

Township of Greater Madawaska
Asset Management Plan: Gravel Roads

2026



TOWNSHIP OF
**GREATER
MADAWASKA**



Empowering your organization through advanced
asset management, budgeting & GIS solutions

Contents

Executive Summary	4
Key Technical Concepts in Asset Management	4
Lifecycle Management Strategies	5
Risk and Criticality	5
Levels of Service	6
Asset Condition	6
Gravel Roads.....	7
Inventory and Valuation	7
Asset Condition	8
Forecasted Rehabilitation Needs	11
Lifecycle Management	11
Risk Analysis.....	13
Risk of Not Addressing Gravel Road Conditions.....	14
Levels of Service (LOS)	15
Financial Strategy.....	16
Assumptions and Limitations	18
Recommendations and Key Considerations.....	18
Data Management and Governance.....	18
Better Asset Management Through Better Asset Data.....	19
Lifecycle Planning	19
Figure 1: Risk Equation	5
Figure 2: Asset Condition: Overall Weighted Condition.....	10
Figure 3: Lifecycle Profile for Gravel Roads (Segment 1)	12
Figure 4: Lifecycle Profile for Gravel Roads (Segment 2)	12
Figure 5: Lifecycle Profile for Gravel Roads (Segment 3)	13
Table 1: Detailed Asset Inventory	7
Table 2: Condition Rating System	8
Table 3: Detailed Asset Condition	9
Table 4: Lifecycle Strategy – Gravel Roads (Segment 1)	11
Table 5: Lifecycle Strategy – Gravel Roads (Segment 2)	12
Table 6: Lifecycle Strategy – Gravel Roads (Segment 3)	13
Table 7: Probability of Failure (Based on Condition).....	13
Table 8: Consequence of Failure (Based on Use)	14
Table 9: Risk Categories and Associated Actions	14
Table 10: Technical Levels of Service	16
Table 11: Annual Available Funding.....	16
Table 12: Tax Increase Requirements for Full Funding	17
Table 13: Tax Increase Options 2-20 Years	17

Executive Summary

The Township of Greater Madawaska's gravel roads are crucial for maintaining connectivity, supporting economic activity and ensuring the safety of residents. The Township of Greater Madawaska relies heavily on an accessible, safe road network.

Understanding the current state of the gravel roads the forecasted future requirements, will assist Council to be strategic and proactive in maintenance and replacement programs to ensure that the desired level of service is provided to businesses and residents.

The purpose of this Gravel Roads Asset Management Plan (AMP) is to provide a structured, data-driven framework for managing the Township's gravel road network over its lifecycle.

This guide establishes standardized methods for condition assessment, defines levels of service, and outlines lifecycle strategies and risk-based approaches to support informed decision-making. It enables the Township to prioritize maintenance and capital investments based on condition, risk, and service expectations.

By linking condition ratings to maintenance actions, lifecycle needs, and risk, the AMP supports:

- Proactive and cost-effective maintenance planning
- Long-term financial sustainability
- Transparent and defensible budgeting decisions
- Compliance with asset management requirements set by the Ontario Ministry of Infrastructure

Ultimately, the Gravel Road AMP ensures that available resources are allocated effectively to maintain safe, reliable, and sustainable gravel road infrastructure.

Key Technical Concepts in Asset Management

Effective asset management integrates several key components, including lifecycle management, risk management, and levels of service. We note that although these elements and concepts are integral to asset management, they also require resources for implementation and monitoring.

Lifecycle Management Strategies

The condition or performance of most assets will deteriorate over time. This process is affected by a range of factors including an asset's characteristics, location, utilization, maintenance history and environment. Asset deterioration has a negative effect on the ability of an asset to fulfill its intended function, and may be characterized by increased cost, risk and even service disruption.

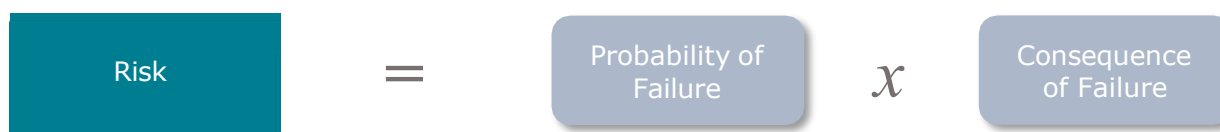
To ensure that municipal assets are performing as expected and meeting the needs of citizens, it is important to establish a lifecycle management strategy to proactively manage asset deterioration.

Risk and Criticality

Asset risk and criticality are essential building blocks of asset management, integral in prioritizing projects and distributing funds where they are needed most based on a variety of factors. Assets in disrepair may fail to perform their intended function, pose substantial risk to the community, lead to unplanned expenditures, and create liability for the municipality. In addition, some assets are simply more important to the community than others, their role in delivering essential services, the impact of their failure on public health and safety, and the extent to which they support a high quality of life for community stakeholders.

Risk is a product of two variables: the probability that an asset will fail, and the resulting consequences of that failure event. It can be a qualitative measurement, (low, medium, high) or quantitative measurement (1-5), that can be used to rank assets and projects, identify appropriate lifecycle strategies, optimize short- and long-term budgets, minimize service disruptions, and maintain public health and safety.

Figure 1: Risk Equation



Probability of Failure

Several factors can help decision-makers estimate the probability or likelihood of an asset's failure, including its condition, age, previous performance history, and exposure to extreme weather events.

Consequence of Failure

Estimating criticality also requires identifying the types of consequences that the organization and community may face from an asset's failure, and the magnitude of those consequences. Consequences of asset failure will vary across the infrastructure portfolio; the failure of some assets may result primarily in high direct financial cost but may pose limited risk to the community. Other assets may have a relatively minor financial value, but any downtime may pose significant health and safety hazards to residents.

Levels of Service

A level of service (LOS) is a measure of the services that the Municipality is providing to the community and the nature and quality of those services.

Asset Condition

An incomplete or limited understanding of asset condition can mislead long-term planning and decision-making. Accurate and reliable condition data helps to prevent premature and costly rehabilitation or replacement and ensures that lifecycle activities occur at the right time to maximize asset value and useful life.

Gravel Roads

The Township maintains a comprehensive inventory of gravel road assets within Citywide, including:

- Road segments (unique Asset ID)
- Location (from/to limits)
- Length (km)
- Road classification
- Traffic volumes (AADT)
- Environmental context (drainage/flood risk)

This inventory forms the foundation for condition, risk, and lifecycle modeling

The Township of Greater Madawaska is responsible for maintaining roughly 140kms of gravel roads. As gravel roads are perpetually maintained, there is no replacement cost associated with them. However, there is an average operating cost associated with maintaining the infrastructure.

The current average annual requirement for the gravel road network is \$304,250. This includes the operating costs for both graveling and dust control.

Inventory and Valuation

Table 1 summarizes the quantity and average annual requirement of the Township's gravel road network.

Table 1: Detailed Asset Inventory

Segment	Quantity	Unit of Measure	Average Annual Requirement
Gravel Roads	139.98	Length (km)	\$304,250

Asset Condition

Service levels define the Township's expected performance of gravel roads and guide maintenance standards. Gravel road condition is assessed using a standardized field-based evaluation model incorporating:

- Ride Quality
- Washboarding
- Rutting
- Gravel Thickness
- Drainage Condition
- Crown Condition

These inputs are combined into a Gravel Condition Index (GCI) to ensure consistency and repeatability.

Condition Rating System

Condition ratings are based on visual and operational assessments and reflect the ability of the road to meet defined service levels. Ratings are used to prioritize maintenance and lifecycle investment.

Table 2: Condition Rating System

Rating	Description	Criteria	What it Feels Like	Action	Condition %
1-Very Good	Meets or Exceeds Service Levels	Smooth Surface, Strong Crown (water sheds to ditches) No potholes, rutting or washboarding Gravel layer is intact and even	Comfortable ride at posted speed	Routine Grading	80-100
2-Good	Adequate with Minor defects (routine maintenance)	Minor roughness Light Washboarding in spots Surface still holds shape	Slight vibration but acceptable	Maintain (grading/dust control)	60-80

Rating	Description	Criteria	What it Feels Like	Action	Condition %
3-Fair (trigger point)	Increased Risk of not meeting Service Levels Requires Attention	Washboarding, light rutting Gravel thinning Crown becoming less defined	Rough ride, especially at speed	Plan re-gravel (segmented schedule)	40-60
4-Poor	Not Meeting Service Levels	Moderate to severe rutting Drainage Issues Present Thin Gravel Layer	Uncomfortable, potentially unsafe ride	Re-gravel ASAP and address drainage	20-40
5-Very Poor	Unfit for sustained service	Base exposed (mud/clay) Severe rutting/potholes Standing Water/Washouts No defined Crown	Very rough, possible vehicle damage	Rehabilitation or rebuild	0-20

Each asset is assigned a Condition Score (1-5) for system integration and reporting

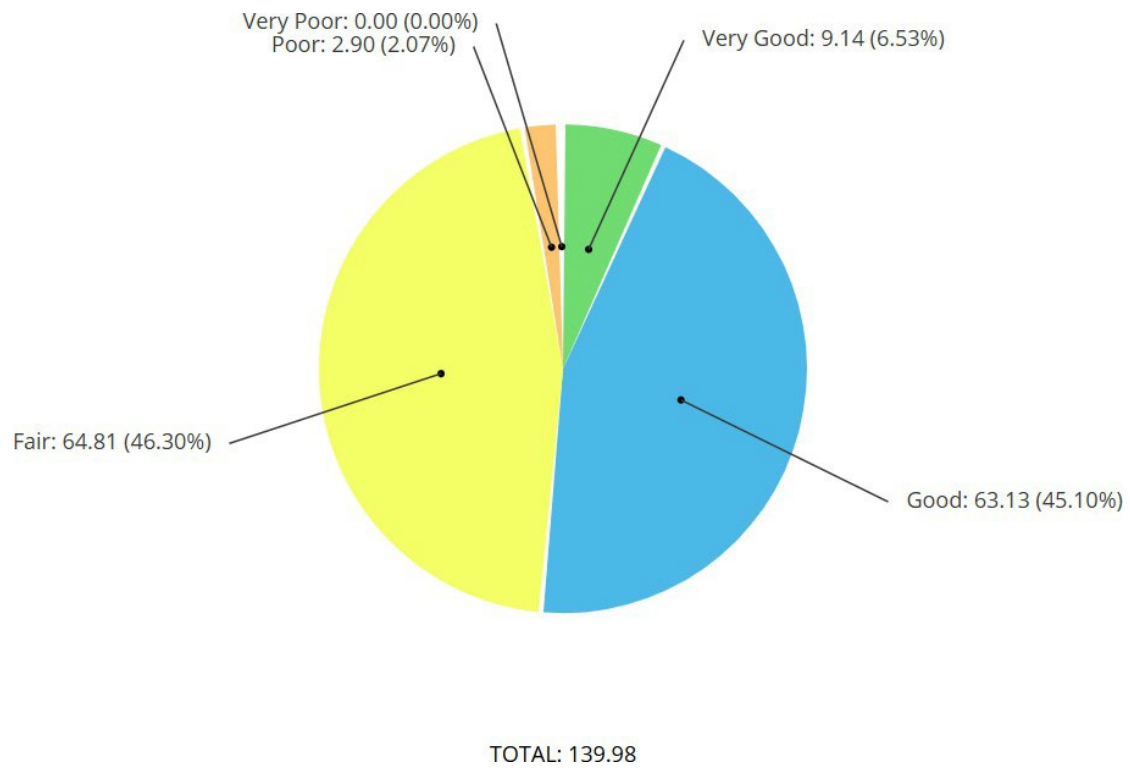
*Condition ratings are based on visual and operational assessment and reflect the ability of the road to meet defined service levels. Ratings are used to prioritize maintenance and lifecycle investment.

Recent assessments have been conducted on the Township's gravel road network. Overall the gravel road network is in good condition. At the time of this report 100% of the Gravel Roads have been assessed.

Table 3: Detailed Asset Condition

Segment	≤ Poor (km)	≤ Poor %	≥ Fair (km)	≥ Fair %	Average Condition
Gravel Roads	2.90 km	2.1%	137.08 km	97.9%	64%

Figure 2: Asset Condition: Overall Weighted Condition



Forecasted Rehabilitation Needs

The cyclical short-, medium- and long-term infrastructure rehabilitation requirements for the Township's gravel road network were modelled, and the analysis was run out to 10 years from current day. The Annual Requirement to fund future rehabilitation needs is \$304k. Although actual spending may fluctuate substantially from year to year, this figure is a useful benchmark value for annual operating expenditure targets (or allocations to reserves) to ensure projects are not deferred and rehabilitation needs are met as they arise.

Often, the magnitude of annual requirements is substantially higher than most municipalities can afford to fund. However, quantifying and monitoring these spikes is essential for long-term financial planning, including establishing dedicated reserves. Regular condition assessments and a robust risk framework will ensure that high-criticality assets receive proper and timely lifecycle intervention, including replacements.

Lifecycle Management

This section outlines the Township's current approach to managing its gravel network. Gravel roads are managed as a distinct asset class due to their maintenance-driven lifecycle and unique performance characteristics.

Unlike paved roads, gravel roads require frequent operational interventions to maintain service levels. The Township's approach emphasizes proactive maintenance, including grading, dust control, and periodic re-gravelling, to extend asset life and maintain safe driving conditions.

The gravel road structure is managed as two components:

- **Surface Layer (Consumable):** Requires regular replenishment due to traffic wear, weather, and grading loss
- **Base Structure (Long-Term Asset):** Provides structural support and is replaced only when failure occurs

The figures and tables below depict the current lifecycle strategies that have been applied to the gravel roads. These models should be continuously reviewed for applicability and refined as strategies evolve and new data is available.

Table 4: Lifecycle Strategy – Gravel Roads (Segment 1)

Event Name	Event Class	Event Range / Trigger	Impact on Asset Condition	Cost Per Unit
Re-Gravel	Rehabilitation or Renewal	Every 8-10 Years	Restore to Good Condition	\$25,100/km
Dust Control	Maintenance	Annually	Maintain Condition	\$1,221/km

Figure 3: Lifecycle Profile for Gravel Roads (Segment 1)

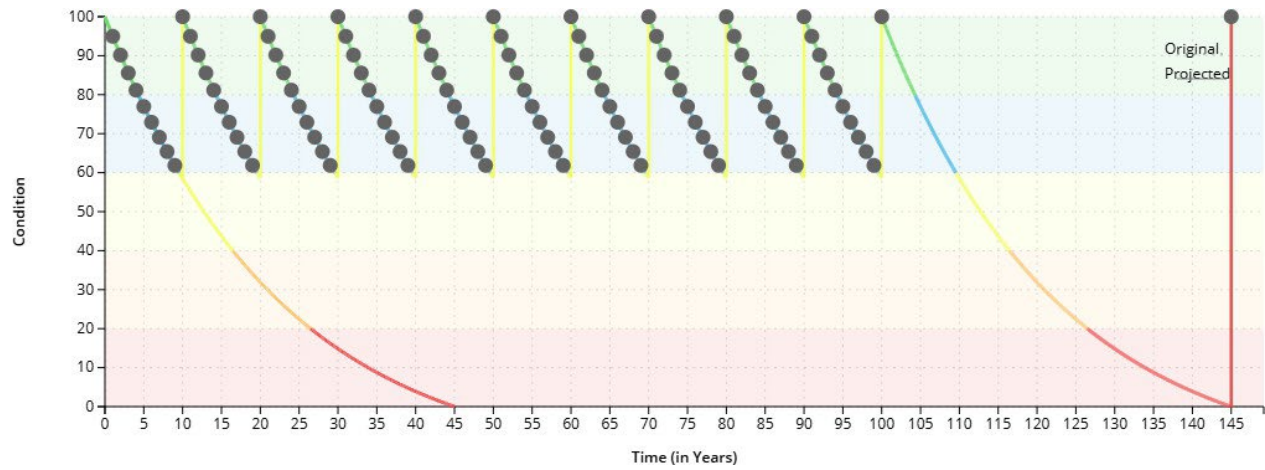


Table 5: Lifecycle Strategy – Gravel Roads (Segment 2)

Event Name	Event Class	Event Range / Trigger	Impact on Asset Condition	Cost Per Unit
Re-Gravel	Rehabilitation or Renewal	Every 10-12 Years	Restore to Good Condition	\$25,100/km
Dust Control	Maintenance	Annually	Maintain Condition	\$1,221/km

Figure 4: Lifecycle Profile for Gravel Roads (Segment 2)

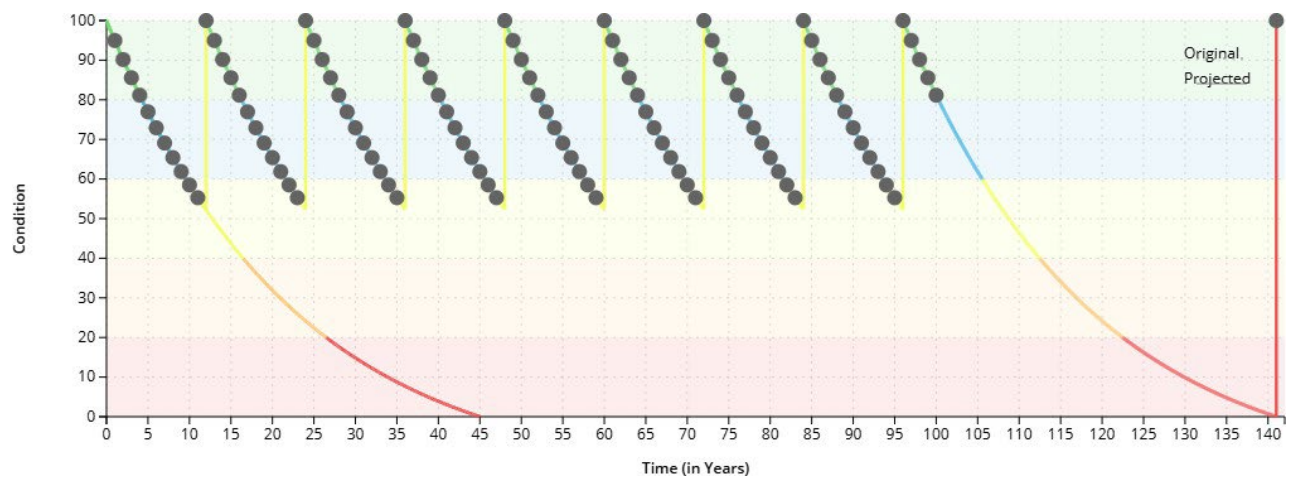
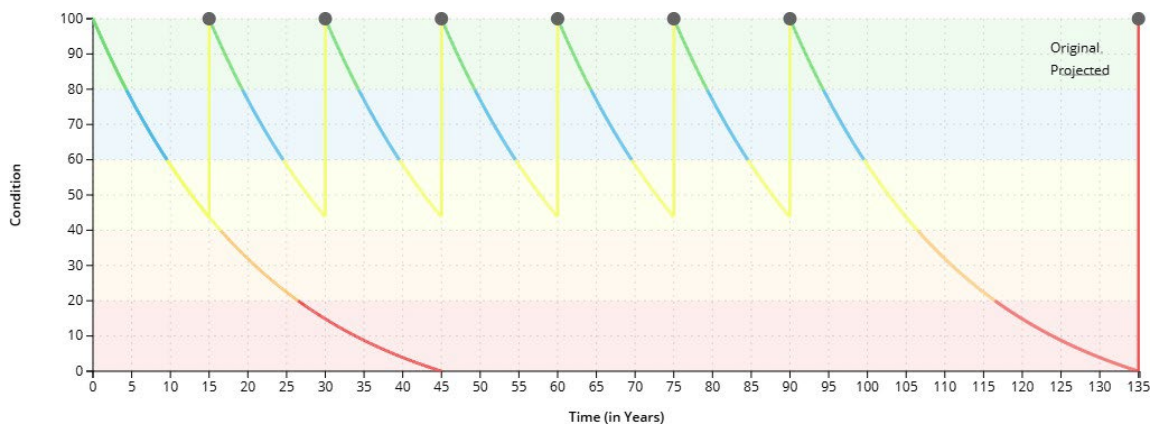


Table 6: Lifecycle Strategy – Gravel Roads (Segment 3)

Event Name	Event Class	Event Range / Trigger	Impact on Asset Condition	Cost Per Unit
Re-Gravel	Rehabilitation or Renewal	Every 13-17 Years	Restore to Good Condition	\$25,100/km

Figure 5: Lifecycle Profile for Gravel Roads (Segment 3)



Risk Analysis

The Township uses a risk-based framework to prioritize investments, considering both probability of failure and consequence of failure.

Probability is primarily informed by condition ratings, while consequence is influenced by factors such as traffic volumes, road classification, and environmental conditions (e.g., drainage and flooding risks).

This approach allows the Township to prioritize maintenance and lifecycle investments on segments that present the greatest risk to service delivery, safety, and network reliability.

Table 7: Probability of Failure (Based on Condition)

Condition %	Probability of Failure	Meaning
80-100	1	Very low probability of failure
60-80	2	Low probability
40-60	3	Moderate probability
20-40	4	High probability
0-20	5	Very high probability

Table 8: Consequence of Failure (Based on Use)

Factor	Low (1)	Medium (2)	High (3)
Traffic	<50 AADT	50–200	>200
Function	Local	Collector	Key route / emergency
Environment	Stable	Some drainage issues	Flood-prone

Consequence is determined using the highest applicable score across all factors.

Risk Calculation

The risk score for each gravel road segment is determined by multiplying the probability of failure, as informed by condition assessment, by the consequence of failure, which is established using the highest applicable rating across defined service and environmental factors.



Risk Categories for Decision-Making

1-3 Very Low	4-6 Low	7-9 Moderate	10-12 High	13-15 Very High
-------------------------------	--------------------------	-------------------------------	-----------------------------	----------------------------------

Table 9: Risk Categories and Associated Actions

Condition	Action
Very Good/Good	Routine Maintenance
Fair	Plan re-gravel (1-2 years)
Poor	Re-gravel immediately
Very Poor	Rehabilitation or reconstruction

Risk of Not Addressing Gravel Road Conditions

Failure to address deteriorating gravel road conditions in a timely manner can result in escalating risks to safety, service delivery, and long-term financial sustainability.

As conditions decline, the probability of surface and structural failure increases, leading to defects such as rutting, wash-boarding, loss of crown, and drainage failure. If left unaddressed, these issues accelerate deterioration of the underlying road base and significantly increase future rehabilitation or reconstruction costs.

Key risks include:

- **Safety Risks:**
Poor surface conditions can reduce vehicle control and increase collision risk, particularly at higher speeds or during adverse weather.
- **Service Level Impacts:**
Reduced ride quality, increased dust, and unreliable seasonal access (e.g., during spring thaw or heavy rainfall) negatively impact residents, emergency response, and overall network reliability.
- **Drainage and Environmental Impacts:**
Inadequate maintenance can result in standing water, erosion, and localized flooding, weakening the road structure.
- **Increased Lifecycle Costs:**
Delayed maintenance leads to more costly interventions. Preventative maintenance is significantly more cost-effective than reconstruction.
- **Operational Inefficiencies:**
Poor roads require more frequent reactive maintenance, increasing operational strain.
- **Reputational and Liability Risk:**
Deteriorating conditions may lead to complaints, reduced public confidence, and potential liability exposure.

Proactive, risk-based management of gravel roads is essential to maintaining safe service levels, optimizing lifecycle costs, and ensuring the long-term sustainability of the transportation network.

Levels of Service (LOS)

Community LOS (Qualitative)

The Township's service objectives are to provide the following:

- Comfortable travel at posted speeds
- Acceptable dust levels
- Reliable access
- Safe driving conditions
- Effective drainage

Technical LOS (Quantitative)

Table 10: Technical Levels of Service

Measure	KPI	Current	Target
Condition	Average Condition	67%	$\geq 70\%$
Lifecycle	Re-gravel cycle	8 – 17 years (segment dependent)	Maintain
Risk	High Risk Roads	2%	$\leq 5\%$

Financial Strategy

The financial strategy for gravel roads is based on maintaining assets at defined service levels while minimizing lifecycle costs through proactive maintenance.

Annual funding requirements are driven by:

- Routine maintenance activities (grading, dust control)
- Lifecycle renewal needs (re-gravelling)
- Long-term rehabilitation and reconstruction

Sustainable funding levels will be evaluated based on:

- Network condition targets (e.g., % in Good or better)
- Lifecycle modeling and renewal cycles
- Identified funding gaps between current and required investment

Investment prioritization is guided by the Township's risk-based framework to ensure available funding is directed to the highest-risk road segments.

Preliminary analysis indicates that current funding levels are insufficient to maintain desired service levels, resulting in a projected funding gap of approximately \$143,250 per year.

Current Funding Position

The following table shows Greater Madawaska's average annual asset investment requirements, current funding positions, and funding increases required to achieve full funding on gravel roads.

Table 11: Annual Available Funding

Asset Category	Avg. Annual Requirement	Annual Funding Available			Annual Deficit
		Operating	Dust Control	Total Available	
Gravel Roads	\$304,250	\$140,000	\$21,000	\$161,000	\$143,250

The average annual investment requirement for the gravel roads is \$304,250. Annual revenue currently allocated to these assets is \$161,000 leaving an annual deficit of \$143,250. Put differently, gravel roads are currently funded at 52.9% of their long-term requirements.

Current Funding Position

In 2026, the Township of Greater Madawaska had budgeted annual tax revenues of approximately \$4.9 million. As illustrated in the following table, without consideration of any other sources of revenue or cost containment strategies, full funding would require the following tax change over time:

Table 12: Tax Increase Requirements for Full Funding

Asset Category	Tax Change Required for Full Funding
Gravel Roads	2.9%

Our scenario modeling include capturing the above changes and allocating them to the infrastructure deficit outlined above. The table below outlines this concept and presents several options:

Table 13: Tax Increase Options 2-20 Years

	2 Years	3 Years	4 Years	5 Years	10 Years	15 Years	20 Years
Infrastructure Deficit	143,250	143,250	143,250	143,250	143,250	143,250	143,250
Tax Increase Required	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
Annually:	1.5%	1.0%	0.8%	0.6%	0.3%	0.2%	0.2%

Financial Strategy Recommendations

Considering all the above information, we recommend the 5-year option. This involves full funding being achieved over 5 years by:

- increasing tax revenues by 0.6% each year for the next 5 years solely for the purpose of phasing in full funding to the asset categories covered in this section of the AMP.
- increasing existing and future infrastructure budgets by the applicable inflation index on an annual basis in addition to the deficit phase-in.

Notes:

1. As in the past, periodic senior government infrastructure funding will most likely be available during the phase-in period. By Provincial AMP rules, this periodic funding cannot be incorporated into an AMP unless there are firm commitments in place.
2. We realize that raising tax revenues by the amounts recommended above for infrastructure purposes will be very difficult to do. However, considering a longer phase-in window may have even greater consequences in terms of infrastructure failure.

Assumptions and Limitations

- This report was compiled using the best available data at the time within the Citywide database.
- The data for this specific asset category is current and confidence is considered high. The Township has recent condition assessments and rehabilitation costs for each segment.
- Where gaps existed in rehabilitation costs, in-service dates and conditions, staff was consulted prior to any changes being made to the data.

Recommendations and Key Considerations

Data Management and Governance

- Further clarify and identify roles and responsibilities for regular upkeep and maintenance of asset register (Citywide), asset datasets. A data management and governance strategy may be warranted to support long-term asset management initiatives. We note that effective data management and governance may also require additional and dedicated resources.
- Ensure critical asset data, such as condition, replacement costs and EUL and other attribute data, is shared with asset management lead so that it is regularly integrated with asset register. Consider reviewing and further aligning the financial asset data with the spatial data.
- Conduct semi-annual data audit or data gap analysis of inventory to evaluate for completeness, currency, accuracy, and validity. Key asset data that needs to exist for reporting, In-Service Date, Replacement Cost, Estimated Useful Life.

Better Asset Management Through Better Asset Data

- Continuously review, refine, and calibrate lifecycle and risk profiles created to better reflect actual practices and improve capital projections. In particular:
 - the timing of various lifecycle events, the triggers for treatment, anticipated impacts of each treatment, and costs.

Periodically update rehabilitation costs based on recent projects, invoices, or estimates, as well as condition assessments, or any other technical reports and studies. Material and labour costs can fluctuate due to local, regional, and broader market trends.

Lifecycle Planning

- Continue to dedicate funding for regular condition assessment programs, particularly for high-criticality assets across all asset categories. Condition data is integral in estimating accurate annual needs and refining estimates for infrastructure backlogs.
- Criticality should account for not only an asset's financial value or replacement cost, but also its role in delivering essential services, supporting the local economy, and providing a high quality of life to residents.
- Evaluate lifecycle events, timing, and costs on a regular basis and update lifecycle models in Citywide to reflect necessary changes.