Subtotal	$1,000,000
Retaining Wall			
	Cost per Sq. Meter	Quantity	Cost
Retaining Wall	$800	4300	$3,440,000
		Subtotal	$3,440,000
		Civil Subtotal	$9,240,000

Project: Saskatoon Grade Separation Study
Preston Ave
Road Work

B. Miscellaneous			
Detouring			
	Cost per Lin Meter	Quantity	Cost
Temporary 2 lane Roadway Detour	$1,100	800	$880,000
	Cost LS		
Detour Signing and Signals	$200,000	1	$200,000
		Subtotal	$1,080,000
Utilities			
	Cost LS	Quantity	Cost
Utility adjustment	$2,000,000	1	$2,000,000
		Subtotal	$2,000,000
Drainage			
	Cost LS	Quantity	Cost
Drainage	$500,000	1	$500,000
		Subtotal	$500,000
		Miscellaneous Subtotal	$3,580,000
		Total Road Cost	**$12,820,000**

Project: Saskatoon Grade Separation Study
Preston Ave
Railroad Work

Railroad Work			
New Track			
	Cost per Meter	Quantity	Cost
New Railway Track	1,500	30	$45,000
		Subtotal	$45,000
Detour at Grade Crossing			
	Cost LS	Quantity	Cost
Railroad Xing and Signal	500,000	1	$500,000
		Subtotal	$500,000
Railroad Xing and Signal Removal			
	Cost LS	Quantity	Cost
Railroad Xing and Signal Removal	100,000	1	$100,000
		Subtotal	$100,000
Railroad Flagging			
	Cost per Days	Quantity	Cost
Flagging	1,100	100	$110,000
		Subtotal	$110,000
		Total Railroad Cost	**$755,000**

Project: Saskatoon Grade Separation Study
Preston Ave
Total Cost

Subtotal Costs			
		Bridge Subtotal	$2,694,529
		Road Subtotal	$12,820,000
		Railroad Subtotal	$755,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$16,819,529
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$1,681,953
		Subtotal	$1,681,953
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$925,074
Construction Engineering		5%	$925,074
		Subtotal	$1,850,148
Contingency		**% Increase**	**Cost**
Contingency		30%	$6,105,489
		Subtotal	$6,105,489
		Total Cost	**$26,457,118**

Project: Saskatoon Grade Separation Study
Central Ave & Gray Ave
Bridge Structure over Rail

A. Bridge Superstructure			
Concrete Bridge Girders			
	Cost per Lin. Meter	Quantity	Cost
Precast Prestressed I-Girders	$580	315	$182,700
	Cost per Cubic Meter		
Deck Concrete	$1,200	158	$189,000
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	25	$129,402
	Cost per Lin. Meter		
Expansion joint	$2,800	44	$121,969
		Subtotal	$623,071
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	44	$304,922
		Subtotal	$304,922
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	69	$82,675
		Subtotal	$82,675
		Superstructure Subtotal	$1,010,668
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	656	$786,749
	Cost per ton	Quantity	Cost
Reinforcing Steel	$4,500	78	$349,611
		Subtotal	$1,136,360
Foundation			
	Cost per Each	Quantity	Cost
H- Pile	$9,750	56	$546,000
		Subtotal	$546,000
		Substructure Subtotal	$1,682,360
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$161,581.67
		6%	$161,582
		Total Bridge Cost	**$2,854,609**

Project: Saskatoon Grade Separation Study
Central Ave & Gray Ave
Access Road Bridge (1)

A. Bridge Superstructure			
Cast-in-Place Flat Slab			
	Cost per Cubic Meter	Quantity	Cost
Deck Concrete	$1,200	84	$100,800
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	13	$69,014
	Cost per Lin. Meter		
Expansion joint	$2,800	28	$78,400
		Subtotal	$248,214
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	7	$49,000
		Subtotal	$49,000
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	21	$25,200
		Subtotal	$25,200
		Superstructure Subtotal	$322,414
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	538	$646,080
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	43	$191,401
		Subtotal	$837,481
Foundation			
	Cost per Each	Quantity	Cost
H- Pile	$8,450	28	$236,600
		Subtotal	$236,600
		Substructure Subtotal	$1,074,081
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction, increase cost by 6 %.		6%	$83,789.74
		6%	$83,790
		Total Access Bridge Cost	**$1,480,285**

Project: Saskatoon Grade Separation Study
Central Ave & Gray Ave
Access Road Bridge (2)

A. Bridge Superstructure			
Cast-in-Place Flat Slab			
	Cost per Cubic Meter	Quantity	Cost
Deck Concrete	$1,200	84	$100,800
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	13	$69,014
	Cost per Lin. Meter		
Expansion joint	$2,800	28	$78,400
		Subtotal	$248,214
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	7	$49,000
		Subtotal	$49,000
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	21	$25,200
		Subtotal	$25,200
		Superstructure Subtotal	$322,414
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	483	$579,840
	Cost per ton	Quantity	Cost
Reinforcing Steel	$4,500	38	$171,778
		Subtotal	$751,618
Foundation			
	Cost per Each	Quantity	Cost
H-Pile	$8,450	28	$236,600
		Subtotal	$236,600
		Substructure Subtotal	$988,218
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction cost increase		6%	$78,637.92
		6%	$78,638
		Total Access Bridge Cost	**$1,389,270**

A. Road Work				
Earthwork				
	Cost per Cubic Meter		Quantity	Cost
General Fill	$25		40400	$1,010,000
Asphalt/Concrete Removal & Dispo	$135		2100	$283,500
		Subtotal		$1,293,500
Surfacing				
	Cost per ton		Quantity	Cost
Asphalt Pavement	$170		3400	$578,000
	Cost per Cubic Meter			
Base Course	$85		1600	$136,000
Subbase Course	$75		1600	$120,000
Drainage Layer	$95		2100	$199,500
	Cost per Sq. Meter			
Sidewalk	$130		1900	$247,000
	Cost per Lin. Meter			
Curb and Gutter	$110		2400	$264,000
Guide Rail	$380		300	$114,000
Pedestrian Barrier	$130		600	$78,000
Pedestrian Railing	$200		700	$140,000
		Subtotal		$1,876,500
Landscaping				
	Cost LS		Quantity	Cost
Art and Landscaping	$300,000		1	$300,000
		Subtotal		$300,000
Traffic Items				
	Cost LS		Quantity	Cost
Traffic and Street Light, Sign, Pavement Marking	$700,000		1	$700,000
		Subtotal		$700,000
Retaining Wall				
	Cost per Sq. Meter		Quantity	Cost
Retaining Wall	$800		5700	$4,560,000
		Subtotal		$4,560,000
			Civil Subtotal	$8,730,000

B. Miscellaneous				
Detouring				
	Cost LS		Quantity	Cost
Temporary Road Work	$900,000		1	$900,000
Detour Signing and Signals	$200,000		1	$200,000
		Subtotal		$1,100,000
Utilities				
	Cost LS		Quantity	Cost
Utility adjustment (overhead power)	$1,500,000		1	$1,500,000
		Subtotal		$1,500,000
Drainage				
	Cost LS		Quantity	Cost
Drainage	$500,000		1	$500,000
		Subtotal		$500,000
			Miscellaneous Subtotal	$3,100,000
			Total Road Cost	**$11,830,000**

Project: Saskatoon Grade Separation Study
Central Ave & Gray Ave
Railroad Work

Railroad Work			
New Track			
	Cost per Meter	Quantity	Cost
New Railway Track	1,500	40	$60,000
		Subtotal	$60,000
Railroad Xing and Signal Removal			
	Cost LS	Quantity	Cost
Railroad Xing and Signal Removal	200,000	1	$200,000
		Subtotal	$200,000
Railroad Flagging			
	Cost per Days	Quantity	Cost
Flagging	1,100	100	$110,000
		Subtotal	$110,000
		Total Railroad Cost	**$370,000**

Project: Saskatoon Grade Separation Study
Central Ave & Gray Ave
Total Cost

Subtotal Costs			
		Bridge Subtotal	$5,724,165
		Road Subtotal	$11,830,000
		Railroad Subtotal	$370,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$18,474,165
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$1,847,416
		Subtotal	$1,847,416
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$1,016,079
Construction Engineering		5%	$1,016,079
		Subtotal	$2,032,158
Contingency		**% Increase**	**Cost**
Contingency		30%	$6,706,122
		Subtotal	$6,706,122
		Total Cost	**$29,059,861**

Project: Saskatoon Grade Separation Study
33rd Street and Edmonton Ave
Bridge Structure

A. Bridge Superstructure			
Cast-in-Place, Post Tensioned Concrete Through Girder Bridge (CIP/PT/TG)			
	Cost per Cubic Meter	Quantity	Cost
CIP Box Girder Concrete, Skewed	$1,900	656	$1,245,450
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	104	$538,559
	Cost per Lin. Meter		
Expansion joint	$2,800	47	$131,805
	Cost per Sq. Meter		
Waterproofing	$600	330	$198,000
	Cost per Lin. Meter		
Pedestrian Railing	**$200**	120	$24,000
		Subtotal	$2,137,813
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	24	$164,756
		Subtotal	$164,756
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	91	$109,210
		Subtotal	$109,210
		Superstructure Subtotal	$2,411,779
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	**Quantity**	**Cost**
Substructure Concrete	$1,200	815	$977,914
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	129	$579,414
		Subtotal	$1,557,327
Foundation			
	Cost per Each	**Quantity**	**Cost**
Drilled Shaft	**$97,500**	**9**	**$877,500**
		Subtotal	**$877,500**
		Substructure Subtotal	**$2,434,827**
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction increase		**6%**	**$290,796.36**
Phased construction and framework increase		**10%**	**$484,660.60**
		16%	**$775,457**
		Total Bridge Cost	**$5,622,063**
Estimated Culvert Cost	**Cost per Meter**	**Quantity**	**Cost**
Culvert	**$5,000**	**25**	**$125,000**
		Culvert Cost	**$125,000**

Project: Saskatoon Grade Separation Study
33rd Street and Edmonton Ave
Railroad Work

A. Railroad Work				
Remove Existing Track				
	Cost per Meter		Quantity	Cost
Remove Existing Track (Rail, Tie, Ballast)	$40		2200	$88,000
		Subtotal		$88,000
Earthwork				
	Cost per Cubic Meter		Quantity	Cost
Embankment	$25		115200	$2,880,000
		Subtotal		$2,880,000
Retaining Wall				
	Cost per Sq. Meter		Quantity	Cost
Retaining Wall	$800		6460	$5,168,000
		Subtotal		$5,168,000
New Track				
	Cost per Meter		Quantity	Cost
New S&I Single Track (136lb Rail, Tie, Bal	1,200		2200	$2,640,000
S&I Sub-Ballast	240		2200	$528,000
		Subtotal		$3,168,000
Railroad Flagging				
	Cost per Days		Quantity	Cost
Flagging	1,100		700	$770,000
		Subtotal		$770,000
B. Miscellaneous				
Shoofly Track				
	Cost per Meter		Quantity	Cost
Shoofly Track (Rail, Tie, Ballast, Subballast, embankment)	1,500		2200	$3,300,000
	Cost LS			
Railroad Xing and Signal	500,000		1	$500,000
		Subtotal		$3,800,000
Drainage				
	Cost LS		Quantity	Cost
Drainage	$2,000,000		1	$2,000,000
		Subtotal		$2,000,000
Utilities				
	Cost LS		Quantity	Cost
Utility adjustment	$3,000,000		1	$3,000,000
		Subtotal		$3,000,000
			Total Railroad Cost	**$20,874,000**

Project: Saskatoon Grade Separation Study
33rd Street and Edmonton Ave
Total Cost

Subtotal Costs			
		Bridge Subtotal	$5,872,063
		Railroad Subtotal	$20,874,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$27,296,063
Traffic Control		**% Increase**	**Cost**
Traffic Control		5%	$1,364,803
		Subtotal	$1,364,803
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$2,729,606
		Subtotal	$2,729,606
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$1,501,283
Construction Engineering		5%	$1,501,283
		Subtotal	$3,002,567
Contingency		**% Increase**	**Cost**
Contingency		30%	$10,317,912
		Subtotal	$10,317,912
		Total Cost	**$44,710,951**

Project: Saskatoon Grade Separation Study
Marquis Drive
Bridge Structure

A. Bridge Superstructure			
Concrete Bridge Superstructure			
	Cost per Lin. Meter	Quantity	Cost
Precast Prestressed I-Girders	$550	400	$220,000
	Cost per Cubic Meter		
Concrete Deck	$1,200	200	$240,000
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	32	$164,320
	Cost per Lin. Meter		
Expansion joint	$2,800	40	$112,000
		Subtotal	$736,320
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	40	$280,000
		Subtotal	$280,000
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	30	$36,000
		Subtotal	$36,000
		Superstructure Subtotal	$1,052,320
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	564	$676,800
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	45	$200,502
		Subtotal	$877,302
Foundation			
	Cost per Each	Quantity	Cost
H- Pile	$8,450	48	$405,600
		Subtotal	$405,600
		Substructure Subtotal	$1,282,902
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$140,113.32
		6%	$140,113
		Total Bridge Cost	**$2,475,335**

A. Road Work			
Earthwork			
	Cost per Cubic Meter	**Quantity**	**Cost**
General Fill	$25	67800	$1,695,000
Asphalt/Concrete Removal & Dispos	$135	2000	$270,000
		Subtotal	$1,965,000
Surfacing			
	Cost per ton	**Quantity**	**Cost**
Asphalt Pavement	$170	3200	$544,000
	Cost per Cubic Meter		
Base Course	$85	1600	$136,000
Subbase Course	$75	1600	$120,000
Drainage Layer	$95	2100	$199,500
	Cost per Sq. Meter		
Sidewalk	$130	1700	$221,000
	Cost per Lin. Meter		
Curb and Gutter	$110	2400	$264,000
Guide Rail	$380	200	$76,000
Pedestrian Barrier	$130	500	$65,000
Pedestrian Railing	$200	1200	$240,000
		Subtotal	$1,865,500
Landscaping			
	Cost LS	**Quantity**	**Cost**
Art and Landscaping	$300,000	1	$300,000
		Subtotal	$300,000
Traffic Items			
	Cost LS	**Quantity**	**Cost**
Traffic and Street Light, Sign, Pavement Marking	$700,000	1	$700,000
		Subtotal	$700,000
Retaining Wall			
	Cost per Sq. Meter	**Quantity**	**Cost**
Retaining Wall	$800	3700	$2,960,000
			$2,960,000
		Civil Subtotal	$7,790,500

B. Miscellaneous			
Detouring			
	Cost per Lin Meter	**Quantity**	**Cost**
Temporary Roadway Detour	$1,100	350	$385,000
	Cost LS		
Temporary Road Work	$500,000	1	$500,000
Detour Signing and Signals	$200,000	1	$200,000
		Subtotal	$1,085,000
Utilities			
	Cost LS	**Quantity**	**Cost**
Utility adjustment (overhead power)	$1,500,000	1	$1,500,000
		Subtotal	$1,500,000
Drainage			
	Cost LS	**Quantity**	**Cost**
Drainage	$500,000	1	$500,000
		Subtotal	$500,000
		Miscellaneous Subtotal	$3,085,000
		Total Road Cost	**$10,875,500**

Railroad Work			
New Track			
	Cost per Meter	**Quantity**	**Cost**
New Railway Track	1,500	30	$45,000
		Subtotal	$45,000
Detour at Grade Crossing			
	Cost LS	**Quantity**	**Cost**
Railroad Xing and Signal	500,000	1	$500,000
		Subtotal	$500,000
Railroad Xing and Signal Removal			
	Cost LS	**Quantity**	**Cost**
Railroad Xing and Signal Removal	100,000	1	$100,000
		Subtotal	$100,000
Railroad Flagging			
	Cost per Days	**Quantity**	**Cost**
Flagging	1,100	100	$110,000
		Subtotal	$110,000
		Total Railroad Cost	**$755,000**

Project: Saskatoon Grade Separation Study
Marquis Drive
Total Cost

Subtotal Costs			
		Bridge Subtotal	$2,475,335
		Road Subtotal	$10,875,500
		Railroad Subtotal	$755,000
Environmental			
	Cost LS	**Quantity**	**Cost**
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$14,655,835
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$1,465,584
		Subtotal	$1,465,584
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$806,071
Construction Engineering		5%	$806,071
		Subtotal	$1,612,142
Contingency		**% Increase**	**Cost**
Contingency		30%	$5,320,068
		Subtotal	$5,320,068
		Total Cost	**$23,053,629**

Project: Saskatoon Grade Separation Study
11 Street & Circle Drive
Bridge Structure over Rail

A. Bridge Superstructure			
Concrete Bridge Superstructure			
	Cost per Lin. Meter	Quantity	Cost
Precast Prestressed I-Girders	$740	1098	$812,520
	Cost per Cubic Meter		
Concrete Deck	$1,200	378	$453,600
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	60	$310,565
	Cost per Lin. Meter		
Expansion joint	$2,800	48	$134,400
		Subtotal	$1,711,085
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	24	$168,000
		Subtotal	$168,000
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	36	$43,200
		Subtotal	$43,200
		Superstructure Subtotal	$1,922,285
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	1416	$1,699,200
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	168	$755,082
		Subtotal	$2,454,282
Foundation			
	Cost per Each	Quantity	Cost
Pipe Pile	$11,700	80	$936,000
		Subtotal	$936,000
		Substructure Subtotal	$3,390,282
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$318,754.01
		6%	$318,754
		Total Bridge Cost	**$5,631,321**

Project: Saskatoon Grade Separation Study
11 Street & Circle Drive
Bridge Structure over Circle Dr

A. Bridge Superstructure			
Concrete Bridge Superstructure			
	Cost per Lin. Meter	Quantity	Cost
Precast Prestressed I-Girders	$550	300	$165,000
	Cost per Cubic Meter		
Concrete Deck	$1,200	150	$180,000
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	24	$123,240
	Cost per Lin. Meter		
Expansion joint	$2,800	48	$134,400
		Subtotal	$602,640
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	24	$168,000
		Subtotal	$168,000
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	36	$43,200
		Subtotal	$43,200
		Superstructure Subtotal	$813,840
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	1342	$1,610,400
	Cost per ton	Quantity	Cost
Reinforcing Steel	$4,500	159	$715,622
		Subtotal	$2,326,022
Foundation			
	Cost per Each	Quantity	Cost
Pipe Pile	$11,700	60	$702,000
		Subtotal	$702,000
		Substructure Subtotal	$3,028,022
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$230,511.69
		6%	$230,512
		Total Bridge Cost	**$4,072,373**

A. Road Work			
Earthwork			
	Cost per Cubic Meter	Quantity	Cost
General Fill	$25	137000	$3,425,000
Asphalt/Concrete Removal & Dispo	$135	2000	$270,000
		Subtotal	$3,695,000
Surfacing			
	Cost per ton	Quantity	Cost
Asphalt Pavement	$170	6300	$1,071,000
Cost per Cubic Meter			
Base Course	$85	3100	$263,500
Subbase Course	$75	3100	$232,500
Drainage Layer	$95	4100	$389,500
Cost per Sq. Meter			
Sidewalk	$130	1800	$234,000
Cost per Lin. Meter			
Curb and Gutter	$110	3400	$374,000
Guide Rail	$380	250	$95,000
Barrier to Block the Closed Roads	$450	300	$135,000
Pedestrian Barrier	$130	500	$65,000
Pedestrian Railing	$200	600	$120,000
		Subtotal	$2,979,500
Landscaping			
	Cost LS	Quantity	Cost
Art and Landscaping	$500,000	1	$500,000
		Subtotal	$500,000
Traffic Items			
	Cost LS	Quantity	Cost
Traffic and Street Light, Sign, Pavement Marking	$1,200,000	1	$1,200,000
		Subtotal	$1,200,000
Retaining Wall			
	Cost per Sq. Meter	Quantity	Cost
Retaining Wall	$800	5600	$4,480,000
		Subtotal	$4,480,000
		Civil Subtotal	**$12,854,500**

B. Miscellaneous			
Detouring			
	Cost LS	Quantity	Cost
Temporary Road Work	$500,000	1	$500,000
Detour Signing and Signals	$200,000	1	$200,000
		Subtotal	$700,000
Utilities			
	Cost LS	Quantity	Cost
Utility Adjustment	$2,000,000	1	$2,000,000
		Subtotal	$2,000,000
Drainage			
	Cost LS	Quantity	Cost
Drainage	$1,000,000	1	$1,000,000
		Subtotal	$1,000,000
		Miscellaneous Subtotal	$3,700,000
		Total Road Cost	$16,554,500

Railroad Work			
New Track			
	Cost per Meter	Quantity	Cost
New Railway Track	1,500	150	$225,000
		Subtotal	$225,000
Railroad Xing and Signal Removal			
	Cost LS	Quantity	Cost
Railroad Xing and Signal Removal	300,000	1	$300,000
		Subtotal	$300,000
Railroad Flagging			
	Cost per Days	Quantity	Cost
Flagging	1,100	100	$110,000
		Subtotal	$110,000
		Total Railroad Cost	$635,000

Project: Saskatoon Grade Separation Study
11 Street & Circle Drive
Total Cost

Subtotal Costs			
		Bridge Subtotal	**$9,703,694**
		Road Subtotal	**$16,554,500**
		Railroad Subtotal	**$635,000**
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$27,443,194
Mobilization		**% Increase**	**Cost**
Mobilization		**10%**	**$2,744,319**
		Subtotal	**$2,744,319**
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$1,509,376
Construction Engineering		5%	$1,509,376
		Subtotal	$3,018,751
Right-of-Way			
	Cost LS	Quantity	Cost
Land Acquisition	$400,000	1	$400,000
		Subtotal	$400,000
Contingency		**% Increase**	**Cost**
Contingency		30%	$10,081,879
		Subtotal	$10,081,879
		Total Cost	**$43,688,144**

Project: Saskatoon Grade Separation Study
51 Street-Lenore Dr
Bridge Structure

A. Bridge Superstructure			
Concrete Bridge Superstructure			
	Cost per Lin. Meter	**Quantity**	**Cost**
Precast Prestressed I-Girders	$580	675	$391,500
	Cost per Cubic Meter		
Concrete Deck	$1,200	338	$405,000
	Cost per ton		
Reinforcing/ Prestressing Steel	5,200	53	$277,290
	Cost per Lin. Meter		
Expansion joint	$2,800	61	$171,144
		Subtotal	$1,244,934
Bearing Material			
	Cost per Sq. Meter	Quantity	Cost
Neoprene Bearing Pads	$7,000	61	$427,861
		Subtotal	$427,861
Approach Slab			
	Cost per Cubic Meter	Quantity	Cost
Concrete Approach Slab	$1,200	66	$79,483
		Subtotal	$79,483
		Superstructure Subtotal	$1,752,278
B. Bridge Substructure			
Abutments and Piers			
	Cost per Cubic Meter	Quantity	Cost
Substructure Concrete	$1,200	910	$1,092,340
	Cost per ton	**Quantity**	**Cost**
Reinforcing Steel	$4,500	108	$485,409
		Subtotal	$1,577,749
Foundation			
	Cost per Each	Quantity	Cost
H- Pile	$9,750	56	$546,000
		Subtotal	$546,000
		Substructure Subtotal	$2,123,749
C. Estimate Conditional Variables		**% Increase**	**Cost**
Urban construction Increase		6%	$232,561.62
		6%	$232,562
		Total Bridge Cost	$4,108,589

A. Road Work			
Earthwork			
	Cost per Cubic Meter	Quantity	Cost
General Fill	$25	87000	$2,175,000
Asphalt/Concrete Removal & Dispo	$135	3500	$472,500
		Subtotal	$2,647,500
Surfacing			
	Cost per ton	Quantity	Cost
Asphalt Pavement	$170	6300	$1,071,000
	Cost per Cubic Meter		
Base Course	$85	3000	$255,000
Subbase Course	$75	3000	$225,000
Drainage Layer	$95	4000	$380,000
	Cost per Sq. Meter		
Sidewalk	$130	1500	$195,000
	Cost per Lin. Meter		
Curb and Gutter	$110	2300	$253,000
Guide Rail	$380	200	$76,000
Pedestrian Barrier	$130	700	$91,000
Pedestrian Railing	$200	800	$160,000
		Subtotal	$2,706,000
Landscaping			
	Cost LS	Quantity	Cost
Art and Landscaping	$300,000	1	$300,000
		Subtotal	$300,000
Traffic Items			
	Cost LS	Quantity	Cost
Traffic and Street Light, Sign, Pavement Marking	$700,000	1	$700,000
		Subtotal	$700,000
Retaining Wall			
	Cost per Sq. Meter	Quantity	Cost
Retaining Wall	$800	3800	$3,040,000
		Subtotal	$3,040,000
		Civil Subtotal	$9,393,500

B. Miscellaneous			
Detouring			
	Cost per Lin Meter	Quantity	Cost
Temporary Roadway Detour	$1,100	1500	$1,650,000
	Cost LS		
Detour Signing and Signals	$200,000	1	$200,000
		Subtotal	$1,850,000
Utilities			
	Cost LS	Quantity	Cost
Utility adjustment (overhead power)	$1,500,000	1	$1,500,000
		Subtotal	$1,500,000
Drainage			
	Cost LS	Quantity	Cost
Drainage	$500,000	1	$500,000
		Subtotal	$500,000
		Miscellaneous Subtotal	$3,850,000
		Total Road Cost	**$13,243,500**

Railroad Work			
New Track			
	Cost per Meter	Quantity	Cost
New Railway Track	1,500	50	$75,000
		Subtotal	$75,000
Detour at Grade Crossing			
	Cost LS	Quantity	Cost
Railroad Xing and Signal	500,000	1	$500,000
		Subtotal	$500,000
Railroad Xing and Signal Removal			
	Cost LS	Quantity	Cost
Railroad Xing and Signal Removal	100,000	1	$100,000
		Subtotal	$100,000
Railroad Flagging			
	Cost per Days	Quantity	Cost
Flagging	1,100	100	$110,000
		Subtotal	$110,000
		Total Railroad Cost	**$785,000**

Project: Saskatoon Grade Separation Study
51 Street-Lenore Dr
Total Cost

Subtotal Costs			
		Bridge Subtotal	$4,108,589
		Road Subtotal	$13,243,500
		Railroad Subtotal	$785,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$50,000	1	$50,000
Restoration	$500,000	1	$500,000
		Subtotal	$550,000
		Unadjusted Total	$18,687,089
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$1,868,709
		Subtotal	$1,868,709
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$1,027,790
Construction Engineering		5%	$1,027,790
		Subtotal	$2,055,580
Contingency		**% Increase**	**Cost**
Contingency		30%	$6,783,413
		Subtotal	$6,783,413
		Total Cost	**$29,394,790**

Appendix B - Detailed Construction Cost Estimates for Elevated Option

Project: Saskatoon Rail Relocation vs Grade Separation Feasibility Study
CPR Elevated Option Cost Estimate
Bridge Structure

Bridge Lump Sum Cost Estimate at Several Locations			
AVENUE P S			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	25	$2,750,000
		Subtotal	$2,750,000
20 St W			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	40	$4,400,000
		Subtotal	$4,400,000
AVENUE H S			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	20	$2,200,000
		Subtotal	$2,200,000
22nd St W			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	65	$7,150,000
		Subtotal	$7,150,000
AVENUE C N			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	25	$2,750,000
		Subtotal	$2,750,000
IDYLWYLD DR			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	75	$8,250,000
		Subtotal	$8,250,000
3RD AVENUE N			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	60	$6,600,000
		Subtotal	$6,600,000
7 AVENUE N			
	Cost per Lin. Meter	Quantity	Cost
Single Track Concrete Rail Bridge	$110,000	25	$2,750,000
		Subtotal	$2,750,000
		Total Bridge Cost	**$36,850,000**

Project: Saskatoon Rail Relocation vs Grade Separation Feasibility Study
CPR Elevated Option Cost Estimate
Railroad Work

A. Railroad Work				
Remove Existing Track and Structure				
	Cost per Meter		Quantity	Cost
Remove Existing Track (Rail, Tie, Ballast)	$40		10000	$400,000
	Cost LS			
Railroad Xing and Signal Removal	1,000,000		1	$1,000,000
	Cost LS			
Remove Existing 7 AVE. N Bridge	30,000		1	$30,000
		Subtotal		$1,430,000
Earthwork				
	Cost per Cubic Meter		Quantity	Cost
Embankment	$25		349000	$8,725,000
		Subtotal		$8,725,000
Retaining Wall				
	Cost per Sq. Meter		Quantity	Cost
Retaining Wall	$800		34000	$27,200,000
		Subtotal		$27,200,000
Mainline Track				
	Cost per Meter		**Quantity**	**Cost**
S&I Single Track (136lb rail, tie, ballast)	**1,500**		4900	$7,350,000
	Cost per Cubic Meter			
S&I Sub-Ballast	**120**		10400	$1,248,000
		Subtotal		$8,598,000
Railroad Flagging				
	Cost per Days		Quantity	Cost
Flagging	1,100		1000	$1,100,000
		Subtotal		$1,100,000
			Railroad Subtotal	$47,053,000

B. Miscellaneous				
Shoofly Track				
	Cost per Meter		Quantity	Cost
Shoofly Track (Rail, Tie, Ballast, Subballast, Embankment)	1,500		4900	$7,350,000
	Cost LS			
Railroad at Grade Crossing and Signal	500,000		4	$2,000,000
		Subtotal		$9,350,000
Drainage				
	Cost LS		Quantity	Cost
Drainage	$10,000,000		1	$10,000,000
		Subtotal		$10,000,000
Utilities				
	Cost LS		**Quantity**	**Cost**
Utility adjustment	**$15,000,000**		**1**	**$15,000,000**
		Subtotal		$15,000,000
			Miscellaneous Subtotal	$34,350,000
			Total Railroad Cost	**$81,403,000**

Project: Saskatoon Rail Relocation vs Grade Separation Feasibility Study
CPR Elevated Option Cost Estimate
Total Cost

Subtotal Costs			
		Bridge Subtotal	$36,850,000
		Railroad Subtotal	$81,403,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$2,000,000	1	$2,000,000
Restoration	$7,000,000	1	$7,000,000
		Subtotal	$9,000,000
		Unadjusted Total	$127,253,000
Traffic Control		**% Increase**	**Cost**
Traffic Control		5%	$6,362,650
		Subtotal	$6,362,650
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$12,725,300
		Subtotal	$12,725,300
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$6,998,915
Construction Engineering		5%	$6,998,915
		Subtotal	$13,997,830
Contingency		**% Increase**	**Cost**
Contingency		30%	$48,101,634
		Subtotal	$48,101,634
		Total Cost	**$208,440,414**

Appendix C-
Detailed Construction Cost Estimate for Trench Option

Project: Saskatoon Rail Relocation vs Grade Separation Feasibility Study
CPR Trench Option Cost Estimate
Trench

A. Trench Construction Work			
Trench			
	Cost per Cubic Meter	**Quantity**	**Cost**
Slab at Bottom of the Trench	$1,200	67900	$81,480,000
	Cost per ton		
Reinforcing Steel	4,500	2700	$12,150,000
	Cost Per Each		
Drilled Shaft Foundation	$90,000	100	$9,000,000
	Cost per Sq. Meter		
Permanent Shoring wall	$1,500	95000	$142,500,000
	Cost LS		
Overhead Bracing	$10,000,000	1	$10,000,000
		Subtotal	$255,130,000
Earthwork			
	Cost per Cubic Meter	**Quantity**	**Cost**
Excavation to Waste	$20	617500	$12,350,000
	Cost Per Sq. Meter		
Insulation	$50	56730	$2,836,500
Granular Fill	$20	58000	$1,160,000
		Subtotal	$16,346,500
Barrier			
	Cost per Lin. Meter	**Quantity**	**Cost**
Pedestrian Barrier	$200	9300	$1,860,000
		Subtotal	**$1,860,000**
Dewatering and Water Treatment			
	Cost LS	**Quantity**	**Cost**
Dewatering and Water Treatment	$10,000,000	1	$10,000,000
		Subtotal	$10,000,000
		Trench Subtotal	$283,336,500

B. Miscellaneous			
Utilities			
	Cost LS	**Quantity**	**Cost**
Utility adjustment (water, sewer, storm, pump stations, and shallow utilities relocation)	$30,000,000	1	$30,000,000
		Subtotal	$30,000,000
Drainage			
	Cost LS	**Quantity**	**Cost**
Drainage for trench only	$8,000,000	1	$8,000,000
		Subtotal	$8,000,000
		Miscellaneous Subtotal	$38,000,000
		Total Trench Cost	**$321,336,500**

Bridge Lump Sum Cost Estimate at Several Locations			
AVENUE P S			
	Cost per Lin. Meter	**Quantity**	**Cost**
CIP Flat Slab Road Bridge	$50,000	25	$1,250,000
		Subtotal	$1,250,000
20 St W			
	Cost per Lin. Meter	**Quantity**	**Cost**
CIP Flat Slab Road Bridge	$50,000	40	$2,000,000
		Subtotal	$2,000,000
AVENUE H S			
	Cost per Lin. Meter	**Quantity**	**Cost**
CIP Flat Slab Road Bridge	$50,000	20	**$1,000,000**
		Subtotal	**$1,000,000**
22nd St W			
	Cost per Lin. Meter	**Quantity**	**Cost**
CIP Flat Slab Road Bridge	$50,000	65	$3,250,000
		Subtotal	$3,250,000
AVENUE C N			
	Cost per Lin. Meter	**Quantity**	**Cost**
CIP Flat Slab Road Bridge	$50,000	25	$1,250,000
		Subtotal	$1,250,000
IDYLWYLD Dr			
	Cost per Lin. Meter	**Quantity**	**Cost**
CIP Flat Slab Road Bridge	$50,000	75	$3,750,000
		Subtotal	$3,750,000
		Total Bridge Cost	**$12,500,000**

Project: Saskatoon Rail Relocation vs Grade Separation Feasibility Study
CPR Trench Option Cost Estimate
Railroad Work

A. Railroad Work				
Remove Existing Track				
	Cost per Meter		**Quantity**	**Cost**
Remove Existing Track (Rail, Tie, Ballast)	$40		10000	$400,000
	Cost per each			
Railroad Xing and Signal Removal	100,000		10	$1,000,000
		Subtotal		$1,400,000
New Track				
	Cost per Meter		**Quantity**	**Cost**
Single Ballasted Track	1,500		4700	$7,050,000
		Subtotal		$7,050,000
Railroad Flagging				
	Cost per Days		**Quantity**	**Cost**
Flagging	1,100		1500	$1,650,000
		Subtotal		$1,650,000
Shoofly Track				
	Cost per Meter		**Quantity**	**Cost**
Shoofly Track (Rail, Tie, Ballast, Subballast, embankment)	1,500		5300	$7,950,000
	Cost per Each			
Railroad Xing and Signal	500,000		10	$5,000,000
		Subtotal		$12,950,000
		Total Railroad Cost		**$23,050,000**

Project: Saskatoon Rail Relocation vs Grade Separation Feasibility Study
CPR Trench Option Cost Estimate
Total Cost

Subtotal Costs			
		Bridge Subtotal	$12,500,000
		Trench Subtotal	$321,336,500
		Railroad Subtotal	$23,050,000
Environmental			
	Cost LS	Quantity	Cost
Environmental Assessment	$1,500,000	1	$1,500,000
Restoration	$10,000,000	1	$10,000,000
		Subtotal	$11,500,000
		Unadjusted Total	$368,386,500
Traffic Control		**% Increase**	**Cost**
Detour/ Traffic Control During Construction		2.5%	$9,209,663
		Subtotal	$9,209,663
Mobilization		**% Increase**	**Cost**
Mobilization		10%	$36,838,650
		Subtotal	$36,838,650
Engineering		**% Increase**	**Cost**
Design Engineering		5%	$20,261,258
Construction Engineering		5%	$20,261,258
		Subtotal	$40,522,515
Contingency		**% Increase**	**Cost**
Contingency		30%	$136,487,198
		Subtotal	$136,487,198
		Total Cost	**$591,444,526**

Appendix D - Detailed Construction Cost Estimate for Relocation Option

CPR Relocation Option Cost Estimate

CPR Mainline Relocation Option 2A Cost Estimate			
Mainline Track			
	Cost per km	**Quantity**	**Cost**
S&I Single Track (136lb rail, tie, ballas	1,500,000	31	$46,500,000
S&I Sub ballast	240,000	31	$7,440,000
Track Embankment Height < 2m	336,000	27.4	$9,206,400
Track Embankment Height 2-4m	594,000	1.6	$950,400
Track Embankment Height 4-6m	990,000	0.8	$792,000
Track Embankment Height Over 6m	2,226,000	1.2	$2,671,200
Wetland Crossing	600,000	5	$3,000,000
	Cost per Each	**Quantity**	**Cost**
S&I No 15 Turnout	200,000	6	$1,200,000
	Subtotal		$71,760,000
Rail Yard			
	Cost per km	**Quantity**	**Cost**
S&I Single Track (115lb rail, tie, ballas	1,150,000	34	$39,100,000
S&I Sub ballast	240,000	34	$8,160,000
Track Embankment Height 2-4m	594,000	34	$20,196,000
Gravel Service Road/Parking Height 2	800,000	16	$12,800,000
	Cost per Each	**Quantity**	**Cost**
S&I No 9 Turnout	120,000	49	$5,880,000
S&I No 15 Turnout	200,000	4	$800,000
Lighting/Site Service	2,000,000	1	$2,000,000
Storm Water Management	2,000,000	1	$2,000,000
Facility (Match Existing)	15,000,000	1	$15,000,000
	Subtotal		$105,936,000
HWY 16 Road Overpass			
	Cost per Sq. Meter	**Quantity**	**Cost**
Concrete Roadway Bridge	5,000	800	$4,000,000
Roadway (Embankment, Pavement, Line Marking, Guard Rail)	585	16800	$9,828,000
	Subtotal		$13,828,000
CN Mainline (Watrous Sub) Grade Separation 1			
	Cost per Lin. Meter	**Quantity**	**Cost**
Single Track Steel Girder Bridge	110,000	20	$2,200,000
	Subtotal		$2,200,000

CPR Relocation Option Cost Estimate

HWY 11 Grade Separation				
	Cost per Lin. Meter		**Quantity**	**Cost**
Rail over Road Bridge	110,000		50	$5,500,000
		Subtotal		$5,500,000
CN Mainline (Craik Sub) at Grade Crossing (Diamo				
	Cost per Each		**Quantity**	**Cost**
Diamond (Including Diamond, Track Work, Signals, Agreement)	**800,000**		**1**	**$800,000**
		Subtotal		**$800,000**
South Saskatchewan River Bridge				
	Cost per Lin. Meter		**Quantity**	**Cost**
Single Track Steel Girder Bridge	**110,000**		**600**	**$66,000,000**
	Cost LS		**Quantity**	**Cost**
Staging	**13,000,000**		**1**	**$13,000,000**
		Subtotal		**$79,000,000**
HWY 219 Road Overpass				
	Cost per Sq. Meter		**Quantity**	**Cost**
Concrete Roadway Bridge	5,000		400	$2,000,000
Roadway (Embankment, pavement, Line Marking, Guard Rail)	585		8000	$4,680,000
		Subtotal		$6,680,000
Valley Road Overpass				
	Cost per Sq. Meter		**Quantity**	**Cost**
Concrete Roadway Bridge	5,000		400	$2,000,000
Roadway (Embankment, pavement, Line Marking, Guard Rail)	585		9000	$5,265,000
		Subtotal		$7,265,000
At Grade Road Crossing				
	Cost per Each		**Quantity**	**Cost**
Crossing (Including Warning System)	800,000		4	$3,200,000
		Subtotal		$3,200,000

CPR Relocation Option Cost Estimate

CN Mainline (Rosetown Sub) at Grade Crossing (Diamond)				
	Cost per Each		**Quantity**	**Cost**
Diamond (Including Diamond, Track Work, Signals, Agreement)	800,000		1	$800,000
		Subtotal		$800,000
HWY 7 Grade Separation				
	Cost per Lin. Meter		**Quantity**	**Cost**
Rail over Road Bridge	**110,000**		**80**	**$8,800,000**
		Subtotal		**$8,800,000**
CN Mainline (Watrous Sub) Grade Separation 2				
	Cost per Lin. Meter		**Quantity**	**Cost**
Bridge	110,000		20	$2,200,000
		Subtotal		$2,200,000
Utility Protection & Relocation				
	Cost LS		**Quantity**	**Cost**
Overhead Powerline Modification	10,000,000		1	$10,000,000
Other Utility Crossing	10,000,000		1	$10,000,000
	Cost per Each		**Quantity**	**Cost**
Natural Gas Pipeline	1,500,000		2	$3,000,000
		Subtotal		$23,000,000
Signal System				
	Cost LS		**Quantity**	**Cost**
Rail Yard Signal System	10,000,000		1	$10,000,000
Signal at tie in - Wye	1,000,000		2	$2,000,000
		Subtotal		$12,000,000

CPR Relocation Option Cost Estimate

Environmental				
	Cost LS		**Quantity**	**Cost**
Environmental Assessment	$2,000,000		1	$2,000,000
Environmental Restoration	$10,000,000		1	$10,000,000
		Subtotal		$12,000,000
Traffic Control				
	Cost LS		**Quantity**	**Cost**
Traffic Control During Construction	$3,000,000		1	$3,000,000
		Subtotal		$3,000,000
			Unadjusted Total	$357,969,000
Righ-of-Way				
	Cost per Acre		**Quantity**	**Cost**
Land Acquisition	$29,600		308	$9,116,800
	Cost LS			
30% Impacts (1/2 of Reaming Property)	$15,717,600		1	$15,717,600
Soft Costs Transactions Costs	$1,770,000		1	$1,770,000
		Subtotal		$26,604,400
Mobilization		**% Increase**		**Cost**
Mobilization			10%	$35,796,900
		Subtotal		$35,796,900
Engineering		**% Increase**		**Cost**
Design Engineering			5%	$19,688,295
Construction Engineering			5%	$19,688,295
		Subtotal		$39,376,590
Contingency		**% Increase**		**Cost**
Contingency			30%	$129,942,747
		Subtotal		$129,942,747
			Total Cost	**$589,689,637**

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We practice increased use of sustainable materials and reduction of material use.