Benefits of Value Engineering and Risk Analysis for Edmonton's North LRT Extension

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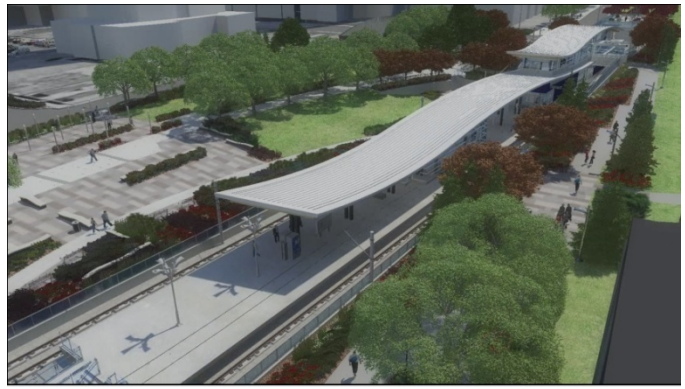
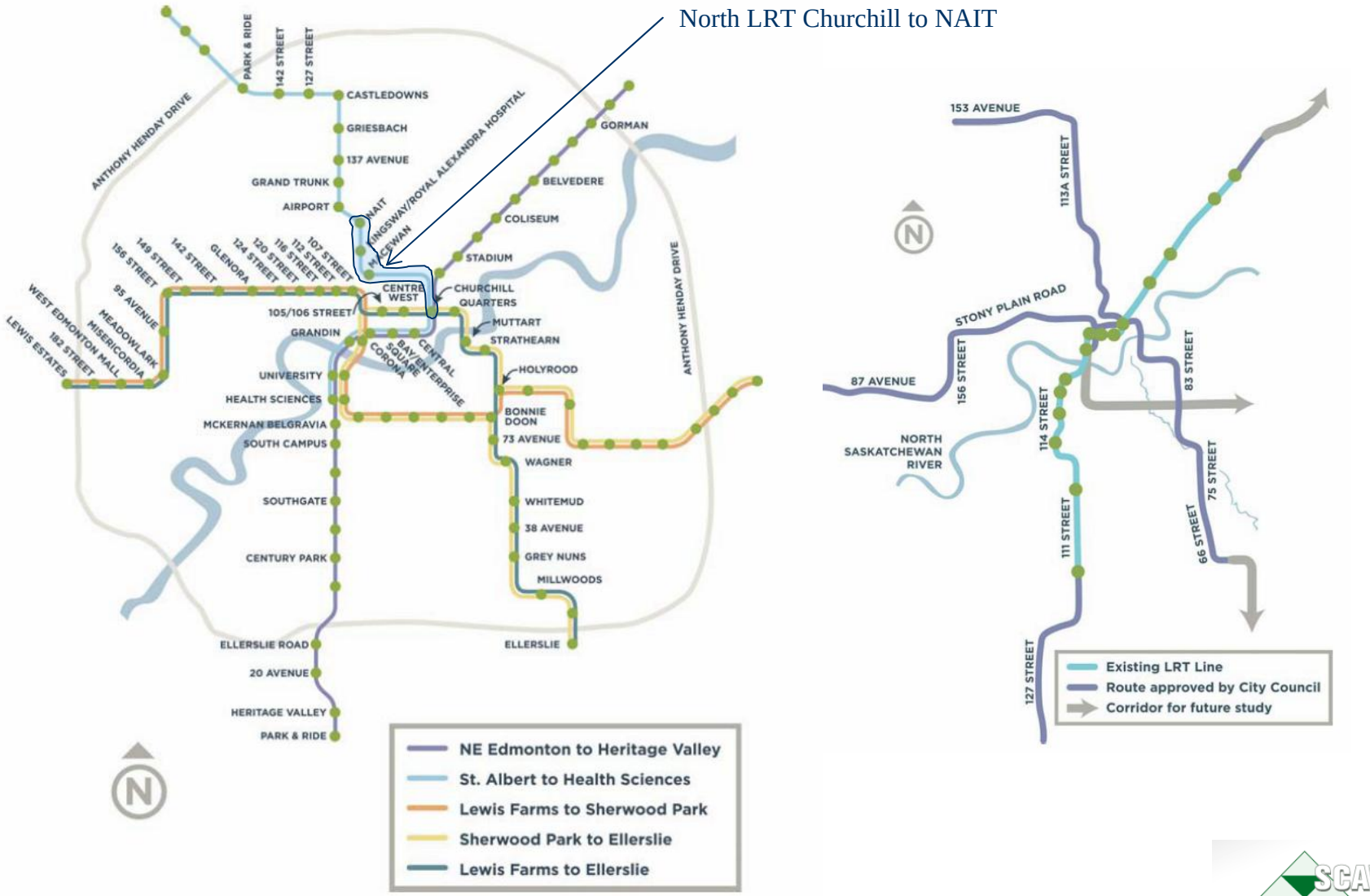
Overview



- North LRT project
- Value Engineering Workshops
- Value Engineering Findings
  - Overall Findings
  - Track Design Option
- Risk Analysis and Risk Mitigation Plan
- Conclusion

Edmonton's LRT System



North LRT Project

Edmonton's North LRT is a $755 million, *3.3 km* extension of Edmonton's current 21-km LRT system, involving tunnelling, street-level construction, and three new LRT stations.

North LRT Milestones

2005 – North Edmonton high-speed transit study identifies NLRT corridor.

2007 – Concept planning initiated, including extensive public involvement.

2008 – City Council approves NLRT concept plan; preliminary engineering begins.

2009 – Detailed design begins; construction of LRT tunnel begins at EPCOR Tower site.

2010 – Right-of-way preparations begin (roadworks, building removals, utility relocations, etc.).

2011 – Tunnel construction and right-of-way preparations continue.

2012 – LRT stations under construction and track bed preparation.

2013 – Track and catenary installation.

2014 – Scheduled opening of NLRT to NAIT

Value Engineering

- The North LRT project detailed design was led by the AECOM team and commenced on September 2009
- Two Value Engineering Workshops were conducted:
  - VE Workshop #1: Whole Project
  - VE Workshop #2: Track Design
- The first workshop objectives:
  - Review and validate the preliminary design
  - Provide value added recommendations to improve the design functionality and cost effectiveness
  - Develop and evaluate creative alternatives to the current design to ensure that the City is getting the most value out of the project
- Second Workshop objective:
  - Identify the highest value option for track design

First Workshop Planning

- 54 participants
- Participants were divided into 6 groups
  - Project Management and Contracting Strategy
  - Systems
  - Roadway
  - Stations
  - Track and Structures
  - Tunnel

Group Activities

1. Divide the *design component* into Work Packages (WP) with associated cost estimates
2. Develop *primary and secondary functions* that each WP is to fulfill
3. Identify all *assumptions, issues, and risks* surrounding the current PE design for each WP
4. Brainstorm and evaluate *Design Recommendations* (DRs) to improve the current design
5. Brainstorm and evaluate *Creative Alternatives* (CAs) to the current design that will significantly improve the value of the design. This includes CAs that will result in cost savings and/or increase functionality.

Workshop Results

Group		1. Overall	2. LRT System	3. Roads and Drainage	4. Stations	5. Track and Structures	6. Tunnel
Ideas Developed	DR	48	8	14	4	8	6
	CA	0	9	18	8	10	4
Ideas Implemented	DR	46	7	12	3	1	1
	CA	0	5	2	3	6	2

- A total of 88 DRs and 49 CAs were developed at the workshop, and of those ideas a total of 70 DRs and 18 CAs are either implemented already or are under serious consideration
- The total estimated savings amounts to $5.3 Million

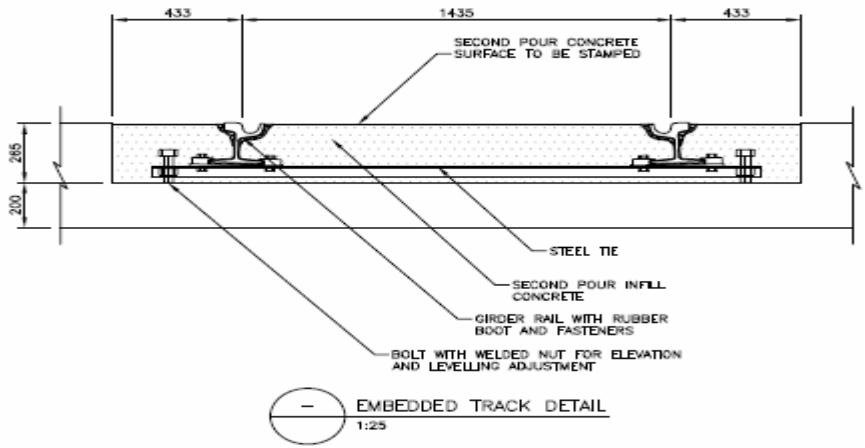
Examples - Creative Ideas

Code	Description / Rationale	Potential Benefit	Comments / Updates / Realized Benefit
CA2.2	Consolidate ROW electrical ductbank with communication ductbank Adv: Possibly very high savings (up to $1M)	$200K-1M (use $600K)	Where possible run communication and electrical equipment in same ductbank. Potentially very large savings.
CA3.15	Embedded Track from MacEwan Station to Princess Elizabeth Avenue Adv: Simplified Drainage (eliminates storm tunnel), enhances urban design, reduces operational costs and overall construction schedule Disadv: Trackwork costs more, longer track construction time	$1-4M (use $2M)	Crossings are already embedded; need facilities input; requires CR/VE for this idea; conduct vibration analysis. This idea will be confirmed or rejected at the VE session on Dec 17, 2009.
CA5.3	Precast Plinths instead of cast-in-place	$1M	Implemented. Will be used in for tunnel section.
CA5.6	Eliminate ballast curbs along road sections where earth structure is sufficiently compacted	$1.2M	If excavating into granular material than do not need ballast curb
CA6.2	Tunnel further distance as an alternative to tangent pile walls	$3M	Implemented.

Ideas - Example

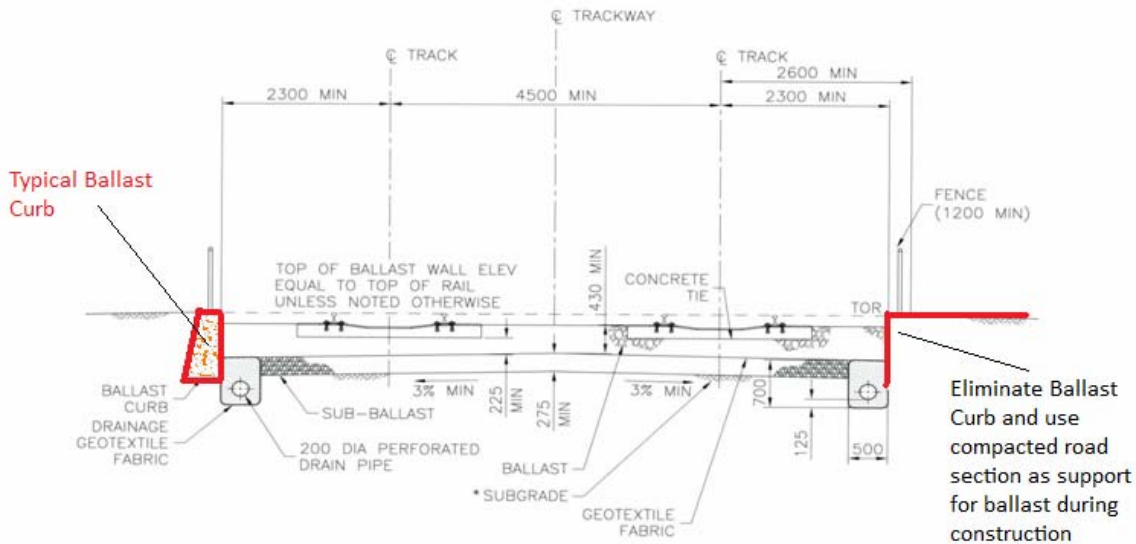
Use cast-in-place Rail Boots

IDEA NAME	ADVANTAGES	DISADVANTAGES	NOTES
CA5.9: Use cast-in-place Rail Boot instead of Icosit on embedded wooden ties	- Easier to replace, ease of maintenance, cost savings	- Less noise absorption, possible corrosion issues with rail boot leakage	GFI: 8 -could use block inserts to save on concrete -could use 2-pour method or use embedded concrete ties
COST IMPLICATIONS -$500K			



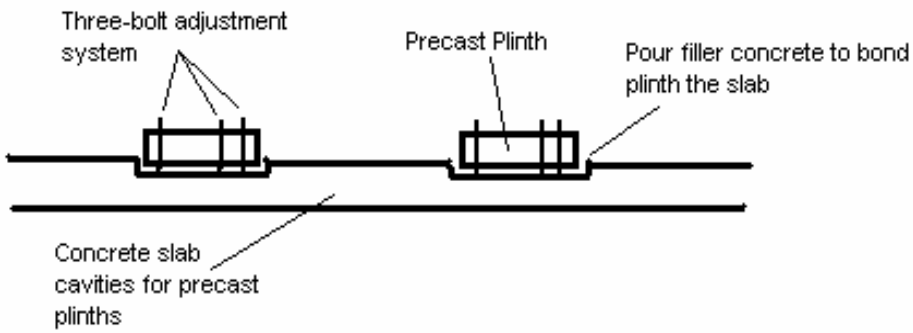
Ideas – Example
Eliminate ballast curbs along road

IDEA NAME	ADVANTAGES	DISADVANTAGES	NOTES
CA5.6: Eliminate ballast curbs along road sections where earth structure is sufficiently compacted	- Large cost savings, faster construction schedule	- Community reaction may not be favorable, may require some additional means for a barrier between ROW and road during construction -Issue with duct bank design (incorporated into Ballast Curb)	GFI: 8
COST IMPLICATIONS			
-$1.2K			



Ideas – Example
Precast Plinths instead of cast-in-place

IDEA NAME	ADVANTAGES	DISADVANTAGES	NOTES
CA5.3: Precast Plinths instead of cast-in-place	-Cost savings -plinth manufacturing occurs in controlled environment -construction technique very similar to cast-in-place	- proof of concept, and must be vertically adjustable, may require exceptional contractor skill -may require contractor with experience with this method	GFI: 9
COST IMPLICATIONS			
-$1M			



Value Engineering #2

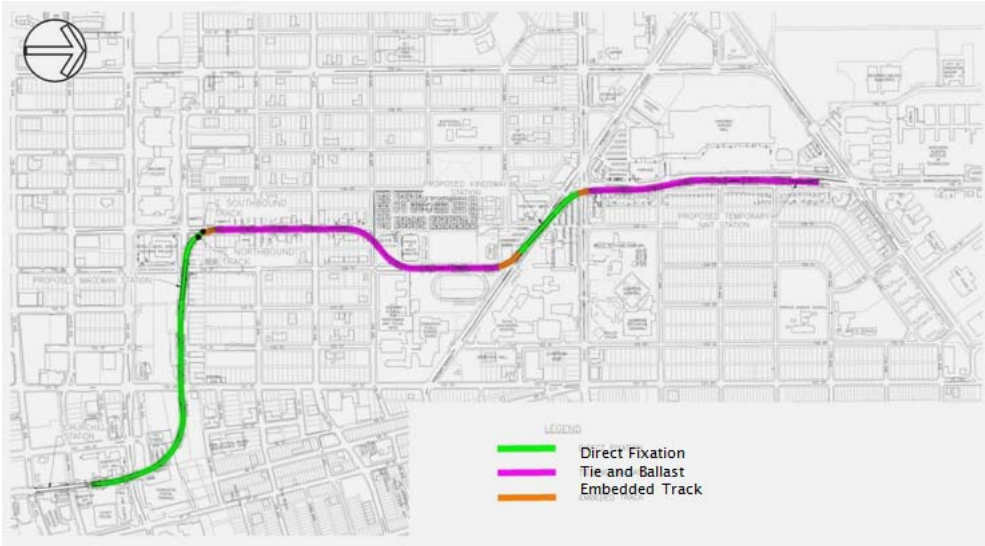
- The purpose of this workshop was to establish the possible track design options
- Life Cycle Cost
- Relationship between track design and drainage requirements
- Three options were identified

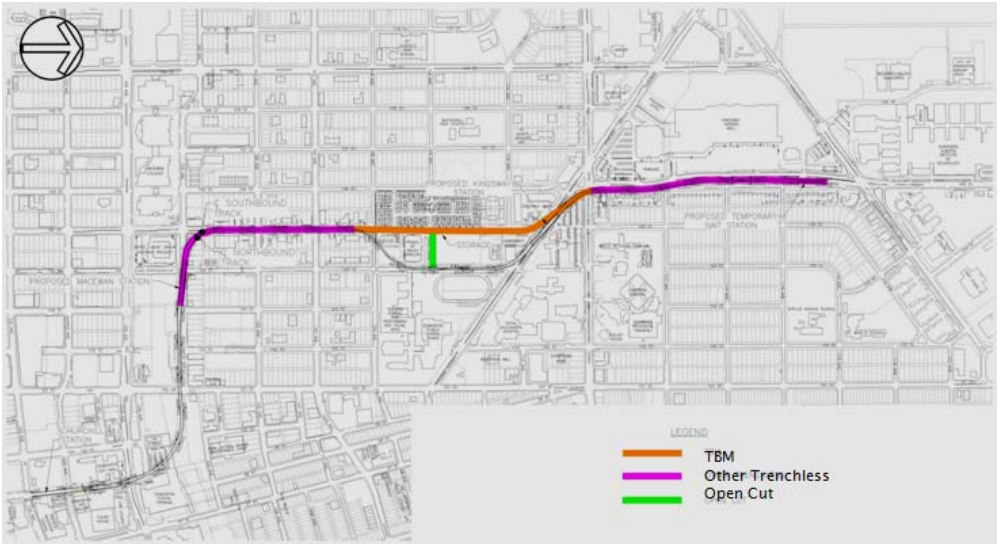
Track - Option 1

Embedded track at curved road crossings

Tie and Ballast at all remaining sections.

The major drainage consists of a Storm Tunnel along the alignment.



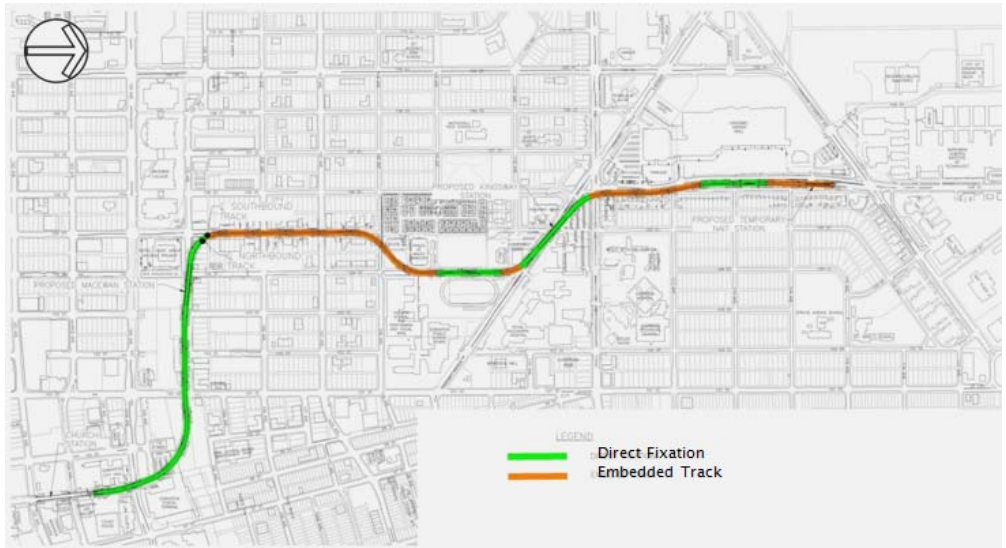


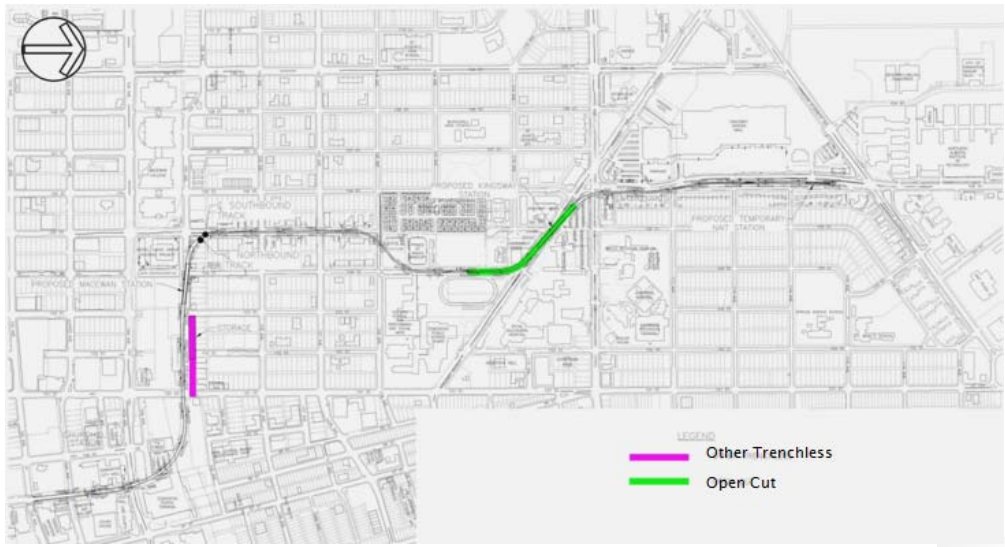
Track - Option2

Direct Fixation in the Tunnel, at Switches, and at stations

Embedded track at all other sections.

Drainage requirements are reduced to a Storage Tunnel at the Portal and a Storm Pipe at 104 St and Kingsway Ave low point.





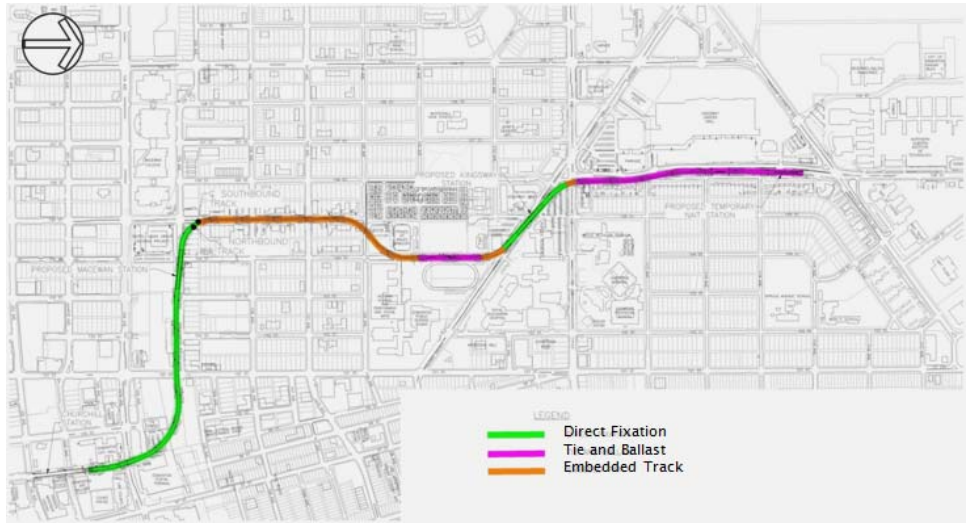
Track - Option3

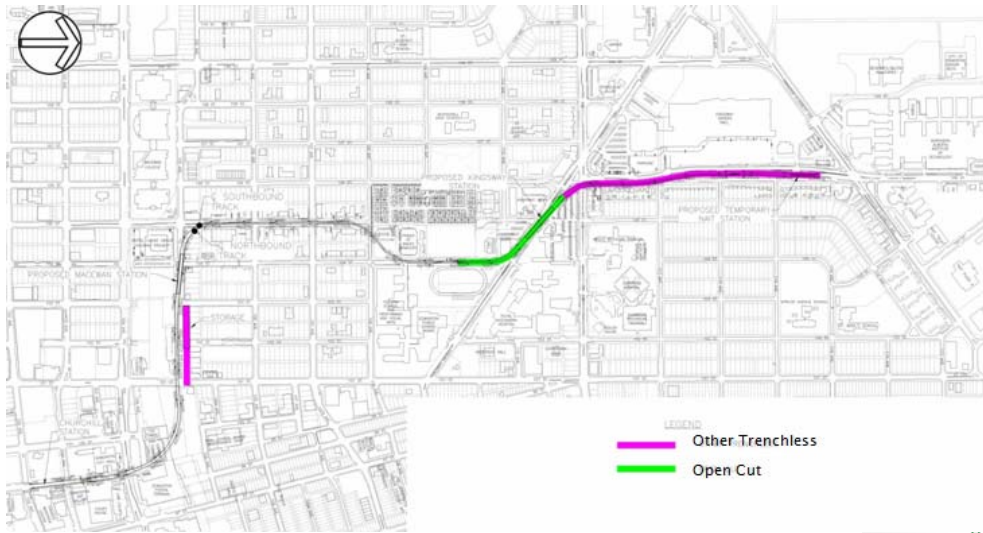
Direct Fixation in Tunnel, at MacEwan Station, and at Kingsway Station

Tie and Ballast at Switches and along 106 St.

Embedded track at curved crossings and from MacEwan Station to approximately 109 Avenue.

Drainage Requirements include a Storage Tunnel at the Portal, a Storm Pipe along Kingsway Ave and Storage Line along 106 St.





Track Options - LCC

	Option 1				Option 2				Option 3			
	Dbl. Trk Units		Cost/Dbl. Trk. KM*	Cost	Dbl. Trk Units		Cost/Dbl. Trk. KM*	Cost	Dbl. Trk Units		Cost/Dbl. Trk. KM*	Cost
Comparison Capital Costs												
Concrete Tie and Ballast	1601	m	$5,514	$8,827,914	0	m	$5,514	$0	939	m	$5,514	$5,177,646
Concrete Tie and Ballast (crossings)	61	m	$12,005	$732,305	0	m	$12,005	$0	0	m	$12,005	$0
Direct Fixation	282	m	$10,298	$2,904,036	705	m	$10,298	$7,260,090	282	m	$10,298	$2,904,036
Embedded Track	0	m	$11,642	$0	1177	m	$11,642	$13,702,634	661	m	$11,642	$7,695,362
Embedded Track (crossings)	112	m	$11,642	$1,303,904	173	m	$11,642	$2,014,066	173	m	$11,642	$2,014,066
Track Subtotal				**$13,768,159**				**$22,976,790**				**$17,791,110**
Track Drainage	1690	m	$676	$1,142,440	188	m	$676	$127,088	1033	m	$676	$698,308
Storm Drainage	1		$12,299,570	$12,299,570	1		$5,145,308	$5,145,308	1		$11,328,500	$11,328,500
Drainage Subtotal				**$13,442,010**				**$5,272,396**				**$12,026,808**
Comparison Life Cycle Maintenance and Operations												
Concrete Tie and Ballast	1.662	km	$7,781,914	$12,933,541	0	km	$7,781,914	$0	0.939	km	$7,781,914	$7,307,217
Direct Fixation	0.282	km	$5,079,736	$1,432,486	0.705	km	$5,079,736	$3,581,214	0.282	km	$5,079,736	$1,432,486
Embedded Track	0.112	km	$12,845,034	$1,438,644	1.35	km	$13,497,510	$18,221,638	0.834	km	$13,497,510	$11,256,923
Pump Station								$500,000				$500,000
Maintenance Subtotal				**$15,804,671**				**$22,302,852**				**$20,496,626**
Comparison Life Cycle Costs				**$43,014,840**				**$50,552,038**				**$50,314,544**
**Monte Carlo Simulation 85th Percentile Value*												

Track Options Evaluation

		Option 1		Option 2		Option 3	
Criteria	Weight	Rating	Score	Rating	Score	Rating	Score
1. Urban Friendly Design	0.24	70	16.55	100	23.64	85	20.09
1. Character		*40*		*100*		*55*	
2. Continuity and Enclosure		*55*		*100*		*85*	
3. Quality Public Realm		*85*		*100*		*85*	
4. Ease of Movement		*100*		*100*		*100*	
5. Adaptability		*40*		*100*		*70*	
6. Legibility		*100*		*100*		*100*	
7. Diversity		*40*		*100*		*70*	
8. Noise		*100*		*70*		*85*	
9. Vibration		*100*		*70*		*85*	
2. Risk	0.06	100	5.67	70	3.97	70	3.97
3. Reliability of Service	0.48	100	48.14	85	40.92	85	40.92
4. Integration with existing system	0.11	100	11.28	85	9.58	85	9.58
5. Compatibility with Future LRT Design	0.11	85	9.58	100	11.28	85	9.58
Criteria Rating			**91.2**		**89.4**		**84.1**

	Option 1	Option 2	Option 3
Option Criteria Rating	91.2	89.4	84.1
Comparison Life Cycle Cost (Millions)	$43	$50.60	$50.30
Value	**21.2**	**17.7**	**16.7**

Option 1 is the highest Value Option

Risk Analysis

ID	Risk Description	Task #	Task Description -- Progress Update	Responsibility	Task % Comp	Current Quantification ID	Likelihood Descriptor	Impact Descriptor
1	**Funding for construction is not secured due to political and stakeholder issues, lack of resources, and provincial/federal grant delays causing cost escalation, loss of credibility, and scope changes.**	1	*Meet with province, council and senior management for updates regularly -- Provincial update meeting attended by LRT D&C. Green TRIP program officially announced on June 22 2010. City is working on application. New risk allowance of $2.36M added to account for risk of funding being delayed until February. $75 Million Provincial Funding Approved. Remainder of the Green Trip will go to the Capital Region Transportation Committee in early September. Regional Mayors have indicated the NAIT line has the highest priority for Green Trip funding in the Edmonton Metropolitan area.[Aug 10] The City of Edmonton applied for Federal funding and will follow up on Building Canada Fund. The City of Edmonton is ready to submit application for Green TRIP upon approval of the Capital Region Board. [Sep 10] The application for the Green TRIP was submitted after obtaining approval by Capital Region Board on September 3, 2010. To acquire the Federal portion of funds is not considered to be an issue for the project. [Oct 10] Borrowing bylaw is not an issue, and LRT D&C is waiting for the approval of the Green TRIP Funding & Building Canada Fund. Request for Qualifications (RFQ) for construction manager was issued in October 2010. [Nov 10] The applications for the Green TRIP and Building Canada Fund are under review by the Provincial and Federal Government. Meeting between LRT D&C and Transport Canada (Federal Department) was held and as a result the application and business case is being modified according to the comments from Transport Canada. [Dec 10] Business case completed and submitted to Transport Canada. Awaiting response.*	LRT D&C.	75%	1	Very Unlikely	Substantial
		2	Develop a detailed Communication Plan and Newsletter -- Communication plan is a living document and will be updated regularly. Quarterly newsletters distributed. Met with Central McDougall Community League on June 16, Square 104 apartment information session held on June 17. Newsletter for mid-August 2010 includes construction schedule items updated on website. [Nov 10] Construction bulletins and updates to the project website and communication plan are ongoing. Remarkable newsletter coming up in February 2011. Construction season media launch will take place in April 2011.	Graeme M., LRT D&C.	100%			
		3	Maintain an updated schedule and adjust as decisions are confirmed -- New baseline schedule set to reflect more realistic start and end dates. Construction schedule in development. Schedule review meeting set for June 24. [Oct 10] The project schedule from the detailed design perspective is completed. The funding milestones are being monitored as part of the project schedule. [Nov 10] Construction schedule baselined and being monitored for utility relocation, demolition and drainage progress.	Tasha B., Team North LRT.	100%			
		4	Develop a financing strategy (look at alternative financing methods and staging alternatives to match funding) -- Financing strategy in development. Detailed design is funded. City is working on financing strategy including Green Trip application, potential federal funding, and city borrowing. If funding approval is delayed until February 2011, allowance would be carried for the escalation, schedule cost, and cost of carrying key members of the design. Advanced funding for the NLRT LRT cars approved. [Nov 10] Funding efforts are being carried out. A financing strategy has not been required so far. [Dec 10] Alternate strategy if funding is not received by February to be developed. **[Jan 11] Capacity to borrow money in worst case. The money is expected.**	LRT D&C.	75%			
		5	Split construction into phases and stage each as funding becomes available (be shovel ready). Monitor existing project budget funding and divert any available funding for construction. -- Station Lands construction, environmental and demolition commencing. Contract packages have been reviewed and updated based on potential funding scenarios and constructability feedback. [Oct 10] Construction phasing is considered complete at this stage of the detailed design.	LRT D&C.	100%			
2	**Political delays caused by poor communication and extended public involvement will delay project**	1	Communication plan to be detailed and implemented. -- Communications plan developed by City. Stakeholders issues continually being monitored and addressed. Draft of communication plan presented during PM meeting on August 4, 2010. Comments from Partnering incorporated. [Oct 10] Video simulation of the project was completed during October as well as a contactor information session (October 21). The website is also being updated constantly. [Nov 10] A communication plan is being detailed in the public communication section of the Project Implementation Plan (PIP). The PIP is expected to be finished by the end of December 2010. [Dec 10] PIP completed with dedicated Public Communication Section.	Graeme M., LRT D&C.	75%	2	Very Unlikely	Moderate
		2	Keep councillors/stakeholders informed on project progress and update senior management / stakeholders regularly through newsletters and informal meetings at milestones. [Oct 10] Councillors and stakeholders are being informed as part of the public communication strategy city approval process of the detailed design. [Nov 10] The responsibility for communicating with the public during construction has been clarified as being the responsibility of LRT D&C and Team North LRT.	Brad S., LRT D&C.	75%			
	Geotechnical issues with the first leg between Churchill and MacEwan Station (106 St) resulting from insufficient		The presence of saturated sand pockets in Clay Till need to be accounted for in Tunnel Design -- Recommended soil parameters for design provided on Jan 4/10. Engaged Derek Martin					

ID	Risk Description	Task #
1	Funding for construction is not secured due to political and stakeholder issues, lack of resources, and provincial/federal grant delays causing cost escalation, loss of credibility, and scope changes.	1

Risk Management Plan-Sample

NLRT-Construction Risk Register Report

ID No. 1 **Risk Name:** Tunnel

Phase: Construction **Category:** A-Construction

Risk Factor Description

Geotechnical issues with the first leg between Churchill and MacEwan Station (106 St) resulting from insufficient information, poor geotechnical conditions and easement access may lead to higher costs, schedule delays, and safety issues.

Quantification

Likelihood	Magnitude	Allowance
Unlikely	Substantial	$1,999,900

Risk Allocation

RISK SHARED
- Owner is responsible for anything outside the expected conditions in the GBR.

NLP is responsible for any constructability failures and all geotechnical issues within the GBR.

Tasks

Task ID **Task Description**

1.1 Need to confirm if portable TPSS can handle 5 car trains at Churchill

15% Complete Started: Feb-11 Expected finish: Sep-11 Responsibility: Vincent L, City

[Oct/11] The portable TPSS will be able to handle 5 car operation with 8 min headway, as planned for the single tracking operation. Upgrades required for 5 min headway.

1.2 As-built survey or check of station lands prior to awarding tunnel contract

0% Complete Started: Jul-11 Expected finish: Jan-11 Responsibility: Brad S, City, Ed R, Engineer

1.3 Plan for inspection of Churchill Wall by experts prior to construction of tunnel breakin to Churchill to assess conditions of wall

15% Complete Started: Aug-11 Expected finish: Oct-12 Responsibility: Robert K, NLP

[Sep/11] NLP will transfer this to tunnel manager
[Oct/11] No work initiated on this. will commence once tunnel contractor is on board

1.4 Assure tie backs at stations lands are destressed before construction

15% Complete Started: Aug-11 Expected finish: Feb-12 Responsibility: Robert K, NLP

[Sep/11] NLP will transfer this to tunnel manager
[Oct/11] No work initiated on this. will commence approximately mid Novemeber

1.5 Remove outer cover in existing opening in Churchill to investigate Churchill face wall for condition

15% Complete Started: Aug-12 Expected finish: Oct-12 Responsibility: Robert K, NLP

[Sep/11] NLP will transfer this to tunnel manager
[Oct/11] No work initiated on this. will commence approximately mid August

Red - High priority and needs updating immediately
Yellow - medium priority and should be addressed
Grey - Complete

02/11/2011
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Conclusions

- Conducting Value Engineering achieved the following:
  - Built common understanding of the owner's values and transferred that knowledge to the design team
  - Identified creative ideas that increased the delivered Functions while cutting unnecessary cost (savings)
  - Identified and clarified operational requirements and their impact on the life cycle cost

Presenters

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