RMA

RURAL MUNICIPALITIES *of* ALBERTA

ASSET DEFICIT SUMMARY REPORT

ROADS

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Introduction

Overview

Rural municipalities in Alberta can be characterized by large geographic areas and low populations, where industrial activities play a significant role in shaping the local economy. Rural municipalities manage a significant amount of Alberta's public infrastructure, providing maintenance and repairs as needed to support communities and provide industries such as forestry, energy, and agriculture with access to natural resources and markets. These sectors contribute to a significant amount of wear and tear on municipal infrastructure and as a result, the maintenance and repair of core infrastructure pose substantial challenges to municipalities.

The Rural Municipalities of Alberta (RMA) has identified a pressing need for up-to-date data to accurately quantify the infrastructure deficit across various asset types. Most critically, this assessment is required for the "core" infrastructure of bridges and culverts, water and wastewater distribution and treatment utility infrastructure, and engineered stormwater infrastructure.

Past work from the RMA has indicated the existence of infrastructure deficits for these core assets. An infrastructure deficit refers to a state of deterioration of these assets below their "optimal" condition levels, which can vary depending on the asset type. As infrastructure naturally deteriorates over its expected lifecycle, only significant maintenance and re-investment can keep the asset at its optimal levels. The growing financial pressures on Alberta's rural municipalities means this deficit has likely grown over time. Limited and inconsistent data on the condition and characteristics of specific assets has made quantifying infrastructure deficits on a provincewide level extremely difficult.

The lack of data also poses a significant risk to municipalities as infrastructure owners and to industries that rely on this infrastructure. Without current and detailed data on the extent of this deficit, it becomes challenging to make informed decisions about the necessary investments to maintain and improve infrastructure.

The RMA developed this project to conduct a comprehensive analysis of various asset types to determine the infrastructure deficit faced by RMA members for each. The project relies on information provided by RMA members. The study's significance lies in its ability to offer evidence-based insights to measure the true level of infrastructure investment required.

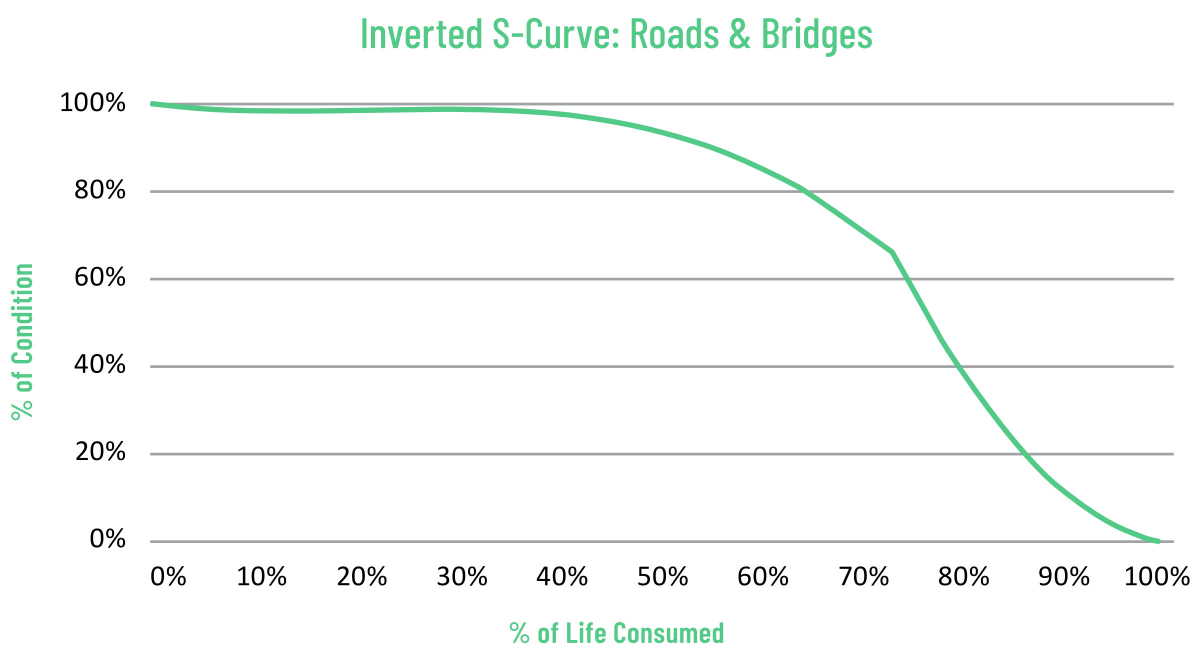
The project will produce separate reports for each asset type, with a final report summarizing and analyzing the overall rural municipal infrastructure deficit. The goal is to provide a robust data set and analyses of said data for future advocacy efforts, offering insights into the rural municipal infrastructure deficit and support overall asset management efforts for RMA members.

This report provides an overview of the analysis specifically for roads managed by RMA members with an overview of the analysis process, key data sources, infrastructure deficit calculations, and identifies key findings for consideration by RMA members as well. RMA has already or soon will release similar reports on other asset types, as well as a final report.

Deterioration Curve Summary

This project is structured around a standardized deterioration curve model. The ability to derive the infrastructure deficit for RMA members relies on the ability to place the current state of member infrastructure portfolios within this model. The deterioration curve model has been used to inform analysis in several RMA reports, including 2013's Apples to Apples: Rural Municipal Finance in Alberta . It was also used as key methodology informing RMA's input into the design of the Municipal Sustainability Initiative in 2007.

The deterioration curve model is based on the fundamental principle that infrastructure does not deteriorate in a linear fashion, and that strategically timing infrastructure investment can lead to greater value for money and reduced risk of rapid infrastructure deterioration or even failure. If infrastructure is not properly protected, there will be little initial change in its condition, but over time, deferred investment leads to dramatically increased loss of condition and value.



[1] Apples to Apples: Rural Municipal Finance in Alberta

Deterioration Curve Key Definitions

This assessment uses several definitions for key terms related to the Deterioration Curves and other portions of the analysis:

Useful Life: Largely based on statistics from Infrastructure Canada. “Average expected useful life of new publicly owned road assets, Infrastructure Canada.” This shows the average expected life of an asset without significant maintenance or reinvestment.

Effective Age: The effective age of the portfolio based on life consumed.

Life Consumed: How much of the useful life the portfolio has consumed.

Condition: The condition of the portfolio. In this study we utilize a percent condition rating.

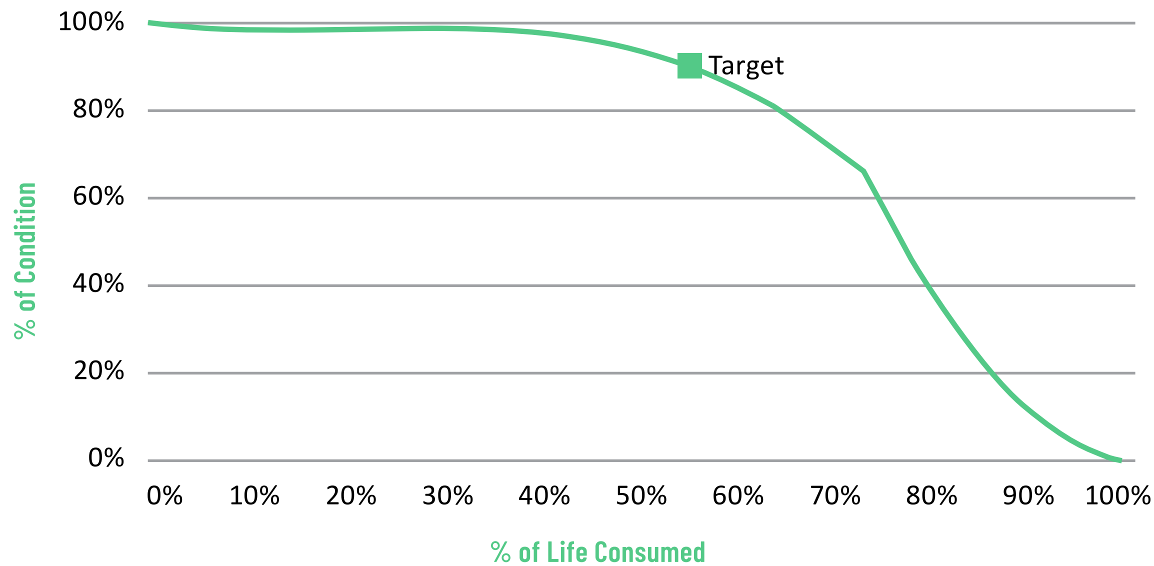
Value: The value of the portfolio based on estimated replacement cost and condition.

Holding Cost: How much it costs to keep the portfolio at the same level from year 0 to year 1.

Target: The optimal point on the deterioration curve to maintain the portfolio.

Cost to get to target: How much it would cost to bring the portfolio from its existing condition to the target condition.

Deterioration Curve Interpretation



The graph above shows the deterioration curve. The curve is a function of two factors: **the percentage of life consumed of the assets**, and **the percentage condition rating of the assets**. The horizontal axis represents the average age of the infrastructure as a percentage of its lifespan (e.g., infrastructure at the end of its life would be rated 100%). The vertical axis represents the average condition of the infrastructure as a percentage of its value. For example, a new asset, worth 100% of its value, would be rated at the 100% condition. Alternatively, a completely failed asset would be rated at a 0% condition.

For this asset study, this curve is used to model the deterioration of overall asset portfolios (all the assets of a particular type managed by rural municipalities), rather than individual assets. That means that investment can be made into individual assets, which will affect the effective condition of the portfolio. If one road is completely rehabilitated, it will naturally "pull" the portfolio back up the curve. If investment lags, the natural change in condition over asset age will occur, with an expectation that aging without intervention will follow the curve shape.

Benefits of the Curve

The deterioration curve used in this report provides a more accurate analysis of the infrastructure deficit than the standard straight-line deterioration method typically employed in Tangible Capital Asset (TCA) accounting. One of the primary advantages of this curve is its ability to account for varying rates of degradation over an asset's lifespan, unlike the straight-line approach which assumes a

consistent level of annual degradation. This assumption in the straight-line method means there is no optimal point identified for maintaining assets. The straight-line approach also tends to underestimate an asset's condition early in its lifespan and overestimate it later when critical investments are needed. In contrast, the deterioration curve used in this analysis incorporates a more realistic view of how assets degrade over time. By considering factors such as the optimal condition to maintain assets and the varying rates of degradation, this curve offers a more precise assessment of the infrastructure deficit.

The Optimal "Target" Point

The curve begins to slope downward at an accelerated rate at approximately 50% of the infrastructure life span, with a corresponding condition rating of 94%. At this point, the investment required simply to hold the asset portfolio at its current condition begins to accelerate. Therefore, **the most economical option is to attempt to hold the portfolio right at this drop-off point.** This point is represented by the "Target State" label, and represents the most cost-effective point to maintain an asset portfolio on this curve.

Calculating an Infrastructure Deficit

This curve also shows the potential impact to municipalities if the infrastructure is left to deteriorate. Municipalities risk having their infrastructure reach the steepest part of the curve, where repairing it becomes extremely expensive. This would put incredible pressure on municipalities to reallocate revenue from other areas to address their infrastructure issues. **Maintaining infrastructure at a higher condition level and lower percentage of lifespan is the most cost-effective way of preserving that infrastructure over time.**

Given the assessment of the curve above, it is also not efficient to fully re-invest into assets to try to make the portfolio brand new (100% condition assessment). Therefore, **the infrastructure deficit is the difference between the current condition of assets observed and the target state level of condition**, which is approximately 94% of new condition. The deficit calculation, therefore, is based on the one-time investment required to move the portfolio to its target state, and can be represented by:

Infrastructure Deficit = Portfolio Target State Value ($) – Portfolio Observed Condition Value ($)

Additional details on the technical nature of the deterioration curve can be found in Appendix A.

Road Infrastructure Background

RMA members are responsible for managing approximately 75% of Alberta's roads. As a result, transportation and infrastructure are often the largest budget item for rural municipalities. Rural Alberta plays a crucial role in driving the province's economy. Without critical transportation links, Alberta's natural resources would not reach processing facilities and markets within the province, across Canada, and beyond. These connections are essential for economic growth, development, and the high quality of life that Albertans enjoy.

To keep the Alberta economy running, governments must understand the important role of rural Alberta's infrastructure and transportation network. They must also understand the financial burden this responsibility places on rural municipalities. Without support from the provincial government, rural municipalities may be unable to continue to build or maintain this network to the standard required to accommodate usage by industry and all Albertans.

Reporting and Data Availability

Municipalities are not required to report on road condition, but must report the length of all open roads; this data is maintained through the Municipal Financial and Statistical Data mandatory reporting. To support this project's analysis, RMA members were asked to provide their internally collected road infrastructure data. Twenty-nine of 69 RMA members contributed road information, which was used to compile a dataset for the road infrastructure analysis. While not specified in all cases, it is reasonable to assume that a large percentage of missing member information is due to a lack of structured asset data. In some cases, even members that did indicate the existence of and/or provided road asset data noted that significant work was required to compile information, indicating that data may not be providing full value in terms of supporting asset management planning and decision-making.

This project has illustrated that, despite RMA's efforts, asset management is not yet a fully developed practice among many rural municipalities. The lack of widespread asset management practices reduces the visibility of infrastructure conditions and the ability of municipalities to make informed decisions about maintenance and investments. Without a clear understanding of the current state of infrastructure, municipalities face significant challenges in planning and prioritizing their resources effectively. Ultimately, the robustness of this analysis was impacted by data availability, and several assumptions were required to derive a value for all RMA members.

Funding Programs

Local roads have been historically funded primarily by municipalities themselves. The Municipal Sustainability Initiative (MSI) operated between 2007 and 2023 to provide funding to municipalities for capital and operating projects. MSI distributed more than $15.2 billion while it was active. In 2024, the program is being replaced by the Local Government Funding Framework (LGFF). Among other things, the MSI program was well utilized by municipalities to care for their roads. Of the 180 accepted RMA member capital projects that used MSI funding in 2022, more than half were specific to roads.

The LGFF provides a legislated infrastructure funding program for local governments in Alberta. Under LGFF, RMA members will receive approximately $149 million in capital funding for 2024. Similarly to MSI funding, eligible capital projects include:

- Roads and bridges
- Public transit vehicles or facilities
- Emergency services facilities or equipment
- Water and wastewater systems
- Solid waste management facilities or equipment
- Other municipal buildings such as recreation and sports facilities, libraries, and cultural and community centers

The other primary funding source for municipalities in Alberta is the Canada Community-Building Fund (CCBF), previously known as the Gas Tax Fund. All municipalities and Metis Settlements are eligible to receive funding under this program. The program provides grants for capital costs of infrastructure projects that meet the program eligibility criteria, which limits the funding to use in essential infrastructure, such as roads and bridges, public transit, drinking water and wastewater infrastructure, and recreational facilities. Municipalities determine projects and activities based on local priorities and can pool and bank this funding, providing financial flexibility.

Funding is first transferred from the federal government to the provinces and territories who in turn distribute the funding to their communities. Each province or territory develops its own formula for distributing funds to their communities. In Alberta, CCBF funding allocations for municipalities are calculated on a per capita basis, according to the most recent Municipal Affairs Population List. Municipalities (with the exception of summer villages) receive a minimum allocation of $50,000 per year. Summer villages receive a base allocation of $5,000 per year, in addition to the per capita amount. [2]

In 2023, RMA members received $45,108,951 of the $265,415,054 Alberta received in funding. This equates to just 17% of funding, despite the fact that 41% of Alberta's public and private investment, and 26% of Alberta's GDP is in rural Alberta. [3]

RMA Advocacy

RMA has been a strong advocate for consistent and sustainable funding processes that support the growth and resiliency of rural transportation networks. Rural municipalities face an increasing infrastructure deficit because municipal taxation revenues alone are not sufficient to build and maintain these vital networks. To address this issue, long-term, predictable funding from other levels of government is necessary to ensure the sustainability of rural Alberta's transportation network and the viability of rural communities. Funding programs must be designed to reflect

2 CCBF – Funding allocations and eligibility
3 The Economic Contribution of Rural Municipalities Report

the unique needs of rural infrastructure. Current per capita funding distribution and merit-based mechanisms often place rural municipalities in direct competition with higher-capacity urban municipalities, which does not adequately address the specific challenges faced by rural areas. Programs like the Canada Community-Building Fund (CCBF) and the Local Government Fiscal Framework (LGFF) need to consider these rural-specific requirements to be effective.

In addition to government funding, industry collaboration is crucial, especially in situations where industry benefits from the use of municipal roads and bridges. Industries should contribute to maintenance and replacement costs, recognizing their role in the wear and tear of rural infrastructure. Implementing local road permits is an effective tool to manage the impact of commercial vehicles on rural roads, ensuring that those who benefit from the infrastructure also help sustain it. Moreover, municipalities require ongoing funding and capacity support to advance asset management planning.

Methodology

The primary data source used for this analysis is data received directly from RMA members in a structured workbook format. The data collected from members was compiled into a database used for the assessment of road infrastructure.

Data was received through a structured data request to municipalities. Twenty-nine RMA members responded to the workbook collection and included road information in the workbook. Data received from these municipalities was filtered into three main categories.

1. Class 1 data contained a condition rating, replacement cost, structure type, and useful life value. These data attributes allowed a fulsome analysis using the mathematical formula of the deterioration curve.
   a. Class 1 data accounted for 44.50% of all data received.
2. Class 2 data contained structure type, useful life, and section length (KM). These data attributes allowed us to extrapolate a deficit based on Class 1 data and the section length.
   a. Class 2 data accounted for 44.05% of all data received.
3. Class 3 data is the remainder of the data received from municipalities. This data is accounted for through further extrapolation processes.
   a. Class 3 data accounted for 11.45% of all data received.

To account for the remaining rural municipalities who did not participate in road workbook completion, MFIS reported road lengths were used to extrapolate the deficit. More information can be found in Appendix B, Technical Methodology.

The following steps were taken to refine the information and identify the infrastructure deficit:

- Adjustments were made to ensure all cost figures used were in 2023 dollars (inflation rates used are from the Statistics Canada Consumer Price Index).
- 40.55% of Class 1 road assets have an inspection date in 2023, the remainder were manually aged to represent their expected asset condition and life consumed in 2023.

ASSET SUBCATEGORY	USEFUL LIFE
Highway	45
Rural Highway	12
Arterial	28
Collector	35
Local	34
Lanes/Alleys	23

- Standardized useful life figures were applied based on the assigned asset subtype. The useful life was used to determine how far along the curve each asset subcategory moves each year.
- Weighted averages, based on expected replacement value, were calculated for the effective age and condition level of the overall portfolio.

A detailed overview of the methodology used can be found in Appendix B of this report.

Data Summary

The data summary section of this report provides an overview of the current profile of road infrastructure managed by rural municipalities.

Portfolio Profile

CATEGORY	RESULT
Kilometers of assets in the portfolio:	135,448
Average first in service year:	1978
Average kilometers of assets per RMA member:	1,963
Oldest asset in the portfolio:	1942, M.D. of Wainwright
Kilometers of assets with a 100% condition rating:	175
Kilometers of assets with less than 50% condition rating:	49,189

Inspection Recency

LAST INSPECTION DATE	KM OF ROADS
2023	1,875
2022	35,594
2021	6,617
2020	228
2019	24,418
Prior to 2019	47,420

Overall Deficit Findings

As noted, the infrastructure deficit represents the gap between the current value of infrastructure and its value if it were in an optimal state (94% on the curve). In simpler terms, it is the difference between what we have today and what we need to invest back into our roads to ensure they are safe, reliable, and financially efficient. As an example, if a piece of infrastructure, like a road, would normally have a 50-year life span, each year we let the road sit it can be expected to lose 2% of its expected life. Depending on the road's current point on the deterioration curve, this 2% of life consumed can result in vastly different condition impacts. We can reverse this natural aging process by reinvesting into the road and performing the necessary maintenance to reduce its effective age and bring its condition back up the curve. This process holds for a larger portfolio of assets as well. When we consider multiple roads, investing in maintenance for one road per year may only hold us on the current point of the curve, as the non-repaired roads naturally age 2% per year.

Value, in this context, is a direct reflection of a road's condition. Roads that are well-maintained and in good repair have a higher value because they are safe, reliable, and capable of supporting the necessary traffic loads. Conversely, roads in poor condition have a lower value due to the risks and limitations they present.

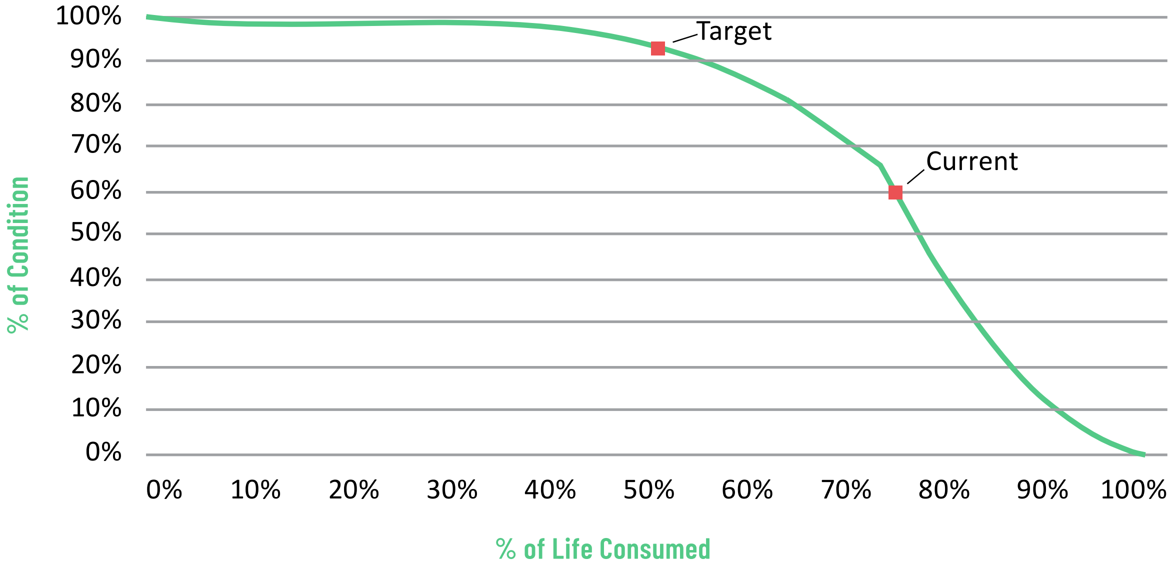
Based on the deterioration curve, a road can lose value if it isn't properly maintained. Factors like usage, weather conditions, and age can cause a road to deteriorate over time. Heavy traffic, extreme weather events, and natural aging processes all contribute to the wear and tear of road infrastructure. If we don't invest in repairs and maintenance, the road's condition worsens, its value decreases, and it becomes less safe and reliable. Therefore, the infrastructure deficit highlights the amount of investment needed to bring the roads up to their optimal state.

The infrastructure deficit grows when investment in maintenance and repairs is insufficient to keep up with the rate of deterioration. For example, if a road requires $1,000,000 in repairs to maintain its condition but only receives $500,000, the deficit increases by the unmet need of $500,000. Over time, if the necessary repairs are not made, the condition of the road continues to decline, and the cost to bring it back to an optimal state rises, increasing the deficit. Conversely, the infrastructure deficit shrinks when adequate investments are made to repair and maintain the roads. Regular maintenance and timely repairs are crucial to managing and reducing the deficit, as they prevent small issues from becoming major problems that are more expensive to fix.

Alberta's rural municipal road portfolio has a deficit of $11.99 billion. This overall deficit analysis has been supplemented with additional analyses for more specific road characteristics, like structure type, surface type, number of lanes, and regional levels. All of these more detailed analyses show bridge infrastructure, no matter what characteristics we look at, is at a poor condition level and in need of significant investment.

Overall Rural Municipal Road Infrastructure Deficit

As noted, the overall rural municipal road infrastructure deficit is just under $12 billion. This equates to approximately $16,800 per person based on the total population of RMA's member municipalities (approximately 714,000 people). The figure and table below show that the overall RMA road portfolio is well below the target condition level. This is an expensive point of the curve, and increases the risk to fundamental usability, safety and reliability of the transportation network.



While graphically, we can see the portfolio is far below the optimal condition level, it is also helpful to compare some key calculations on the state of the current road portfolio compared to an idealized target state. The following table shows a comparison between the current road portfolio and a hypothetical ideal target state portfolio. The comparison shows overall portfolio values, life consumed, condition, the annual holding cost (investment required to hold the position on the curve), and the effective age.

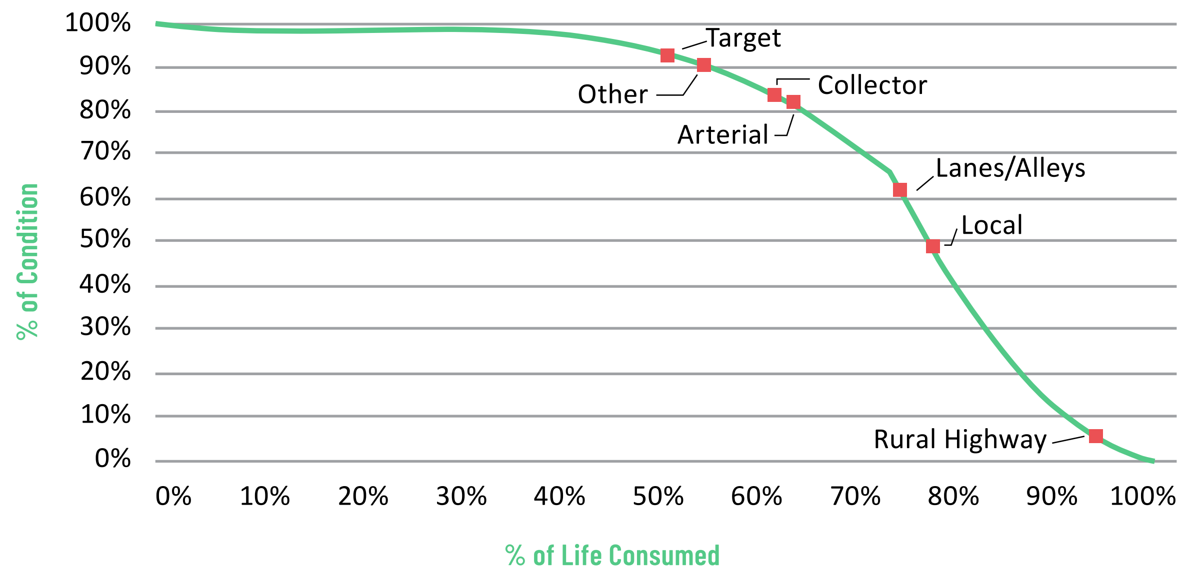
CATEGORY	CURRENT	TARGET
Portfolio Value:	$21.95 Billion	$33.94 Billion
Life Consumed:	74.90%	50.00%
Condition:	60.76%	93.96%
Holding Cost:	$5.55 Billion	$870.90 Million
Effective Age:	20.44 years (useful life 27.29)	20.44 years (useful life 27.29)

Road Subtype Comparison

As noted, we have conducted additional analyses on a range of road characteristics to better understand this deficit figure. The overall road portfolio can be categorized and broken up in several ways, each providing a unique perspective on the overall condition and needs of the network. By examining roads categorized by type, surface type, and other characteristics, we can gain a more nuanced understanding of the infrastructure deficit and identify specific areas requiring attention. This information will allow us to make more informed decisions about where to allocate resources and how to address the infrastructure deficit most effectively.

Data Note: It is very important to note that the following analyses can only account for road assets with a condition rating. Many municipalities were not able to provide a condition rating for their assets. This has resulted in medium to low confidence in the accuracy of the following graphs as only 14 of 69 municipalities were able to provide road information containing condition data. As a result of these sample sizes, the results may be subject to significant variation. We have attempted to account for this in our assessment of the results.

The sections below show the results of each sub-analysis of various characteristics. Note: the detailed data these graphs represent can be found in Appendix C.



The road portfolio is composed of six primary types; rural highways, arterial, collector, local, lanes/alleys, and other. Most of the portfolio is composed of local roads, followed by collector roads, other, arterial roads, rural highway roads, and finally lanes / alleys.

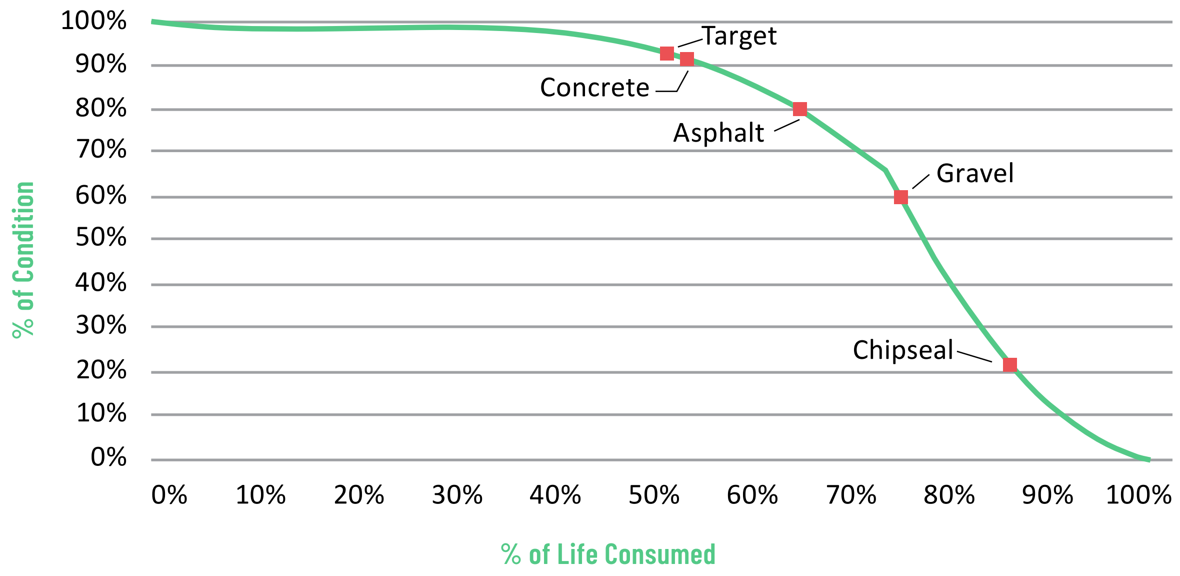
Rural highways have a significantly lower condition rating than the overall portfolio, though the specific reasons for this result are not clear. These roads have extremely variable traffic counts, depending on their location, so many may not be prioritized for renewal. Arterial roads are designed and used for a higher traffic count. This higher traffic volume necessitates more frequent maintenance and repairs, which can result in better overall condition ratings. This suggests that traffic volume and maintenance investment play significant roles in the condition of road infrastructure.

Note: Although 'Highway' was offered as a category type in the workbook process, it was not utilized by municipalities.

For Consideration:

Local roads and lanes / alleys have only a 3% life consumed difference, but their conditions vary significantly at 13.01%. This variation reflects the steepness of the deterioration curve at the specific age points for these structures. Although local roads are only 3% further along in their lifespan, they have deteriorated much further down the curve than lanes / alleys

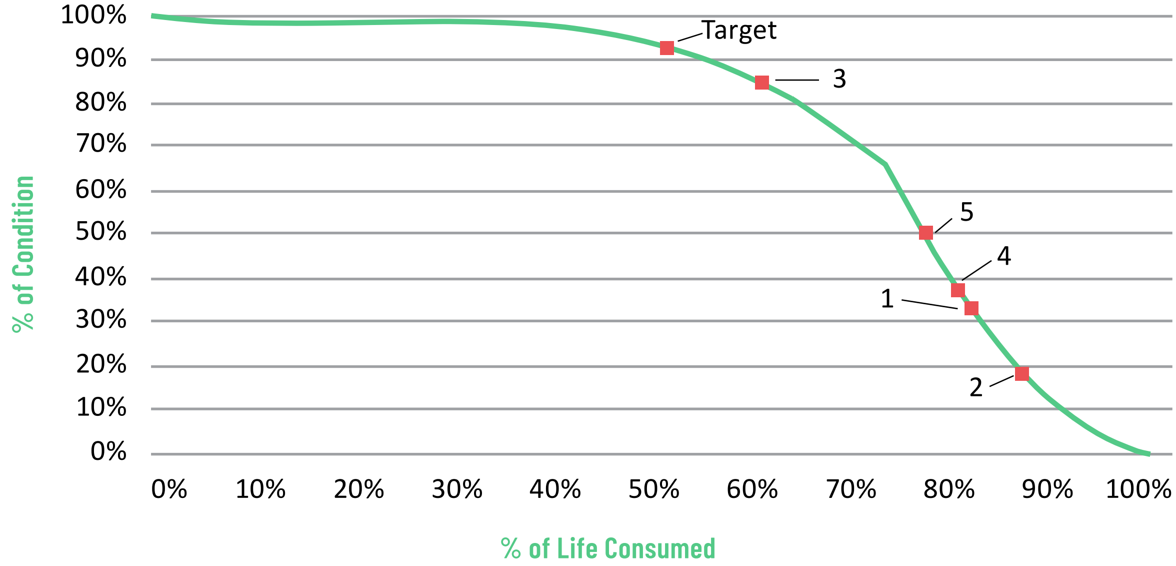
Roads by Surface Type



Building off the analysis above, 'Roads' as a sub-category can also be categorized by their surface types. Most RMA member roads (at least by length) are gravel, followed by asphalt. Concrete and chipseal surface types account for a smaller number of roads.

Asphalt and gravel roads sit at comparative mid points on the curve. Considering they make up much of the portfolio, this aligns with the overall road portfolio's condition rating of 60.76%. It can be assumed that the condition levels seen here roughly align with the expected traffic levels on each surface type, so the results are mostly expected.

Roads by District



Roads can be analyzed by the location of the municipality that manages the asset. This analysis considers the current state of roads between the RMA's five districts as distinct sub-groups. On average, 2.8 of 13.8 municipalities per district are included in this analysis, which limits its representative value and likely limits the significance of this analysis, especially for the high (District 3) and low (District 2) outliers. Again, this graph should be analyzed with the knowledge that a small number of roads are able to be represented here.

While both road deficits and bridge deficits (outlined in an earlier report) impact all municipalities and all regions of the province to some extent, the regional differences in road condition are surprising and greatly exceed the results of the bridge analysis. It is likely that sample size differences are predominantly responsible for the variation, as the large number of available bridge data showed a very small condition variation between regions. As a result, we are hesitant to conclude there is a significant regional difference in road asset condition and recommend additional study with complete data.

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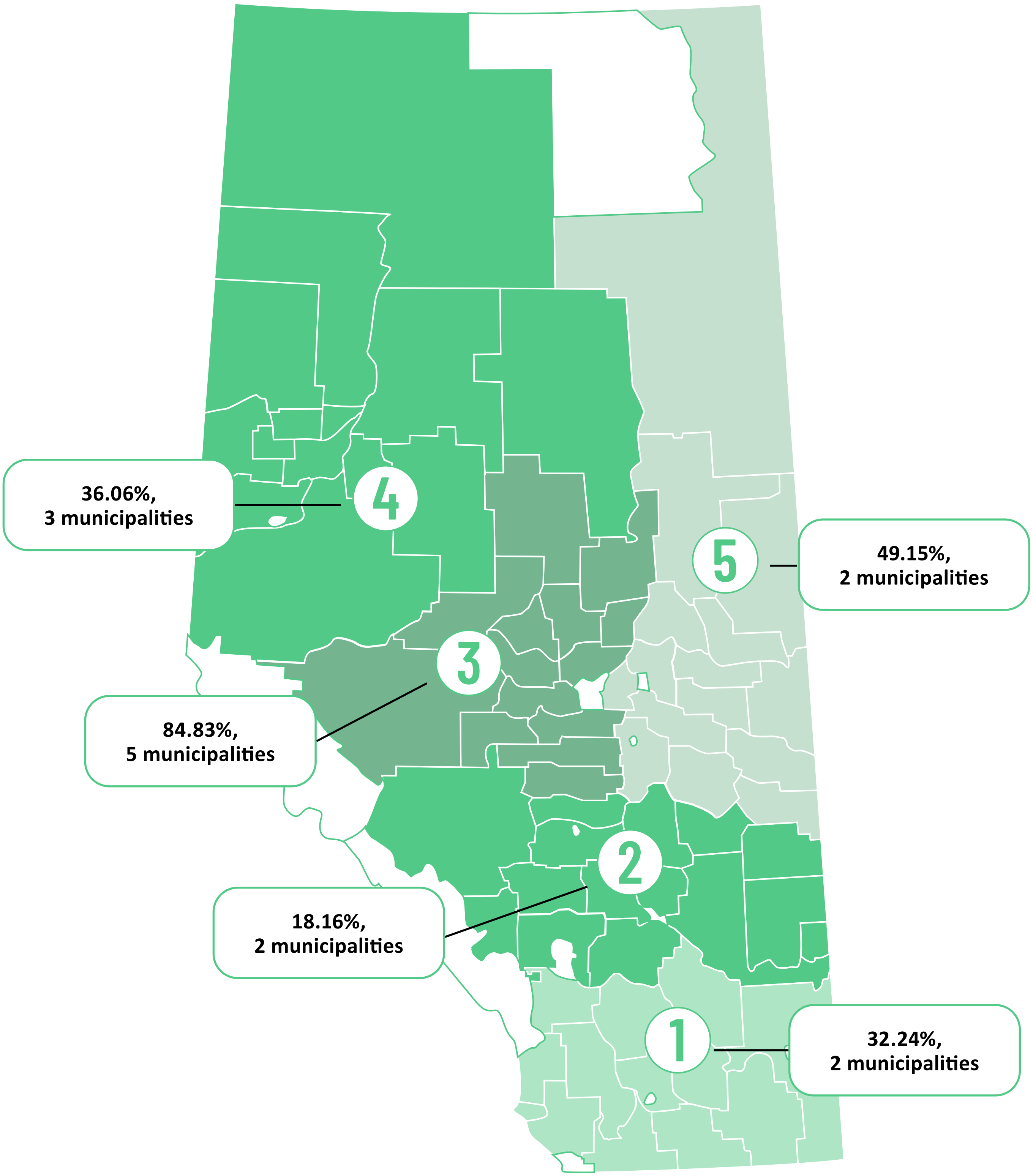
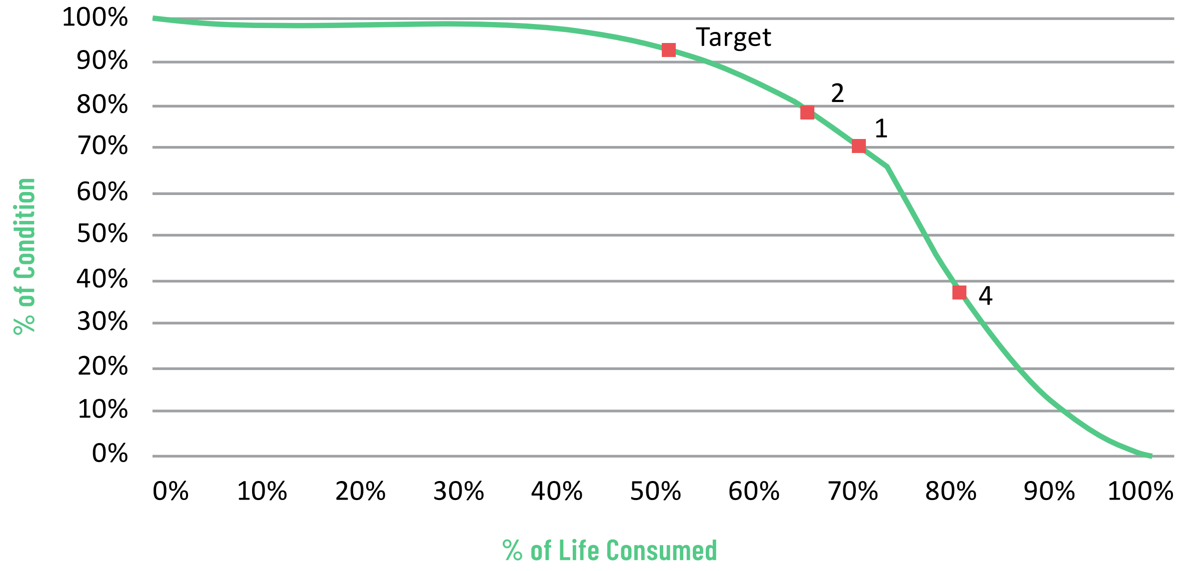


Roads by Number of Lanes



Road data also included the number of lanes. The results show that roads with one or two lanes have generally higher condition ratings. Roads with four lanes, likely rural highways, sit lower on the curve. This aligns with the rural highways shown above. Again, the traffic counts on rural highways appear to be highly variable, and it is expected that low-traffic rural highways are having an outsized impact on the results. Typically, we would expect the number of lanes to correlate with higher condition ratings, which is not what is being observed here. For details on each surface type, refer to Appendix B.

It is important to note that not all road assets analyzed included information on lanes. As a result, approximately 50% of the roads analyzed were further excluded from this graph.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Financial Summary

As noted above, the overall infrastructure deficit for roads managed by RMA members is $11.99 billion. To understand the gravity of this number, there are a few things to consider. Firstly, it is important to understand the meaning of the term holding cost.

> **Holding Cost:** How much it costs to keep the portfolio at the same condition level from one year to the next. As an example, if a road sits at 50% condition in 2023, it naturally deteriorates to approximately 48% condition in 2024, consistent with the deterioration curve. The cost to "fix" the road in 2024 and return it back to 50% condition level constitutes the holding cost.

The holding cost of the rural municipal road portfolio at its current level of 60.76% condition is $5,546,551,346. This means it costs $5.55 billion annually just to keep the portfolio's condition at its current depreciated point. Any investment level below that will result in even further deterioration of the portfolio. As discussed earlier, keeping infrastructure at 94% condition is the least expensive point on the curve year-over-year. Instead, if an investment was made into the road portfolio to improve its condition to 94%, the holding cost would decrease significantly to just $871 million per year.

PORTFOLIO (CURRENT)	
60.76% condition	$5.55 Billion Holding Cost

PORTFOLIO (IDEAL)		
93.96% condition	$871 Million Holding Cost	7.15 Year ROI

This means that investing $11.99 billion into rural municipal roads to bring the portfolio to 94% condition would reduce the year-over-year holding cost by $4.68 billion. This creates a return on investment (ROI) in only 2.56 years.

Projecting the Future State

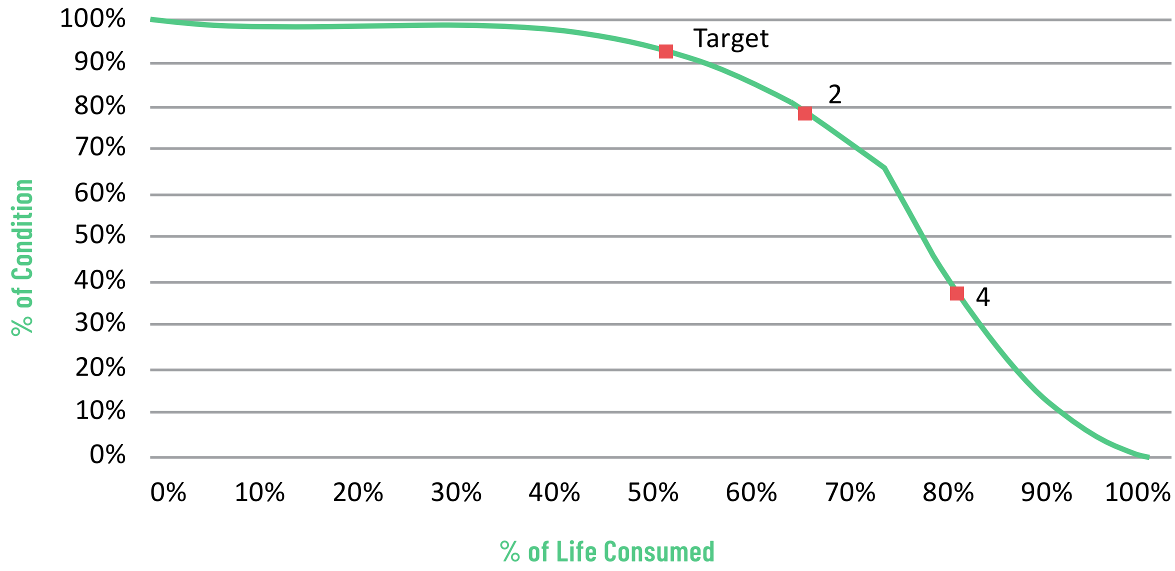
The level of investment used to project the future state of the rural municipal road portfolio is $146.76 million. This number represents the total project cost of all RMA member road projects supported by the Strategic Transportation Infrastructure Program (STIP) and the Municipal Sustainability Initiative (MSI) funding. An average of 2020, 2021, and 2022 values were used to account for variability in funding across years, and the data available as of the time of publication of this report. The STIP program is funded 75% by the Government of Alberta and 25% by municipalities. Based on previous RMA analysis conducted in 2018, Alberta rural municipalities already spend nearly 50% of their overall expenses on transportation infrastructure, which is much more than Alberta urban municipalities and municipalities in other provinces (approximately 10%). This suggests that rural municipalities are already spending a disproportionate share of their own-source revenue on roads and bridges, meaning that any significant growth in spending on bridges will have to come from the province.

2023-2028 Outlook

If Alberta continues with the same level of provincial investment ($146.763M) into rural municipal roads, 2028 will see a dramatically decreased road portfolio condition rating. Condition will drop from 60.76% to 14.09%, decreasing the value of the portfolio by $19.25 billion. The road network will be unable to keep up with the demand being placed on it, especially at significantly reduced condition levels.

For Consideration:

Rural Alberta's infrastructure sits at a critical point on the deterioration curve. Investment needs to be made now to save significantly in the long term.



4 Strategic Transportation Infrastructure Program 2023 Approved projects

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Rural municipal road infrastructure is currently positioned at an extremely critical point on the deterioration curve, with much more rapid deterioration inevitable. Current provincial funding is nowhere near enough to maintain the current 60.76% condition rating, accounting for less than 1% of the $5.55 billion annual holding cost. Further, in 2028, the cost to move the portfolio to the 94% target levels will increase to $31.24 billion from $11.99 billion today. This highlights the urgent need for increased funding and strategic investment to prevent further deterioration and ensure the safety and functionality of the road network. As a result, without a significant increase in investment, the condition and value of the road infrastructure in rural Alberta will decline rapidly.

Based on the current level of provincial investment, it would cost $19.25 billion in 2028 to return the rural road portfolio to its 2023 condition.

In 2028, the holding cost will be $1.79 billion annually. This number is so low because the value of the portfolio will have decreased to $2.70 billion. The holding cost will cost 66.36% of the entire portfolio value!

Year	Life Consumed	Condition	Value	Holding Cost	Target Holding Cost	Cost to get to Target
2023	74.90%	60.76%	$21.94 billion	$5.55 billion	$870.90 million	$11.99 billion
2024	78.50%	45.81%	$16.55 billion	$4.68 billion	$870.90 million	$17.39 billion
2025	82.10%	33.26%	$12.01 billion	$3.97 billion	$870.90 million	$21.92 billion
2026	85.70%	22.69%	$8.19 billion	$3.25 billion	$870.90 million	$25.74 billion
2027	89.30%	14.09%	$5.09 billion	$2.54 billion	$870.90 million	$28.85 billion
2028	92.80%	7.46%	$2.70 billion	$1.79 billion	$870.90 million	$31.24 billion

Other Findings and Considerations

Infrastructure resiliency is a growing concern:

Climate change is expected to have significant impacts on infrastructure, including increased risks of fire, flooding, erosion, and other severe weather events. Combined, this can overtax the infrastructure, impact expected lifespans, require more regular maintenance, or require major rehabilitation interventions over and above regular expected maintenance investment. A road portfolio that is already showing signs of underinvestment may deteriorate even faster with the impacts of climate change.

Of course, these risks are not just financial, especially for roads where safety is paramount. Roads must be designed and maintained to withstand the regular forces of nature, and will now have to contend with an increased frequency of major, "one-in-a-hundred year" events including heavy rainfall, snow loads, and flooding. Regular inspections and maintenance are crucial to ensuring that roads remain safe and structurally sound, even in the face of adverse weather conditions. In fact, one of the key resiliency measures is to ensure assets are in good condition to begin with.

Beyond maintenance, ensuring climate resiliency may require adjustments in materials and construction techniques as well. These adaptive remediations may be required outside of normal investment cycles, further increasing the needed investment into the portfolio. Of course, these adaptive measures may also be more expensive than routine maintenance. Overall, there is a clear need for investment into climate adaptation and resiliency as it relates to infrastructure. This level of investment will likely be higher than the standard "target state" holding cost given the impacts of climate change.

There is increasing need for additional road funding:

There is also a need for continued investment in infrastructure maintenance and renewal to address the existing infrastructure deficit and ensure that infrastructure remains safe, reliable, and resilient. This includes investing in road rehabilitation and replacement projects to address deteriorating infrastructure and improve overall network performance. When considering new investment, adopting new technologies in the construction and maintenance of roads will be essential for improving efficiency, safety, and resilience. Technologies such as advanced materials, sensors, and data analytics can help municipalities better understand the condition of their roads, predict maintenance needs, and optimize repair and replacement schedules. By embracing innovation, municipalities can reduce long-term maintenance costs and ensure that their road infrastructure remains safe and reliable for years to come.

Asset management remains a challenge for municipalities:

Effective asset management is essential for municipalities to maintain and improve their infrastructure in a strategic and sustainable manner. Despite RMA's efforts over the years, this analysis has revealed that many rural municipalities are still struggling to implement comprehensive asset management practices. This gap poses a significant challenge for the upkeep and development of rural transportation networks. One of the primary challenges in asset management is the lack

of comprehensive data collection. Many municipalities do not have the resources or systems in place to regularly assess and record the condition of their roads and other infrastructure assets. This deficiency hinders their ability to make informed decisions about maintenance, rehabilitation, and replacement projects. Without accurate data, municipalities cannot prioritize their efforts effectively, leading to potential neglect of critical infrastructure needs.

As well, the practices for asset management vary widely among municipalities, resulting in inconsistent approaches to infrastructure maintenance and investment. While some municipalities have established robust asset management frameworks, others have yet to develop or adopt such practices. This inconsistency contributes to disparities in infrastructure conditions across the province. However, the cost of conducting regular inspections, maintaining detailed asset inventories, and implementing advanced management systems can be prohibitive. Resource constraints and staff expertise are a primary barrier to effective asset management. Many rural municipalities operate with limited budgets and staffing, making it challenging to allocate sufficient resources for comprehensive asset management activities. Consequently, many municipalities are forced to take a reactive rather than proactive approach to infrastructure maintenance, addressing issues only when they become critical.

What’s Next?

The next phase of this project will apply similar analysis to the infrastructure deficit for utilities. This will provide a more comprehensive understanding of the overall infrastructure deficit faced by Alberta’s rural municipalities. By examining a wider range of assets, we can gain insight into the broader challenges and investment needs of the region’s infrastructure.

The final report will consolidate the findings from each individual asset type report, summarizing the total infrastructure deficit for all asset categories. This comprehensive overview will offer stakeholders a clear picture of the scale of the infrastructure challenge faced by rural municipalities and recommendations to address it.

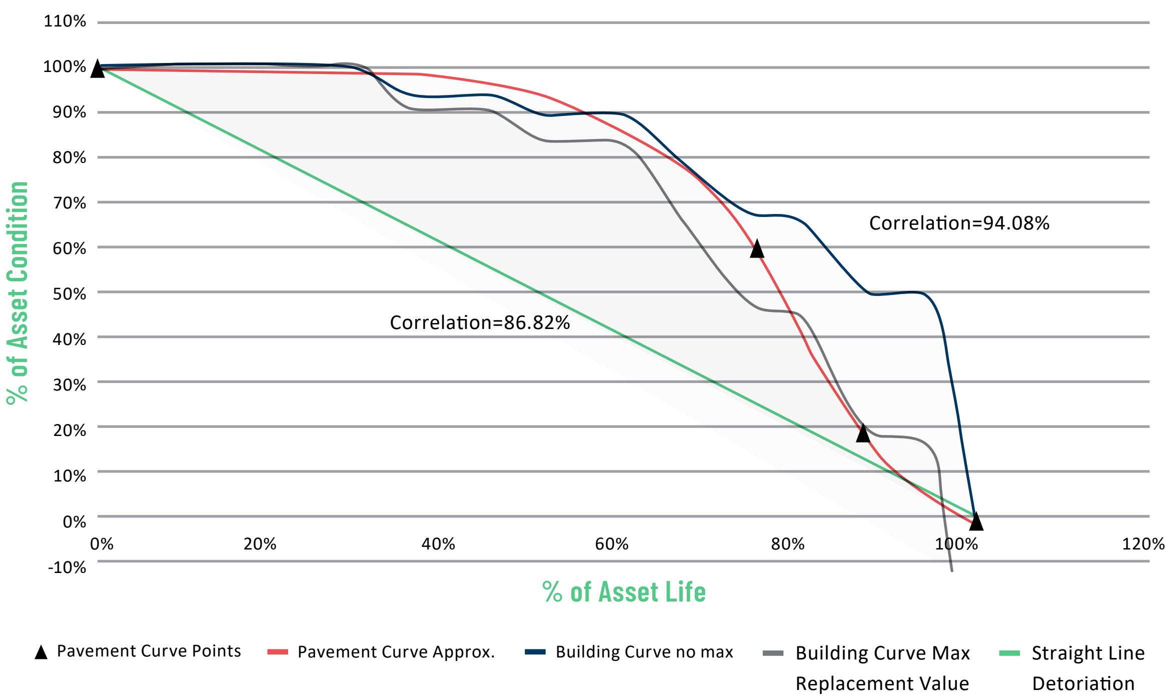
Questions about this report, or any others in the series, can be directed to **Wyatt Skovron, General Manager of Policy and Advocacy** at **780.955.4096** or **wyatt@rmalberta.com.**

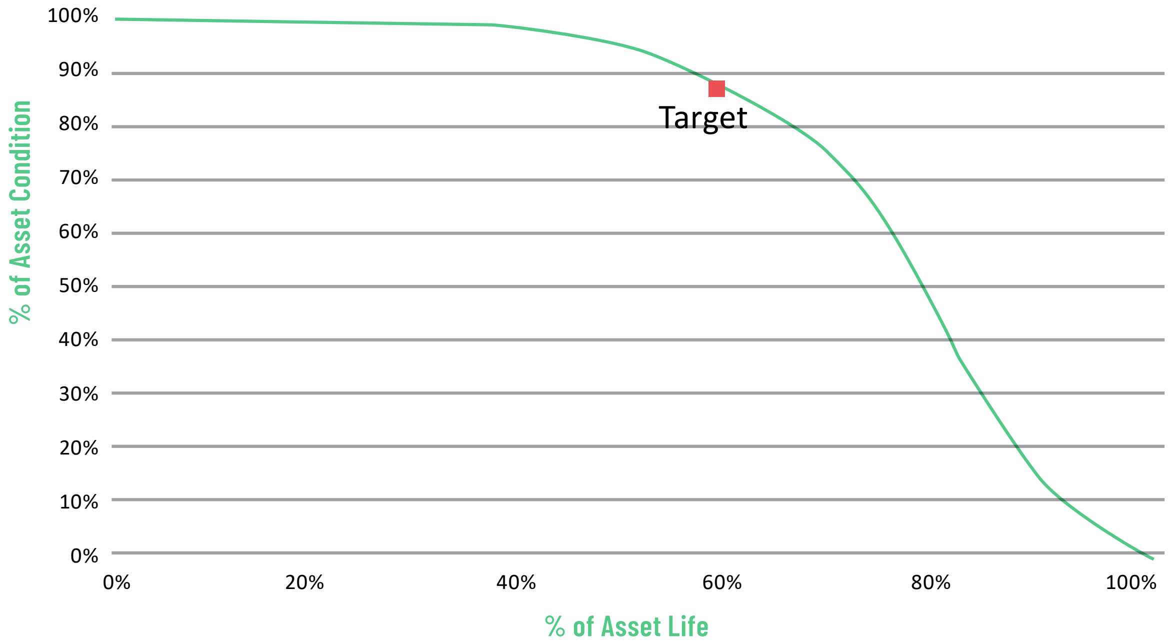
Appendix A: Deterioration Curve Technical Data

Two different deterioration curves have been used to analyze the state of rural infrastructure in Alberta. The first curve, an S-Curve, is used for bridges and roads. The S-Curve was adapted from a standard pavement deterioration curve. The second deterioration curve, the Utility Curve, is used for utility (water, wastewater, and stormwater) infrastructure. The Utility Curve was adapted from a standard sanitary sewer deterioration curve. Both curves are mathematical formulas that forecast the condition of the overall portfolio based on the weighted average point in the asset's life.

S-Curve

In the early 2000s, it was determined that the S-Curve has a 94% correlation with a building deterioration curve provided by Alberta Infrastructure's asset management methodology. An Alberta Environment and Protected Areas report completed at that time validated the use of the standard pavement deterioration curve to approximate the deterioration of all infrastructure classes in the Environment and Protected Areas portfolio by comparing the predicted rate of decline with data provided from the Infrastructure Information Management System (IMS). Using the IMS, the primary comparison drawn predicted the cumulative maintenance expenses for a 500 sq. ft., stick frame constructed building. The results were then correlated with the pavement curve, assuming a 30-year life of the building. The result was a correlation of 94.08%. When contrasting the deterioration curve with a straight-line curve (traditionally used in accounting), the straight-line curve resulted in a lower correction of 86.97%.





The target point of the S-Curve is a derived calculation which considers the life consumed compared to the slope (i.e. holding cost) of the curve at any given point. It is intuitive that the best value point on the curve is one where we have utilized as many of the 'cheap' years of an asset, while not letting it start to slide down to steeper points on the curve. The S-Curve begins to slope downward at 50% of the infrastructure life span (94% condition). The most economical option is if the curve can be prevented from dropping by lengthening the infrastructure life at this point. The holding cost is determined by the required investment to stay at the same point on the curve, year over year. The deficit calculation is based on the one-time investment required to move the portfolio to its target state (50% of life expectancy).

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Utility Curve

Through the development of this project, it became apparent that the standard S-curve would not provide an effective model for all asset types that are in-scope. In particular, we observed a number of instances, including from RMA members, where the standard deterioration curves for utility infrastructure were quite different than the standard S-curve model above. While consensus of a baseline utility curve appears to be less settled than road infrastructure, it was decided to leverage utility modelling conducted by the City of Ottawa[5] to derive our utility curve. Specifically, a curve-fitting exercise was conducted on a published sanitary infrastructure curve to derive the curve below.

Despite the change in shape, the Utility Curve functions similarly to the S-curve above. The optimum point is a derived calculation which considers the annual investment required to keep assets at the previous year's condition level. Keeping assets at this condition through investment will keep annual depreciation below the annual change in value of the depreciating asset.

However, the Utility Curve does not have the same inflection points as the S-curve above, so the key point of acceleration is less prominent. As a result, the target point of the Utility Curve is a different derived calculation which considers annual investment required to keep assets at the previous year's condition level. It is again intuitive that the best value point on the curve is one where we have utilized as many of the "cheap" years of an asset, while not letting it begin to slide down to steeper points on the curve. The steepest slope of the Utility Curve beings at around 64% of the infrastructure life span (87% condition). The most economical option is to keep assets at this condition, where annual depreciation will stay below the annual change in value of the depreciating asset.

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Like the S-curve, through investment, the Utility Curve can be prevented from dropping by lengthening the infrastructure life at this point. The holding cost is determined by the required investment to stay at the same point on the curve, year over year. The deficit calculation is based on the one-time investment required to move the portfolio to its target state (64% of life expectancy).

As noted, this curve will only apply to various utility infrastructure for that specific report, and is not applied to the road or bridge/culvert reports.

Deterioration Curves Interpretation

Regardless of the specifics of the deterioration curve being used, using a deterioration curve results in a better analysis of the infrastructure deficit than the standard straight-line deterioration method used in Tangible Capital Asset (TCA) accounting. The first key advantage of this curve over the traditional straight-line depreciation approach is its ability to account for varying rates of degradation over an asset's lifespan. The assumption of the same level of annual degradation in the straight-line approach means there is no optimal point to maintain assets, leading to potentially inefficient allocation of resources. Additionally, the accounting-focused straight-line approach tends to underestimate an asset's condition early in its lifespan and overestimate it later when investment is critical, which can result in suboptimal asset management decisions. In contrast, the curve used in this analysis provides a more realistic and asset-management focused view of infrastructure deterioration. By incorporating factors such as the optimal condition to maintain assets and the varying rates of degradation over time, this approach offers a more accurate assessment of the infrastructure deficit. This is particularly valuable for long-term planning and decision-making, as it allows municipalities to prioritize maintenance and investment efforts based on the actual condition of their assets.

Assets can be manually moved up and down a deterioration curve. To theoretically "age" an asset, its useful life is used to move the asset along the curve each year. For example, an asset with a useful life of 50 years would move down the x-axis at 2% each year. In year zero, the asset would have a 0% life consumed, and consequently, a 100% condition. As an example of how this applies to the S-curve above, in year one, the life consumed would be 2%, and the condition would be 99.52%. At year 25, the life consumed would be 50%, and the corresponding condition would be 93.96%. However, this assumes no investment into the asset. If investment is made into the asset, the asset would move up the y-axis based on the change to asset condition. For example, if an asset at 40% condition, and 80% life consumed receives an investment that improves its condition by 10%, the asset would move up the y-axis to 50% condition with a corresponding 77.5% life consumed. This essentially "de-ages" the asset, extending its actual life. The utility curve functions similarly, though specific values will change.

Appendix B: Technical Methodology

To calculate the overall rural municipal infrastructure deficit, it was critical to place the current state of infrastructure on the deterioration curve outlined above. To do this, two key pieces of information are needed: the ideal value of the infrastructure portfolio and the actual current value of the infrastructure. The deficit is calculated by subtracting the current value from the ideal value. However, it is important to note that the ideal value of infrastructure is not the same as the value of brand-new infrastructure. As shown in the "Deterioration Curve" section of the report, road infrastructure should ideally be maintained at approximately 94% condition with 50% of its life consumed.

To complete the analysis of the infrastructure deficit there are two paths to calculate the total deficit, depending on what information is available on the asset. Both paths require:

- Structure Type
    - ex. Local road, rural highway, arterial road.
- Useful Life
    - Pre-populated in the workbook based on Infrastructure Canada standards. Municipalities were encouraged to override the provided value if their if their municipality uses a different expected useful life than the one prefilled.
- Estimated Replacement Cost
    - How much it would cost to fully replace the asset.

The first path relies on two key pieces of information for each asset: the condition assessment and last inspection date. The condition assessment is the y-axis of the deterioration curve and represents the average condition of the infrastructure as a percentage of its value. The last inspection date is required to ensure all assets can be viewed in 2023 dollars. The second path is used when the condition assessment is not available. This path requires the first in service year and the total capital investment into the asset. The first in service year is also the date of construction, and the total capital investment into the asset is the total dollar amount of capital that has been invested into this asset. This does not include scheduled maintenance or daily operating costs.

The following sections outline the various phases of work that were conducted to achieve placement on the deterioration curve.

Road Information

Unlike bridges, there is not a central database of other asset types within the province. Municipalities are tasked with allocating their own resources to inspect, record, and analyze their infrastructure. To create the database needed in this project to analyze the infrastructure deficit, municipalities were asked to provide the project team information on their assets.

A request for asset management data was sent to all RMA members. This request included a stakeholder primer and requested volunteers to participate in the process, if they felt they had

appropriate asset management data available. Municipalities were also provided with individualized workbooks during this engagement process. During this time, the project team presented work completed to date at the 2024 Spring RMA Convention. The combination of personalized requests and publicity for participation resulted in an up-tick in project participation throughout RMA membership. Thirty of 69 RMA members provided data to be utilized in this project. RMA is extremely grateful to all members who participated in this process and were able to provide any asset management data to the project. Municipalities that were unable to provide information are represented in the deficit calculation through an extrapolation process.

Infrastructure Workbook

To make collecting the required data as easy and uniform as possible, the project team created a workbook that was sent to all 69 RMA members. This workbook was intended to collect detailed information on various infrastructure assets, including roads, bridges, and utilities. The data collected from these workbooks aimed to quantify the rural municipal infrastructure deficit, providing a foundation for informed advocacy and future planning. The workbook contained an introduction, FAQ, and separate tabs for each category of infrastructure (bridge, roads, and utilities). Specific directions to fill out the workbook and which data fields were required for each asset were clearly explained. The data fields were colour coded as follows:

GREEN: Mandatory for ALL assets.

GREY: Optional but helpful. Please try to fill out these fields if possible.

ORANGE: Mandatory. If you do not have this data, please see the blue columns.

BLUE: If you do not have data for all orange columns, all blue columns are required.

The following columns were requested for road assets:

- Green
  - Structure Type (dropdown menu)
  - Useful Life (pre-populated)
  - Estimated Surface Replacement Cost
  - Estimated Substructure Replacement Cost
- Grey
  - File Number
  - Description or Name
  - Other (Please Describe)
    - If the Structure Type selected is “Other” this field becomes mandatory to describe the structure type
  - Primary Usage
  - Managed By
  - Owned By
  - Year Surface Replacement Cost was Estimated

    - Year Substructure Replacement Cost was Estimated
    - Estimated AADT
    - Number of Lanes
    - Road Width (Meters)
    - Surface Type
    - Section Length (KM)
- Orange
    - Surface Condition Rating
    - % Surface Condition Rating (if different than condition rating)
    - Substructure Condition Rating
    - % Substructure Condition Rating (if different than condition rating)
    - Last Inspection Date
- Blue
    - First in Service Year
    - Capital Investment into Asset

Data Standardization

To promote consistency across the analysis, municipalities directly providing data through the workbook process were asked to include the "year replacement cost was estimated." Municipalities were asked to consider the year in which their dollars are valued. The example given was:

"If you've planned to spend $10 million to replace the asset in 2034 and you've already adjusted for inflation to 2034, enter 2034. If your estimate is in today's dollars (for example, $10 million in 2023 dollars), enter 2023. The inverse is also true, if in the year 2000 you estimated it would cost $5 million to replace the asset in 2024, and you end up spending the current value of $5 million (let's say it's $8 million now), please enter 2000. If you considered inflation in 2000 and today you've spent $5 million, enter 2023."

When workbooks were received back from all municipalities who chose to participate, the deficit calculations began. In the analysis and calculation of the deficit, all dollar values were adjusted to be representative of 2023 values. This helps to ensure consistency across municipalities and asset categories. Inflation rates used are based directly on the Statistics Canada Consumer Price Index.[6]

In keeping with the idea of consistency, where required, all assets have been manually "aged" to reflect condition as of 2023. This involves utilizing the asset's "useful life." To categorize the useful life of assets, we turned to the Government of Canada Statistics: Infrastructure Canada data[7]. This data was released in 2022 and contains information for the asset categories of road assets, potable water assets, culture, recreation and sport facilities, wastewater assets, stormwater assets, and public transit assets. The data is entitled "Average expected useful life of new municipally owned

6 Consumer Price Index, annual average, not seasonally adjusted
7 Statistics Canada: Infrastructure

[asset category], by urban and rural, and population size, Infrastructure Canada." Where data exists, we have selected the average useful life specific to "Alberta Rural Municipalities." When the rural category is not available, the "Alberta Urban Municipalities" value was selected. In very few categories, specific subcategories were not documented in the Infrastructure Canada database. In these cases, data was collected from various sources such as the participant workbook for the course "Asset Management for Municipal Staff: The Technical Basics," and targeted to Rural Alberta as much as possible.

The primary subcategories used in the Road category are Highway, Rural Highway, Arterial, Collector, Local, and Lanes / Alleys. The following table contains a brief definition of the subcategories and their useful life.

ASSET SUBCATEGORY	DEFINITION	USEFUL LIFE (YEARS)[9]
Highway	Roads that move high volumes of traffic and have controlled entrance and exit, a dividing strip between the traffic in opposite directions, and typically two or more lanes in each direction. Highways do not provide access to property, and generally do not accommodate cyclists or pedestrians.	45
Rural Highway	Roads that move varied traffic volumes depending on location, are medium to high speed, and are usually one, but sometimes two lanes in each direction. These highways usually have no dividing strip and allow for direct access from adjacent developments.	12
Arterial	Roads that move moderate to high traffic volumes over moderate distances between principal areas of traffic generation, and gather traffic from collector roads and local roads and move it to the highway system. Arterial roads are generally designed for medium speed, have capacity for two to six lanes, and may be divided, with limited or controlled direct access from adjacent developments and with on-street parking discouraged.	28
Collector	Roads that move low to moderate traffic volumes within specific areas of a municipality and collect local traffic for distribution to the arterial or highway system. Collector roads are generally designed for medium speed, have capacity for two to four lanes, are usually undivided, with direct access from adjacent development permitted but usually controlled, and with controlled on-street parking usually permitted.	35

8 Asset Management for Municipal Staff: The Technical Basics

9 Average expected useful life of new municipally owned road assets, Infrastructure Canada

Local	Roads that provide for low volumes of traffic and access to private properties; local roads are designed for low speeds, have capacity for two undivided lanes of traffic; through traffic is discouraged and parking is usually permitted though often controlled.	34
Lanes / Alleys	A narrow road intended chiefly to give access to the rear of buildings and parcels of land.	23

An "Other" option was provided to municipalities to include assets that fell under the category of Roads but did not fall into one of the subcategories. This option was utilized for less than 0.3% of received information. Municipalities who utilized this option provided their own useful life value, which closely aligned with the useful life values provided for other categories.

To age the asset to 2023, the useful life was used to determine how far along the curve each asset subcategory moves each year. Except in cases where municipalities have indicated otherwise through the workbook, this involved assuming that no investment has been made into the asset since its last inspection date. 40.55% of Class 1 road assets have an inspection date in 2023, the remainder have been manually aged to represent their expected asset condition and life consumed in 2023. In some cases, the result off the calculated condition rating or life consumed exceeded 0% or 100%, respectively. In these cases, the roads were capped at 0% condition and 100% life consumed. The manually-capped roads account for 9.64% of all roads and 21.82% of Class 1 roads. More details regarding the manual aging process can be found in the following section entitled "Deterioration Curve."

Extrapolation Process

Data was received through a structured data request to municipalities. Approximately 42% of RMA members responded to the workbook collection and included their road information in the workbook. Of the data received from these municipalities, 44.50% of the data contained the information needed to calculate an infrastructure deficit. This left two main groups of information to account for:

1. Data received from municipalities without the required information for the deficit calculation.
   A. For each asset the required data is a useful life value, replacement cost, structure type, and either a condition rating or total capital investment. More information can be found in the section entitled "Appendix B: Technical Methodology."
2. Municipalities who did not participate in the workbook process.

To extrapolate for the information received for the workbook process, but without key pieces of information, the structure type and section length of the road was utilized. Using the fully complete data, a deficit per kilometer value was found. This was further separated by structure type. Using the deficit per kilometre, separated into structure type deficit per kilometre, these values were applied to the remainder of the information received from municipalities. However, this approach

relies on municipalities providing the section length. In 11.45% of the data received, neither a section length nor enough information to calculate the deficit was available. To account for the remaining received data, the reported kilometres were compared to kilometres recorded in MFIS data for each municipality. On average, there was a 94.68% match against recorded MFIS data. Each municipality's deficit was then either grossed up or down based on their reported MFIS road length.

Secondly, to account for municipalities who were unable to participate in the workbook process, reported MFIS road length was also utilized. To extrapolate to these municipalities the total infrastructure deficit for all received information was divided by reported MFIS kilometres of the municipalities who participated in the workbook process. The deficit per kilometre was then applied to the remaining municipalities based on their MFIS road length values.

Exceptions to Methodology

In the case of a minority of RMA members, special circumstances were accommodated for to assist in the reporting of their asset management information. The following list details these situations:

1. A minority of municipalities were not able to participate in the structured workbook process. In such cases, the project team translated their provided asset management information into the workbook. The workbook was then sent back to the municipalities for confirmation.
2. A small number of municipalities were not able to provide condition ratings in a percentage format, only having subjective ratings such as "Good", "Fair", etc. The project team worked with these municipalities to translate their subjective condition ratings into percentage conditions. This translation was based on a standard useful life remaining of the asset. In all cases, municipalities approved the translation efforts.
3. A very small percentage of roads did not have a last inspection date or year replacement cost was estimated. In these cases, it was assumed to use 2023 for both values.

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Appendix C: Road Characteristic Comparison Data

Note: It is important to remember that the values contained within these charts represent a limited subset of the rural road portfolio. Only roads with condition ratings were able to be included in this analysis.

Roads by Type

BY TYPE	LIFE CONSUMED	CONDITION	VALUE	CURRENT HOLDING COST	TARGET HOLDING COST	COST TO GET TO TARGET
Rural Highway	94.30%	5.19%	$1,305,205	$3,865,330	$606,922	$22,344,385
Arterial	63.40%	82.08%	$171,790,380	$32,142,309	$5,046,885	$24,868,764
Collector	62.50%	83.15%	$868,274,509	$160,363,906	$25,179,838	$112,894,219
Local	77.80%	48.85%	$2,619,484,675	$823,516,720	$129,306,014	$2,419,110,819
Lanes / Alleys	74.60%	61.86%	$15,060,844	$3,739,028	$587,090	$7,815,983
Other	55.60%	90.11%	$1,148,401,165	$195,716,532	$30,730,796	$49,068,677

Roads by Surface Type

BY TYPE	LIFE CONSUMED	CONDITION	VALUE	CURRENT HOLDING COST	TARGET HOLDING COST	COST TO GET TO TARGET
Asphalt	65.40%	79.45%	$951,298,380	$183,886,302	$28,873,251	$173,789,516
Chipseal	85.80%	22.32%	$13,375,099	$9,200,478	$1,444,630	$42,917,001
Concrete	52.10%	92.69%	$426,584,464	$70,675,792	$11,097,291	$5,837,515
Gravel	74.80%	60.81%	$2,924,800,023	$738,677,506	$115,984,826	$1,594,716,175

Roads by District

BY TYPE	LIFE CONSUMED	CONDITION	VALUE	CURRENT HOLDING COST	TARGET HOLDING COST	COST TO GET TO TARGET
1	82.40%	32.24%	$319,120,167	$152,000,546	$23,866,649	$610,878,274
2	87.50%	18.16%	$106,610,269	$90,156,854	$14,156,147	$445,004,419
3	61.00%	84.83%	3,459,674,649	$626,276,334	$98,335,947	$372,127,474
4	81.30%	36.06%	$507,537,878	$216,120,411	$33,934,549	$814,770,828
5	77.70%	49.15%	$431,373,815	$134,789,679	$21,164,253	$393,321,853

Roads by Number of Lanes

BY TYPE	LIFE CONSUMED	CONDITION	VALUE	CURRENT HOLDING COST	TARGET HOLDING COST	COST TO GET TO TARGET
1	70.90%	70.76%	$986,375	$214,078	$33,614	$323,435
2	66.80%	77.37%	1,995,573,816	$396,072,835	$62,190,115	$427,753,792
4	80.70%	38.05%	$3,412	$1,377	$216	$5,013

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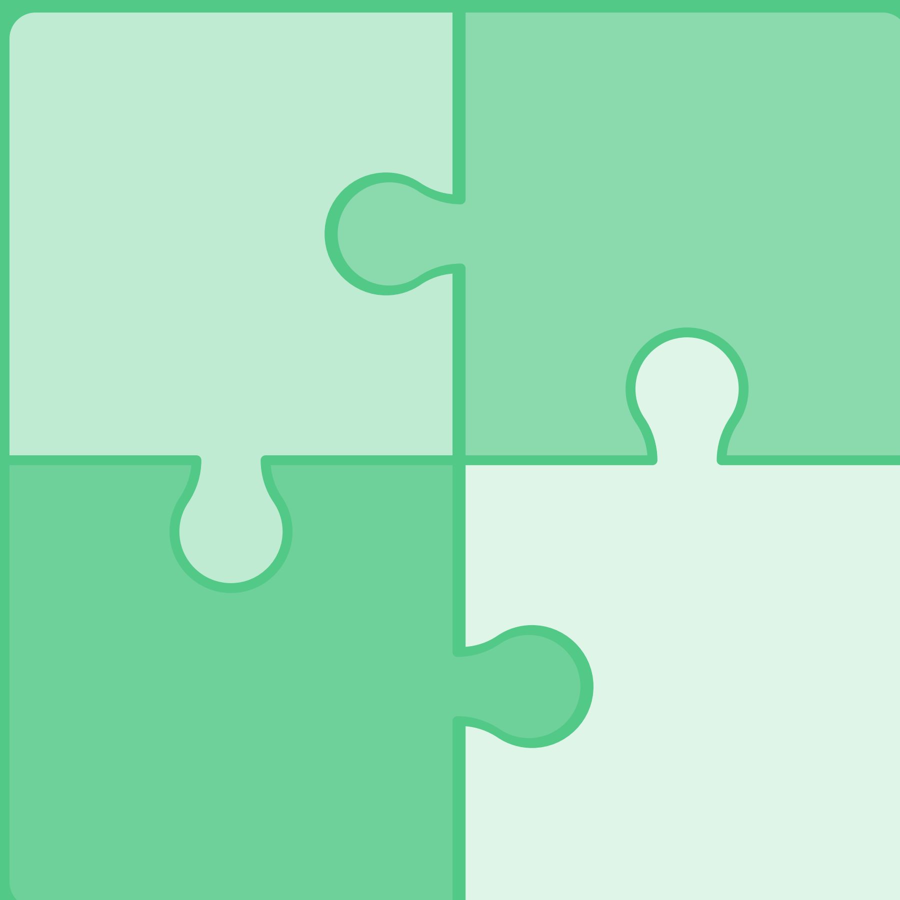

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