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Innovative Approach to the Development of a Strategic Plan for the Alaska Highway

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Presentation Agenda

- **Background**
- **Purpose of this Asset Management Study**
- **Project Scope**
- **Discussion on Drivers**
- **Methodology**
- **Deliverables**
- **Questions & Discussion**

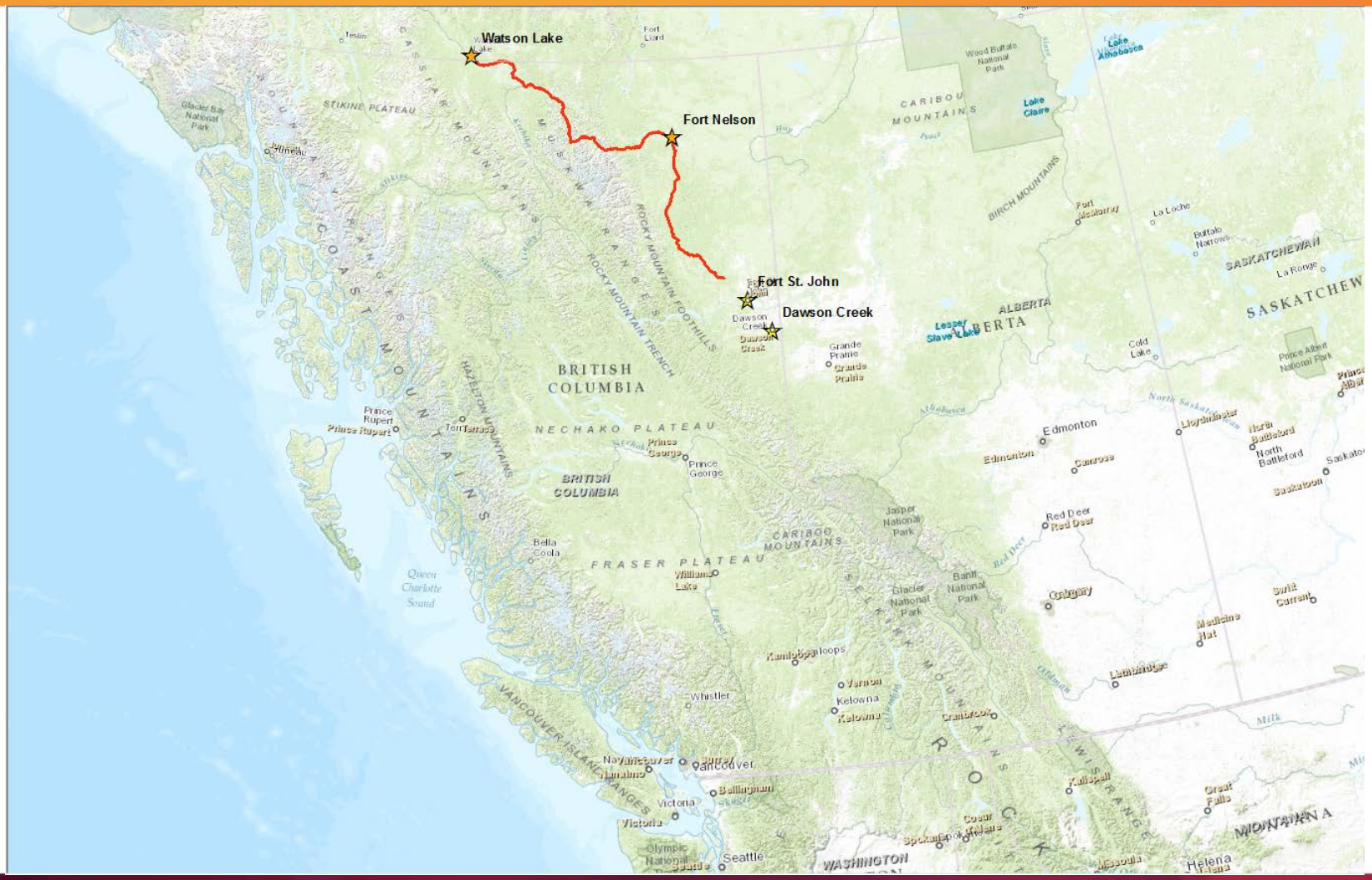
Background

- Alaska Highway stretches 2,450 kms (1520 mi) through northern BC, the Yukon and the State of Alaska.
  - Built during World War II for the purpose of connecting the contiguous United States to Alaska through Canada.
  - Begins in Dawson Creek, British Columbia, and runs to Delta Junction, Alaska, via Whitehorse, Yukon.
  - Completed in 1942.
- In past there has been an ongoing program by the US, Alaska, Yukon, BC and Canadian governments to improve this original pioneer road to make it safer, handle more traffic, accommodate increasing highway speeds, and permit larger commercial loads.
- Public Works and Government Services Canada (PWGSC) are responsible for the 827 km (514 mi) through British Columbia.
- Sections of the highway have been reconstructed to a higher standard. This standard is known as RAU-100 (rural, arterial, undivided, 100 km/h (62 mph) design speed).
- Within PWGSC's jurisdiction, sections with total length of 221 km (137 mi) have not yet been upgraded. This includes 196 kilometers in a continuous segment between km 554 and 750 that are of a much inferior standard when compared to the rest of the Alaska Highway.

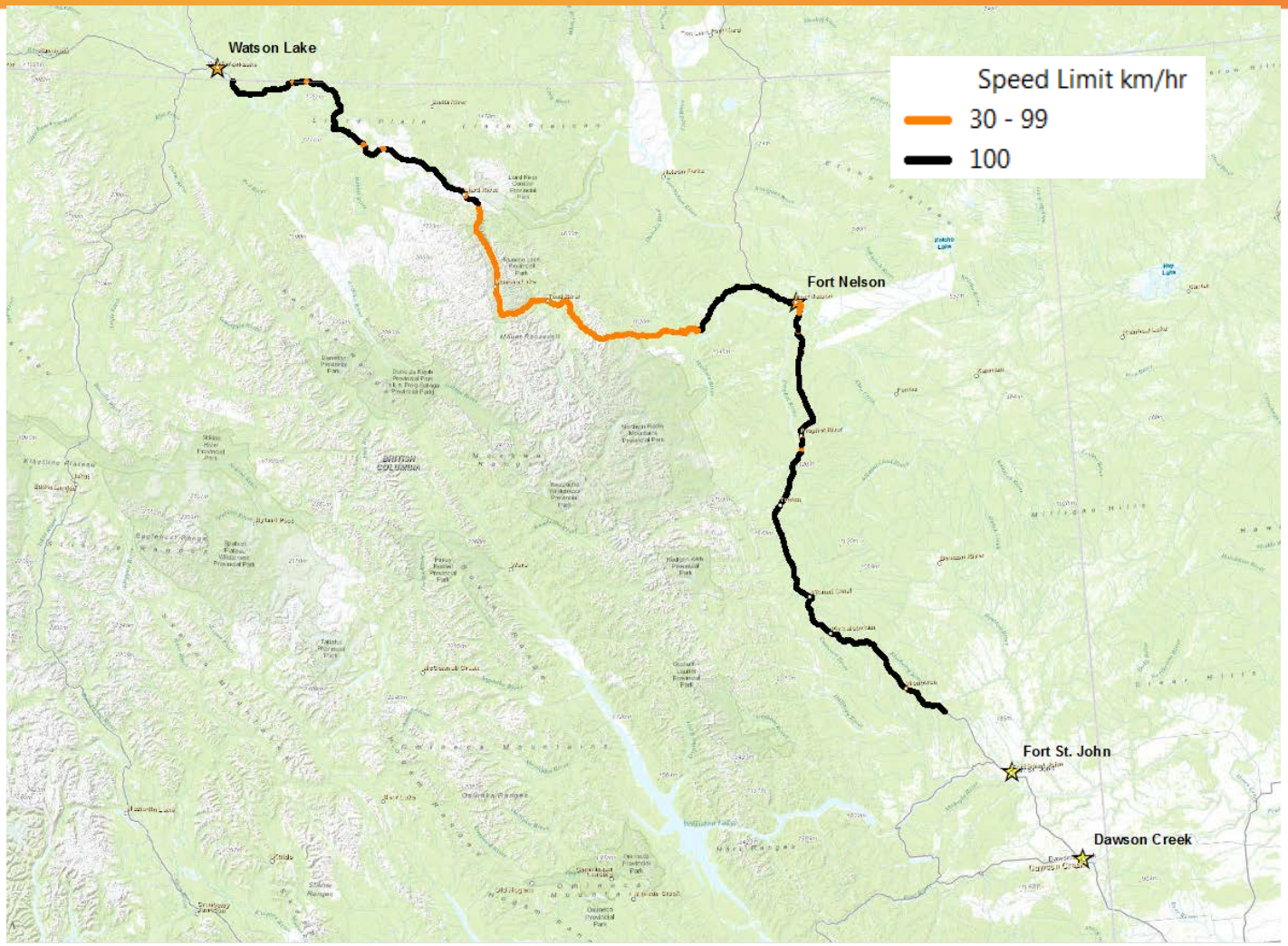
Overview


Alaska Highway
1,390 miles
Nunavut
Alaska
Northwest Territories
Delta Junction
Yukon Territory
Dawson Creek
Alberta
British Columbia
Montana
Washington
Idaho

Overview


Watson Lake
Fort Nelson
Fort St. John
Dawson Creek
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
STIKINE PLATEAU
NECHAKO PLATEAU
FRASER PLATEAU
CARIBOU MOUNTAINS
BIRCH MOUNTAINS
ROCKY MOUNTAIN FOOTHILLS
ROCKY MOUNTAIN TRENCH
MUSKWA RANGES
HAZELTON MOUNTAINS
COAST MOUNTAINS
VANCOUVER ISLAND RANGES
ROCKY MOUNTAINS
Whitehorse
Prince Rupert
Prince George
Edmonton
Calgary
Red Deer
Kamloops
Kelowna
Vernon
Whistler
Vancouver
Victoria
Seattle
Spokane
Great Falls
Helena
MONTANA
WASHINGTON

Overview


Watson Lake
Fort Nelson
Fort St. John
Dawson Creek
Speed Limit km/hr
30 - 99
100

Project Scope of Services

- The scope of the project is to develop a strategic asset management plan concentrating on asset preservation and capital improvements of the following components:
  - Pavements – Preservation and Potential upgrade of BST to ACP
  - Geometric improvements to reduce accidents and/or mandated upgrades (shoulders, turning lanes, intersections, horizontal and vertical curves, clear zone and side slopes).
  - Bridges – Preservation and potential upgrade to current standards
  - Bridge-culverts (i.e. span greater than or equal to 3 m).
  - There are 3 truss bridges that have been flagged for replacement due to functional inadequacies
- The strategic plan is to identify major works for 5, 10, 15, 20, 25, 50, and 75 year periods.

Project Challenges

- This project posed many unique challenges that would require innovative thinking to address, namely:
  - Multiple assets
    - Pavements
    - Bridges/Culverts
  - Competing objectives
    - Even within same asset class
  - Limited resources
    - Budget
  - Pre-existing constraints
    - Existing construction
    - Truss bridges
  - Remote Access

Asset Background Info

- The major assets in this project include:
  - Pavements; and
  - Structures including bridges and bridge culverts.
- The pavements comprised of ACP (Asphalt Cement Pavement) and Bituminous Surface Treatments (BST). There were three types of BST within the project:
  - Class 1: BST applied directly to unimproved subgrade;
  - Class 2: BST applied on top of 75 to 150 mm (3-6”) of crushed gravel; and
  - Class 3: Initially full depths of sub-base and base are placed with a BST surface.
- The length and percentage of each pavement type in the network is:
  - ACP, 177.2 km (21.4% of road network) (110.1 mi),
  - BST Class 1, 149.2 km (18.0%) (92.7 mi),
  - BST Class 2, 27.3 km (3.3%) (17 mi), and,
  - BST Class 3, 474 km (57.3%) (294.5 mi)
- Furthermore, there were 25 Bridges and 31 major bridge-culverts (i.e. span greater than or equal to 3 m) on the section of the Alaska Highway that is covered by this project scope. The bridges are divided into 4 types:
  - Concrete
  - Steel Box Girders
  - Steel I-girders
  - Steel Truss

Project Drivers

- Three key drivers as identified by PWGSC are:
  - Critical health and safety
  - Asset preservation
  - Capital improvements driven by health and safety

Project Drivers Used by Tt

- An engineering economics based benefit/cost ratio approach was used to rank preservation and capital improvement projects.
- The engineering economics include as benefits the reduction of:
  - Direct Agency Costs
  - Collision (accidents) costs;
  - User delay costs;
  - User vehicle operating costs;
  - Environmental costs associated with greenhouse gas emissions at current carbon trading rates; and
  - The risk for bridges and bridge-culverts closure.
    - This is defined as the probability of unacceptable performance (i.e. closure) multiplied by the consequences which will be a combination of repair time, detour distance, traffic volume, and the value of users' time.

Available Data

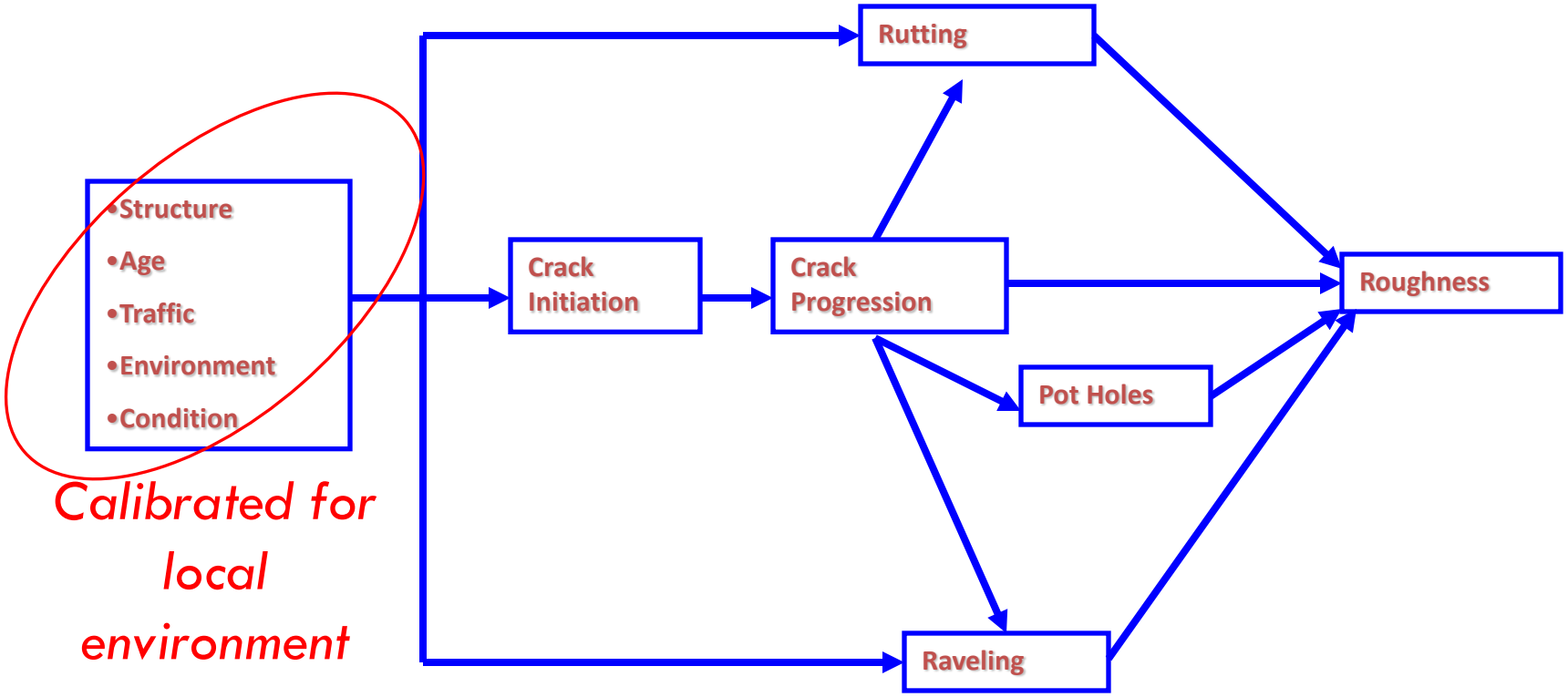
- Basic inventory
- Traffic volume - varied from a high of 2200 vehicles per day (vpd) in the south to a low of about 400 vpd at the north end.
- Annual growth rate of 2.4% was provided by PWGSC.
- Construction history including pavement surface age and treatment type,
- Pavement layers thickness and structural capacity data from km 206 to km 553 were also available based on FWD testing and coring data collected by the author's company,
- Posted Speed Analysis,
- Clear Zone Analysis,
- Location of horizontal curves along with curve radius,
- Location of vertical curves along with k factor,
- Lane and shoulder width data,
- Road profile, cross fall, rut and roughness data,
- Digital Photo Inventory,
- Visual distress ratings were used from the 2012 PWGSC ACP and BST surveys reports (includes PCI – Pavement Condition Index, BCI – Bituminous Condition Index, and RCI – Riding Comfort Index),
- All police-reported collisions within the corridor (km 133-km 968) from 2008 to 2012 summarized by fatal, personal injury or property damage only and cause,
- For bridges and culverts, the primary data source was the ongoing inspections of every bridge and bridge culvert (5). During the inspection, the bridge/culvert is rated for structural (SCR) and functional (FCR) condition of bridges and culverts from 1 to 6 (6 perfect, 1 failed) and an assessment of each component of the bridge or culvert assigned a material condition rating (MCR) and a performance condition rating (PCR) from 1 to 6.

Analysis Methodology

- Pavement Deterioration Prediction Models
  - The latest models to predict PCI and BCI based on pavement age were available from BST and Pavement Management System reports.
  - Locally calibrated versions of HDM IV (Highway Development and Management) performance models were also used to predict All Structural Crack Area (ACA) and IRI.
- Bridge Performance Models
  - The bridge performance modelling consists of two types of curves. The first is a condition rating curve against time (Weibull) and the second is a Probability of Unsatisfactory Performance (PUP) against time.
  - A PUP was established by an experienced bridge engineer for each condition rating of each primary structural component of each bridge. Condition ratings of 6 or 5 correspond to essentially zero probability of bridge closure, whereas a condition rating of 1 corresponds to approximately 50% probability of bridge closure in a given year (e.g. critically inadequate).

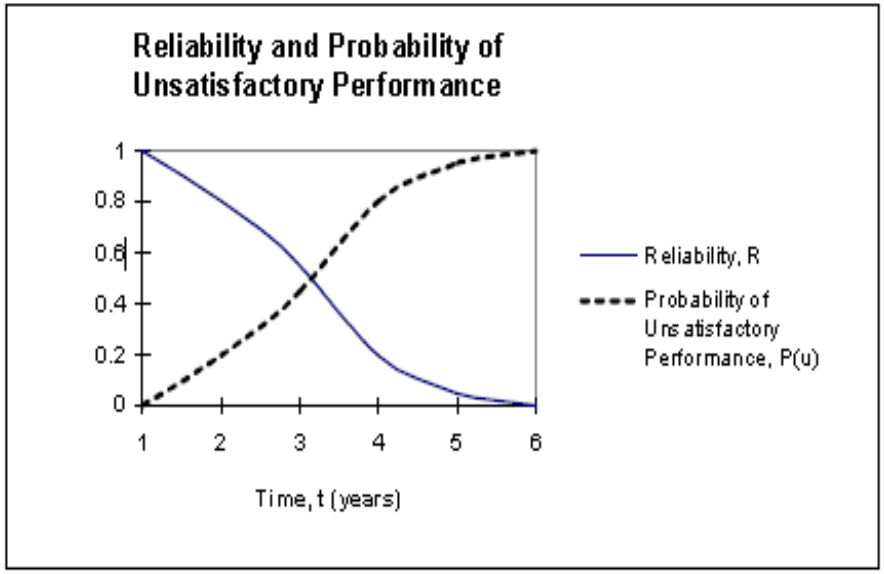
Pavement Distress Prediction Modeling

World Bank Pavement Performance - Distress Prediction Modeling

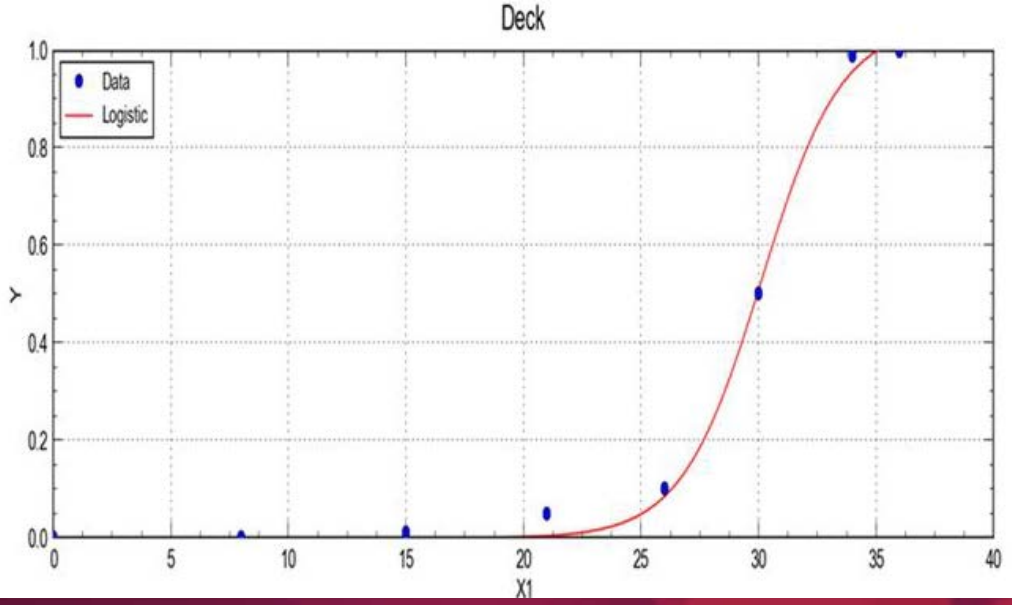


Bridge Probability Curves

- Deterministic curves were used to predict bridge ratings. Probability of Unsatisfactory Performance (PUP) is a function of the ratings.



- US Army Corps of Engineers (USACE EC 1110-2-6062)
- Risk and Reliability Engineering for Major Rehabilitation Studies
  - Example PUP Curve for Deck Component. Bridge Engineer developed PUP curves for each **Primary** component of each bridge/culvert. A primary component was deemed to be one that if it failed would require bridge closure.



Treatments

- 50 mm (2”) overlay of existing ACP
  - Used to correct minor pavement deficiencies ($30/m^2) ($2.80 ft^2).
- Major Rehabilitation of existing ACP (Reclaim and Overlay)
  - Removal of defective material from the driving lanes and replacement with new ACP ($50/m^2) ($4.60 ft^2).
- Conversion of BST surface to AC surface
  - This strategy is used for Class 3 BSTs when traffic volumes warrant ($400,000 /km) ($650,000 /mi).
- Reconstruction of roadway to Geometric Standard (RAU-100)
  - This strategy is used for sections that are not RAU-100 (Class 1 and Class 2 BSTs).
- Ripup and ReBST of existing BST surface
  - Varied from $60,000 /km to $70,000 /km depending on the BST Class) ($96,000 /mi to $113,000 /mi
- Maintenance
  - The maintenance treatment is defined for both ACP and BST surface and include annual minor repairs like crack sealing and patching. BST maintenance cost was a function of BCI, however, the ACP maintenance cost was calculated based on cracking area ($14/m^2) ($1.30 /ft^2).
- Bridge and Culvert Components Rehabilitation
  - Three different levels of rehabilitation (level 1, 2 and 3) were assumed for each component regarding their condition rating (cost of every treatment was estimated by bridge engineer for every component for every bridge)
- Bridge Replacement or New Bridge.

Benefits

- Key is to equate everything to a common denominator. In this project, that was monetary savings. That is:
  - For pavements, Vehicle Operating Cost (VOC)
  - For bridges/culverts, Risk in dollars

Pavement Benefits

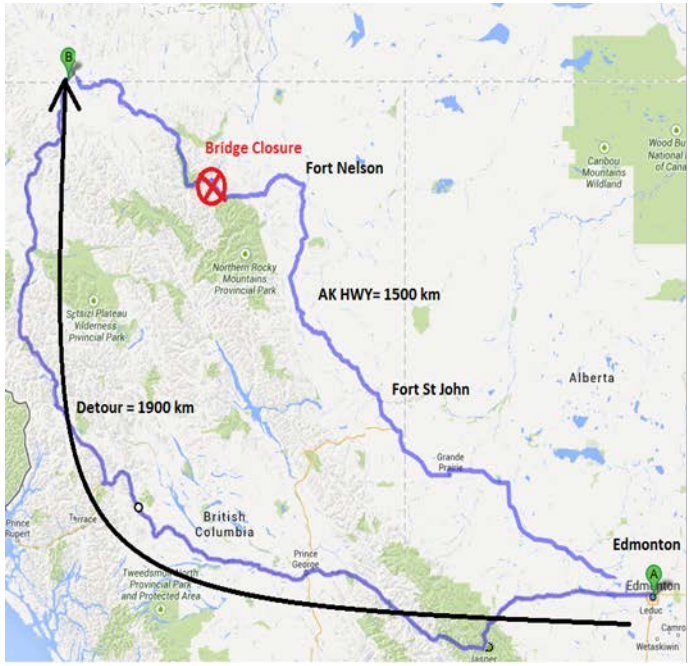
- VOC is comprised of:
  - **Collision Cost** – Based on Number and Severity of collisions which in turn is a function of AADT, Length, Width, Vertical and Horizontal Curvature
  - **User Time Cost** – Function of AADT, type of vehicles, occupancy rate, vehicle speed
  - **Vehicle Operation Cost** – Function of IRI, Fuel Consumption, Tire Wear, Vehicle Maintenance etc.
  - **Greenhouse Gas Cost** – Function of IRI, AADT, Commercial Veh, Fuel, Tire, Vehicle Consumption

Bridge Benefits

- Risk is comprised of:
  - **Probability of Unsatisfactory Performance**
  - **Consequence Cost** – similar to pavements, is vehicle operating cost
- Since consequence is monetary, therefore, Risk is also monetary
- This is critical to be able to compare pavement strategies to bridge strategies

Consequence of Bridge Closure Parameters

- Detour Closure Time
- Detour Length (see diagrams below)
- AADT
- Speed limit
- Percent commercial vehicles
- Replacement Cost of Bridge



Consequence of Bridge Closure

- The following equation is used to calculate consequence:
  - (AADT*Detour_Closure_Time*User_Time_Cost*Detour_Length/Speed_Limit + AADT*(1.0-Percent_Comm/100.0)*Detour_Closure_Time*VOC_Non_Comm*Detour_Length + AADT*Percent_Comm/100.0*Detour_Closure_Time*VOC_Comm*Detour_Length) * (1+Replacement_Cost/If("B",TBRC,TCRC))
- Where:
  - AADT is the average annual daily traffic,
  - Detour_Closure_Time is length of time detour is in effect (days),
  - Detour_Length is length of the detour (km),
  - User_Time_Cost is the blended user time cost calculated to be 31.20 ($/veh/hr),
  - Speed_Limit is posted speed limit (km/h),
  - Percent_Comm is the percent commercial vehicles,
  - VOC_Non_Comm is the vehicle operating cost for non-commercial vehicles, (assumed 0.5 $/km/veh)
  - VOC_Comm is the vehicle operating cost for commercial vehicles, (assumed 2.00 $/km/veh)
  - Replacement_Cost is the cost to replace the bridge or culvert to new
  - TBRC, TCRC is the total cost to replace all bridges or culverts respectively

Constraints - Budgets

- Three budgets considered for analysis in a 50 year analysis period:
  - Unlimited – for best case scenario
  - Do Nothing – base case for comparison
  - $23M annually, consists of:
    - $13M Capital funds (roads and bridges)
    - **Less** $2M staff cost
    - $6M ReBST
    - $2M North section maintenance
    - $2M South section maintenance

Sample Reconstruction Road Strategy

	Road	From	From_Description	To	To_Description	ElementID	Length	Model_Geometric	Posted_Speed	Traf_AADT	Cond_BCI	Cond_ACA	Cond_ACL	Cond_ACW	Cond_IRI
1	Alas	623.912		627.4		An_089_New	3.579	2.09	80	550	65	0.0	0.0	0.0	3.3
2	Alas	628.474		630.7		An_091_New	2.252	2.02	80	550	65	0.0	0.0	0.0	2.7
3	Alas	649.549		652.0		An_106_New	2.507	1.81	80	575	66	0.0	0.0	0.0	2.9
4	Alas	616.83		620.6		An_086_New	3.796	1.80	80	550	68	0.0	0.0	0.0	2.6
5	Alas	648.053		648.2		An_104_New	0.171	1.75	80	575	63	0.0	0.0	0.0	2.7
6	Alas	588.613		591.5		An_069_New	2.930	1.72	80	550	61	0.0	0.0	0.0	2.7
7	Alas	570.858		572.5		An_061_New	1.662	1.69	80	550	64	0.0	0.0	0.0	3.3

Strategies for Element ID: An_089_New54

ID	PV Benefits	PV Cost	Benefit/Cos	IBC	Minimum C	Committed	Base Com	Selected	Do Nothing	Savings	Suggested	Year	1st Major
1	5611950.9	$3,925,777	1.4295132	1.4295132	False	False	False	True	False	0	False	2013	Reconstruc
2	5471734.7	$3,788,150	1.4444344	1.4444344	False	False	False	False	False	0	False	2014	Reconstruc
3	5334711.8	$3,656,695	1.4588888	1.4588888	False	False	False	False	False	0	False	2015	Reconstruc
4	5294500.9	$3,819,622	1.3861321	1.3861321	False	False	False	False	False	0	False	2013	Reconstruc
5	5197376.3	$3,531,006	1.4719250	1.4719250	False	False	False	False	False	0	False	2016	Reconstruc
6	5161200.7	$3,682,177	1.4016709	1.4016709	False	False	False	False	False	0	False	2014	Reconstruc
7	5046876.0	$3,410,741	1.4797004	1.4797004	False	False	False	False	False	0	False	2017	Reconstruc
8	5030909.7	$3,551,294	1.4166412	1.4166412	False	False	False	False	False	0	False	2015	Reconstruc
9	4917810.5	$3,295,619	1.4922262	1.4922262	False	False	False	False	False	0	False	2018	Reconstruc
10	4891215.0	$3,426,454	1.4274855	1.4274855	False	False	False	False	False	0	False	2016	Reconstruc
11	4790316.9	$3,185,410	1.5038305	1.5038305	False	False	False	False	False	0	False	2019	Reconstruc
12	4758466.5	$3,307,210	1.4388157	1.4388157	False	False	False	False	False	0	False	2017	Reconstruc

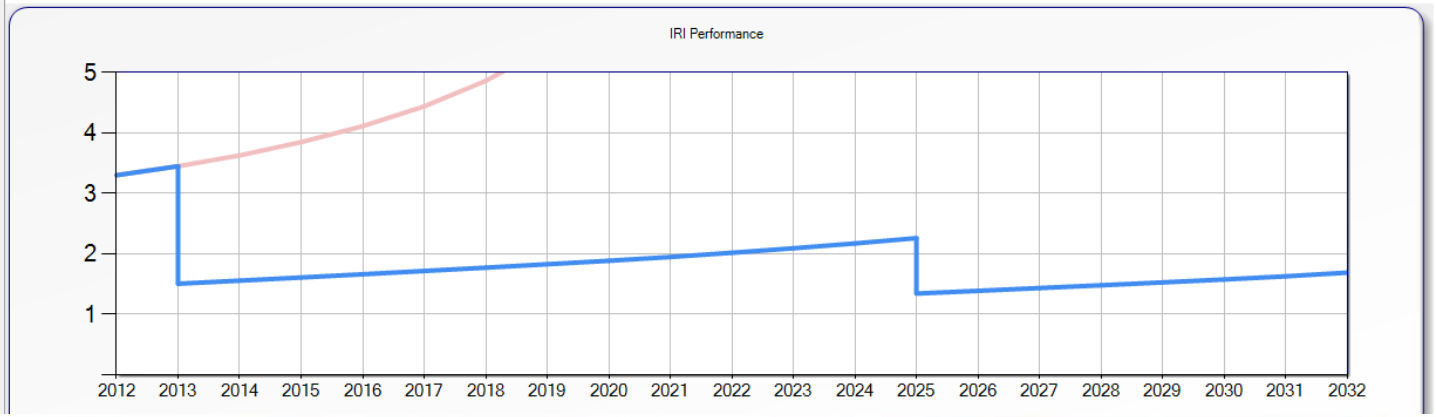
Reconstruction

Strategies for Element ID: An_089_New54 | Strategy Treatments | Analysis Variables

Efficiency Chart | Variables Chart

Analysis Variable: IRI

IRI Performance



Sample ReBST Road Strategy

	Road	From	From_Description	To	To_Description	ElementID	Length	Model_Geometric	Posted_Speed	Traf_AADT	Cond_BCI	Cond_ACA	Cond_ACL	Cond_ACW	Cond_IRI	Cond_RUT	Cond_PCI	Cond_SNP
1	Alas	623.912		627.4		An_089_New	3.575	2.09	80	550	65	0.0	0.0	0.0	3.3	4	-1	1.86
2	Alas	628.474		630.7		An_091_New	2.252	2.02	80	550	65	0.0	0.0	0.0	2.7	3	-1	1.86
3	Alas	649.549		652.0		An_106_New	2.507	1.81	80	575	66	0.0	0.0	0.0	2.9	3	-1	1.86
4	Alas	616.83		620.6		An_086_New	3.796	1.80	80	550	68	0.0	0.0	0.0	2.6	4	-1	1.86
5	Alas	648.053		648.2		An_104_New	0.171	1.75	80	575	63	0.0	0.0	0.0	2.7	4	-1	1.86
6	Alas	588.613		591.5		An_069_New	2.930	1.72	80	550	61	0.0	0.0	0.0	2.7	3	-1	1.86
7	Alas	570.858		572.5		An_061_New	1.662	1.69	80	550	64	0.0	0.0	0.0	3.3	4	-1	1.86

Strategies for Element ID: An_089_New54

ID	PV Benefits	PV Cost	Benefit/Cos	IBC	Minimum C	Committed	Base Com	Selected	Do Nothing	Savings	Suggested	Year	1st Major
24	3362469.8	$2,288,324	1.4694024	1.4694024	False	False	False	False	False	0	False	2028	Reconstruc
25	3232908.2	$2,218,822	1.4570375	1.4570375	False	False	False	False	False	0	False	2029	Reconstruc
26	3106582.3	$2,153,002	1.4429067	1.4429067	False	False	False	False	False	0	False	2030	Reconstruc
27	2982892.4	$2,090,889	1.4266138	1.4266138	False	False	False	False	False	0	False	2031	Reconstruc
28	2858876.2	$2,032,520	1.4065669	1.4065669	False	False	False	False	False	0	False	2032	Reconstruc
29	920935.94	$785,754.3	1.1720405	1.1720405	False	False	False	False	False	0	False	2014	ReBST
30	732994.23	$702,280.5	1.0437342	1.0437342	False	False	False	False	False	0	False	2014	ReBST
31	511779.50	$605,824.3	0.8447655	0.8447655	False	False	False	False	False	0	False	2014	ReBST
32	252204.53	$488,572.1	0.5162073	0.5162073	False	False	False	False	False	0	False	2014	ReBST
33	0	$352,897.7	0	0	True	False	False	False	False	0	False		
34	0	$0.00		0	False	False	False	False	True	0	False		

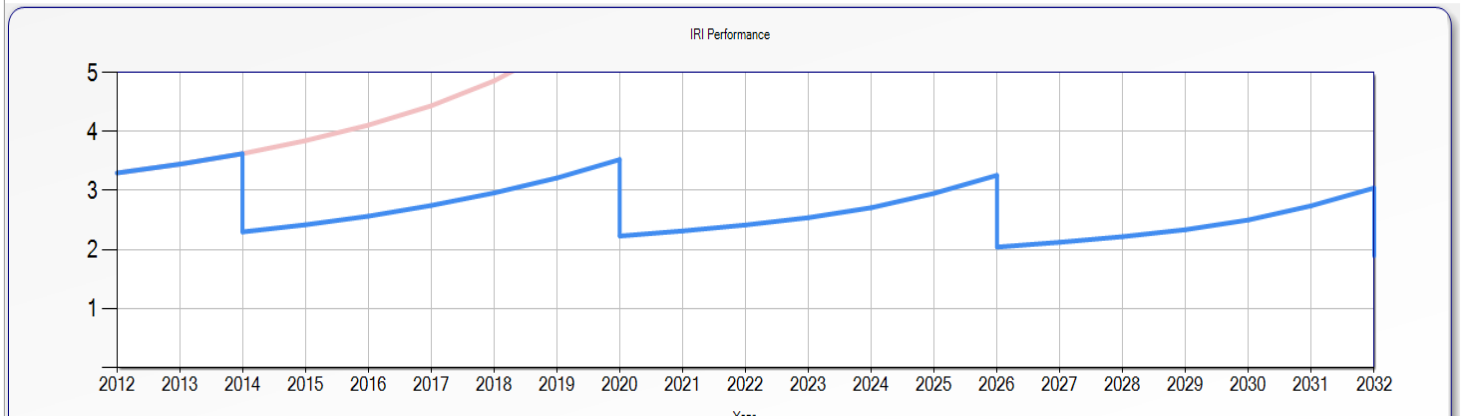
ReBST

Strategies for Element ID: An_089_New54 | Strategy Treatments | Analysis Variables

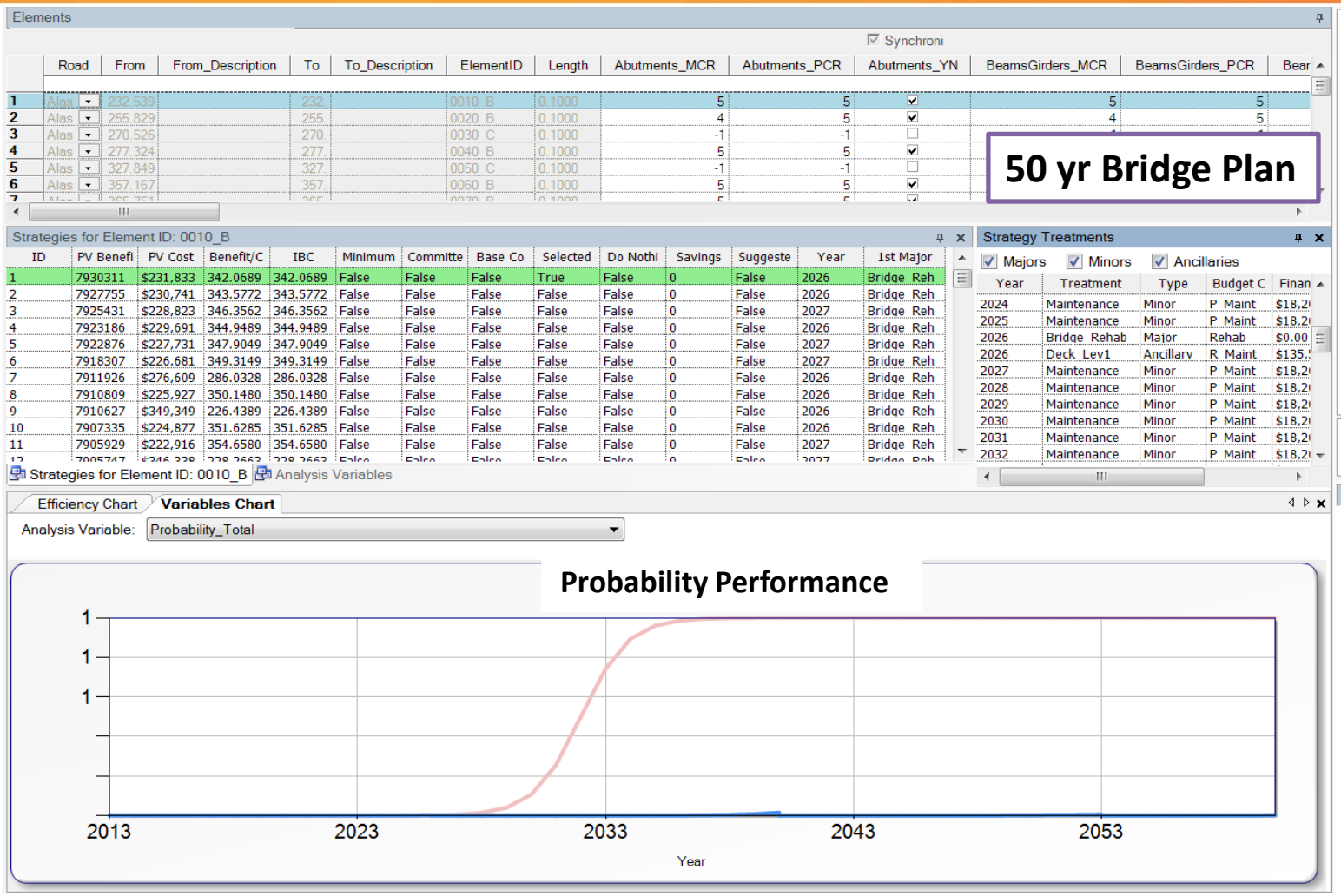
Efficiency Chart | Variables Chart

Analysis Variable: IRI

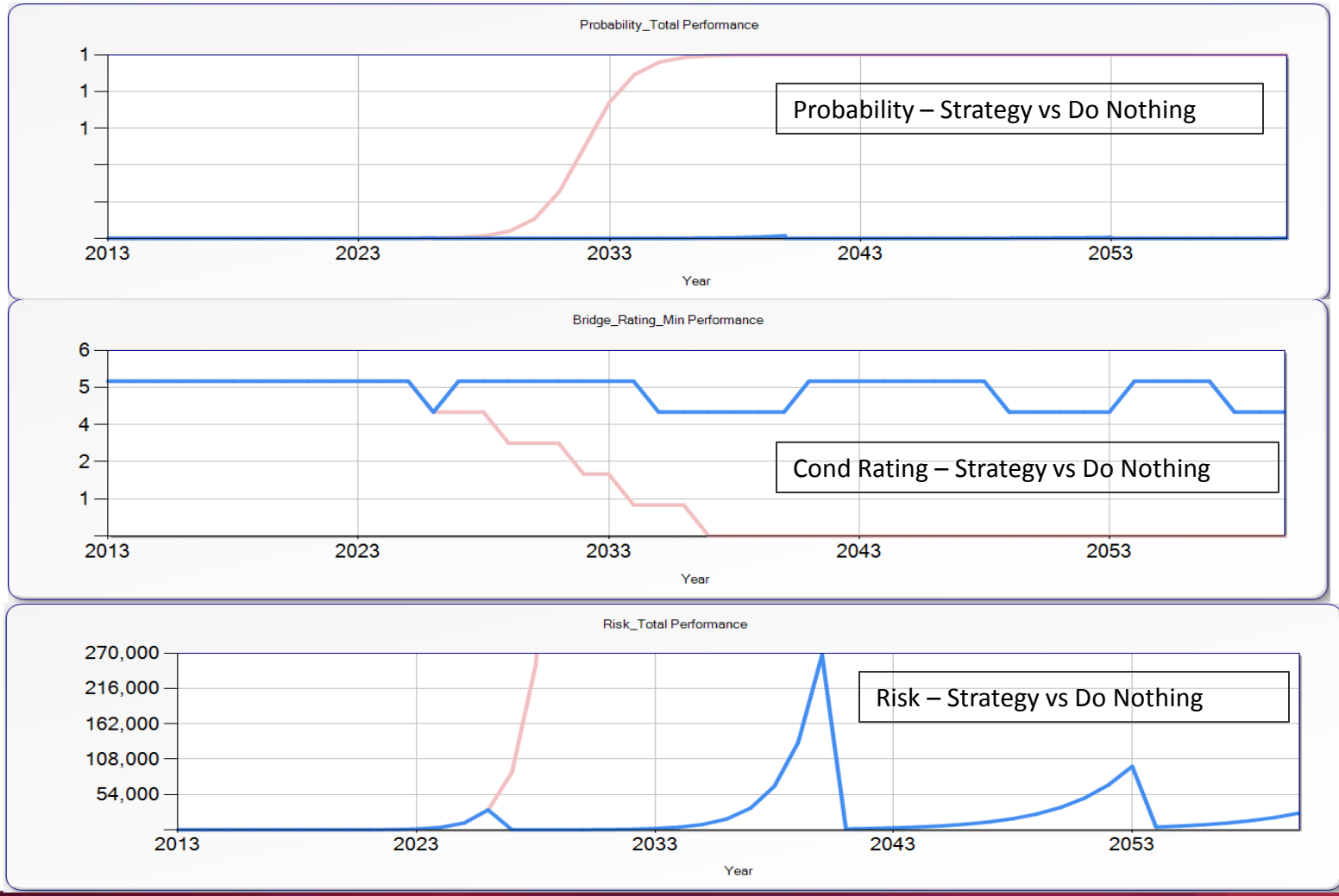
IRI Performance



Sample Bridge Strategy



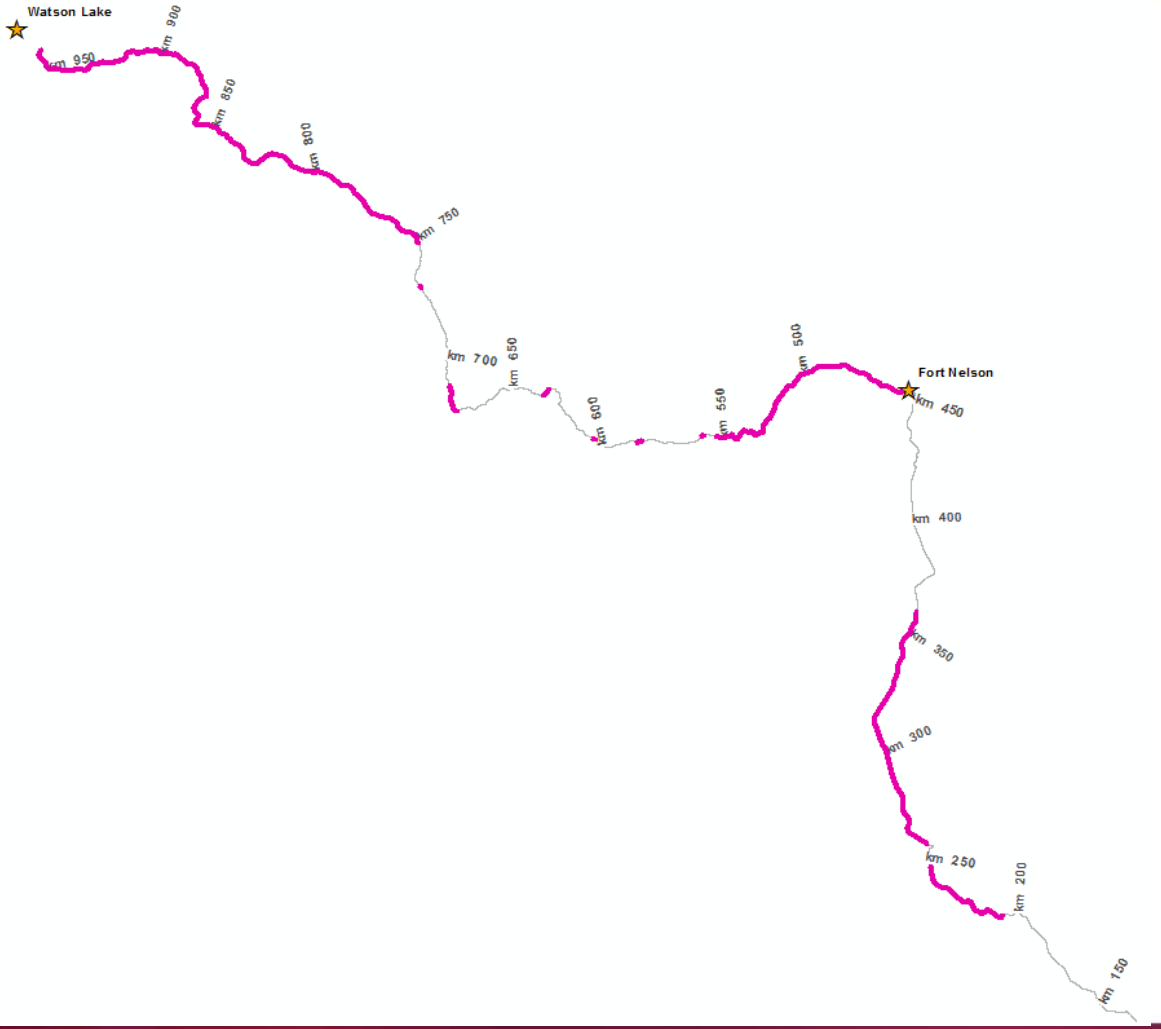
Condition Plots – Sample Bridge



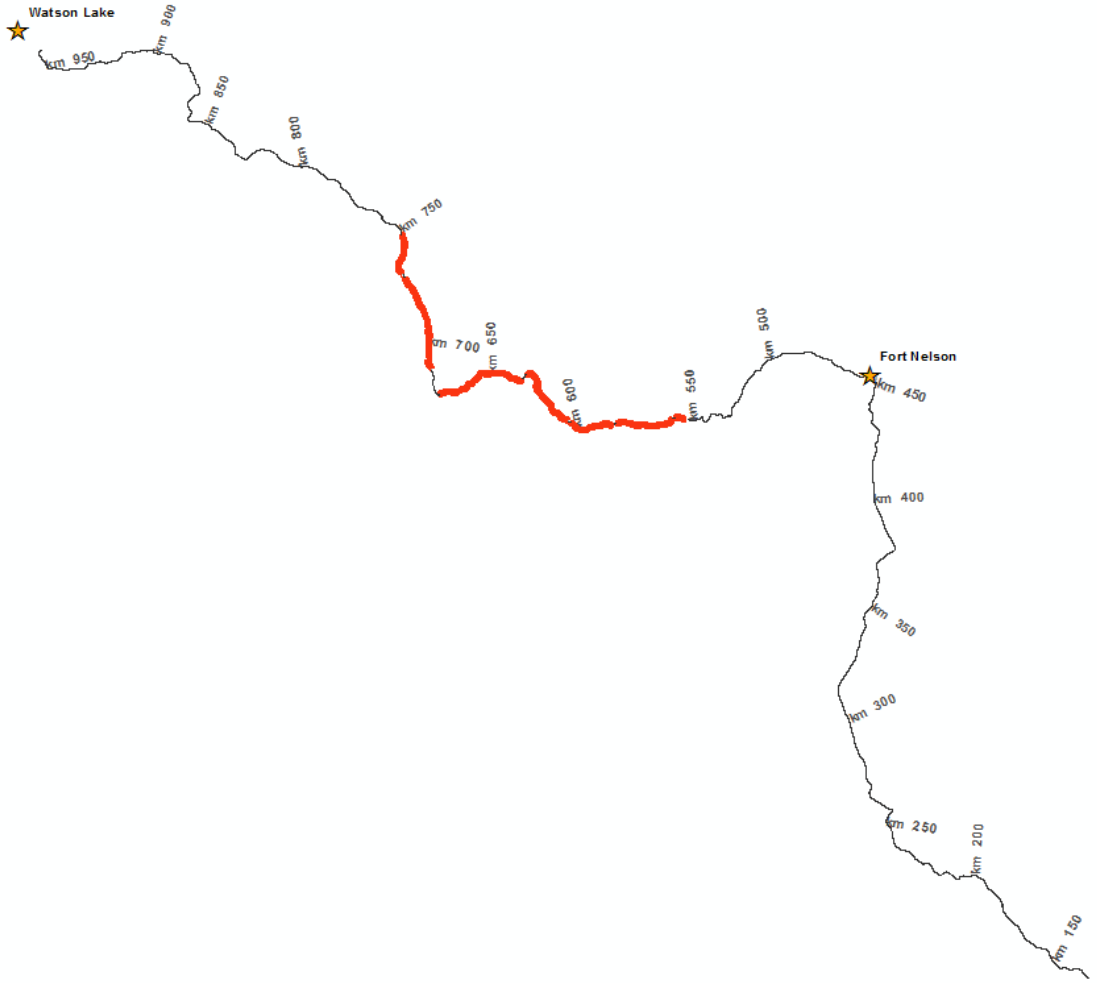
Sample Detailed Bridge Results

		Delcan recommendation				dTIMS Output_6000k		
Bridge_Name	ElementID	Components	MCR_2011	PCR_2011	Recommendation_2011	Treatment	Year	Cost
Beatton River Bridge	0010_B	Deck	5	5	Deck-5yr	Deck_Lev1	2026	$135,546
						BeamsGirders_Lev1	2040	$39,789
						Deck_Lev1		$135,546
						Watercourse_Lev2		$200,000
						Connections_Lev1	2053	$6,224
						Deck_Lev1		$135,546
Sikanni Chief River Bridge	0020_B	Abutment_1	4	5	Abutment-10yr	Abutment_Lev1	2014	$9,576
		Abutment_2	4	5	Abutment-10yr	BeamsGirders_Lev1		$547,020
		Deck	4	4	Deck-1yr,5yr	Connections_Lev1		$54,702
		Pier_1	5	5	Pier-M	Deck_Lev1		$372,803
		Pier_2	5	5	Pier-5yr,M	Piers_Lev1		$90,432
		Pier_3	5	5	Pier-M	Watercourse_Lev2		$200,000
		Pier_4	4	5	Pier-5yr,M	Deck_Lev1	2027	$372,803
		Watercourse	4	4	Watercourse-M,10yr		2041	$372,803
						Watercourse_Lev2	2041	$200,000
						Connections_Lev1	2054	$54,702
						Deck_Lev1		$372,803
						Foundations_Lev3		$500,000
Mason Creek Bridge - Culvert	0030_C	Outlet	5	5	Outlet-M	Inlet_Lev2	2019	$81,773
		Soil/Steel Structures	4	4	Soil/Steel Structures-M	SoilSteelStructures_Lev2		$54,515
						Outlet_Lev1	2041	$13,629
						Watercourse_Lev2		$100,000
						Inlet_Lev2	2052	$81,773
						SoilSteelStructures_Lev2		$54,515
Buckinghorse River Bridge	0040_B	Deck	4	5	Deck-5yr	Deck_Lev1	2013	$208,800
		Watercourse	4	4	Watercourse-1yr	Watercourse_Lev2		$200,000
						Deck_Lev1	2026	$208,800
							2039	$208,800
						Watercourse_Lev2		$200,000
						BeamsGirders_Lev2	2046	$369,600
						Foundations_Lev3		$500,000
						Connections_Lev1	2052	$11,563
						Deck_Lev1		$208,800

Candidate sections for BST Conversion



Candidate sections for Reconstruct



Priorities of Conversion to ACP (km 130-km 550)

Total Length=**229 km**
Total Cost= **$91,617,200**

Priority Rating	From	To	Length (km)	IRI	BCI	RCI	AADT	Conversion Cost_2014	PVCost_50Yr	PVBen_50Yr	Benefit/Cost
1	208	215	7.0	3.0	59	4.8	1200	$2,799,600	$4,181,309	$5,566,872	**1.33**
2	206	208	2.0	2.9	60	5.0	1200	$801,600	$1,191,542	$1,516,785	**1.27**
3	215	226	11.0	2.4	65	5.5	1200	$4,400,400	$6,603,145	$8,026,564	**1.22**
4	468	484.3	16.3	2.7	57	4.8	901 (65% Comm)	$6,526,000	$9,664,250	$11,276,748	**1.17**
5	458	468	10.0	2.0	63	5.5	901(65% Comm)	**$4,003,600**	$5,908,178	$6,380,264	**1.08**
6	226	232	6.0	2.6	63	5.3	1000 (40% Comm)	$2,402,400	$3,586,770	$3,769,969	**1.05**
7	232	246	14.0	2.7	66	5.6	930	$5,598,000	$8,339,828	$8,434,589	**1.01**
8	258	278	20.0	2.3	66	5.3	930	$7,998,000	$11,940,970	$11,567,619	**0.97**
9	300	313	13.0	2.3	69	5.7	846	$5,202,400	$6,834,415	$6,517,629	**0.95**
10	313	319	6.0	2.2	71	5.8	846	$2,401,200	$3,145,334	$2,982,135	**0.95**
11	328	351	23.0	2.8	62	5.0	846	$9,202,800	$13,105,455	$12,396,777	**0.95**
12	351	359	8.0	3.0	59	4.9	846	$3,203,200	$4,706,843	$4,227,012	**0.90**
13	278	287	9.0	2.3	66	5.5	846	$3,600,000	$5,309,693	$4,753,471	**0.90**
14	319	328	9.0	2.2	73	5.8	846	$3,602,800	$5,214,737	$4,477,936	**0.86**
15	287	300	13.0	2.3	67	5.4	846	$5,203,600	$7,631,436	$6,250,025	**0.82**
16	509	520	11.0	2.6	81	7.0	600	$4,398,400	$5,867,100	$3,807,391	**0.65**
17	540	546.2	6.2	2.9	56	5.0	600	$2,459,600	$3,607,391	$2,339,118	**0.65**
18	528	530	2.0	3.3	82	6.5	600	$786,400	$1,164,376	$754,976	**0.65**
19	520	528	8.0	3.3	82	6.7	600	$3,181,200	$4,736,712	$3,031,134	**0.64**
20	484.3	496	11.7	3.1	60	5.2	600	$4,684,000	$6,901,163	$4,321,619	**0.63**
21	535	540	5.0	2.9	59	5.0	600	$1,980,400	$2,904,569	$1,795,976	**0.62**
22	530	535	5.0	2.8	63	5.3	600	$1,974,400	$2,973,169	$1,800,462	**0.61**
23	501	509	8.0	2.0	67	5.5	600	$3,206,000	$4,229,918	$2,452,135	**0.58**
24	496	501	5.0	2.9	57	4.8	600	$2,001,200	$2,951,889	$1,666,770	**0.56**

Chosen Conversion to ACP (Constrained Budget)

Priority Rating	From	To	Length (km)	Benefit/Cost _2014	Constrain Budget Scenario	
					Treatment	Year
1	208	215	7.0	**1.33**	Conversion	2014
2	206	208	2.0	**1.27**	Conversion	2016
3	215	226	11.0	**1.22**	Conversion	2016
4	468	484.3	16.3	**1.17**	Conversion	2014
5	458	468	10.0	**1.08**	Conversion	2014
6	226	232	6.0	**1.05**	Conversion	2016
7	232	246	14.0	**1.01**	Conversion	2020
8	258	278	20.0	**0.97**	Conversion	2018
9	300	313	13.0	**0.95**	Conversion	2024
10	313	319	6.0	**0.95**	Conversion	2024
11	328	351	23.0	**0.95**	Conversion	2022
12	351	359	8.0	**0.90**	Conversion	2016
13	278	287	9.0	**0.90**	Conversion	2022
14	319	328	9.0	**0.86**	Conversion	2024
15	287	300	13.0	**0.82**	Conversion	2026
16	509	520	11.0	**0.65**	**ReBST**	
17	540	546.2	6.2	**0.65**	Conversion	2028
18	528	530	2.0	**0.65**	**ReBST**	
19	520	528	8.0	**0.64**	**ReBST**	
20	484.3	496	11.7	**0.63**	**ReBST**	
21	535	540	5.0	**0.62**	Conversion	2030
22	530	535	5.0	**0.61**	Conversion	2030
23	501	509	8.0	**0.58**	**ReBST**	
24	496	501	5.0	**0.56**	**ReBST**	

Priorities of Reconstruction

(96 small sections)

Total Length=**177 km**
Total Cost= **$207,552,871**

Priority Rating	From	To	Length (km)	Posted_Speed	IRI	Reconstruction Cost_2014	PVCost_50Yr	PVBen_50Yr	Benefit/Cost
1	647.514	648.26	0.745	50	2.5	$782,250	$887,409	$1,707,530	**1.92**
2	691.831	695.445	3.617	80	2.7	$2,785,090	$3,380,169	$6,199,467	**1.83**
3	618.039	619.176	1.136	80	3.2	$795,200	$970,843	$1,762,881	**1.82**
4	636.784	637.296	0.512	80	3.0	$322,560	$403,101	$716,093	**1.78**
5	555.447	560.847	2.592	80	3.4	$1,995,840	$2,389,624	$4,202,407	**1.76**
6	627.441	631.017	3.579	80	3.3	$4,509,540	$4,985,821	$7,641,891	**1.53**
7	651.583	651.755	0.171	80	2.7	$179,550	$203,687	$304,606	**1.50**
8	616.862	617.385	0.522	80	2.4	$365,400	$446,109	$665,576	**1.49**
9	631.999	634.25	2.252	80	2.7	$2,837,520	$3,137,209	$4,580,527	**1.46**
10	716.664	720	3.338	80	2.9	$2,102,940	$2,628,032	$3,750,683	**1.43**
11	611.744	613.246	1.505	80	3.2	$1,053,500	$1,286,196	$1,831,465	**1.42**
12	713.36	713.772	0.412	80	3.1	$259,560	$324,371	$454,782	**1.40**
13	714.335	715.036	0.701	80	2.8	$441,630	$551,902	$751,621	**1.36**
14	710.057	712.224	2.166	80	2.7	$2,046,870	$2,361,356	$3,212,980	**1.36**
15	665.737	669.553	3.816	80	2.7	$4,140,360	$4,673,865	$5,946,531	**1.27**
16	720	723.219	3.222	80	2.7	$2,480,940	$2,970,435	$3,757,378	**1.26**
17	653.08	655.587	2.507	80	2.9	$3,509,800	$3,829,924	$4,662,455	**1.22**
18	715.036	716.664	1.629	80	2.8	$1,026,270	$1,282,524	$1,547,710	**1.21**
19	712.224	713.36	1.135	80	2.7	$715,050	$893,594	$1,075,234	**1.20**
20	713.772	714.335	0.563	80	2.7	$354,690	$443,254	$532,444	**1.20**
21	635.722	636.784	1.059	80	3.0	$667,170	$833,759	$990,673	**1.19**
22	574.359	576.021	1.662	80	3.3	$2,094,120	$2,315,293	$2,727,590	**1.18**
23	645.039	647.514	2.477	80	2.5	$2,600,850	$2,950,487	$3,437,146	**1.16**
24	640.521	644.452	3.933	80	3.5	$4,129,650	$4,684,807	$5,355,489	**1.14**
25	673.084	674.006	0.921	80	3.7	$1,095,990	$1,221,033	$1,382,209	**1.13**

Priorities of Overlay

(14 sections)

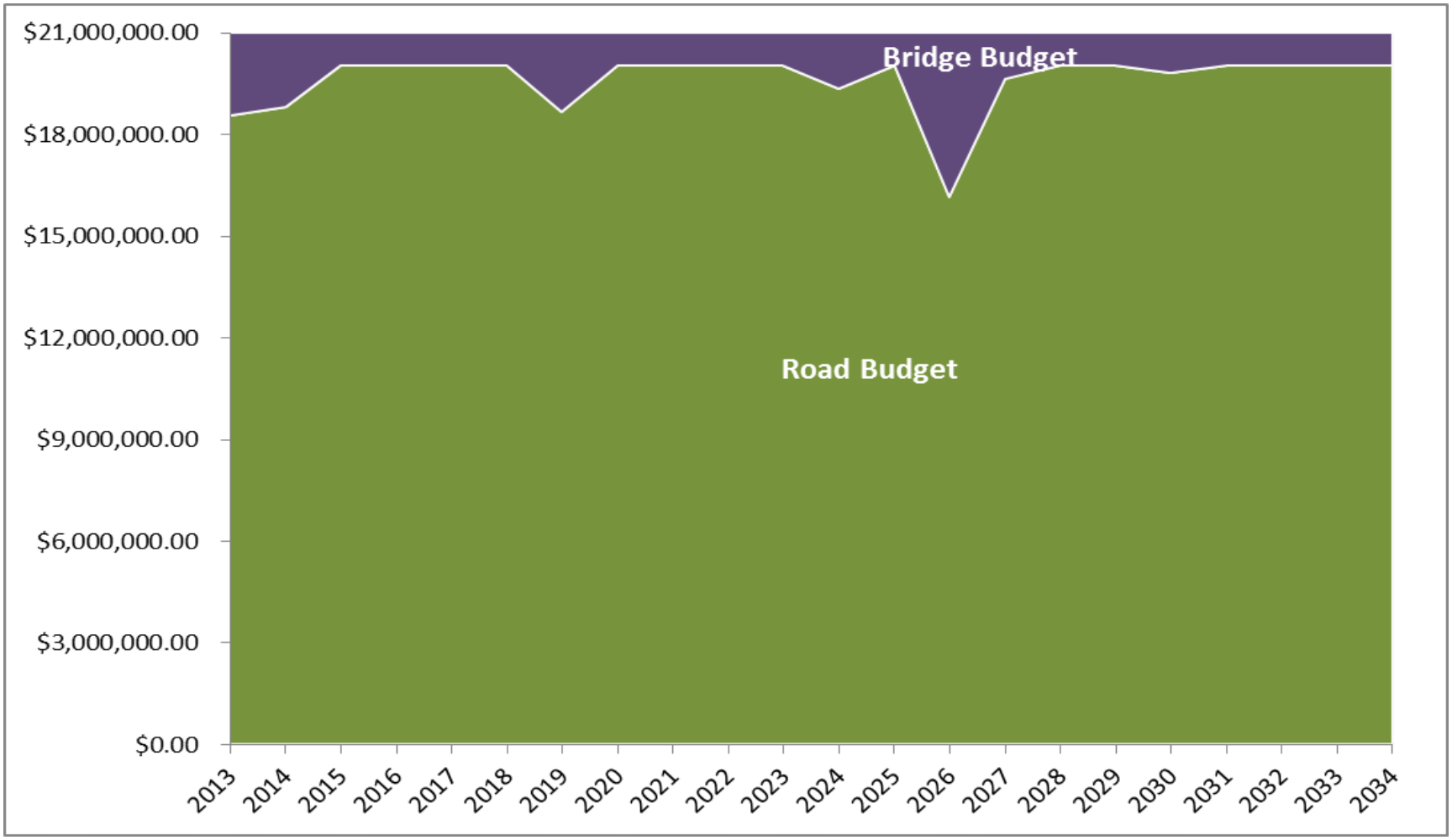
Total Cost= **$58,017,394**

From	To	Length (km)	IRI	PCI	AADT	Overlay Year	Overlay Cost	PVCost_50Yr	PVBen_50Yr	Benefit/Cost
133	145	12	1.2	67	2162	2020	$3,116,360	$4,185,132	$6,915,780	1.65
145	165	20	1.1	68	2162	2019	$5,198,180	$7,282,272	$11,865,708	1.63
165	193	28	0.9	71	1650	2020	$7,279,220	$9,745,104	$11,807,021	1.21
193	200	7	1.1	70	1650	2020	$1,818,700	$2,435,993	$3,058,930	1.26
200	202	2	1.8	79	1650	2026	$620,930	$556,996	$739,788	1.33
202	204	2	2.3	67	1450	2014	$1,041,560	$1,345,458	$1,027,305	0.76
204	206	2	3.1	44	1450	2014	$1,142,280	$1,478,230	$1,684,042	1.14
246	258	12	2.5	81	930	2027	$3,418,290	$2,948,388	$3,838,321	1.30
359	388	29	1.2	76	846	2021	$7,825,410	$9,967,479	$5,867,449	0.59
388	396	8	1.3	70	846	2019	$2,159,730	$3,078,333	$1,697,592	0.55
396	424.5	28.5	0.9	72	846	2021	$7,694,190	$9,767,203	$5,790,355	0.59
424.5	435.5	11	1.1	74	831	2021	$2,968,110	$3,767,795	$1,717,901	0.46
435.5	443.3	7.8	1.2	77	900	2027	$2,104,650	$1,815,330	$1,242,138	0.68
443.3	451.2	7.9	1.5	82	1000	2028	$2,132,730	$1,768,798	$1,378,943	0.78

Recommended Program

- Optimization routine used to select recommended option. Multi-steps:
  - Determination made for budget required to maintain level of service on bridges
  - Capital budget reduced by bridge amount and then overlay, conversion to BST, ReBST or reconstruction options chosen by B/C
  - Practical considerations applied for final program.

Combined Draft Construction Plan



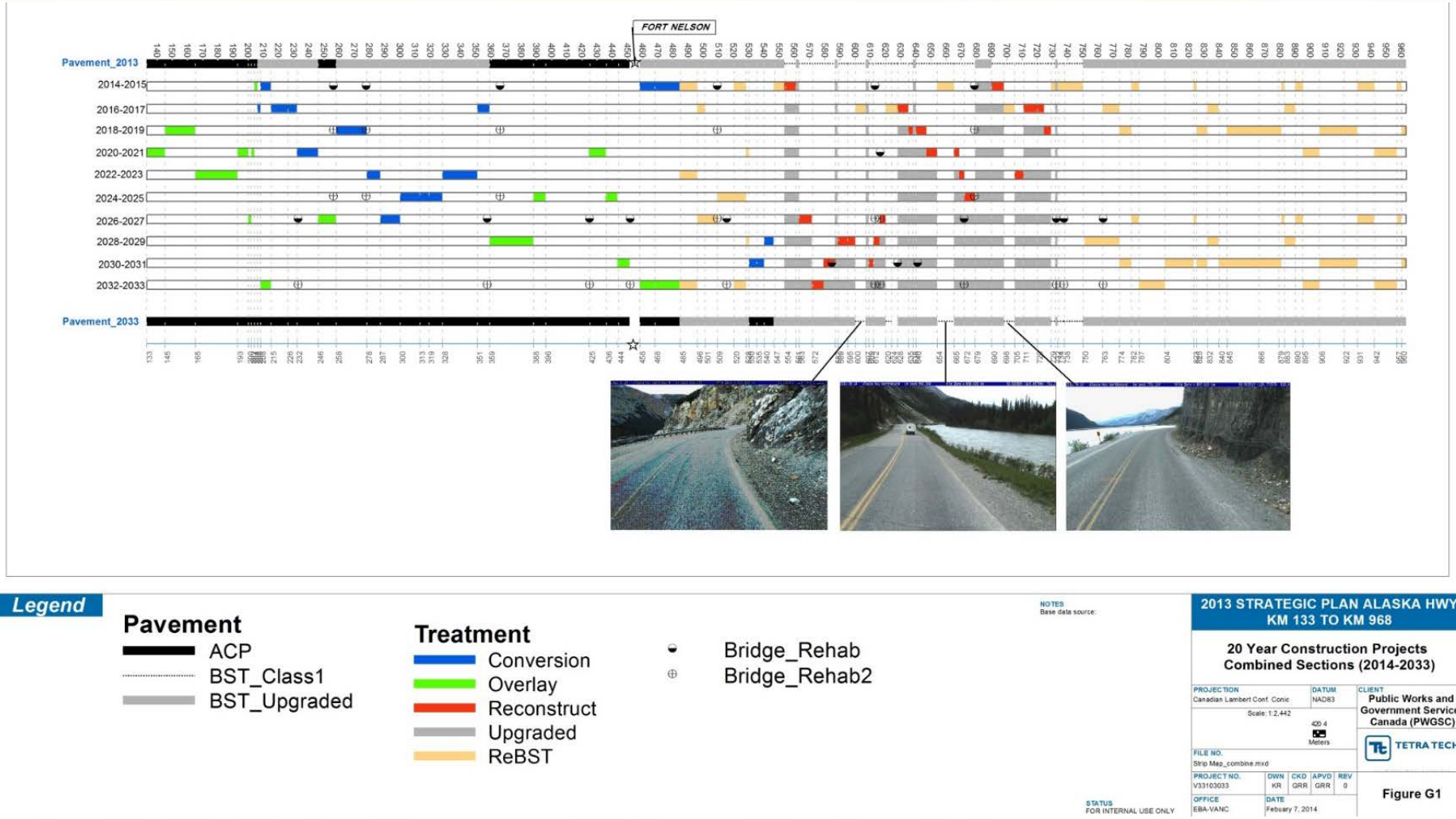
Road Draft Construction Plan

		BST_Total		Capital				
Year	Maintenance	ReBST	MajorRehab_BST	Conversion to ACP	Reconstruct to RAU100	Overlay	MajorRehab_ACP	Rehab2
2013	3,311,005	5,288,500	0	370,700	8,369,480	0	1,142,280	0
2014	3,722,959	2,689,140	0	103,400	12,268,340	0	0	0
2015	3,784,187	1,720,885	1,951,349	265,650	12,156,970	0	0	0
2016	3,517,122	5,761,640	0	4,153,050	6,497,820	0	0	0
2017	3,817,441	3,653,720	0	0	12,436,060	0	0	0
2018	4,156,140	837,270	0	1,307,900	8,473,150	5,198,180	0	0
2019	3,995,520	739,835	373,692	374,000	422,730	12,735,060	0	0
2020	3,687,846	1,646,230	7,295,880	489,500	6,840,750	0	0	0
2021	3,799,907	0	11,207,078	0	4,797,800	0	0	0
2022	3,513,028	4,036,610	7,883,533	0	4,162,620	0	0	0
2023	3,748,323	1,365,285	3,862,069	6,050,550	4,598,160	0	0	0
2024	3,702,628	1,094,330	999,666	5,504,950	5,822,250	2,159,730	0	0
2025	3,593,158	2,948,960	1,827,420	502,150	3,430,350	7,694,190	0	0
2026	3,682,746	2,326,260	0	615,450	8,878,905	620,930	0	0
2027	3,609,078	2,394,005	0	647,900	1,391,250	11,243,700	0	0
2028	3,288,466	5,346,890	0	0	10,848,600	0	0	0
2029	3,179,307	6,121,150	0	0	10,690,120	0	0	0
2030	3,278,129	4,065,040	0	0	10,351,460	2,104,650	0	0
2031	3,016,578	6,789,585	0	0	7,342,720	2,132,730	0	196,015
2032	3,064,978	4,249,600	5,216,594	0	7,396,060	0	0	53,580
2033	3,247,698	1,179,780	0	0	14,631,680	0	0	708,795
2034	3,287,408	1,747,680	0	0	6,604,080	0	5,936,220	2,130,415

Combined Draft Construction Plan

Year	Maintenance_Total	BST_Total	CAP_Road	CAP_Bridge
2013	3,311,005	5,288,500	9,882,460	2,458,156
2014	3,722,959	2,689,140	12,371,740	2,207,876
2015	3,784,187	3,672,234	12,422,620	983,403
2016	3,517,122	5,761,640	10,650,870	983,403
2017	3,817,441	3,653,720	12,436,060	983,403
2018	4,156,140	837,270	14,979,230	983,403
2019	3,995,520	1,113,527	13,531,790	2,333,999
2020	3,687,846	8,942,110	7,330,250	983,403
2021	3,799,907	11,207,078	4,797,800	983,403
2022	3,513,028	11,920,143	4,162,620	983,403
2023	3,748,323	5,227,354	10,648,710	983,403
2024	3,702,628	2,093,996	13,486,930	1,651,034
2025	3,593,158	4,776,380	11,626,690	983,403
2026	3,682,746	2,326,260	10,115,285	4,842,004
2027	3,609,078	2,394,005	13,282,850	1,351,035
2028	3,288,466	5,346,890	10,848,600	983,403
2029	3,179,307	6,121,150	10,690,120	983,403
2030	3,278,129	4,065,040	12,456,110	1,200,314
2031	3,016,578	6,789,585	9,671,465	983,403
2032	3,064,978	9,466,194	7,449,640	983,403
2033	3,247,698	1,179,780	15,340,475	983,403
2034	3,287,408	1,747,680	14,670,715	983,403
Average	**3,545,621**	**4,846,349**	**11,038,774**	**1,399,794**

Overall Plan



Summary

- The main competing forces were:
  - Conversion BST to ACP
  - Pavement Overlay on Existing ACP
  - Reconstruction (Geometric improvements)
  - Bridge Rehabilitation/Replacement

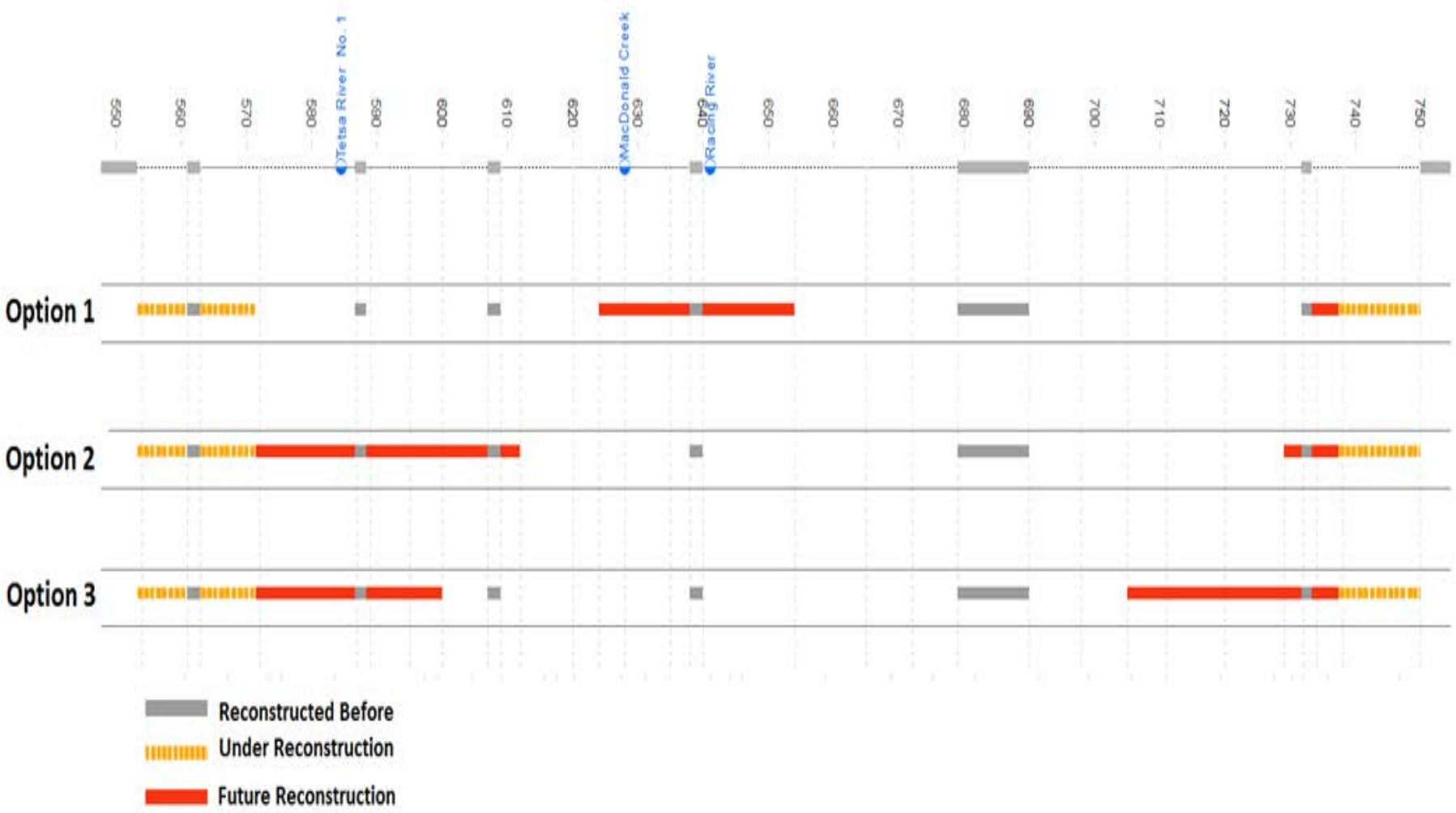
Summary

- Economic Considerations:
  - Annual capital budget of about $11 million was assumed in this plan ($220 million over next 20 years).
  - Required funding to convert all BST sections in the south end of the Highway (km 484) and complete all overlay projects on the existing pavements over 20 years is $67 Million and $48 Million respectively.
  - $90 Million over 20 years for the remaining reconstruction after some other PWGSC commitments are addressed.

Summary

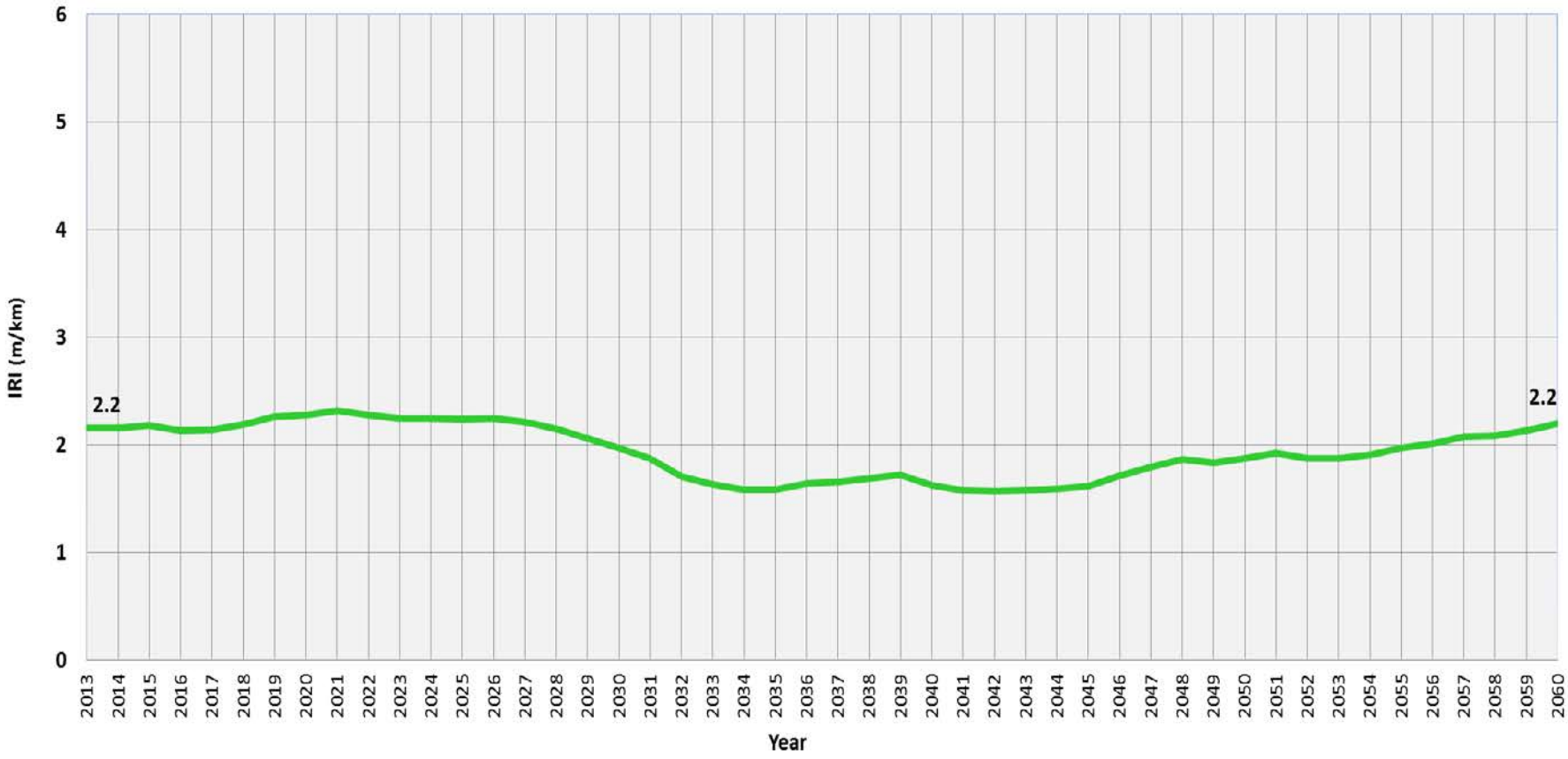
- Operational Considerations:
  - Take into account both the practicality of actually performing the work by a contractor and the concerns of the travelling public.
  - The user benefit of reconstruction is based on time savings in increasing the speed limit from 80 km/h to 100 km/h.
  - Only long stretches in the order of 20 or 30 kilometres (12-18 mi) should be considered for RAU-100.
  - To reconstruct some isolated sections in different years is not realistic and the practical plan needs to consider a more continuous upgrade to RAU-100.
  - Reconstruction from both ends of the corridor and moving inwards and extending already reconstructed sections is more practical than isolated sections of reconstruction. This was a key consideration and ultimately decided the final option.
  - Plan should try for a minimum length of about 10 km (6 mi) paving work to make economical tender packages for the contactor.
  - Other consideration - There are three truss bridges that have been flagged for replacement due to functional inadequacies.

Summary


550
560
570
580
Tetsa River No. 1
590
600
610
620
MacDonald Creek
630
640
Racing River
650
660
670
680
690
700
710
720
730
740
750
Option 1
Option 2
Option 3
Reconstructed Before
Under Reconstruction
Future Reconstruction

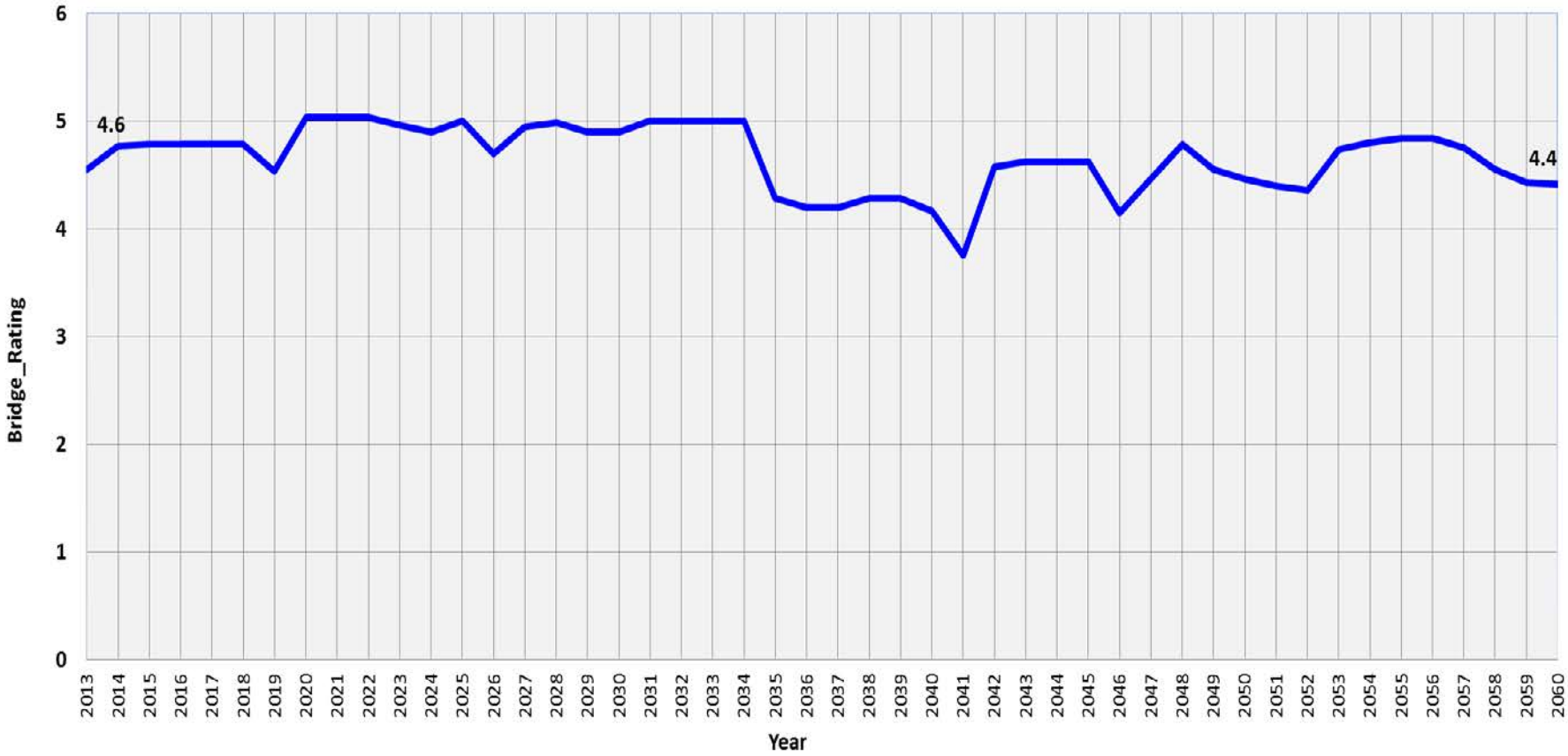
Average Condition Rating - Road

IRI Prediction based on the construction Plan



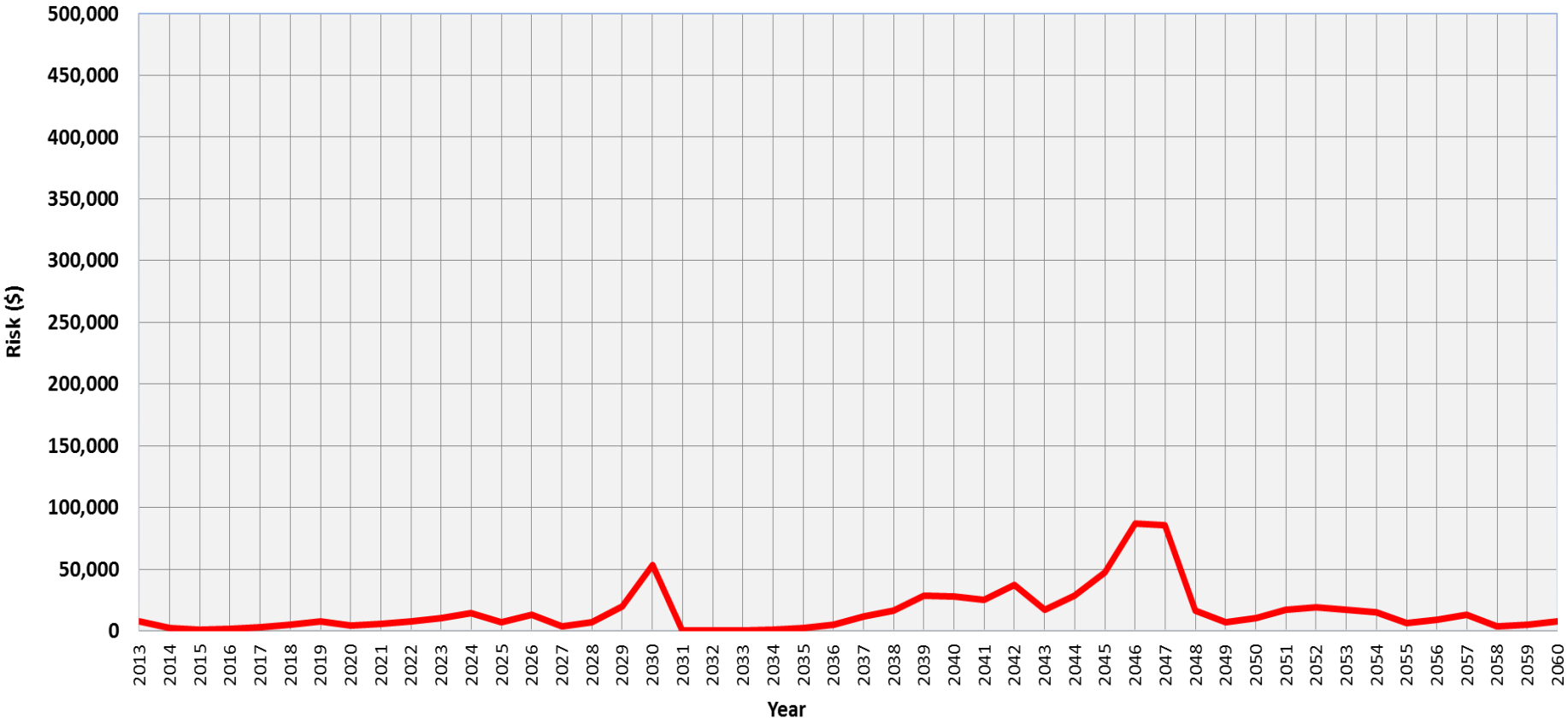
Average Condition Rating - Bridge

Bridge Rating based on the construction Plan



Risk- Bridge

Risk based on the construction Plan



Key Deliverables

- The development of a GIS for the Alaska Highway;
- Development of a strategic AMP concentrating on improving safety, preserving existing assets, upgrading the highway and bridges/culverts where necessary;
- Identification of major asset works for 50 years using life cycle cost analysis;
- Development of engineering economics to include as benefits the reduction of: accident costs, user delay costs, user detour costs, user vehicle operating costs, environmental costs associated with greenhouse gas emissions at current carbon trading rates and cost of risk for bridges/culverts;
- Development of risk assessment and mitigation measures;
- Perform life-cycle cost analysis comparing multiple pavement preservation, geometric upgrades and bridge/culvert works, and;
- Development of a risk based Bridge Management System.

Key Takeaways

- Competing objectives can be evaluated with common benefits.
- Risk can be used in bridge management and asset management in general.
- Economic considerations are imperative but cannot trump practical considerations.

Questions & Discussion

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