THURBER ENGINEERING LTD.

EQUIVALENT MUNICIPALITIES PAVEMENT DESIGNS
RIGID AND FLEXIBLE PAVEMENTS

PROVINCE OF ALBERTA

Report to

Cement Association of Canada

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EXECUTIVE SUMMARY

Most municipalities in the Province of Alberta currently construct flexible pavements for their road network. Although suitable for lower volume roadways or areas with competent subgrade conditions, flexible pavements may not always be the correct pavement type when designing heavier travelled roadways, nor the most cost-effective alternative when comparing life cycle costs.

To provide assistance to municipal agencies in the Province of Alberta, pavement design comparisons were developed for various traffic volumes, roadway classifications, and subgrade strengths. For each set of conditions, both flexible and rigid pavement designs were developed using the AASHTOWare *Pavement ME* software program, supplemented with the results of other commonly used programs such as AASHTO's (1993) DARWin and the American Concrete Pavement Association (ACPA) StreetPave 12.

Design inputs used in the analysis were compiled from a number of provincial and municipal documents, supplemented with information from Alberta Transportation (AT), City of Calgary (Calgary), City of Edmonton (Edmonton), and the Cement Association of Canada (CAC). For comparison purposes, the equivalent pavement designs were evaluated with a Life Cycle Cost Analysis (LCCA) to determine the total cost to municipal agencies for each pavement section over a 50-year analysis period. Unit rates used in the LCCA were established taking into consideration typical rates from the City of Calgary, City of Edmonton, AT, supplemented by local industry.

Details on the pavement design analysis, resulting comparison design matrix, and LCCA are provided in this report.

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1.0 INTRODUCTION

Most municipalities in the Province of Alberta currently construct flexible pavements for their road network. Although suitable for lower volume roadways or areas with competent subgrade conditions, flexible pavements may not always be the correct pavement type when designing heavier travelled roadways, nor the most cost-effective alternative when comparing life cycle costs.

Canadian municipalities have been using rigid pavements as a viable pavement alternative for decades, particularly for roadways that support heavy truck traffic, or in areas with weak subgrade conditions. Although not very common in Alberta, rigid pavements can provide municipal agencies with an alternative pavement type that could provide a more cost-effective solution to address some of their transportation infrastructure needs.

To provide assistance to municipal agencies in the Province of Alberta, pavement design comparisons were developed for various traffic volumes, roadway classifications, and subgrade strengths. For each set of conditions, both flexible and rigid pavement designs were developed using the AASHTOWare *Pavement ME* software program. This state-of-the-practice tool for the design of new and rehabilitated pavements is based on mechanistic-empirical principles. This robust design procedure empirically relates the cumulative damage for both flexible and rigid pavements to observed pavement distresses. Equivalent pavement designs presented in this document are based on the results of the *Pavement ME* analysis, supplemented with the results of other commonly used programs such as AASHTO's (1993) DARWin and the American Concrete Pavement Association (ACPA) StreetPave 12.

Comparable pavement designs were evaluated using a Life Cycle Cost Analysis (LCCA), in terms of their Net Present Worth. The resulting costs represents the total cost to the agency for each pavement type over a 50-year analysis period.

Details on the pavement design analysis, resulting comparison design matrix, and LCCA are provided in this report.

2.0 PAVEMENT DESIGN INPUT PARAMETERS

In order to develop the pavement design comparison matrix, a number of input design parameters were required for the analysis. Design inputs used in the analysis were compiled from a number of provincial and municipal documents, supplemented with information from Alberta Transportation (AT), City of Calgary (Calgary), City of Edmonton (Edmonton), and the

Cement Association of Canada (CAC). Pavement design input parameters used to complete the AASHTOWare Pavement ME analysis are summarized in the ensuing sections.

2.1 Roadway Classifications

Upon a review of standard specifications for the City of Edmonton and the City of Calgary, the roadway classifications used for the study have been divided into four main categories: Industrial, Major Collector, Minor Arterial, and Major Arterial. Traffic information for the different roadway classifications were provided by survey studies completed by the City of Edmonton, which included an Average Annual Daily Truck Traffic (AADTT) volume for each roadway classification. The two levels of AADTT for each road classification were selected and included the average truck volume and the highest truck volumes.

Table 1. Roadway Classification and Associated Truck Volumes

Roadway Classifications	AADTT
Industrial	250 & 500
Major Collector	750 & 1,600
Minor Arterial	2,500 & 5,000
Major Arterial	7,500 & 10,000

As identified in the AT Pavement Design Manual, the average growth in traffic on the Alberta primary highway network is approximately 2.3 percent per annum. Anticipating that the growth rate within a municipal environment is slightly less, a compounded growth rate of 2.0 percent will be used for the analysis.

2.2 Design Reliability Levels:

Defining design reliability levels are important for pavement designs purposes. For the purposes of this comparison study, the reliability levels from Table 8.3 of the Alberta Transportation (AT) Pavement Design Manual were modified to reflect the roadway classifications that will be considered. Applicable design reliability values are provide in Table 2.

Table 2. Design Reliability for Each Roadway Classification

Roadway Classifications	Reliability Level
Industrial	85 %
Major Collector	85 %
Minor Arterial	90 %
Major Arterial	95 %

As per the City of Calgary specifications, the reliability values required for design purposes include: 95% for Major roadways; and 85% for Industrial roadways. This criterion is considered

similar to the values provided in the table above, which are considered to be appropriate for the purposes of this study.

2.3 Distress Prediction Target Values

For developing comparable pavement designs, a design life of 25 years was used for all roadway classifications. To evaluate the results of the pavement designs, the predicted distresses were required to meet a certain threshold value. Based on the information provided for agencies in the Province of Alberta, the following target values were used for developing comparable pavement designs.

Table 3. Distress Prediction Target Values

Flexible Pavement – Performance Criteria	
Initial IRI	1.0 m/km
Predicted Terminal IRI	3.0 m/km
Permanent Deformation - AC only	10 mm
Permanent Deformation - Total Pavement	19 mm
AC Bottom-up Fatigue Cracking	20 %
AC Thermal Fracture	200 m/km
Rigid Pavement – Performance Criteria	
Initial IRI	1.5 m/km
Predicted Terminal IRI (m/km)	3.0 m/km
Transverse Cracking (Percent Slabs)	15 %
Mean Slab Faulting	6 mm

2.4 Vehicle Class Distribution

Each of the roadway classifications have distinct truck traffic that use that facility. The vehicle class distributions presented in Table 4 were provided by the City of Edmonton.

The remaining traffic information required for the Pavement ME analysis was provided by AT, collected at the Leduc Weigh-in-Motion (WIM) site, on Highway 2A. The information was collected in 2010 and includes single, tandem, Tridem, Quad Axle Load Distributions, AADTT Distribution, Hourly Distribution, Number of Axles, and Monthly Adjustment Factors. The WIM data from this site was selected, as the AADTT distribution closely resembled the provided vehicle distribution for Major Arterial roadways in the City of Edmonton.

For the purpose of this analysis, a directional distribution factor of 50 percent was assumed. Furthermore, the roadways with an AADTT greater than 1,000 were assumed to have 2 lanes in each direction, with an 80 percent lane distribution for the design lane. Lower volume roadways (<1,000 AADTT) were assumed to be two-lane roadways.

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Table 4. Vehicle Class Distributions

FHWA Vehicle Classification			Industrial	Major Collector	Minor Arterial	Major Arterial
Class 4		2 or 3-Axle Busses	1.0%	20.5%	13.0%	9.4%
Class 5		2-Axle, 6-Tire, Single Unit Trucks	36.6%	33.8%	27.1%	22.6%
Class 6		3-Axle Single Units	6.8%	9.2%	6.0%	4.5%
Class 7		4 or more Axles, Single Unit Trucks	1.9%	1.5%	0.4%	0.4%
Class 8		4 or less Axles, Single Trailer Trucks	9.7%	8.9%	2.7%	1.5%
Class 9		5-Axle Single Trailer Trucks	16.4%	22.0%	19.1%	18.0%
Class 10		6 or more Axle Single Trailer Trucks	18.9%	1.8%	15.5%	25.0%
Class 11		5 or less Axle Multi-Trailer Trucks	0.3%	0.7%	0.5%	0.1%
Class 12		6-axle Multi-Trailer Trucks	0.5%	0.2%	0.5%	0.4%
Class 13		7 or more Axle Multi-Trailer Trucks	7.9%	1.4%	15.2%	18.1%

Although the *AASHTOWare Pavement ME* program used for the analysis does not convert the traffic into Equivalent Single Axle Loads (ESAL), the program does provide an output file with the calculated ESALs for the design inputs. The calculated Design ESALs by Pavement ME for each roadway classification and pavement type are provided in Table 5.

Table 5. Pavement ME Calculated Design ESALs

Roadway Classifications	AADTT	Flexible Design ESALs (Millions)	Rigid Design ESALs (Millions)
Industrial	250	0.9	1.4
	500	1.8	2.7
Major Collector	750	1.9	2.3
	1,600	4.0	4.8
Minor Arterial	2,500	8.7	12.8
	5,000	17.4	25.5
Major Arterial	7,500	30.6	46.7
	10,000	40.8	62.3

2.5 Climate Station Information

The Pavement ME software includes climate station information for 30 weather stations across the Province of Alberta. As expected, climate station information throughout the province was

found to be variable, with mean annual air temperatures ranging from as low as -5ºC in Fort Chipewyan to 5.9ºC in Lethbridge and Medicine Hat. A sample of the climate properties from four climate stations are provided in Table 6.

Table 6. Climate File Comparison (TAC Pavement ME User Group)

Climate Properties	High Level	Edmonton, (International)	Calgary	Lethbridge
Mean Annual Air Temp. (ºC)	-0.5	3.1	4.6	5.9
Mean Annual Precipitation (mm)	366.5	464.8	416.9	394.2
Number of Wet Days	119.6	122.4	109.6	99.3
Freezing Index (ºC-days)	3400.1	2222.2	1697.3	1558.1
Average Annual No. Freeze-Thaw Cycles	84	122.7	144.7	112.1
Years of Climate Data	20	20	20	20

The selection of climate files for this study was limited to the provinces most populated areas. In comparison of the various climate properties, the climate file for the Edmonton International Airport was selected to best represent municipalities in the southern part of the province.

2.6 Subgrade Soil Properties

Subgrade soil conditions are expected to change throughout the province, and often throughout a municipality's jurisdiction. To capture the effects of changing subgrade soils, three different subgrade soils were used for developing pavement designs. These soils included: Highly Plastic Clay, Low Plastic Clay; and Gravely Silty Sand. Instead of assuming a resilient modulus for each of these soils, the subgrade strengths for each group of soils were determined using Level 2 Inputs in Pavement ME. The gradation and other engineering properties for these soils were obtained from available geotechnical information throughout the province. The subgrade soil properties used for the Level 2 calculation are provided in the Table 7.

The resilient modulus for each soil type was calculated using the equations in Pavement ME, which represents the soil strength at optimum moisture content. The subgrade strengths determined by the Level 2 analysis varied from 33 MPa for the Highly Plastic Clay, 71 MPa for the Low Plastic Clay, to 193 MPa for the Gravely Silty Sand. It is noted that the resilient modulus used in the Pavement ME analysis (at optimum moisture content) is not the same value as typically used in the AASHTO '93 design analysis (average strength). Further discussion on the difference between these two values can be found in the 2014 TAC proceedings, *Lessons Learned by Canadian Practitioners in Interpreting and Applying Pavement ME Design Results* (TAC 2014).

Table 7. Subgrade Soils – Input Parameters

Characteristic	Highly Plastic Clay	Low Plastic Clay	Gravely Silty Sand
Poisson's Ratio	0.35	0.35	0.35
Coefficient of Lateral Earth Pressure	0.5	0.5	0.5
Percent Passing 25 mm	100 %	100 %	100 %
Percent Passing 19 mm	100 %	86 %	89 %
Percent Passing 12.5 mm	100 %	84 %	85 %
Percent Passing 9.5 mm	100 %	83 %	80 %
Percent Passing 4.75 mm	99 %	81 %	74 %
Percent Passing 2.0 mm	98 %	79 %	67 %
Percent Passing 425 µm	96 %	76 %	56 %
Percent Passing 75 µm	92 %	64 %	34 %
Percent Passing 1 µm	43 %	13 %	4 %
Liquid Limit	62 %	30 %	16 %
Plasticity Index	40 %	16 %	3 %
Maximum Dry Unit Weight	1,640 kg/m^3	1,858 kg/m^3	2,012 kg/m^3
Optimum Moisture Content	20.0 %	14.4 %	8.4 %
Is Layer Compacted?	Yes	Yes	Yes
Resilient Modulus - Level 2 Calculation (at optimum moisture content)	33 MPa	71 MPa	196 MPa
Approximate AASHTO '93 Resilient Modulus	*10 MPa*	*30 MPa*	*50 MPa*

2.7 Hot Mix Asphalt Properties

The properties for the asphalt mixes used for the flexible design analysis were provided by the City of Edmonton. The asphalt mixes include typical asphalt mixes used in the construction of the various roadway classes. For roadways classified as 'Industrial' (AADTT of 500 or less), an Asphalt Concrete Residential (ACR) asphalt mix was assumed, while an Asphalt Concrete Base (ACB) and Asphalt Concrete Overlay (ACO) was assumed for all other roadway classifications

A summary of the asphalt material properties are provided in Table 8.

2.8 Concrete Properties

The material inputs for the Portland Cement Concrete material comes from various sources, including:

1. City of Edmonton Construction Specification – Section 03055
2. City of Calgary Construction Specification – 310.00.00
3. FHWA HIF-09-015

Table 8. Hot Mix Asphalt – Input Parameters

Traffic Levels		**AADTT ≤ 500**	**AADTT > 500**	
Asphalt Material Type		ACR	ACO	ACB
Mixture Volumetric				
Unit Weight (kg/m^3)		2,360	2,350	2,375
Effective Binder Content - by Volume (%)		12.0	11.0	10.2
Air Voids (%)		5.0	5.0	5.0
Poisson's Ratio		0.35		
Mechanical Properties				
Dynamic Modulus		Calculated		
Aggregate Gradation	% Passing the 19 mm Sieve	100	100	92
	% Passing the 9.5 mm Sieve	85	87	75
	% Passing the 4.75 mm Sieve	57	58	55
	% Passing the 75 µm Sieve	7	7	7
G Star Predictive Model		"Use viscosity based model (nationally calibrated)" selected		
Reference Temperature		21.1 ºC		
Asphalt Binder		PG 58-34	PG 64-34	PG 64-34
Indirect Tensile Strength – 10 deg.C (MPa)		Calculated		
Creep Compliance (1/GPa)		"Input level: 3" selected		
Thermal Properties				
Thermal Conductivity (watt/meter-Kelvin)		1.16		
Heat Capacity (joule/kg-Kelvin)		963		
Thermal Contraction		Calculated		

A study completed by the FHWA, found that since the coarse aggregates make up the bulk of the volume of concrete, the most influential factor in the CTE of the concrete is the CTE of the coarse aggregates. The study further determined the quartzite aggregate has the highest CTE of the commonly used course aggregate types in concrete pavement construction. For this reason, the recommend CTE value of 9.34 was used in the concrete material properties, as Quartz aggregates are the likely type of course aggregates to be used in the Province of Alberta.

A summary of the concrete material properties used in the rigid pavement design analysis is provided Table 9.

Table 9. Portland Cement Concrete - Input Parameters

Portland Cement Concrete Properties	
Unit Weight	2,350 kg/m^3
Poisson's Ratio	0.2
Thermal Properties	
PCC Coefficient of Thermal Expansion (mm/mm ^{o}C x 10^{-6})	9.34
PCC Thermal Conductivity (watt/meter-Kelvin)	1.09
PCC Heat Capacity (joule/kg-Kelvin)	917
Concrete Mix Properties	
Cement Type	GU (Type 1)
Cementious Material Content	332 kg/m^3
Water/Cement Ratio	0.45
Aggregate Type	Quartzite
PCC Set Temperature	Calculated (23.1)
Ultimate Shrinkage (Microstrain)	Calculated (654.1)
Reversible Shrinkage (% of Ultimate Shrinkage)	50 %
Time to Develop 50% of Ultimate Shrinkage	35 Days
Curing Method	Curing Compound
Material Strength	
PCC Strength and Modulus	"Level 3" selected
28 Day Modulus of Rupture (MPa)	4.2
Elastic Modulus (GPa)	28.3
JPCP Design Parameters	
PCC Surface Shortwave Absorptivity	0.85
PCC Joint Spacing (m)	4.5 m (AADTT = 10,000) 4.0 m (All Other Classes)
Sealant Type	Hot Pour Asphalt
Doweled Joints	32M @ 300mm Spacing (AADTT > 750) No Dowels (AADTT ≤ 750)
Widened slab	True
Tied Shoulders	Tied
Load efficiency (%)	70
Erodibility Index	Very Erodible (5)
PCC-base Contact Friction	Default (True)
Permanent Curl/Warp Effective Temperature Difference (^{o}C)	Default (-5.60)

2.9 Granular Properties

The properties of the granular base and subbase were provided by the City of Edmonton. The specific granular material properties used in the analysis are provided in Table 10. Similar to the subgrade soils, a Level 2 analysis used for determining the resilient modulus for the respective granular base and subbase.

Table 10. Granular Material Default Parameters

Unbound Material Properties		**Crushed Gravel**	**Sub-base Gravel**
Poisson's Ratio		0.35	
Coefficient of Lateral Pressure (k_0)		0.5	
Material Modulus			
Resilient Modulus (Level 2 Calculation)		*246 MPa*	*184 MPa*
Gradation and Other Engineering Properties			
Aggregate Gradation (percent passing)	75 µm	5	4
	300 µm	13.5	33.5
	1.18 mm	27.5	55
	4.75 mm	45	55
	9.5 mm	61.5	-
	13.2 mm	77.5	-
	19.0 mm	92.5	-
	25 mm	100	75
Liquid Limit		6	11
Plasticity Index		0	
Is layer compacted		Yes	
Maximum dry unit weight (kg/m^3)		Calculated	
Saturated hydraulic conductivity (m/hr)		Calculated	
Specific gravity of solids		Calculated	
Optimum gravimetric water content (T)		Calculated	

2.10 Software Calibration

Pavement distress prediction models, or transfer functions, are the key components of any M-E design analysis procedure. The accuracy of the performance prediction models in Pavement ME depend on an effective process of calibration and subsequent validation with independent data sets. It is understood that all performance models in the Pavement ME software were calibrated on a global level to available field performance data throughout North America.

Local calibration of the performance models is a very involved and expensive exercise, which has not been completed by any Canadian agency to date. It is acknowledged that the pavement design analysis completed for this study relied on the default global calibration factors, supplemented by available material test results.

3.0 PAVEMENT DESIGN COMPARISONS

The development of the pavement designs for both flexible and rigid pavements considered the bound and unbound pavement materials typically used in roadway construction by municipalities in the Province of Alberta. A range of subgrade soils were used to represent the various soil conditions present within the province. The subgrade soil properties used in the design analysis were obtained from actual laboratory test results completed on collected soil samples.

A pavement design matrix was developed, with rigid and flexible pavement designs for each combination of roadway classification, traffic volumes, and subgrade soils. Initial pavement designs were selected using typical municipal cross sections, adjusted for a 25-year design life, and analyzed using the *AASHTOWare Pavement ME* software. The predicted distresses for each analysis were examined to determine the pavement structures required to meet the identified target thresholds. The designs were then modified to either address the premature failure of the pavement, or to reduce layer thickness to prevent over-designing the pavement type.

The preliminary designs developed using *Pavement ME* software were compared to other design procedures, including StreetPave 12 and the AASHTO Guide for the Design of Pavement Structures (1993). The resulting design matrix was then reviewed by practicing Engineers in the Province of Alberta to ensure the results were appropriate to current practices.

A comparison of flexible and rigid pavement structures for the various roadway conditions is provided in Table 11. The designs presented in this table are considered typical for the varying conditions that existing across the province. However, it is important to note that conditions do change throughout the province, and designers may need to vary layer thicknesses to ensure that pavement structures address the needs of local conditions.

Furthermore, the pavement designs presented in the comparison matrix do not consider any soil remediation treatments that may be completed prior to the placement of the pavement layers, or the placement of additional material required for constructability purposes. Should agencies require the need for soil stabilization techniques for improving subgrade strength, then the resulting pavement structure should be selected that appropriate represents the combined strength of the treated and untreated subgrade soil.

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Table 11. Equivalent Municipal Pavement Designs: Province of Alberta

Subgrade Strength*	Pavement Type	Average Annual Daily Truck Traffic							
		Industrial Roadway		Major Collector Roadway		Minor Arterial Roadway		Major Arterial Roadway	
		250	500	750	1,600	2,500	5,000	7,500	10,000
10 MPa	PCC	180 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	200 mm PCC 300 mm GBC	200 mm PCC 300 mm GBC	210 mm PCC 300 mm GBC	220 mm PCC 500 mm GBC	250 mm PCC 500 mm GBC
	HMA	120 mm ACP 150 mm GBC 700 mm SGSB	150 mm ACP 150 mm GBC 750 mm SGSB	150 mm ACP 150 mm GBC 750 mm SGSB	170 mm ACP 150 mm GBC 800 mm SGSB	220 mm ACP 150 mm GBC 800 mm SGSB	260 mm ACP 200 mm GBC 800 mm SGSB	330 mm ACP 200 mm GBC 800 mm SGSB	350 mm ACP 200 mm GBC 800 mm SGSB
30 MPa	PCC	180 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	210 mm PCC 200 mm GBC	220 mm PCC 300 mm GBC	230 mm PCC 300 mm GBC
	HMA	120 mm ACP 150 mm GBC 300 mm SGSB	130 mm ACP 150 mm GBC 300 mm SGSB	130 mm ACP 150 mm GBC 300 mm SGSB	150 mm ACP 150 mm GBC 400 mm SGSB	175 mm ACP 150 mm GBC 500 mm SGSB	220 mm ACP 150 mm GBC 500 mm SGSB	250 mm ACP 200 mm GBC 500 mm SGSB	270 mm ACP 200 mm GBC 600 mm SGSB
50 MPa	PCC	180 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	210 mm PCC 200 mm GBC	220 mm PCC 300 mm GBC	230 mm PCC 300 mm GBC
	HMA	120 mm ACP 150 mm GBC 200 mm SGSB	130 mm ACP 150 mm GBC 200 mm SGSB	130 mm ACP 150 mm GBC 200 mm SGSB	150 mm ACP 150 mm GBC 300 mm SGSB	175 mm ACP 150 mm GBC 300 mm SGSB	200 mm ACP 150 mm GBC 300 mm SGSB	225 mm ACP 150 mm GBC 400 mm SGSB	240 mm ACP 150 mm GBC 400 mm SGSB
Concrete Slab Properties		No Dowel Bars Slab Length = 4.0m Tied Curb/shoulders			32M Dowel Bar Slab Length = 4.0m Tied Curb/shoulders				32M Dowel Bar Slab Length = 4.5m Tied Curb/shoulders

Note: * - Subgrade Strength indicates the equivalent estimated AASHTO '93 Resilient Modulus design value.
Subgrade Strength values do not consider any soil remediation treatments.

4.0 LIFE CYCLE COST ANALYSIS

The equivalent pavement structures will be compared using a Life Cycle Cost Analysis (LCCA) in terms their Net Present Worth (NPW). This LCCA approach calculates the initial construction costs for each pavement structure, and predicts future maintenance and rehabilitation costs, while discounting any salvage value that may remain at the end of the analysis period.

The LCCA assumed the construction and maintenance of a 1 km roadway length, over a 50-year analysis period. Roadways with an AADTT less than 1,000 are considered to contain a two-lane pavement platform, while pavements supporting more than 1,000 AADTT are four-lane roadways.

4.1 Initial Construction Costs

The initial construction costs used in the LCCA were estimated for each of the pavement comparisons in the design matrix. Cost estimates considered the roadway platform widths, construction materials, and layer thickness required to construct each pavement type. It is important to note that platform width for rigid pavements was 1 m wider, to account for the widened lane required for design purposes at the pavement edge.

Construction costs assumed that a pavement platform will be constructed on grade; therefore earth excavation will be required for the thickness of the new pavement structure. Furthermore, initial cost estimates did not consider items similar to both pavement types, such as the installation of subdrains, curb and gutters, or pavement markings.

4.2 Pavement Preservation Costs

To predict future maintenance and rehabilitation costs for each pavement alternative, a pavement preservation plan is required that reflects typical activities required by an agency to extend the service life of the roadway to meet the analysis period of the LCCA. A review of pavement preservation practices by agencies in the Province of Alberta was limited to the provinces *Guidelines for Assessing Pavement Preservation Treatments and Strategies, July 2006*. The document provides:

- A tool box of preservation treatments;
- Basic guidelines for selecting treatments;
- Matrices to select preventative maintenance treatments; and
- A methodology for assessing rehabilitation treatments and strategies.

The document was considered to be a valuable resource for identifying various preservation treatments available for flexible pavements, the intended application for each treatment, and the expected treatment service life. However, for the purposes of this comparative study, the guidelines provided in this document were considered to be incomplete, and not entirely applicable for municipal environments.

The pavement preservation plan discussed in the provincial guidelines only considered major rehabilitation treatment in the LCCA, which only required a second or third treatment to achieve a minimum 30-year life cycle. Although this rehabilitation strategy could be applicable for the province network of highways, in a municipal environment, preventative maintenance treatments are often completed to maintain road conditions or extend the service life of the rehabilitation treatments. Furthermore, the document does not consider rigid pavements, nor any pavement preservation treatments that would be associated with extending the service life for these types of roadways.

The LCCA for comparing equivalent pavement structures will be completed over a 50-year analysis period, and will use a discount rate of 4 percent (as recommended in the AT Pavement Design Manual). The pavement preservation plans (for both pavement types) were developed using information available from the provincial documents, supplemented by information available from similar studies completed for other Canadian municipalities, modified for conditions and construction practices in Alberta.

It is important to acknowledge that the application of pavement preservation treatments throughout the life of a pavement is a cost-effective approach for extending the intended design life, or the service life for a particular roadway. Although some municipalities may not complete certain maintenance activities (such as crack sealing and patching), it can be expected that not performing these tasks will reduce the intended pavement design life, increasing the frequency of more costly rehabilitation treatments. In these situations, it can be expected that the life cycle cost of these pavement would be higher than if the preservation treatments were completed.

The pavement preservation plans that were used for the LCCA in this study are provided in the ensuing tables.

Table 12. Flexible Pavement Preservation Plan – Industrial Roadways (AADTT 250 & 500)

Expected Year	Activity Description	Estimated Quantity
10	Rout and seal	250 m
10	Spot repairs (mill 40 mm/patch 40 mm)	8%
20	Mill HMA	40 mm
20	Resurface with new surface asphalt	40 mm
25	Rout and seal	500 m
30	Spot repairs (mill 40 mm/patch 40 mm)	10%
35	Mill HMA	40 mm
35	Full-depth asphalt base repairs	10%
35	Resurface with new surface asphalt	40 mm
40	Rout and seal	500 m
43	Spot repairs (mill 40 mm/patch 40 mm)	8%
48	Mill HMA	40 mm
48	Resurface with new surface asphalt	40 mm

Table 13. Flexible Pavement Preservation Plan – Major Collector (AADTT 750 & 1,600)

Expected Year	Activity Description	Estimated Quantity
10	Rout and seal	250 m
10	Spot repairs (mill 40 mm/patch 40 mm)	8%
15	Spot repairs (mill 40 mm/patch 40 mm)	10%
20	Mill HMA	40 mm
20	Resurface with new surface asphalt	40 mm
25	Rout and seal	500 m
30	Spot repairs (mill 40 mm/patch 40 mm)	10%
35	Mill HMA	40 mm
35	Full-depth asphalt base repairs	10%
35	Resurface with new surface asphalt	40 mm
40	Rout and seal	500 m
43	Spot repairs (mill 40 mm/patch 40 mm)	8%
48	Mill HMA	90 mm
48	Resurfacing with new base asphalt	50 mm
48	Resurface with new surface asphalt	40 mm

Table 14. Flexible Pavement Preservation Plan – Minor Arterial (AADTT 2,500 & 5,000)

Expected Year	Activity Description	Estimated Quantity
5	Rout and seal	250 m
10	Rout and seal	500 m
10	Spot repairs (mill 40 mm/patch 40 mm)	8%
20	Mill HMA	40 mm
20	Resurface with new surface asphalt	40 mm
25	Rout and seal	1,000 m
30	Spot repairs (mill 40 mm/patch 40 mm)	15%
35	Mill HMA	90 mm
35	Resurfacing with new base asphalt	50 mm
35	Resurface with new surface asphalt	40 mm
40	Rout and seal	1,500 m
43	Spot repairs (mill 40 mm/patch 40 mm)	10%
48	Mill HMA	40 mm
48	Full-depth asphalt base repairs	10%
48	Resurface with new surface asphalt	40 mm

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Table 15. Flexible Pavement Preservation Plan – Major Arterial (AADTT 7,500 & 10,000)

Expected Year	Activity Description	Estimated Quantity
8	Rout and seal	200 m
8	Spot repairs (mill 40 mm/patch 40 mm)	5%
13	Rout and seal	1,000 m
13	Spot repairs (mill 40 mm/patch 40 mm)	15%
18	Mill HMA	50 mm
18	Full-depth asphalt base repairs	10%
18	Resurface with new surface asphalt	50 mm
23	Rout and seal	500 m
28	Rout and seal	1,500 m
28	Spot repairs (mill 40 mm/patch 40 mm)	10%
32	Mill HMA	90 mm
32	Resurfacing with new base asphalt	50 mm
32	Resurface with new surface asphalt	40 mm
37	Rout and seal	1,500 m
40	Spot repairs (mill 40 mm/patch 40 mm)	10%
45	Mill HMA	50 mm
45	Full-depth asphalt base repairs	10%
45	Resurface with new surface asphalt	50 mm
48	Rout and seal	1,500 m

Table 16. Rigid Pavement Preservation Plan – Industrial Roadways (AADTT 250 & 500)

Expected Year	Activity Description	Estimated Quantity
12	Reseal joints	10 %
25	Partial depth PCC repairs	2 %
25	Full depth PCC repairs	5 %
25	Reseal joints	20 %
40	Partial depth PCC repairs	5 %
40	Full depth PCC repairs	10 %
40	Reseal joints	20 %

Table 17. Rigid Pavement Preservation Plan – Major Collector (AADTT 750 & 1,600)

Expected Year	Activity Description	Estimated Quantity
12	Reseal joints	20 %
25	Partial depth PCC repairs	5 %
25	Full depth PCC repairs	10 %
25	Reseal joints	25 %
40	Partial depth PCC repairs	5 %
40	Full depth PCC repairs	15 %
40	Reseal joints	25 %

Table 18. Rigid Pavement Preservation Plan – Minor Arterial (AADTT 2,500 & 5,000)

Expected Year	Activity Description	Estimated Quantity
12	Reseal Joints	25 %
12	Partial depth PCC repairs	2 %
25	Partial depth PCC repairs	5 %
25	Full depth PCC repairs	10 %
25	Reseal joints	25 %
40	Partial depth PCC repairs	5 %
40	Full depth PCC repairs	15 %
40	Reseal joints	25 %

Table 19. Rigid Pavement Preservation Plan – Major Arterial (AADTT 7,500 & 10,000)

Expected Year	Activity Description	Estimated Quantity
12	Reseal Joints	25 %
12	Partial depth PCC repairs	2 %
25	Partial depth PCC repairs	5 %
25	Full depth PCC repairs	10 %
25	Reseal joints	50 %
25	Texturize Surface	25 %
40	Partial depth PCC repairs	5 %
40	Full depth PCC repairs	15 %
40	Reseal joints	50 %
40	Texturize Surface	50 %

4.3 Unit Rates for LCCA

Unit rates for the various construction, maintenance, and rehabilitation activities obtained from projects recently administered by the province, as well as the cities of Calgary and Edmonton. Although individual rates were found to fluctuate between tasks and agencies, the unit rates used in the analysis were intended to be a balanced average for each operation in a typical municipal environment. Furthermore, unit rates were estimated for projects that include reasonable quantities for each tender item.

As not all of the unit rates required for the LCCA were included in recent projects, available information was supplemented by typical costs from other Canadian municipalities, as well as information obtained from local contractors. Although not considered in this LCCA, it can be expected that the unit rates for the various construction materials and activities required for concrete pavements will deceased as more projects with this pavement type are tendered, and more local contractors gain experience.

The unit rates used for calculating initial construction costs are provided in Table 20, while typical costs for the various pavement preservation treatments are provided in Table 21.

Table 20. Unit Costs of Initial Construction Activities

Pavement Layer	Description of Pavement Layer	Units	Unit Rates
HMA	Low volume asphalt (ACR)	t	$ 105
	High volume surface asphalt (ACO)	t	$ 145
	High volume base asphalt (ACB)	t	$ 135
	Tack Coat	m^2	$ 0.50
PCC	180 mm PCC pavement, no dowels	m^2	$ 73
	190 mm PCC pavement, no dowels	m^2	$ 74
	200 mm PCC pavement, 32M dowels	m^2	$ 100
	210 mm PCC pavement, 32M dowels	m^2	$ 101
	220 mm PCC pavement, 32M dowels	m^2	$ 104
	230 mm PCC pavement, 32M dowels	m^2	$ 107
	250 mm PCC pavement, 32M dowels	m^2	$ 113
Base	Crushed gravel	m^3	$ 35
Subbase	Subbase gravel	m^3	$ 26
Subgrade	Excavation and grading	m^3	$ 16

Table 21. Unit Costs for Pavement Preservation Treatments

	Units	Unit Rates
Flexible Pavements		
Rout and seal	m	$ 5.50
Spot repairs (mill/patch)	m^2	$ 45
Full depth asphalt base repairs	m^2	$ 100
Mill HMA	t	$ 7.50
Rigid Pavements		
Resealing joints	m	$ 12
Partial depth PCC repairs	m^2	$ 200
Full depth PCC repairs	m^2	$ 150
Surface texturize	m^2	$ 15

4.4 LCCA Comparison

Based on the available information, a LCCA was completed to evaluate the overall cost a municipal agency could expected between the two pavement types over a 50-year analysis period. Estimated life cycle costs for rigid pavement were compared with the estimated costs to construct and maintain the comparable flexible pavement. The resulting difference is an indication of the cost savings that can be expected between the comparable pavements for each of the design categories.

It is noted that a negative cost difference in the summary tables below indicate that a rigid pavement has a lower life cycle cost than a comparable flexible pavement. A positive results indicates the reverse.

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Table 22. LCCA Results for Major Arterial Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	Pavement Preservation Costs	Life Cycle Cost	Cost Difference
Major Arterial (10,000 AADTT)	10 MPa	PCC	$2,280,000	$141,056	$2,421,056	-21.39%
		Flexible	$2,531,250	$548,587	$3,079,837	
	30 MPa	PCC	$2,015,680	$141,056	$2,156,736	-14.76%
		Flexible	$1,981,650	$548,587	$2,530,237	
	50 MPa	PCC	$2,015,680	$141,056	$2,156,736	-2.41%
		Flexible	$1,661,363	$548,587	$2,209,949	
Major Arterial (7,500 AADTT)	10 MPa	PCC	$2,128,320	$150,543	$2,278,863	-23.42%
		Flexible	$2,427,225	$548,587	$2,975,812	
	30 MPa	PCC	$1,965,120	$150,543	$2,115,663	-10.48%
		Flexible	$1,814,625	$548,587	$2,363,212	
	50 MPa	PCC	$1,965,120	$150,543	$2,115,663	-0.76%
		Flexible	$1,583,344	$548,587	$2,131,930	

The results of the LCCA for Major Arterial roadways indicate that under the various conditions for this roadway classification, rigid pavement would be more cost-effective over a 50-year analysis period.

Table 23. LCCA Results for Minor Arterial Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	Pavement Preservation Costs	Life Cycle Cost	Cost Difference
Minor Arterial (5,000 AADTT)	10 MPa	PCC	$1,914,560	$101,418	$2,015,978	-15.72%
		Flexible	$2,055,638	$336,262	$2,391,899	
	30 MPa	PCC	$1,832,960	$101,418	$1,934,378	-1.14%
		Flexible	$1,620,338	$336,262	$1,956,599	
	50 MPa	PCC	$1,832,960	$101,418	$1,934,378	12.52%
		Flexible	$1,382,813	$336,262	$1,719,074	
Minor Arterial (2,500 AADTT)	10 MPa	PCC	$1,896,000	$101,418	$1,997,418	-6.91%
		Flexible	$1,809,338	$336,262	$2,145,599	
	30 MPa	PCC	$1,814,400	$101,418	$1,915,818	11.71%
		Flexible	$1,378,781	$336,262	$1,715,043	
	50 MPa	PCC	$1,814,400	$101,418	$1,915,818	20.56%
		Flexible	$1,252,781	$336,262	$1,589,043	

The results of the LCCA for Minor Arterial roadways indicate that rigid pavements could be considered more cost-effective in areas where weaker subgrade soils are expected.

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Table 24. LCCA Results for Major Collector Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	M & R Costs	Life Cycle Cost	Cost Difference
Major Collector (1,600 AADTT)	10 MPa	PCC	$1,007,250	$44,316	$1,051,566	28.85%
		Flexible	$671,963	$144,143	$816,106	
	30 MPa	PCC	$963,900	$44,316	$1,008,216	55.51%
		Flexible	$504,188	$144,143	$648,331	
	50 MPa	PCC	$963,900	$44,316	$1,008,216	63.45%
		Flexible	$472,688	$144,143	$616,831	
Major Collector (750 AADTT)	10 MPa	PCC	$741,540	$44,316	$785,856	3.60%
		Flexible	$614,438	$144,143	$758,581	
	30 MPa	PCC	$741,540	$44,316	$785,856	37.55%
		Flexible	$427,163	$144,143	$571,306	
	50 MPa	PCC	$741,540	$44,316	$785,856	45.58%
		Flexible	$395,663	$144,143	$539,806	

Table 25. LCCA Results for Industrial Roadways

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction Costs	M & R Costs	Life Cycle Cost	Cost Difference
Industrial (500 AADTT)	10 MPa	PCC	$741,540	$25,869	$767,409	3.97%
		Flexible	$614,438	$123,659	$738,097	
	30 MPa	PCC	$741,540	$25,869	$767,409	39.32%
		Flexible	$427,163	$123,659	$550,822	
	50 MPa	PCC	$741,540	$25,869	$767,409	47.77%
		Flexible	$395,663	$123,659	$519,322	
Industrial (250 AADTT)	10 MPa	PCC	$731,680	$25,869	$757,549	15.49%
		Flexible	$532,275	$123,659	$655,934	
	30 MPa	PCC	$731,680	$25,869	$757,549	42.95%
		Flexible	$406,275	$123,659	$529,934	
	50 MPa	PCC	$731,680	$25,869	$757,549	51.99%
		Flexible	$374,775	$123,659	$498,434	

As traffic volume reduce, rigid pavements become less cost-effective. However, in areas where soft soils exist rigid pavements remain a comparable option. This is particularly true in areas where high ground water levels complicate the excavation of the required pavement structure.

5.0 CLOSURE

The primary purpose of this study is to provide municipalities in the Province of Alberta with a resource for considering rigid pavements as a viable option in reconstruction of their road network. The reduced pavement thickness, and increased durability of the pavement surface make concrete pavements applicable in many urban areas, particularly for roadways experiencing heavy truck/bus movements.

The pavement design matrix provided in Appendix A has been developed to assist municipalities (within the Province of Alberta) with an easy-to-use reference table. Flexible and rigid pavement designs in this table are considered to be equivalent pavement structures for the variety of subgrade soils, roadway classifications, and traffic conditions. The equivalent pavement designs were evaluated with a LCCA, over a 50-year analysis period. This costing exercise provided a reasonable comparison of the total costs that could be expected for each pavement type. It can be expected that as conditions change, so will the cost to construct the selected pavement structure.

The pavement design matrix should be used for preliminary pavement design purposes. It is strongly recommended that municipalities carry out detailed design analysis to review the site conditions and determine the suitability of the preliminary designs. Furthermore, the long-life performance associated with rigid pavements is largely dependent on proper design and construction practices. Detailed designs for concrete pavements should be completed by an experienced Pavement Engineer and include site specific details for the construction of this pavement, such as a joint layout plan, load transfer devices, and surface texture.

The analysis presented in this report is based on design inputs, provided by others, supplemented by Thurber's experience with pavement engineering projects throughout the Province of Alberta. We note that any changes in soil conditions, traffic volumes, construction materials or procedures, may have a significant impact on design assumptions made for the purposes of developing the preliminary pavement designs.

Respectfully Submitted,
Thurber Engineering Ltd.

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APPENDIX A

COMPARABLE PAVEMENT DESIGN MATRIX

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Equivalent Municipal Pavement Design Matrix
Province of Alberta

Subgrade Strength*	Pavement Type	Average Annual Daily Truck Traffic							
		Industrial Roadway		Major Collector Roadway		Minor Arterial Roadway		Major Arterial Roadway	
		250	500	750	1,600	2,500	5,000	7,500	10,000
10 MPa	PCC	180 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	200 mm PCC 300 mm GBC	200 mm PCC 300 mm GBC	210 mm PCC 300 mm GBC	220 mm PCC 500 mm GBC	250 mm PCC 500 mm GBC
	HMA	120 mm ACP 150 mm GBC 700 mm SGSB	150 mm ACP 150 mm GBC 750 mm SGSB	150 mm ACP 150 mm GBC 750 mm SGSB	170 mm ACP 150 mm GBC 800 mm SGSB	220 mm ACP 150 mm GBC 800 mm SGSB	260 mm ACP 200 mm GBC 800 mm SGSB	330 mm ACP 200 mm GBC 800 mm SGSB	350 mm ACP 200 mm GBC 800 mm SGSB
30 MPa	PCC	180 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	210 mm PCC 200 mm GBC	220 mm PCC 300 mm GBC	230 mm PCC 300 mm GBC
	HMA	120 mm ACP 150 mm GBC 300 mm SGSB	130 mm ACP 150 mm GBC 300 mm SGSB	130 mm ACP 150 mm GBC 300 mm SGSB	150 mm ACP 150 mm GBC 400 mm SGSB	175 mm ACP 150 mm GBC 500 mm SGSB	220 mm ACP 150 mm GBC 500 mm SGSB	250 mm ACP 200 mm GBC 500 mm SGSB	270 mm ACP 200 mm GBC 600 mm SGSB
50 MPa	PCC	180 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	190 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	200 mm PCC 200 mm GBC	210 mm PCC 200 mm GBC	220 mm PCC 300 mm GBC	230 mm PCC 300 mm GBC
	HMA	120 mm ACP 150 mm GBC 200 mm SGSB	130 mm ACP 150 mm GBC 200 mm SGSB	130 mm ACP 150 mm GBC 200 mm SGSB	150 mm ACP 150 mm GBC 300 mm SGSB	175 mm ACP 150 mm GBC 300 mm SGSB	200 mm ACP 150 mm GBC 300 mm SGSB	225 mm ACP 150 mm GBC 400 mm SGSB	240 mm ACP 150 mm GBC 400 mm SGSB
Concrete Slab Properties		No Dowel Bars Slab Length = 4.0m Tied Curb/shoulders			32M Dowel Bar Slab Length = 4.0m Tied Curb/shoulders				32M Dowel Bar Slab Length = 4.5m Tied Curb/shoulders

Note: * - Subgrade Strength indicates the equivalent estimated AASHTO '93 Resilient Modulus design value.
- Subgrade Strength values do not consider any soil remediation treatments.

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APPENDIX B

LIFE CYCLE COST ANALYSIS
DETAILED WORK SHEETS

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COMPARABLE MUNICIPAL PAVEMENT DESIGNS
PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS RESULTS

Roadway Classification	Subgrade Strength	Pavement Type	Initial Construction	M & R Costs	Life Cycle Cost	Cost Difference*
Major Arterial 10,000	10 MPa	PCC	$2,280,000	$141,056	$2,421,056	-21.39%
		Flexible	$2,531,250	$548,587	$3,079,837	
	30 MPa	PCC	$2,015,680	$141,056	$2,156,736	-14.76%
		Flexible	$1,981,650	$548,587	$2,530,237	
	50 MPa	PCC	$2,015,680	$141,056	$2,156,736	-2.41%
		Flexible	$1,661,363	$548,587	$2,209,949	
Major Arterial 7,500	10 MPa	PCC	$2,128,320	$150,543	$2,278,863	-23.42%
		Flexible	$2,427,225	$548,587	$2,975,812	
	30 MPa	PCC	$1,965,120	$150,543	$2,115,663	-10.48%
		Flexible	$1,814,625	$548,587	$2,363,212	
	50 MPa	PCC	$1,965,120	$150,543	$2,115,663	-0.76%
		Flexible	$1,583,344	$548,587	$2,131,930	
Minor Arterial 5,000	10 MPa	PCC	$1,914,560	$101,418	$2,015,978	-15.72%
		Flexible	$2,055,638	$336,262	$2,391,899	
	30 MPa	PCC	$1,832,960	$101,418	$1,934,378	-1.14%
		Flexible	$1,620,338	$336,262	$1,956,599	
	50 MPa	PCC	$1,832,960	$101,418	$1,934,378	12.52%
		Flexible	$1,382,813	$336,262	$1,719,074	
Minor Arterial 2,500	10 MPa	PCC	$1,896,000	$101,418	$1,997,418	-6.91%
		Flexible	$1,809,338	$336,262	$2,145,599	
	30 MPa	PCC	$1,814,400	$101,418	$1,915,818	11.71%
		Flexible	$1,378,781	$336,262	$1,715,043	
	50 MPa	PCC	$1,814,400	$101,418	$1,915,818	20.56%
		Flexible	$1,252,781	$336,262	$1,589,043	
Major Collector 1,600	10 MPa	PCC	$1,007,250	$44,316	$1,051,566	28.85%
		Flexible	$671,963	$144,143	$816,106	
	30 MPa	PCC	$963,900	$44,316	$1,008,216	55.51%
		Flexible	$504,188	$144,143	$648,331	
	50 MPa	PCC	$963,900	$44,316	$1,008,216	63.45%
		Flexible	$472,688	$144,143	$616,831	
Major Collector 750	10 MPa	PCC	$741,540	$44,316	$785,856	3.60%
		Flexible	$614,438	$144,143	$758,581	
	30 MPa	PCC	$741,540	$44,316	$785,856	37.55%
		Flexible	$427,163	$144,143	$571,306	
	50 MPa	PCC	$741,540	$44,316	$785,856	45.58%
		Flexible	$395,663	$144,143	$539,806	
Industrial 500	10 MPa	PCC	$741,540	$25,869	$767,409	3.97%
		Flexible	$614,438	$123,659	$738,097	
	30 MPa	PCC	$741,540	$25,869	$767,409	39.32%
		Flexible	$427,163	$123,659	$550,822	
	50 MPa	PCC	$741,540	$25,869	$767,409	47.77%
		Flexible	$395,663	$123,659	$519,322	
Industrial 250	10 MPa	PCC	$731,680	$25,869	$757,549	15.49%
		Flexible	$532,275	$123,659	$655,934	
	30 MPa	PCC	$731,680	$25,869	$757,549	42.95%
		Flexible	$406,275	$123,659	$529,934	
	50 MPa	PCC	$731,680	$25,869	$757,549	51.99%
		Flexible	$374,775	$123,659	$498,434	

Note: * - Cost Difference calculation is the comparison of LCC of the Rigid pavement to the Flexible pavement. Negatie values indicate that the Rigid pavements option is a more cost-effective alternative.

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COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial HMA**
Pavement Type: **Flexible Pavement**
AADTT: **10,000**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

50	mm	High Volume Surface Asphalt
300	mm	High Volume Base Asphalt
200	mm	Crushed Gravel Base
800	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145.00	$271,875
Base HMA	High Volume Base Asphalt	300	mm	t	11,025	$135.00	$1,488,375
Tack Coat	Tack Coat - 4 Lifts			m^2	60,000	$0.50	$30,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,000	$35.00	$105,000
Crushed Subbase	Crushed Gravel Subbase	800	mm	m^3	12,000	$26.00	$312,000
Excavation	Earth Excavation	1350	mm	m^3	20,250	$16.00	$324,000
					Total Initial Pavement Construction Cost		**$2,531,250**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	200	m	$5.50	$1,100.00	$804
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$45.00	$33,750.00	$24,661
13	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$3,303
	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$60,808
18	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$6,664
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$77,746
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$134,205
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,702
23	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,116
28	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$2,751
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$22,510
32	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,927
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$70,712
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$62,000
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$4,276
37	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,933
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$14,060
45	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$2,311
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$26,964
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$46,545
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,284
48	Rout and Seal Cracks	1,500	m	$45.00	$67,500.00	$10,273
50	Salvage Value	7	year(s)	-$37,531.25	-$262,718.75	-$36,968
				Total Maintenance and Rehabilitation Cost		**$548,587**

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COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **10,000**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

250	mm	Portland Cement Concrete
500	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	250	mm	m^2	16,000	$113.00	$1,808,000
Crushed Base	Crushed Gravel Base	500	mm	m^3	8,000	$35.00	$280,000
Excavation	Earth Excavation	750	mm	m^3	12,000	$16.00	$192,000
						Total Initial Pavement Construction Cost	**$2,280,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,389	m	$11.00	$15,277.78	$9,542
	Partial Depth Joint Repairs (2%)	111	m^2	$200.00	$22,222.22	$13,880
25	Partial Depth Joint Repairs (5%)	278	m^2	$200.00	$55,555.56	$20,840
	Full Depth Joint Repairs (10%)	356	m^2	$150.00	$53,333.33	$20,006
	Reseal Transverse/Longitudinal Joints (50%)	2,778	m	$11.00	$30,555.56	$11,462
	Texturize Surface (25%)	4,000	m^2	$15.00	$60,000.00	$22,507
40	Partial Depth Joint Repairs (5%)	278	m^2	$200.00	$55,555.56	$11,572
	Full Depth Joint Repairs (15%)	533	m^2	$150.00	$80,000.00	$16,663
	Reseal Transverse/Longitudinal Joints (50%)	2,778	m	$11.00	$30,555.56	$6,364
	Texturize Surface (50%)	8,000	m^2	$15.00	$120,000.00	$24,995
50	Salvage Value	5	year(s)	-$23,842.59	-$119,212.96	-$16,775
				Total Maintenance and Rehabilitation Cost		**$141,056**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**10,000**
Subgrade (MPa):	**30 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
220	mm	High Volume Base Asphalt
200	mm	Crushed Gravel Base
600	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145.00	$271,875
Base HMA	High Volume Base Asphalt	220	mm	t	8,085	$135.00	$1,091,475
Tack Coat	Tack Coat - 3 Lifts			m^2	45,000	$0.50	$22,500
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,000	$35.00	$105,000
Crushed Subbase	Crushed Gravel Subbase	600	mm	m^3	9,000	$26.00	$234,000
Excavation	Earth Excavation	1070	mm	m^3	16,050	$16.00	$256,800
					Total Initial Pavement Construction Cost		**$1,981,650**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	200	m	$5.50	$1,100.00	$804
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$45.00	$33,750.00	$24,661
13	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$3,303
	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$60,808
18	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$6,664
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$77,746
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$134,205
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,702
23	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,116
28	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$2,751
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$22,510
32	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,927
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$70,712
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$62,000
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$4,276
37	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,933
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$14,060
45	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$2,311
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$26,964
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$46,545
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,284
48	Rout and Seal Cracks	1,500	m	$45.00	$67,500.00	$10,273
50	Salvage Value	7	year(s)	-$37,531.25	-$262,718.75	-$36,968
				Total Maintenance and Rehabilitation Cost		**$548,587**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **10,000**
Subgrade (MPa): **30 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

230	mm	Portland Cement Concrete
300	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	230	mm	m^2	16,000	$107.00	$1,712,000
Crushed Base	Crushed Gravel Base	300	mm	m^3	4,800	$35.00	$168,000
Excavation	Earth Excavation	530	mm	m^3	8,480	$16.00	$135,680
						Total Initial Pavement Construction Cost	**$2,015,680**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,389	m	$11.00	$15,277.78	$9,542
	Partial Depth Joint Repairs (2%)	111	m^2	$200.00	$22,222.22	$13,880
25	Partial Depth Joint Repairs (5%)	278	m^2	$200.00	$55,555.56	$20,840
	Full Depth Joint Repairs (10%)	356	m^2	$150.00	$53,333.33	$20,006
	Reseal Transverse/Longitudinal Joints (50%)	2,778	m	$11.00	$30,555.56	$11,462
	Texturize Surface (25%)	4,000	m^2	$15.00	$60,000.00	$22,507
40	Partial Depth Joint Repairs (5%)	278	m^2	$200.00	$55,555.56	$11,572
	Full Depth Joint Repairs (15%)	533	m^2	$150.00	$80,000.00	$16,663
	Reseal Transverse/Longitudinal Joints (50%)	2,778	m	$11.00	$30,555.56	$6,364
	Texturize Surface (50%)	8,000	m^2	$15.00	$120,000.00	$24,995
50	Salvage Value	5	year(s)	-$23,842.59	-$119,212.96	-$16,775
				Total Maintenance and Rehabilitation Cost		**$141,056**

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**10,000**
Subgrade (MPa):	**50 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
190	mm	High Volume Base Asphalt
150	mm	Crushed Gravel Base
400	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145.00	$271,875
Base HMA	High Volume Base Asphalt	190	mm	t	6,983	$135.00	$942,638
Tack Coat	Tack Coat - 3 Lifts			m^2	45,000	$0.50	$22,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	2,250	$35.00	$78,750
Crushed Subbase	Crushed Gravel Subbase	400	mm	m^3	6,000	$26.00	$156,000
Excavation	Earth Excavation	790	mm	m^3	11,850	$16.00	$189,600
					Total Initial Pavement Construction Cost		**$1,661,363**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	200	m	$5.50	$1,100.00	$804
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$45.00	$33,750.00	$24,661
13	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$3,303
	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$60,808
18	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$6,664
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$77,746
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$134,205
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,702
23	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,116
28	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$2,751
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$22,510
32	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,927
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$70,712
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$62,000
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$4,276
37	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,933
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$14,060
45	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$2,311
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$26,964
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$46,545
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,284
48	Rout and Seal Cracks	1,500	m	$45.00	$67,500.00	$10,273
50	Salvage Value	7	year(s)	-$37,531.25	-$262,718.75	-$36,968
				Total Maintenance and Rehabilitation Cost		**$548,587**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **10,000**
Subgrade (MPa): **50 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

230	mm	Portland Cement Concrete
300	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	230	mm	m^2	16,000	$107.00	$1,712,000
Crushed Base	Crushed Gravel Base	300	mm	m^3	4,800	$35.00	$168,000
Excavation	Earth Excavation	530	mm	m^3	8,480	$16.00	$135,680
						Total Initial Pavement Construction Cost	**$2,015,680**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,389	m	$11.00	$15,277.78	$9,542
	Partial Depth Joint Repairs (2%)	111	m^2	$200.00	$22,222.22	$13,880
25	Partial Depth Joint Repairs (5%)	278	m^2	$200.00	$55,555.56	$20,840
	Full Depth Joint Repairs (10%)	356	m^2	$150.00	$53,333.33	$20,006
	Reseal Transverse/Longitudinal Joints (50%)	2,778	m	$11.00	$30,555.56	$11,462
	Texturize Surface (25%)	4,000	m^2	$15.00	$60,000.00	$22,507
40	Partial Depth Joint Repairs (5%)	278	m^2	$200.00	$55,555.56	$11,572
	Full Depth Joint Repairs (15%)	533	m^2	$150.00	$80,000.00	$16,663
	Reseal Transverse/Longitudinal Joints (50%)	2,778	m	$11.00	$30,555.56	$6,364
	Texturize Surface (50%)	8,000	m^2	$15.00	$120,000.00	$24,995
50	Salvage Value	5	year(s)	-$23,842.59	-$119,212.96	-$16,775
				Total Maintenance and Rehabilitation Cost		**$141,056**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**7,500**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
280	mm	High Volume Base Asphalt
200	mm	Crushed Gravel Base
800	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145.00	$271,875
Base HMA	High Volume Base Asphalt	280	mm	t	10,290	$135.00	$1,389,150
Tack Coat	Tack Coat - 4 Lifts			m^2	60,000	$0.50	$30,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,000	$35.00	$105,000
Crushed Subbase	Crushed Gravel Subbase	800	mm	m^3	12,000	$26.00	$312,000
Excavation	Earth Excavation	1330	mm	m^3	19,950	$16.00	$319,200
					Total Initial Pavement Construction Cost		**$2,427,225**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	200	m	$5.50	$1,100.00	$804
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$45.00	$33,750.00	$24,661
13	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$3,303
	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$60,808
18	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$6,664
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$77,746
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$134,205
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,702
23	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,116
28	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$2,751
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$22,510
32	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,927
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$70,712
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$62,000
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$4,276
37	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,933
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$14,060
45	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$2,311
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$26,964
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$46,545
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,284
48	Rout and Seal Cracks	1,500	m	$45.00	$67,500.00	$10,273
50	Salvage Value	7	year(s)	-$37,531.25	-$262,718.75	-$36,968
				Total Maintenance and Rehabilitation Cost		**$548,587**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **7,500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

220	mm	Portland Cement Concrete
500	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	220	mm	m^2	16,000	$104.00	$1,664,000
Crushed Base	Crushed Gravel Base	500	mm	m^3	8,000	$35.00	$280,000
Excavation	Earth Excavation	720	mm	m^3	11,520	$16.00	$184,320
						Total Initial Pavement Construction Cost	**$2,128,320**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (50%)	3,000	m	$11.00	$33,000.00	$12,379
	Texturize Surface (25%)	4,000	m^2	$15.00	$60,000.00	$22,507
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (50%)	3,000	m	$11.00	$33,000.00	$6,874
	Texturize Surface (50%)	8,000	m^2	$15.00	$120,000.00	$24,995
50	Salvage Value	5	year(s)	-$25,250.00	-$126,250.00	-$17,765
				Total Maintenance and Rehabilitation Cost		**$150,543**

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**7,500**
Subgrade (MPa):	**30 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
200	mm	High Volume Base Asphalt
200	mm	Crushed Gravel Base
500	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145.00	$271,875
Base HMA	High Volume Base Asphalt	200	mm	t	7,350	$135.00	$992,250
Tack Coat	Tack Coat - 3 Lifts			m^2	45,000	$0.50	$22,500
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,000	$35.00	$105,000
Crushed Subbase	Crushed Gravel Subbase	500	mm	m^3	7,500	$26.00	$195,000
Excavation	Earth Excavation	950	mm	m^3	14,250	$16.00	$228,000
					Total Initial Pavement Construction Cost		**$1,814,625**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	200	m	$5.50	$1,100.00	$804
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$45.00	$33,750.00	$24,661
13	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$3,303
	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$60,808
18	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$6,664
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$77,746
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$134,205
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,702
23	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,116
28	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$2,751
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$22,510
32	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,927
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$70,712
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$62,000
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$4,276
37	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,933
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$14,060
45	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$2,311
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$26,964
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$46,545
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,284
48	Rout and Seal Cracks	1,500	m	$45.00	$67,500.00	$10,273
50	Salvage Value	7	year(s)	-$37,531.25	-$262,718.75	-$36,968
				Total Maintenance and Rehabilitation Cost		**$548,587**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **7,500**
Subgrade (MPa): **30 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

220	mm	Portland Cement Concrete
300	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	220	mm	m^2	16,000	$104	$1,664,000
Crushed Base	Crushed Gravel Base	300	mm	m^3	4,800	$35	$168,000
Excavation	Earth Excavation	520	mm	m^3	8,320	$16	$133,120
						Total Initial Pavement Construction Cost	**$1,965,120**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (50%)	3,000	m	$11.00	$33,000.00	$12,379
	Texturize Surface (25%)	4,000	m^2	$15.00	$60,000.00	$22,507
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (50%)	3,000	m	$11.00	$33,000.00	$6,874
	Texturize Surface (50%)	8,000	m^2	$15.00	$120,000.00	$24,995
50	Salvage Value	5	year(s)	-$25,250.00	-$126,250.00	-$17,765
				Total Maintenance and Rehabilitation Cost		**$150,543**

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Major Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**7,500**
Subgrade (MPa):	**50 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
175	mm	High Volume Base Asphalt
150	mm	Crushed Gravel Base
400	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145	$271,875
Base HMA	High Volume Base Asphalt	175	mm	t	6,431	$135	$868,219
Tack Coat	Tack Coat - 3 Lifts			m^2	45,000	$0.50	$22,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	2,250	$35	$78,750
Crushed Subbase	Crushed Gravel Subbase	400	mm	m^3	6,000	$26	$156,000
Excavation	Earth Excavation	775	mm	m^3	11,625	$16	$186,000
					Total Initial Pavement Construction Cost		**$1,583,344**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
8	Rout and Seal Cracks	200	m	$5.50	$1,100.00	$804
	Spot Repairs - Mill 40 mm/ Patch 40 mm (5%)	750	m^2	$45.00	$33,750.00	$24,661
13	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$3,303
	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$60,808
18	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$6,664
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$77,746
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$134,205
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,702
23	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,116
28	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$2,751
	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$22,510
32	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,927
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$70,712
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$62,000
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$4,276
37	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,933
40	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$14,060
45	Mill Asphalt Surface (50 mm)	1,800	t	$7.50	$13,500.00	$2,311
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$26,964
	Resurface with New Surface Asphalt (50 mm)	1,875	t	$145.00	$271,875.00	$46,545
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,284
48	Rout and Seal Cracks	1,500	m	$45.00	$67,500.00	$10,273
50	Salvage Value	7	year(s)	-$37,531.25	-$262,718.75	-$36,968
				Total Maintenance and Rehabilitation Cost		**$548,587**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Major Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **7,500**
Subgrade (MPa): **50 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

220	mm	Portland Cement Concrete
300	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	220	mm	m^2	16,000	$104	$1,664,000
Crushed Base	Crushed Gravel Base	300	mm	m^3	4,800	$35	$168,000
Excavation	Earth Excavation	520	mm	m^3	8,320	$16	$133,120
						Total Initial Pavement Construction Cost	**$1,965,120**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (50%)	3,000	m	$11.00	$33,000.00	$12,379
	Texturize Surface (25%)	4,000	m^2	$15.00	$60,000.00	$22,507
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (50%)	3,000	m	$11.00	$33,000.00	$6,874
	Texturize Surface (50%)	8,000	m^2	$15.00	$120,000.00	$24,995
50	Salvage Value	5	year(s)	-$25,250.00	-$126,250.00	-$17,765
				Total Maintenance and Rehabilitation Cost		**$150,543**

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Minor Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**5,000**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
210	mm	High Volume Base Asphalt
200	mm	Crushed Gravel Base
800	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145	$271,875
Base HMA	High Volume Base Asphalt	210	mm	t	7,718	$135	$1,041,863
Tack Coat	Tack Coat - 3 Lifts			m^2	45,000	$0.50	$22,500
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,000	$35	$105,000
Crushed Subbase	Crushed Gravel Subbase	800	mm	m^3	12,000	$26	$312,000
Excavation	Earth Excavation	1260	mm	m^3	18,900	$16	$302,400
						Total Initial Pavement Construction Cost	**$2,055,638**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$1,130
10	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,858
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	1,200	m^2	$45.00	$54,000.00	$36,480
20	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$4,929
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$99,264
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,423
25	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$2,063
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$31,217
35	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,158
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$62,863
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$55,118
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$3,801
40	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,718
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$12,499
48	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$1,644
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$23,971
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$33,102
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$32,775.00	-$327,750.00	-$46,119
					Total Maintenance and Rehabilitation Cost	**$336,262**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **5,000**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

210	mm	Portland Cement Concrete
300	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	210	mm	m^2	16,000	$101	$1,616,000
Crushed Base	Crushed Gravel Base	300	mm	m^3	4,800	$35	$168,000
Excavation	Earth Excavation	510	mm	m^3	8,160	$16	$130,560
						Total Initial Pavement Construction Cost	**$1,914,560**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$6,189
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$3,437
50	Salvage Value	5	year(s)	-$13,875.00	-$69,375.00	-$9,762
					Total Maintenance and Rehabilitation Cost	**$101,418**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Minor Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**5,000**
Subgrade (MPa):	**30 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
170	mm	High Volume Base Asphalt
150	mm	Crushed Gravel Base
500	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145	$271,875
Base HMA	High Volume Base Asphalt	170	mm	t	6,248	$135	$843,413
Tack Coat	Tack Coat - 3 Lifts			m^2	45,000	$0.50	$22,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	2,250	$35	$78,750
Crushed Subbase	Crushed Gravel Subbase	500	mm	m^3	7,500	$26	$195,000
Excavation	Earth Excavation	870	mm	m^3	13,050	$16	$208,800
					Total Initial Pavement Construction Cost		**$1,620,338**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$1,130
10	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,858
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	1,200	m^2	$45.00	$54,000.00	$36,480
20	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$4,929
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$99,264
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,423
25	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$2,063
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$31,217
35	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,158
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$62,863
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$55,118
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$3,801
40	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,718
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$12,499
48	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$1,644
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$23,971
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$33,102
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$32,775.00	-$327,750.00	-$46,119
				Total Maintenance and Rehabilitation Cost		**$336,262**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **5,000**
Subgrade (MPa): **30 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

210	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	210	mm	m^2	16,000	$101	$1,616,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,200	$35	$112,000
Excavation	Earth Excavation	410	mm	m^3	6,560	$16	$104,960
						Total Initial Pavement Construction Cost	**$1,832,960**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$6,189
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$3,437
50	Salvage Value	5	year(s)	-$13,875.00	-$69,375.00	-$9,762
					Total Maintenance and Rehabilitation Cost	**$101,418**

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Minor Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**5,000**
Subgrade (MPa):	**50 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
150	mm	High Volume Base Asphalt
150	mm	Crushed Gravel Base
300	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145	$271,875
Base HMA	High Volume Base Asphalt	150	mm	t	5,513	$135	$744,188
Tack Coat	Tack Coat - 2 Lifts			m^2	30,000	$0.50	$15,000
Crushed Base	Crushed Gravel Base	150	mm	m^3	2,250	$35	$78,750
Crushed Subbase	Crushed Gravel Subbase	300	mm	m^3	4,500	$26	$117,000
Excavation	Earth Excavation	650	mm	m^3	9,750	$16	$156,000
					Total Initial Pavement Construction Cost		**$1,382,813**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$1,130
10	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,858
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	1,200	m^2	$45.00	$54,000.00	$36,480
20	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$4,929
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$99,264
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,423
25	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$2,063
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$31,217
35	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,158
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$62,863
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$55,118
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$3,801
40	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,718
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$12,499
48	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$1,644
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$23,971
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$33,102
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$32,775.00	-$327,750.00	-$46,119
				Total Maintenance and Rehabilitation Cost		**$336,262**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **5,000**
Subgrade (MPa): **50 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

210	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	210	mm	m^2	16,000	$101	$1,616,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,200	$35	$112,000
Excavation	Earth Excavation	410	mm	m^3	6,560	$16	$104,960
						Total Initial Pavement Construction Cost	**$1,832,960**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$6,189
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$3,437
50	Salvage Value	5	year(s)	-$13,875.00	-$69,375.00	-$9,762
					Total Maintenance and Rehabilitation Cost	**$101,418**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Minor Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**2,500**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
170	mm	High Volume Base Asphalt
150	mm	Crushed Gravel Base
800	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145	$271,875
Base HMA	High Volume Base Asphalt	170	mm	t	6,248	$135	$843,413
Tack Coat	Tack Coat - 3 Lifts			m^2	45,000	$0.50	$22,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	2,250	$35	$78,750
Crushed Subbase	Crushed Gravel Subbase	800	mm	m^3	12,000	$26	$312,000
Excavation	Earth Excavation	1170	mm	m^3	17,550	$16	$280,800
						Total Initial Pavement Construction Cost	**$1,809,338**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$1,130
10	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,858
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	1,200	m^2	$45.00	$54,000.00	$36,480
20	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$4,929
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$99,264
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,423
25	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$2,063
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$31,217
35	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,158
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$62,863
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$55,118
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$3,801
40	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,718
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$12,499
48	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$1,644
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$23,971
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$33,102
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$32,775.00	-$327,750.00	-$46,119
					Total Maintenance and Rehabilitation Cost	**$336,262**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **2,500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

200	mm	Portland Cement Concrete
300	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	16,000	$100	$1,600,000
Crushed Base	Crushed Gravel Base	300	mm	m^3	4,800	$35	$168,000
Excavation	Earth Excavation	500	mm	m^3	8,000	$16	$128,000
						Total Initial Pavement Construction Cost	**$1,896,000**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$6,189
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$3,437
50	Salvage Value	5	year(s)	-$13,875.00	-$69,375.00	-$9,762
					Total Maintenance and Rehabilitation Cost	**$101,418**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial HMA**
Pavement Type: **Flexible Pavement**
AADTT: **2,500**
Subgrade (MPa): **30 MPa**
Lane Width (m): **3.75**
Width of Road (m): **15**

Pavement Design

50	mm	High Volume Surface Asphalt
125	mm	High Volume Base Asphalt
150	mm	Crushed Gravel Base
500	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145	$271,875
Base HMA	High Volume Base Asphalt	125	mm	t	4,594	$135	$620,156
Tack Coat	Tack Coat - 2 Lifts			m^2	30,000	$0.50	$15,000
Crushed Base	Crushed Gravel Base	150	mm	m^3	2,250	$35	$78,750
Crushed Subbase	Crushed Gravel Subbase	500	mm	m^3	7,500	$26	$195,000
Excavation	Earth Excavation	825	mm	m^3	12,375	$16	$198,000
					Total Initial Pavement Construction Cost		**$1,378,781**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$1,130
10	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,858
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	1,200	m^2	$45.00	$54,000.00	$36,480
20	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$4,929
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$99,264
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,423
25	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$2,063
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$31,217
35	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,158
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$62,863
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$55,118
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$3,801
40	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,718
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$12,499
48	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$1,644
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$23,971
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$33,102
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$32,775.00	-$327,750.00	-$46,119
				Total Maintenance and Rehabilitation Cost		**$336,262**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **2,500**
Subgrade (MPa): **30 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	16,000	$100	$1,600,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,200	$35	$112,000
Excavation	Earth Excavation	400	mm	m^3	6,400	$16	$102,400
						Total Initial Pavement Construction Cost	**$1,814,400**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$6,189
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$3,437
50	Salvage Value	5	year(s)	-$13,875.00	-$69,375.00	-$9,762
					Total Maintenance and Rehabilitation Cost	**$101,418**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway:	**Minor Arterial HMA**
Pavement Type:	**Flexible Pavement**
AADTT:	**2,500**
Subgrade (MPa):	**50 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**15**

Pavement Design

50	mm	High Volume Surface Asphalt
125	mm	High Volume Base Asphalt
150	mm	Crushed Gravel Base
300	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	High Volume Surface Asphalt	50	mm	t	1,875	$145	$271,875
Base HMA	High Volume Base Asphalt	125	mm	t	4,594	$135	$620,156
Tack Coat	Tack Coat - 2 Lifts			m^2	30,000	$0.50	$15,000
Crushed Base	Crushed Gravel Base	150	mm	m^3	2,250	$35	$78,750
Crushed Subbase	Crushed Gravel Subbase	300	mm	m^3	4,500	$26	$117,000
Excavation	Earth Excavation	625	mm	m^3	9,375	$16	$150,000
					Total Initial Pavement Construction Cost		**$1,252,781**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
5	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$1,130
10	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,858
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	1,200	m^2	$45.00	$54,000.00	$36,480
20	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$4,929
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$99,264
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$3,423
25	Rout and Seal Cracks	1,000	m	$5.50	$5,500.00	$2,063
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (15%)	2,250	m^2	$45.00	$101,250.00	$31,217
35	Mill Asphalt Surface (90 mm)	3,240	t	$7.50	$24,300.00	$6,158
	Resurface with New Base Asphalt (50 mm)	1,838	t	$135.00	$248,062.50	$62,863
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$55,118
	Tack Coat - 2 Layers	30,000	m^2	$0.50	$15,000.00	$3,801
40	Rout and Seal Cracks	1,500	m	$5.50	$8,250.00	$1,718
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	1,500	m^2	$45.00	$67,500.00	$12,499
48	Mill Asphalt Surface (40 mm)	1,440	t	$7.50	$10,800.00	$1,644
	Full Depth Asphalt Base Repairs (10%)	1,500	m^2	$105.00	$157,500.00	$23,971
	Resurface with New Surface Asphalt (40 mm)	1,500	t	$145.00	$217,500.00	$33,102
	Tack Coat - 1 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$32,775.00	-$327,750.00	-$46,119
				Total Maintenance and Rehabilitation Cost		**$336,262**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 4-Lane Roadway

Roadway: **Minor Arterial HMA**
Pavement Type: **Rigid Pavement**
AADTT: **2,500**
Subgrade (MPa): **50 MPa**
Lane Width (m): **3.75m Inner Lanes & 4.25m Outer Lanes**
Width of Road (m): **16**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	16,000	$100	$1,600,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	3,200	$35	$112,000
Excavation	Earth Excavation	400	mm	m^3	6,400	$16	$102,400
						Total Initial Pavement Construction Cost	**$1,814,400**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$10,306
	Partial Depth Joint Repairs (2%)	120	m^2	$200.00	$24,000.00	$14,990
25	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$22,507
	Full Depth Joint Repairs (10%)	400	m^2	$150.00	$60,000.00	$22,507
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$6,189
40	Partial Depth Joint Repairs (5%)	300	m^2	$200.00	$60,000.00	$12,497
	Full Depth Joint Repairs (15%)	600	m^2	$150.00	$90,000.00	$18,746
	Reseal Transverse/Longitudinal Joints (25%)	1,500	m	$11.00	$16,500.00	$3,437
50	Salvage Value	5	year(s)	-$13,875.00	-$69,375.00	-$9,762
					Total Maintenance and Rehabilitation Cost	**$101,418**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Major Collector**
Pavement Type:	**Flexible Pavement**
AADTT:	**1,600**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

170	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
800	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	170	mm	t	3,188	$105	$334,688
Tack Coat	Tack Coat - 2 Lifts			m^2	15,000	$0.50	$7,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	800	mm	m^3	6,000	$26	$156,000
Excavation	Earth Excavation	1120	mm	m^3	8,400	$16	$134,400
						Total Initial Pavement Construction Cost	**$671,963**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (90 mm)	1,620	t	$7.50	$12,150.00	$1,849
	Resurface with New Surface Asphalt (90 mm)	1,688	t	$105.00	$177,187.50	$26,967
	Tack Coat - 2 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$16,403.13	-$164,031.25	-$23,081
				Total Maintenance and Rehabilitation Cost		**$144,143**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,600**
Subgrade (MPa): **10 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design
200 mm Portland Cement Concrete
300 mm Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	8,500	$100	$850,000
Crushed Base	Crushed Gravel Base	300	mm	m^3	2,550	$35	$89,250
Excavation	Earth Excavation	500	mm	m^3	4,250	$16	$68,000
						Total Initial Pavement Construction Cost	**$1,007,250**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$4,294
25	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$11,722
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$11,957
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$3,224
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (15%)	319	m^2	$150.00	$47,812.50	$9,959
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$1,790
50	Salvage Value	5	year(s)	-$7,304.69	-$36,523.44	-$5,139
					Total Maintenance and Rehabilitation Cost	**$44,316**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **1,600**
Subgrade (MPa): **30 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

150	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
400	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	150	mm	t	2,813	$105	$295,313
Tack Coat	Tack Coat - 2 Lifts			m^2	15,000	$0.50	$7,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	400	mm	m^3	3,000	$26	$78,000
Excavation	Earth Excavation	700	mm	m^3	5,250	$16	$84,000
					Total Initial Pavement Construction Cost		**$504,188**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (90 mm)	1,620	t	$7.50	$12,150.00	$1,849
	Resurface with New Surface Asphalt (90 mm)	1,688	t	$105.00	$177,187.50	$26,967
	Tack Coat - 2 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$16,403.13	-$164,031.25	-$23,081
				Total Maintenance and Rehabilitation Cost		**$144,143**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,600**
Subgrade (MPa): **30 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	8,500	$100	$850,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	400	mm	m^3	3,400	$16	$54,400
						Total Initial Pavement Construction Cost	**$963,900**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$4,294
25	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$11,722
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$11,957
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$3,224
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (15%)	319	m^2	$150.00	$47,812.50	$9,959
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$1,790
50	Salvage Value	5	year(s)	-$7,304.69	-$36,523.44	-$5,139
				Total Maintenance and Rehabilitation Cost		**$44,316**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Major Collector**
Pavement Type:	**Flexible Pavement**
AADTT:	**1,600**
Subgrade (MPa):	**50 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

150	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
300	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	150	mm	t	2,813	$105	$295,313
Tack Coat	Tack Coat - 2 Lifts			m^2	15,000	$0.50	$7,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	300	mm	m^3	2,250	$26	$58,500
Excavation	Earth Excavation	600	mm	m^3	4,500	$16	$72,000
					Total Initial Pavement Construction Cost		**$472,688**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (90 mm)	1,620	t	$7.50	$12,150.00	$1,849
	Resurface with New Surface Asphalt (90 mm)	1,688	t	$105.00	$177,187.50	$26,967
	Tack Coat - 2 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$16,403.13	-$164,031.25	-$23,081
				Total Maintenance and Rehabilitation Cost		**$144,143**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **1,600**
Subgrade (MPa): **50 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design

200	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	200	mm	m^2	8,500	$100	$850,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	400	mm	m^3	3,400	$16	$54,400
						Total Initial Pavement Construction Cost	**$963,900**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$4,294
25	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$11,722
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$11,957
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$3,224
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (15%)	319	m^2	$150.00	$47,812.50	$9,959
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$1,790
50	Salvage Value	5	year(s)	-$7,304.69	-$36,523.44	-$5,139
				Total Maintenance and Rehabilitation Cost		**$44,316**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Flexible Pavement**
AADTT: **750**
Subgrade (MPa): **10 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

150	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
750	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	150	mm	t	2,813	$105	$295,313
Tack Coat	Tack Coat - 2 Lifts			m^2	15,000	$0.50	$7,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	750	mm	m^3	5,625	$26	$146,250
Excavation	Earth Excavation	1050	mm	m^3	7,875	$16	$126,000
					Total Initial Pavement Construction Cost		**$614,438**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (90 mm)	1,620	t	$7.50	$12,150.00	$1,849
	Resurface with New Surface Asphalt (90 mm)	1,688	t	$105.00	$177,187.50	$26,967
	Tack Coat - 2 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$16,403.13	-$164,031.25	-$23,081
				Total Maintenance and Rehabilitation Cost		**$144,143**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **750**
Subgrade (MPa): **10 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design
190 mm Portland Cement Concrete
200 mm Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	190	mm	m^2	8,500	$74	$629,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	390	mm	m^3	3,315	$16	$53,040
						Total Initial Pavement Construction Cost	**$741,540**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$4,294
25	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$11,722
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$11,957
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$3,224
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (15%)	319	m^2	$150.00	$47,812.50	$9,959
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$1,790
50	Salvage Value	5	year(s)	-$7,304.69	-$36,523.44	-$5,139
					Total Maintenance and Rehabilitation Cost	**$44,316**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Major Collector**
Pavement Type:	**Flexible Pavement**
AADTT:	**750**
Subgrade (MPa):	**30 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

130	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
300	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	130	mm	t	2,438	$105	$255,938
Tack Coat	Tack Coat - 1 Lift			m^2	7,500	$0.50	$3,750
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	300	mm	m^3	2,250	$26	$58,500
Excavation	Earth Excavation	580	mm	m^3	4,350	$16	$69,600
					Total Initial Pavement Construction Cost		**$427,163**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (90 mm)	1,620	t	$7.50	$12,150.00	$1,849
	Resurface with New Surface Asphalt (90 mm)	1,688	t	$105.00	$177,187.50	$26,967
	Tack Coat - 2 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$16,403.13	-$164,031.25	-$23,081
				Total Maintenance and Rehabilitation Cost		**$144,143**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **750**
Subgrade (MPa): **30 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design
190 mm Portland Cement Concrete
200 mm Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	190	mm	m^2	8,500	$74	$629,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	390	mm	m^3	3,315	$16	$53,040
						Total Initial Pavement Construction Cost	**$741,540**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$4,294
25	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$11,722
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$11,957
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$3,224
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (15%)	319	m^2	$150.00	$47,812.50	$9,959
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$1,790
50	Salvage Value	5	year(s)	-$7,304.69	-$36,523.44	-$5,139
				Total Maintenance and Rehabilitation Cost		**$44,316**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Major Collector**
Pavement Type:	**Flexible Pavement**
AADTT:	**750**
Subgrade (MPa):	**50 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

130	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
200	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	130	mm	t	2,438	$105	$255,938
Tack Coat	Tack Coat - 1 Lift			m^2	7,500	$0.50	$3,750
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	200	mm	m^3	1,500	$26	$39,000
Excavation	Earth Excavation	480	mm	m^3	3,600	$16	$57,600
					Total Initial Pavement Construction Cost		**$395,663**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
15	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$18,740
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (90 mm)	1,620	t	$7.50	$12,150.00	$1,849
	Resurface with New Surface Asphalt (90 mm)	1,688	t	$105.00	$177,187.50	$26,967
	Tack Coat - 2 Layers	15,000	m^2	$0.50	$7,500.00	$1,141
50	Salvage Value	10	year(s)	-$16,403.13	-$164,031.25	-$23,081
				Total Maintenance and Rehabilitation Cost		**$144,143**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Major Collector**
Pavement Type: **Rigid Pavement**
AADTT: **750**
Subgrade (MPa): **50 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design
190 mm Portland Cement Concrete
200 mm Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	190	mm	m^2	8,500	$74	$629,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	390	mm	m^3	3,315	$16	$53,040
						Total Initial Pavement Construction Cost	**$741,540**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$4,294
25	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$11,722
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$11,957
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$3,224
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (15%)	319	m^2	$150.00	$47,812.50	$9,959
	Reseal Transverse/Longitudinal Joints (25%)	781	m	$11.00	$8,593.75	$1,790
50	Salvage Value	5	year(s)	-$7,304.69	-$36,523.44	-$5,139
					Total Maintenance and Rehabilitation Cost	**$44,316**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Industrial**
Pavement Type:	**Flexible Pavement**
AADTT:	**500**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

150	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
750	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	150	mm	t	2,813	$105	$295,313
Tack Coat	Tack Coat - 2 Lifts			m^2	15,000	$0.50	$7,500
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	750	mm	m^3	5,625	$26	$146,250
Excavation	Earth Excavation	1050	mm	m^3	7,875	$16	$126,000
					Total Initial Pavement Construction Cost		**$614,438**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$822
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$11,985
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$571
50	Salvage Value	8	year(s)	-$7,325.00	-$58,600.00	-$8,246
				Total Maintenance and Rehabilitation Cost		**$123,659**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Industrial**
Pavement Type: **Rigid Pavement**
AADTT: **500**
Subgrade (MPa): **10 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design

190	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	190	mm	m^2	8,500	$74	$629,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	390	mm	m^3	3,315	$16	$53,040
						Total Initial Pavement Construction Cost	**$741,540**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	313	m	$11.00	$3,437.50	$2,147
25	Partial Depth Joint Repairs (2%)	63	m^2	$200.00	$12,500.00	$4,689
	Full Depth Joint Repairs (5%)	106	m^2	$150.00	$15,937.50	$5,978
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$2,579
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$6,639
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$1,432
50	Salvage Value	5	year(s)	-$5,833.33	-$29,166.67	-$4,104
				Total Maintenance and Rehabilitation Cost		**$25,869**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Industrial**
Pavement Type:	**Flexible Pavement**
AADTT:	**500**
Subgrade (MPa):	**30 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

130	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
300	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	130	mm	t	2,438	$105	$255,938
Tack Coat	Tack Coat - 1 Lifts			m^2	7,500	$0.50	$3,750
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	300	mm	m^3	2,250	$26	$58,500
Excavation	Earth Excavation	580	mm	m^3	4,350	$16	$69,600
					Total Initial Pavement Construction Cost		**$427,163**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$822
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$11,985
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$571
50	Salvage Value	8	year(s)	-$7,325.00	-$58,600.00	-$8,246
				Total Maintenance and Rehabilitation Cost		**$123,659**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Industrial**
Pavement Type: **Rigid Pavement**
AADTT: **500**
Subgrade (MPa): **30 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design
190 mm Portland Cement Concrete
200 mm Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	190	mm	m^2	8,500	$74	$629,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	390	mm	m^3	3,315	$16	$53,040
						Total Initial Pavement Construction Cost	**$741,540**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	313	m	$11.00	$3,437.50	$2,147
25	Partial Depth Joint Repairs (2%)	63	m^2	$200.00	$12,500.00	$4,689
	Full Depth Joint Repairs (5%)	106	m^2	$150.00	$15,937.50	$5,978
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$2,579
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$6,639
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$1,432
50	Salvage Value	5	year(s)	-$5,833.33	-$29,166.67	-$4,104
				Total Maintenance and Rehabilitation Cost		**$25,869**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Industrial**
Pavement Type:	**Flexible Pavement**
AADTT:	**500**
Subgrade (MPa):	**50 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

130	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
200	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	130	mm	t	2,438	$105	$255,938
Tack Coat	Tack Coat - 1 Lifts			m^2	7,500	$0.50	$3,750
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	200	mm	m^3	1,500	$26	$39,000
Excavation	Earth Excavation	480	mm	m^3	3,600	$16	$57,600
		Total Initial Pavement Construction Cost					**$395,663**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$822
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$11,985
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$571
50	Salvage Value	8	year(s)	-$7,325.00	-$58,600.00	-$8,246
				Total Maintenance and Rehabilitation Cost		**$123,659**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Industrial**
Pavement Type: **Rigid Pavement**
AADTT: **500**
Subgrade (MPa): **50 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design

190	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	190	mm	m^2	8,500	$74	$629,000
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	390	mm	m^3	3,315	$16	$53,040
						Total Initial Pavement Construction Cost	**$741,540**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	313	m	$11.00	$3,437.50	$2,147
25	Partial Depth Joint Repairs (2%)	63	m^2	$200.00	$12,500.00	$4,689
	Full Depth Joint Repairs (5%)	106	m^2	$150.00	$15,937.50	$5,978
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$2,579
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$6,639
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$1,432
50	Salvage Value	5	year(s)	-$5,833.33	-$29,166.67	-$4,104
				Total Maintenance and Rehabilitation Cost		**$25,869**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Industrial**
Pavement Type:	**Flexible Pavement**
AADTT:	**250**
Subgrade (MPa):	**10 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

120	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
700	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	120	mm	t	2,250	$105	$236,250
Tack Coat	Tack Coat - 1 Lifts			m^2	7,500	$0.50	$3,750
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	700	mm	m^3	5,250	$26	$136,500
Excavation	Earth Excavation	970	mm	m^3	7,275	$16	$116,400
		Total Initial Pavement Construction Cost					**$532,275**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$822
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$11,985
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$571
50	Salvage Value	8	year(s)	-$7,325.00	-$58,600.00	-$8,246
				Total Maintenance and Rehabilitation Cost		**$123,659**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Industrial**
Pavement Type: **Rigid Pavement**
AADTT: **250**
Subgrade (MPa): **10 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design

180	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	180	mm	m^2	8,500	$73	$620,500
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	380	mm	m^3	3,230	$16	$51,680
						Total Initial Pavement Construction Cost	**$731,680**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	313	m	$11.00	$3,437.50	$2,147
25	Partial Depth Joint Repairs (2%)	63	m^2	$200.00	$12,500.00	$4,689
	Full Depth Joint Repairs (5%)	106	m^2	$150.00	$15,937.50	$5,978
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$2,579
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$6,639
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$1,432
50	Salvage Value	5	year(s)	-$5,833.33	-$29,166.67	-$4,104
				Total Maintenance and Rehabilitation Cost		**$25,869**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway:	**Industrial**
Pavement Type:	**Flexible Pavement**
AADTT:	**250**
Subgrade (MPa):	**30 MPa**
Lane Width (m):	**3.75**
Width of Road (m):	**7.5**

Pavement Design

120	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
300	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	120	mm	t	2,250	$105	$236,250
Tack Coat	Tack Coat - 1 Lifts			m^2	7,500	$0.50	$3,750
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	300	mm	m^3	2,250	$26	$58,500
Excavation	Earth Excavation	570	mm	m^3	4,275	$16	$68,400
					Total Initial Pavement Construction Cost		**$406,275**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$35,940
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$1,711
25	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$1,032
30	Spot Repairs - Mill 40 mm/ Patch 40 mm (10%)	750	m^2	$45.00	$33,750.00	$10,406
35	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$1,368
	Full Depth Asphalt Base Repairs (10%)	750	m^2	$105.00	$78,750.00	$19,956
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$19,956
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$950
40	Rout and Seal Cracks	500	m	$5.50	$2,750.00	$573
43	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$5,000
48	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$822
	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$11,985
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$571
50	Salvage Value	8	year(s)	-$7,325.00	-$58,600.00	-$8,246
				Total Maintenance and Rehabilitation Cost		**$123,659**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Industrial**
Pavement Type: **Rigid Pavement**
AADTT: **250**
Subgrade (MPa): **30 MPa**
Lane Width (m): **4.25**
Width of Road (m): **8.5**

Pavement Design

180	mm	Portland Cement Concrete
200	mm	Crushed Gravel Base

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface PCC	Portland Cement Concrete	180	mm	m^2	8,500	$73	$620,500
Crushed Base	Crushed Gravel Base	200	mm	m^3	1,700	$35	$59,500
Excavation	Earth Excavation	380	mm	m^3	3,230	$16	$51,680
						Total Initial Pavement Construction Cost	**$731,680**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
12	Reseal Transverse/Longitudinal Joints (10%)	313	m	$11.00	$3,437.50	$2,147
25	Partial Depth Joint Repairs (2%)	63	m^2	$200.00	$12,500.00	$4,689
	Full Depth Joint Repairs (5%)	106	m^2	$150.00	$15,937.50	$5,978
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$2,579
40	Partial Depth Joint Repairs (5%)	156	m^2	$200.00	$31,250.00	$6,509
	Full Depth Joint Repairs (10%)	213	m^2	$150.00	$31,875.00	$6,639
	Reseal Transverse/Longitudinal Joints (20%)	625	m	$11.00	$6,875.00	$1,432
50	Salvage Value	5	year(s)	-$5,833.33	-$29,166.67	-$4,104
				Total Maintenance and Rehabilitation Cost		**$25,869**

THURBER

COMPARABLE MUNICIPAL PAVEMENT DESIGNS - PROVINCE OF ALBERTA
LIFE CYCLE COST ANALYSIS
25 Year Pavement Design and 50 Year LCCA
All Quantities and Costs are for 1km of 2-Lane Roadway

Roadway: **Industrial**
Pavement Type: **Flexible Pavement**
AADTT: **250**
Subgrade (MPa): **50 MPa**
Lane Width (m): **3.75**
Width of Road (m): **7.5**

Pavement Design

120	mm	Low Volume Asphalt
150	mm	Crushed Gravel Base
200	mm	Crushed Gravel Subbase

Initial Pavement Construction Costs

Pavement Layer	Layer Description	Layer Thickness		Units	Quantity per km	Unit Price	Total Cost
Surface HMA	Low Volume Asphalt	120	mm	t	2,250	$105	$236,250
Tack Coat	Tack Coat - 1 Lifts			m^2	7,500	$0.50	$3,750
Crushed Base	Crushed Gravel Base	150	mm	m^3	1,125	$35	$39,375
Crushed Subbase	Crushed Gravel Subbase	200	mm	m^3	1,500	$26	$39,000
Excavation	Earth Excavation	470	mm	m^3	3,525	$16	$56,400
					Total Initial Pavement Construction Cost		**$374,775**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
10	Rout and Seal Cracks	250	m	$5.50	$1,375.00	$929
	Spot Repairs - Mill 40 mm/ Patch 40 mm (8%)	600	m^2	$45.00	$27,000.00	$18,240
20	Mill Asphalt Surface (40 mm)	720	t	$7.50	$5,400.00	$2,464
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	Resurface with New Surface Asphalt (40 mm)	750	t	$105.00	$78,750.00	$11,985
	Tack Coat - 1 Layers	7,500	m^2	$0.50	$3,750.00	$571
50	Salvage Value	8	year(s)	-$7,325.00	-$58,600.00	-$8,246
				Total Maintenance and Rehabilitation Cost		**$123,659**

THURBER

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Pavement Design

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Initial Pavement Construction Costs

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Excavation	Earth Excavation	380	mm	m^3	3,230	$16	$51,680
						Total Initial Pavement Construction Cost	**$731,680**

Flexible Pavement Maintenance and Rehabilitation Costs

Scheduled Maint./Rehab. Year	Maintenance/ Rehabilitation Activity	Quantities		Pay Item Price $	Cost/km $	Present Worth
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				Total Maintenance and Rehabilitation Cost		**$25,869**