City of Edmonton

UNPAVED ROADS ASSET MANAGEMENT PLAN

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1. Executive Summary

What this plan is

This is the City of Edmonton's (the City) first Unpaved Road Asset Management Plan (AMP). It is also the first AMP developed for any of the City's infrastructure assets.

This plan details the City's unpaved road assets and how they are managed from a strategic and tactical perspective. It provides an overview of the outcomes the City's unpaved road assets contribute to, how these outcomes are measured, how service delivery performance is measured, and the forecast investment required to deliver appropriate levels of service to asset users and wider stakeholders. It also provides a snapshot on the current state of our unpaved road assets and how we manage them to deliver services in a way that achieves the required level of service, for least overall cost, and within acceptable risk boundaries.

Why we need this plan

The City is committed to taking a consistent, strategic approach to asset planning and asset management so we deliver the services our customers need while maximizing value-for-money. Improving our ability to extend our public dollars and make informed decisions about our transportation infrastructure, including unpaved road assets, is a core function of our asset management program.

Value is delivered to our community when we effectively manage infrastructure assets, supporting development of resilient communities over the long-term. This plan contributes to more informed decision-making and improved management of risks, and demonstrates how the City is seeking to manage unpaved road assets in a financially sustainable manner.

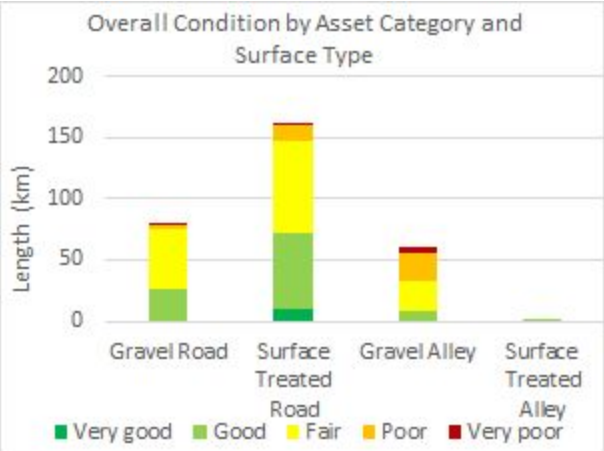
What our unpaved road assets are and why they are important

The City's unpaved road asset class includes surface treated (oiled) roads, gravel roads, and gravel alleys. It does not include paved (concrete or asphaltic concrete) roads or structures (bridges and large culverts) associated with unpaved roads. Unpaved roads make up a very small proportion of the City's total road and alley network. They are typically a lower priority than paved road assets. Most have low traffic volumes and provide few socioeconomic functions.

However, unpaved road assets typically cost much less than paved roads to construct, so are key to providing effective and affordable transportation access in predominantly low volume areas, typically linking residential housing and/or rural agricultural land with the wider transportation network.

What assets we have

The City owns 303.7 kilometers of unpaved road assets, with a current total value of $53.6M. This includes 161.2 km of surface treated road, 61.3 km of gravel alley, 80.9 km of gravel road, and 0.2 km of surface treated alley. Recently completed condition assessment shows that roads are generally in a good to fair condition, while alleys are in a fair to poor condition, as indicated in the adjacent figure.



What we need to do

Operations and maintenance needs are based on the experience and judgement of City staff. Activities identified include road inspections, grading, pothole filling, pavement repairs, vegetation mowing, gravelling, dust suppression and drainage clearing. A maintenance management approach is currently taken, whereby staff utilize the set budgets to deliver the best service levels they can. As the City further develops a structured and integrated approach to managing unpaved road assets, moving closer to best practice asset management, improved understanding around operations and maintenance needs of the roads assets is expected. This understanding will be realized from improving inventory, condition, maintenance activity tracking and defined operational levels of service, and will support a more effective use of maintenance resources.

Renewal (or rehabilitation) needs for unpaved roads are not planned and budgeted for.

How much we are investing

The 2020 budget set for unpaved road maintenance is $5.67M. No budget has been allocated for capital renewal and rehabilitation. Future budgets have not been indicated and required investment levels linked to levels of service are not yet developed.

What improvements we can make

While there is a strong knowledge base within the City regarding asset issues, documentation and monitoring of the issues and objectives is done informally. The City is committed to gaining a better understanding of our assets and their future needs, enabled by a maturing organizational infrastructure asset management approach.

Through development of this plan, various improvement items have been identified to support more effective and efficient long term investment decision making and service delivery. These improvements largely relate to improving asset data, but recommend developing further the coordinated and integrated approach to unpaved road asset management across the City's various departments.

A key mechanism for continuous improvement is the documentation of improvement tasks within this Asset Management Plan. The Improvement Plan in Section 9 captures the various asset management initiatives identified for future improvement.

The assumptions and limitations with regards to the development of this plan

The information and recommendations provided in this Asset Management Plan are based on the best available information at the time this plan was written. Some of the information is approximate or assumed values. As information about the assets is improved, the accuracy of the information and forecasts will improve.

Determining required future investment levels has not been completed due to a lack of robust information regarding work activities, costs and levels or service. This is a key opportunity for improvement going forward, to inform and justify the development of annual budgets.

2. Introduction & Context

The City of Edmonton (the City) is committed to taking a consistent, strategic approach to asset planning and asset management, so we deliver the services our customers need while maximizing value-for-money. We use infrastructure assets to deliver services to our customers. Improving our ability to extend our public dollars and make informed decisions about our unpaved road assets is a core function of our asset management program.

This chapter provides an overview of the services being supported by the assets and how they fit with the City's obligations, goals and objectives. It also defines the scope of the assets class and context of the Asset Management Plan (AMP).

The following icons have been included throughout this AMP:

Sustainability

The leaf symbol appears in the left margin beside sections that directly address sustainability. This provides a link back to the City's overarching Infrastructure Management Strategy objectives.

Continuous Improvement Indicator

The symbol indicates an area where the City has identified the need to track and measure Continuous Improvement of asset management practices and outcomes.

Purpose of This Plan

This AMP is a tactical plan and describes how the unpaved road asset class are currently managed. The plan describes the characteristics and condition of infrastructure assets, the Levels of Service expected from them, planned actions to ensure the assets are providing the expected Levels of Service at the lowest possible lifecycle cost, and financing strategies to implement the planned actions.

The purpose of this Asset Management Plan is to demonstrate how we are managing our assets by:

- Communicating the relationship between the City's physical assets and the services delivered to the community
- Providing a common, and authoritative, reference point for conversations with stakeholders about service standards and outcomes
- Providing evidence for decision making and ensuring the resulting plan is appropriately funded, prioritized and scheduled
- Improving access to infrastructure assets funding from other levels of government
- Identifying improvements in the approach to managing the assets over the short, medium, and long-term
- Outlining improvements to support a long-term plan for the assets including developing service expectations, timelines, funding, and resource requirements

Scope of This Plan

This tactical plan covers the City's unpaved road assets, which includes gravel roads, oiled (or surface treated) roads, and gravel alleys.

Unpaved roads provide cost effective access for our stakeholders. This includes access to rural residences and land, to urban residences and industrial properties, and to spaces such as parks and reserves.

The primary users of unpaved road assets are passenger vehicles, trucks transporting goods, and industry-related equipment. There is little transit or tourism, and walking and cycling are not common modes due to the low density and nature of land development.

This plan includes road formation, pavement and surface. It does not include associated infrastructure assets such as bridges, culverts, signs and drains, which will be included in other Asset Management Plans.

The scope of this Plan includes:

- How we assess and measure service delivery according to defined Levels of Service
- A summary of the current asset inventory, valuation and condition
- How assets are inspected and how information is used to support decision making
- Our asset decision model methods, processes and criteria that support life cycle planning
- Who is responsible for delivering services
- Identification of critical assets
- What the anticipated annual costs will be to meet the desired Levels of Service as well as a 20-year long term financial plan
- How the results are evaluated and what actions we are taking to improve.

Goals & Objectives of Asset Ownership

How the City's assets are managed and operated plays a key role in achieving the City's four goals, which focus on our people, place, region and environment. The City is achieving the goals through delivering services to Edmontonians. To enable service delivery to the public, the City manages seven supporting programs that capture how we as an organization will work collaboratively with internal and external stakeholders. Asset Management is an important supporting program, as it provides overarching management of the City's capital assets with accountability for service delivery.

The City's goal for Asset Management is to build an effective, transparent, data-driven asset management system that connects asset investment with progress towards strategic goals and service level outcomes. The Asset Management Plans lay a critical foundation for long-term actions to advance this goal. The outputs of these plans have a broad impact on the city; in how it impacts operations, infrastructure planning, and the role of asset management in providing services to citizens.

Table 2.1 outlines the City's Strategic Actions, Programs and Services applicable to the unpaved road asset class. **Appendix A** includes the full scope of Corporate Strategic Actions, Programs and Services.

Strategic Goal	Strategic Goal Statement	Asset Specific Goal
HEALTHY CITY	Edmonton is a neighbourly city with community and personal wellness that embodies and promotes equity for all Edmontonians.	• To provide reasonable access across demographic, geographic, socio-economic and mobility spectrums. • To provide access for emergency response services to support user safety and security.
URBAN PLACES	Edmonton neighbourhoods are more vibrant as density increases, where people and businesses thrive and where housing and mobility options are plentiful.	• To optimize the use of transportation infrastructure and support best practices for land uses. • To keep transportation infrastructure in a good state of repair and accommodate future growth in a fiscally responsible and sustainable manner.
REGIONAL PROSPERITY	Edmonton grows prosperity for our Metro Region by driving innovation, competitiveness and relevance for our businesses at the local and global level.	• To allow people and goods to move efficiently throughout the city and beyond. • To enable efficient movement of goods, convenient mobility of the labour force, and access to a vibrant city centre.
CLIMATE RESILIENCE	Edmonton is a city transitioning to a low-carbon future, has clean air and water, and is adapting to a changing climate.	• To create sustainable, livable communities that minimize the need for new infrastructure and increase quality of life by considering environmental, financial and social impacts when making decisions.

Table 2.1 City of Edmonton's Strategic Goals

Sustainability

Sustainability is the key theme underlying all of the City's strategic goals and corporate outcomes. This includes ensuring that infrastructure assets are socio-culturally, environmentally and economically sustainable in the long-term. The City Plan sets out the City Building Outcomes, Intentions, and Directions for the City to achieve environmental sustainability and resilience.

Sustainability challenges related to unpaved roads include:

- Air quality; Although Edmonton has 'good' air quality more than 90 per cent of the time, we do have an issue with two specific pollutants — Particulate Matter and Ozone (O3) — that are components of urban smog. Particulate matter is emitted by combustion from a number of sources including vehicles and wood burning. It is also a component of road dust and can be formed by atmospheric photochemical processes.
- Climate change; The City and its communities will need to withstand more frequent and powerful environmental stressors. This forces a need for infrastructure system redundancy including electrical power, transport, fresh water and fuel supplies, wastewater processing, and food supply.

The City Plan identifies the following Intentions related to managing transportation infrastructure to achieve its sustainability goals:

- 1.4.2 Ensure Edmonton's air, land and water is safe and clean.
- 2.4.1 Support ecological function and energy efficiency through the design of Edmonton's infrastructure, buildings and neighbourhoods.
- 2.4.2 Ensure civic infrastructure and physical systems are built for sustainability and resiliency.

Relationship to Other Corporate Documents

This AMP is a tactical plan. Figure 2.1 shows the "line of sight" hierarchical relationship from the City's corporate goals and objectives, Infrastructure Asset Management Policy (C598) and Infrastructure Strategy through to all service level AMPs. The City's Corporate Business Plan and the asset management policy, strategy, and plans form a framework for asset management. These documents link "top-down" organizational mandates and objectives with the "bottom-up" operational activities.

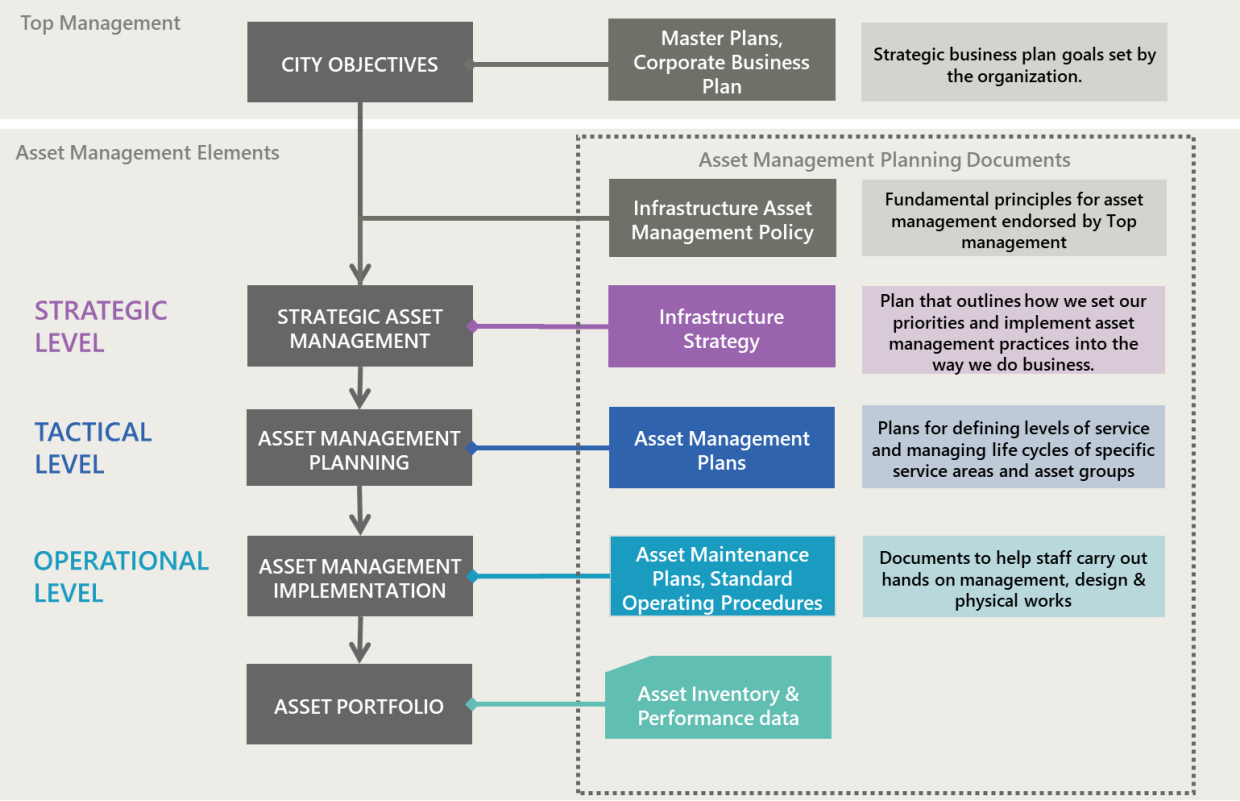


Figure 2.1 Relationship of AMPs to other Corporate Documents

Our Context

Unpaved roads make up a very small proportion of the City's total road and alley network. They are typically lower priority than paved road assets. Most, outside of industrial areas, are low volume and provide few, if any, socioeconomic functions.

The City does not typically build new unpaved roads, and has not done so for some time. Rather, the roads are historic in nature, upgraded in the past from access tracks, or have been inherited from neighbouring municipalities as part of land annexations required to support the City's growth. A recent example is the annexation of land from Leduc County, which essentially doubled the length of the City's unpaved road asset base by assuming ownership and responsibility of roads near Devon, Nisku and Beaumont.

Unpaved road assets are classified as one of the following types:

- Arterial - provide capacity for larger volumes of traffic (people driving as well as those riding transit, walking and wheeling, cycling, and delivering goods) between areas with relatively few and controlled access points. Their primary function is mobility, but they also provide some land access.
- Collector - provide neighbourhood travel between local and arterial streets with direct access to adjacent land. Their function is to provide both mobility and access.
- Local - include service roads. Provide direct access to adjacent lands and serve neighbourhood travel. Their primary function is access, but they also provide some through travel.

- Alley - typically provide direct access to adjacent lands . They do not provide any through travel function. Alleys are parallel to other classification of streets and are typically used for access, deliveries, and waste collection. In core urban areas, some alleys are evolving into shared streets, with alley oriented development.

There are no unpaved roads classified as freeways.

Figure 2.2. Shows the City's unpaved road assets within the overall transportation system, as recorded in the City's GIS system.

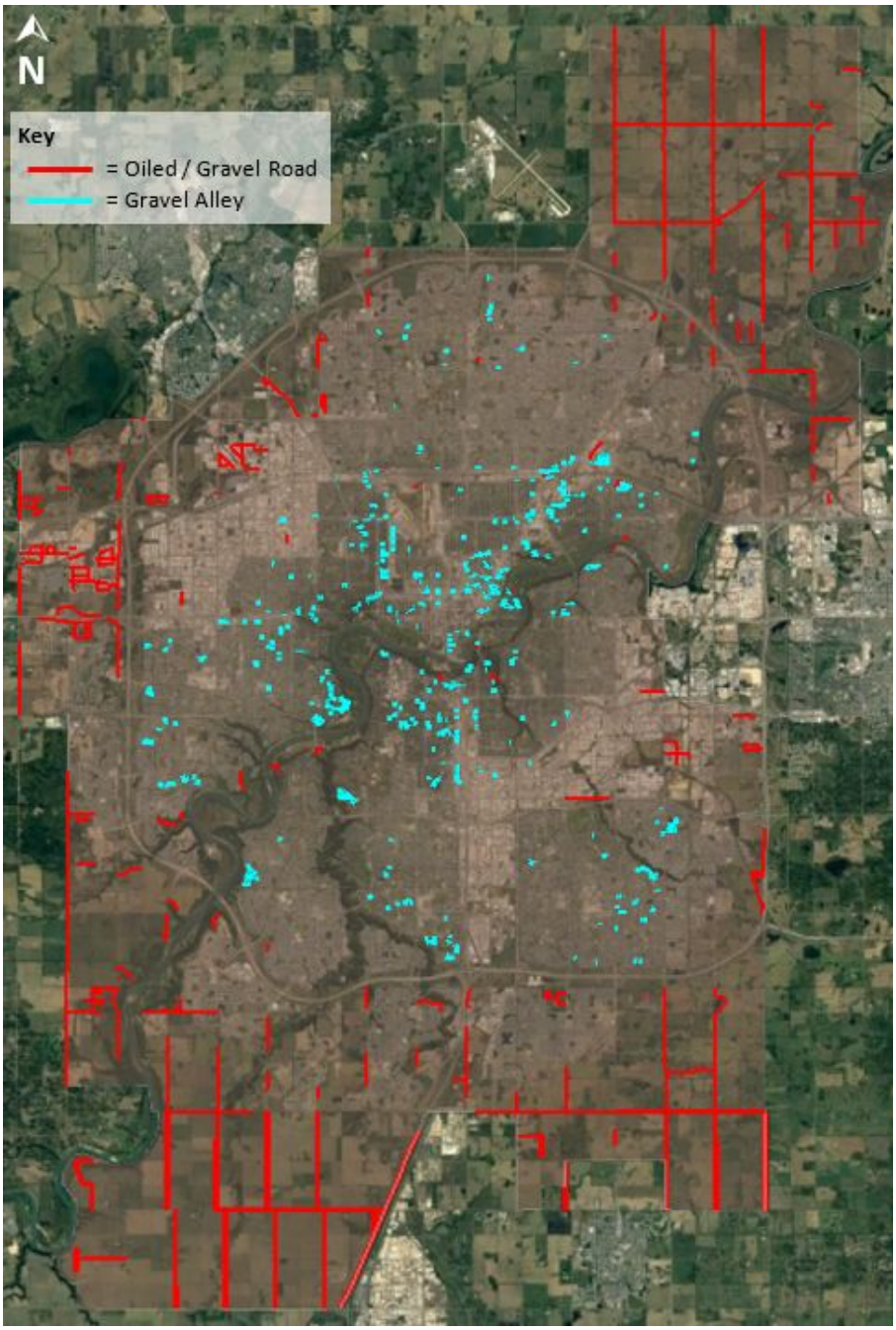


Figure 2.2 Map of City of Edmonton Unpaved Road assets

Growth and Development

The 2019 Municipal Census found that Edmonton is home to approximately 972,000 people, up from about 899,000 people in the 2016 census and 782,000 people in the 2009 census. Figure 2.3 shows Edmonton's population between 1970 and 2019, as recorded through Municipal Census or Statistics Canada. Population growth is expected to continue and Edmonton's population is expected to surpass two million within the next 30 years if the current trend continues. Current land development, from rural to residential, is expected to support this population growth. It is expected that no additional annexation of neighbouring municipality land will be required.

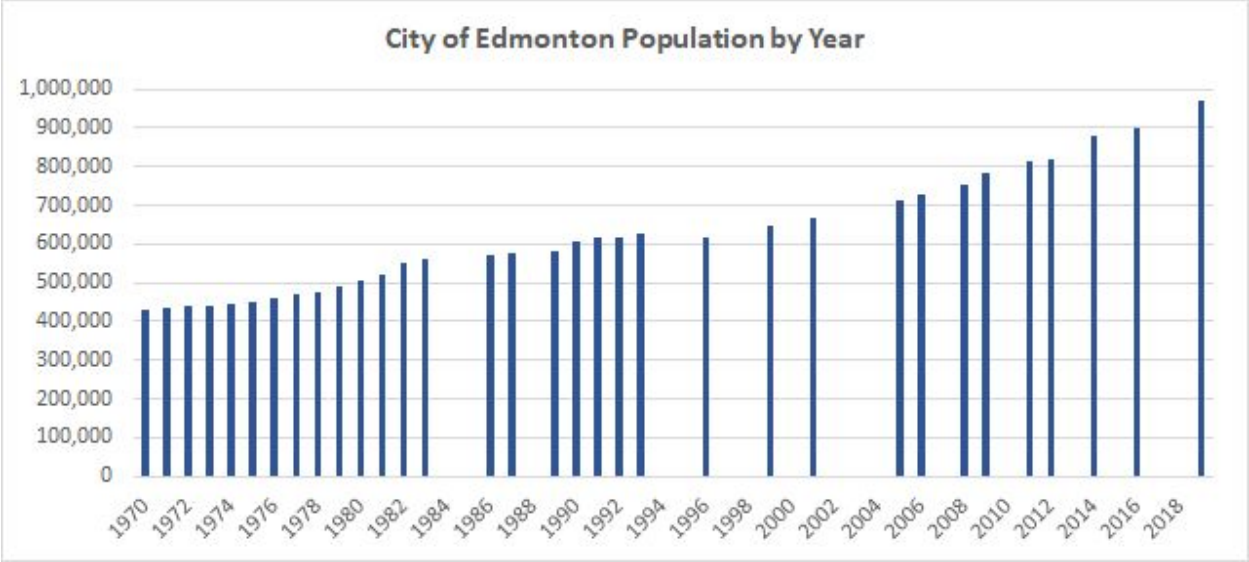


Figure 2.3 City of Edmonton Population by Year

The 2019 census revealed that more than half the city's population is under the age of 39, which makes Edmonton young by Canadian standards. The largest population segment is between 30 and 34 years old - a further indication of continued growth.

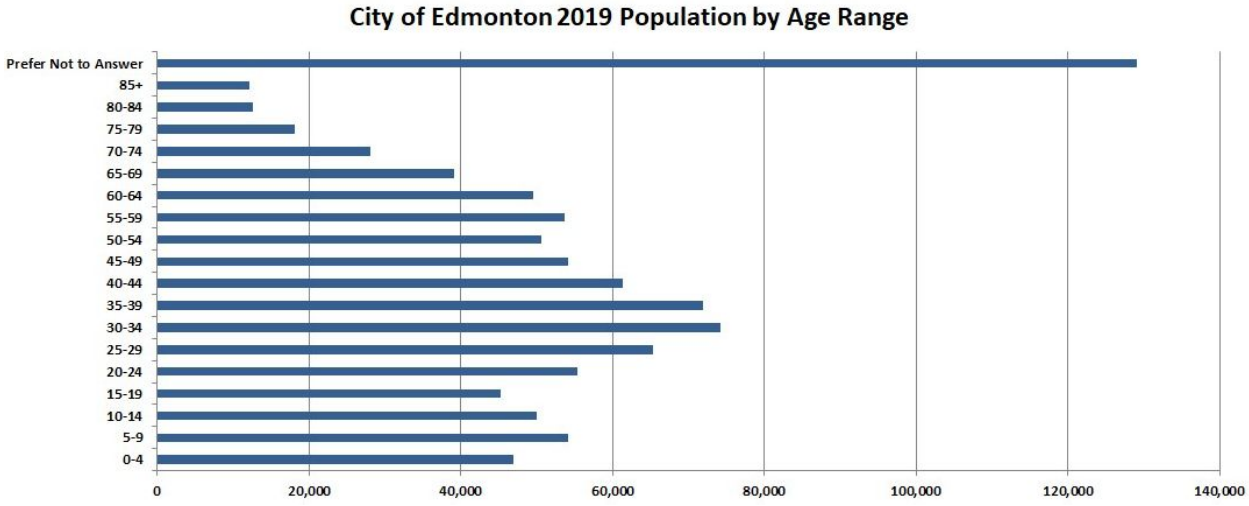


Figure 2.4 City of Edmonton Population by Age Range

Edmonton's 2005 Household Travel Survey showed that of the 2.5 million trips made each day, Edmontonians traveled by car (77%), walking (11%), public transportation (9%), and bicycle (1%). This is one of the highest car dependence rates in Canada.

Citizens, stakeholders, and experts who helped to develop *The Way We Green* identified "sprawl" as a top challenge facing the city in the next 30 years. They cautioned that current patterns of growth and development could negatively affect Edmonton's environment through:

- Loss of ecosystem services, resulting from the loss of agricultural lands, the urban forest, natural areas, natural connections, and biodiversity
- Higher energy consumption, greater pollution, traffic congestion, and increased health costs resulting from greater automobile dependency.

Sprawl is fiscally and environmentally unsustainable. In addition, there are major health risks associated with long trip distances and automobile dependence such as physical inactivity, air pollution, motor vehicle collisions and mental health effects. The city has set a goal to integrate land use planning and transportation decisions to create a compact and efficient urban form.

Future development should be considered as part of all local rural roads decision making.

Leduc County and Beaumont Annexation

From 2012 to 2014, Edmonton grew by 7.4% or more than 60,000 people. To ensure there was land to accommodate growth, the City annexed land south of the boundary: on January 1, 2019, 8,26 hectares from Leduc County, and 7 hectares from the Town of Beaumont[1] became part of Edmonton. As part of the annexation, the City acquired approximately 60 km of unpaved road assets which is a significant addition. The variable state of these "new" assets meant that significant investment was required during 2019 to deliver roads that meet stakeholders' expectations and that provide a level of service consistent with other unpaved roads within the City.

Climate Change

Climate change is a global phenomenon affecting different regions of the world in different ways. In January 2011, NASA's Goddard Institute for Space Studies in New York reported that global surface temperatures in 2010 tied 2005 as the warmest year on record. In the Edmonton area, mean annual temperatures are predicted to increase by 2°C to 4°C by the 2020s. In addition to the likelihood of more extreme weather, it is expected that warmer average temperatures will cause increased precipitation (five per cent more by the 2050s) with the greatest increases occurring in the summer months.

Historical climate records indicate that Edmonton is warming at a faster rate than the global average. Scientists predict that Edmonton will be exposed to higher temperatures, drier summers, more extreme precipitation events, more variable extreme weather events, and an overall warmer and drier climate.

The City of Edmonton is focused on adapting the city to deal with climate change impacts, towards the goal of a climate resilient city. Climate resilience refers to the capacity to adapt and thrive in response to future climate conditions - including extreme weather such as heavy rains, wildfires and wind gusts, and also gradual shifts in temperature and precipitation. Future climate projections for

[1] "Leduc County and Beaumont Annexation :: City of Edmonton." https://www.edmonton.ca/projects_plans/annexation/leduc-county-annexation.aspx. Accessed 28 Jan. 2020.

Edmonton include drier summers, wetter winters and an overall increase in average annual temperature.

The climate change models developed for Edmonton indicate four major climate change impact themes as follows:

1. **Changing temperatures**: By the 2050s , on average it is expected that Edmonton's annual average temperature of +2.1oC will increase to +3.5oC to +5.6oC. Edmonton can also expect maximum temperatures that are hotter than previously experienced. Increasing temperature is expected to result in increased likelihood of drought conditions over the summer.
2. **Changing precipitation**: By the 2050s, on average Edmonton's annual precipitation of 458mm is expected to increase by 40mm to 498mm. Edmonton can expect more heavy rainfall events in the future. Studies show that the likelihood of urban flooding events occurring will almost double by the 2050s.
3. **Changing weather extremes**: As temperature rises, it is expected that atmospheric conditions will be more conducive to producing more frequent and intense extreme weather events, such as wildfires and high winds.
4. **Changing ecosystems**: Changes in climate variables such as frost days indicate that there will be a long term overall trend of warming and drying in our climate. Specific to Edmonton, the shift to a warmer and drier climate overall is likely to contribute to long term ecological change.

Factors that can affect unpaved roads include: more intense rainfall events leading to surface flooding, drought conditions, high winds, freezing rain and increasing temperature. These factors could affect the useability of the roads and emergency access. Climate trends and their associated impact on unpaved road assets is summarized in Table 2.2.

Climate Trend	Impact on Unpaved Road Assets
Annual frequency of freeze-thaw cycles: decreasing (currently in transition period of increasing)	Effect on road performance unchanged
Annual precipitation as percent of very intense events: increasing	Increased risk of gravel loss and road washout
Freezing Rain: increasing	Reduced traction on unpaved roads
Drought: increasing	Increased dust. Difficult to maintain gravel roads due to prolonged dry conditions
Urban flooding: increasing	Depth of ponding may exceed drainage parameters of existing unpaved roads
High winds: increasing	Reduced reliability (e.g. increase in trees potentially falling) and safety (e.g. increased dust and impact on high vehicles)

Table 2.2 Climate Trends and Impacts

The City of Edmonton has developed the Climate Resilient Edmonton Adaptation Strategy and Action Plan, which lists among others the following actions:

- The City of Edmonton in partnership with community stakeholders develops and integrates climate adaptation and resilience standards into urban and strategic planning, design, and development approval processes
- The City of Edmonton develops and implements a "Cool Edmonton" program to reduce the impacts of urban heat island effect

- The City of Edmonton in partnership with EPCOR develops and implements an urban flooding resilience program
- Integrate changing climate extremes into coordinated emergency management programs including preparedness, prevention, response and recovery
- The City of Edmonton conducts climate change impacts assessments on existing assets, ongoing maintenance programs, planned retrofits and new infrastructure development.

Access to Local Resources

Although we currently have virtually unlimited access to the global food system, the Edmonton Sustainability Papers caution that this could change. Risks associated with climate disruptions, international protectionist food policies, and higher priced fossil fuels could reduce our access to global food systems. One response to uncertainty associated with the global food market involves ensuring a reasonable proportion of our food comes from local sources. Reliable access to rural, food producing regions will be a key component to meeting this challenge.

The City borders seven neighbouring municipalities. With many of the unpaved roads located near the extremities of the City's border, they are used by motorists to access the City's neighbouring communities.

Roles & Responsibilities for Service Delivery

The City's Infrastructure Strategy outlines the current working practice for the governance of corporate Asset Management. It includes a draft set of responsibilities for a selection of roles (from Mayor and Council to all City employees), and is developed to support future refinements in the asset management system governance structure.

There are also several strategic asset management processes that are managed and coordinated by the Lifecycle Management section of Integrated Infrastructure Services to ensure consistency across the City. These include:

- Provide City-wide leadership and coordination of asset management practices and concepts, and strategy
- Engage stakeholders
- Set asset management objectives
- Develop and update Infrastructure Management Policy and Infrastructure Strategy
- Develop and update decision making and planning frameworks
- Prepare an infrastructure status reports
- Develop a Levels of Service framework that can be consistently applied City-wide
- Forecast and analyze future user requirements and demands
- Coordinate internal and external asset management performance monitoring and reporting
- Facilitate skills development as it relates to asset management across the organization.

Table 2.3 describes the roles within the organization and their respective responsibility for the delivery of asset management services rated to the unpaved road asset class. A full Responsibility Assignment Matrix (RACI – Responsible, Accountable, Consulted, Informed) is included in Appendix B.

Role at the City	Asset Management Responsibility
City Executive Leadership Team	Accountable for the Levels of Service
Integrated Infrastructure Services - Lifecycle Management	Responsible for maintenance of the Asset Management Plan, Levels of Service, Medium and Long Term Investment Planning. Accountable for the Improvement Plan, Asset Data Management, Condition Monitoring and Inspection, Infrastructure Reporting, and Renewal Capital Program Planning
Integrated Infrastructure Services - Transportation Planning and Design	Responsible for Capital Project Planning
Integrated Infrastructure Services - Transportation Infrastructure Delivery	Accountable for Capital Project Delivery
City Operations - Infrastructure Maintenance	Responsible for Asset Data Collection, Condition Monitoring and Maintenance Inspection, Maintenance Program Planning, and Maintenance Program Delivery
City Operations - Infrastructure Operations	Responsible for Operations Program Planning & Delivery
City Operations - Traffic Systems	TBC
Urban Form and Corporate Strategic Development - City Planning	Responsible for future City and land development planning
Financial and Corporate Services - Corporate Accounting	Accountable for Medium and Long-Term Investment Planning
Financial and Corporate Services - Business Integration	Responsible for Asset Data Management, Tangible Capital Assets (TCA)

Table 2.3 Roles and Responsibilities for Service Delivery

Limitations & Assumptions

This AMP has been prepared based on the best information available at the time of writing this plan regarding adequate maintenance and renewal of assets using a 'whole of lifecycle' approach. Financial sustainability has been evaluated by comparing the investment needs of the life cycle strategies with current funding levels in the 20-year plan, assuming that this level of funding remains for the full planning horizon.

Being the first version of the AMP, several limitations exist as described in Table 2.4. These limitations will help inform the continuous improvement process for future versions of the Plan.

Limitation	Description
Asset inventory	Our confidence level of the current unpaved road asset inventory data is low, impacting the accuracy of the State of Infrastructure and Financial Plan. It is expected the accuracy of (and confidence in) this data will increase significantly following formal road inspections and data collection.
Asset valuation	Replacement cost unit rates have been estimated from anecdotal evidence provided by City Operations staff. This will be improved in the future through formal recording of actual physical works costs.
Maintenance Activities	Data standards for completed maintenance activities have changed over recent years, limiting the accuracy of analysis. Significant assumptions have been made based on City staff experience and expertise.
Asset Investment	The recording of maintenance activities and costs has changed more than once in recent years, significantly impacting the ability of robust analysis to be undertaken. Accurate actual costs for specific activities are not available. Significant assumptions have been made.
Asset Management Strategies	In lieu of formalized/documented maintenance processes, the strategies within this plan have been based on discussions with Integrated Infrastructure Services (IIS) City Operations staff.

Table 2.4 Limitations of the AMP

3. State of Infrastructure

The State of the Infrastructure is an assessment of the City's current infrastructure assets against their maximum potential. It provides a benchmark evaluation of the assets and describes the age, condition profile, and current replacement values of the assets. By creating and tracking asset-related information, the City understands:

What do we own? Edmonton owns and manages a variety of different assets. It is important to maintain an accurate inventory of these assets.

What is it worth? What will it cost to renew when it reaches the end of its useful life?

What is the state and condition? Edmonton uses a standardized 5-point rating system on a scale of A to F (Very Good to Very Poor) to identify asset state and condition.

By understanding and tracking these requirements over time, the City can make sound decisions on its long term financial/investment plan to achieve the stated service level.

Asset Data

This section provides a summary of how data is collected and compiled, details on how the data is stored, how assets have been componentized to provide greater detail on specific performance, reliability, completeness, and assumptions applied to fill any data gaps.

A comprehensive asset data inventory serves as the foundation for the City's asset management activities and asset planning and decision making. The asset data supports making informed, strategic decisions about the City's infrastructure assets. By gathering and maintaining this information, the City can be proactive about managing any risks or costs associated with the renewal and replacement of assets.

Data Collection and Attributes

Very little unpaved road asset data is formally managed, largely because the historic quantity of unpaved road assets and associated risks were considered very low until the recent Leduc County annexation. Table 3.1 summarizes the source of truth for the key data attributes.

Data attributes	Inventory Location (where data is found)	Data Collection Processes
Quantity	COE GIS System	No current formal process
Age	COE GIS System	No current formal process
Estimated Useful Life	Not currently recorded	No current formal process
Estimated Replacement Value	Not currently recorded	No current formal process
Condition	COE GIS System	Refer to Appendix D

Table 3.1 Data Attributes, Location and Collection Methodologies

Asset Hierarchy

The City's diverse assets are broken down into six portfolios. These portfolios are further broken down into Asset Classes. To analyze the state and condition of the assets, the classes are further divided into categories, assets and sub-assets as shown in Figure 3.1.

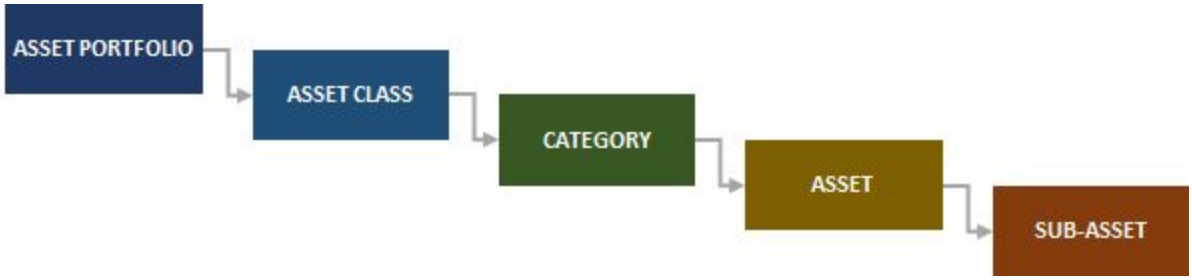


Figure 3.1 Asset Hierarchy

Definitions for each level in the asset hierarchy are included in Table 3.2.

Asset Hierarchy Level	Description	Example
Asset Portfolio	The overarching portfolio the asset class for this Asset Management Plan is part of	Goods and People Movement
Asset Class		Unpaved Road
Category	Road Type	Road, Alley
Asset	The classification of the asset, as per the asset inventory data and as described within the City's Complete Streets Design Standards document	Arterial, Collector, Industrial, Industrial Collector, Residential
Sub-Asset	The type of pavement/surface	Gravel, Surface Treated

Table 3.2 Asset Hierarchy Level Descriptions

Data Review

This data review section provides a grade of reliability for the data used for the State of Infrastructure analysis for the unpaved road asset class.

Currency and accuracy of asset data is critical to effective asset management, accurate financial forecasts, and informed decision-making. However, it is also important to know what the reliability of the information is: for this reason, the data used for the State of Infrastructure analysis has been graded for reliability.

Table 3.3 provides a description for the data confidence grades used to classify the reliability of the unpaved road asset data used in the analysis for this first iteration of this Plan.

Confidence Grade	Description
A - Highly reliable	Data based on sound records, procedures, investigations and analysis, documented properly and agreed as the best method of assessment. Dataset is complete and estimated to be accurate ± 2%
B - Reliable	Data based on sound records, procedures, investigations and analysis, documented properly but has minor shortcomings, for example some of the data is old, some documentation is missing and/or reliance is placed on unconfirmed reports or some extrapolation. Dataset is complete and estimated to be accurate ± 10%
C - Uncertain	Data based on sound records, procedures, investigations and analysis which is incomplete or unsupported, or extrapolated from a limited sample for which grade A or B data are available. Dataset is substantially complete but up to 50% is extrapolated data and accuracy estimated ± 25%
D - Very Uncertain	Data is based on unconfirmed verbal reports and/or cursory inspections and analysis. Dataset may not be fully complete, and most data is estimated or extrapolated. Accuracy ± 40%
E - Unknown	None or very little data held.

Table 3.3 Data Confidence Rating

Using the grading scale from Table 3.3, the key attribute information for the unpaved road assets have been graded as outlined in Table 3.4.

Asset Category	Asset	Confidence Grade			
		Inventory	Age & Estimated Useful Life	Estimated Replacement Value	Condition
Road	All	B	E	D	B
Alley	All	B	E	D	B

Table 3.4 Unpaved Road Assets Data Confidence

Continuous Improvement Indicator

Data Confidence: Data confidence levels can influence the types of decisions the City makes to manage our assets. For example, high confidence condition data can trigger replacement projects. Continuous improvement performance trends can be tracked through the following indicators:

- Average confidence grades for critical assets
- Existing confidence grades and target confidence grades for priority asset categories

Continuous Improvement Recommendation

Improving Asset Data management includes:

- Developing and implementing a Data Management Plan for asset data, which will include asset data collection and management processes, standards and requirements - including periodic quality assessments.
- Assessing asset data systems and potential rationalization to support asset data being recorded, managed and maintained in a single system, and used by all City departments as a single source of the truth.

Asset Summary

This section includes a summary of the assets covered in this plan as well as their age, remaining useful life and replacement value. This helps us to understand which asset categories have the highest value and can help prioritize decision making.

Asset Inventory

The key Unpaved Road assets owned by the City and covered under this AMP are included in Table 3.5.

Asset Category	Asset	Surface Type	Length	Unit
Road	Arterial	Gravel	41.4	km
		Oiled	96.7	km
	Collector	Gravel	9.7	km
		Oiled	16.6	km
	Industrial Collector	Gravel	0.0	km
		Oiled	5.5	km
	Industrial	Gravel	11.0	km
		Oiled	15.4	km
	Residential	Gravel	19.1	km
		Oiled	27.1	km
Alley	Industrial	Gravel	4.9	km
		Oiled	0.0	km
	Residential	Gravel	56.3	km
		Oiled	0.2	km
Total			**303.7**	**km**

Table 3.5 Asset Inventory and Quantities

Continuous Improvement Recommendation

Improving Asset Inventory data includes:

- Development of data standard for asset inventory data, detailing the minimum data requirements and standardized language to use for data collection and management.
- Validation of existing asset inventory data, Identification of critical gaps and implementation of a program to rectify data issues.

Asset Age & Remaining Useful Life

The City typically works with two sets of asset useful lives: theoretical useful lives and estimated useful lives. The theoretical useful lives are approximations determined based on the most accurate standards and guidelines. This theoretical useful life is used by the City's Financial Services staff for asset valuation and Tangible Capital Asset (TCA) reporting. Currently, however, unpaved road assets do not have a useful life as such. This is because the City currently aims to maintain unpaved road assets in perpetuity until they are upgraded to paved assets through capital improvements or land development. An estimated useful life of 200 years has been applied because of this. There is low confidence in the average age due to inaccurate construction dates.

Table 3.6 summarizes the age, useful life estimates, and remaining useful lives for each asset group.

Asset Category	Asset	Average Age (years)	Theoretical Useful Life (years)	Estimated Useful Life (years)	Remaining Useful Life (years)
Road	Arterial	27	30	200	NA
	Collector	29	30	200	NA
	Industrial Collector	28	30	200	NA
	Industrial	27	30	200	NA
	Residential	30	30	200	NA
Alley	Industrial	96	30	200	NA
	Residential	83	30	200	NA

Table 3.6 Age and Remaining Useful Lives Summary

Continuous Improvement Recommendation

Improving Asset Age & Remaining Useful Life data includes:

- Review approach to determining unpaved road useful lives, including consideration of componentizing the assets (e.g. formation, pavement, surface, appurtenances).

Asset Valuation

Table 3.7 includes valuation summaries for various asset groups and types.

The City's Tangible Capital Assets (TCA) report currently states a total value of $33.2M and book value of $7.1M for gravel roads and alleys, which excludes roads recently annexed from Leduc County.

The TCA report provided by Leduc County to the City for unpaved roads annexed states a total value of $20.4M and book value of $0.4M.

Both figures exclude associated land and bridge assets.

Asset Category	Asset	Total Value ($000)
Road[1]	All	$17,643.3
Road[2]	All	$20,387.2
Alley	All	$15,618.7
TOTAL		$53,649.2

Table 3.7 Asset Financial Valuation Summary

[1] Excludes assets acquired through the Leduc County annexation.

[2] Includes assets acquired through the Leduc County annexation only.

It should be noted that these figures are unlikely to represent an accurate replacement value in today's terms. This is largely because, as discussed in other sections of this plan, the City does not typically construct new or replace existing unpaved road assets.

Continuous Improvement Recommendation

Improving Asset Valuation data includes:

- Add the assets acquired as part of the recent Leduc County annexation to the City's financial database and TCA report.
- Review systems and consider rationalizing and/or aligning asset inventory and asset financial data systems to minimize the risk of misalignment.
- Determine and assign appropriate replacement cost values to unpaved roads to minimize the risk of these assets being undervalued.

Asset Condition

The City uses a standardized inspection based condition rating system to evaluate the state and physical condition of existing infrastructure assets. This is detailed in the City's recently developed Unpaved Road Condition Assessment Guide. Table 3.8 provides a summary of the condition grades used by the City for unpaved road assets.

Grade	Grade Description	Description of Condition
A	Very Good Fit for future	New or as new condition. Very few signs of defects. No intervention is required
B	Good Adequate for now	Few signs of defects. Routine maintenance will be sufficient.
C	Fair Requires attention	Obvious defects although little impact on customers. Routine maintenance is required.

D	Poor At risk	Numerous defects impacting customers. Remedial work is required
F	Very poor Unfit for sustained service	Numerous and widespread defects. Asset has failed. Rehabilitation is required

Table 3.8 Condition Grades

Condition assessment of unpaved road assets was completed in July and August of 2020. This was the first time a full network assessment has been completed. Table 3.9 and Figure 3.2 provide a summary of the condition grades for each asset category.

Asset Category	Asset	Condition (km)				
		Very Good	Good	Fair	Poor	Very Poor
Road	Arterial	6.4	54.2	71.7	4.3	-
	Collector	-	9.2	16.9	0.2	-
	Industrial Collector	-	3.3	2.3	-	-
	Industrial	2.7	5.5	10.7	6.3	1.2
	Residential	1.6	16.6	21.3	5.7	0.6
Alley	Industrial	-	0.3	2.1	1.5	1.1
	Residential	0.6	7.4	22.0	22.2	3.7
Total		11.1	96.5	147.0	40.3	6.6

Table 3.9 Asset Category Condition

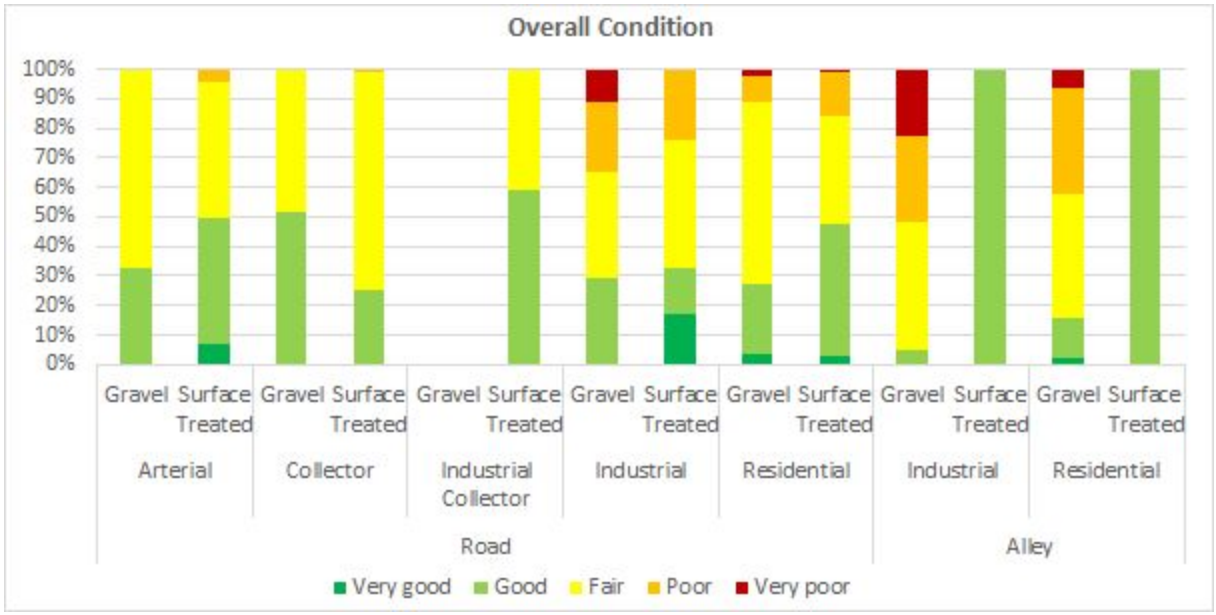


Figure 3.2 Overall Condition Summary

An overall condition rating was determined by assessing and rating various components of the unpaved road assets, as summarized with results below.

Crown rate: A measurement of the road surface shape, indicating its effectiveness in draining surface water away. Results are summarized in Figure 3.3 below.

Figure 3.3 Crown Rate Assessment Summary

Gravel coverage: A rating of the coverage of gravel in the road's surface (for gravel roads only, not surface treated). Results are summarized in Figure 3.4 below.

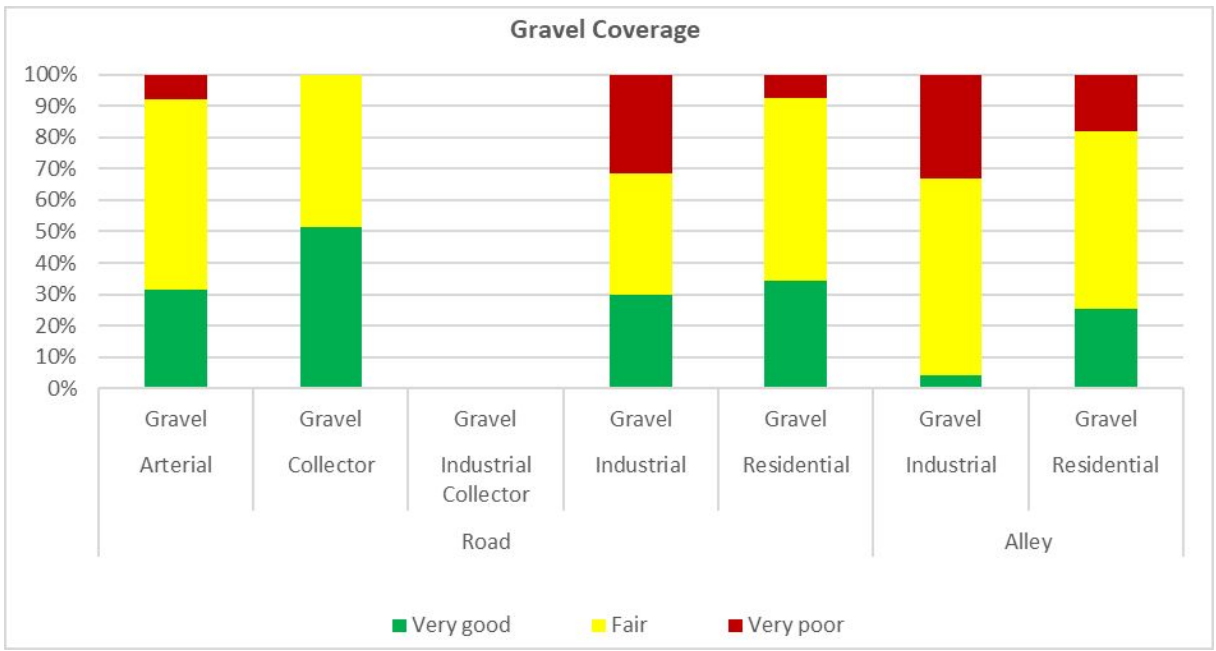


Figure 3.4 Gravel Coverage Assessment Summary

Surface integrity: A rating of how cohesive the top gravel layer is, as shown by the presence of dust and how loose the aggregates are (gravel roads) and by the extent of surface cracking (surface treated roads). Results are summarized in Figure 3.5 below.

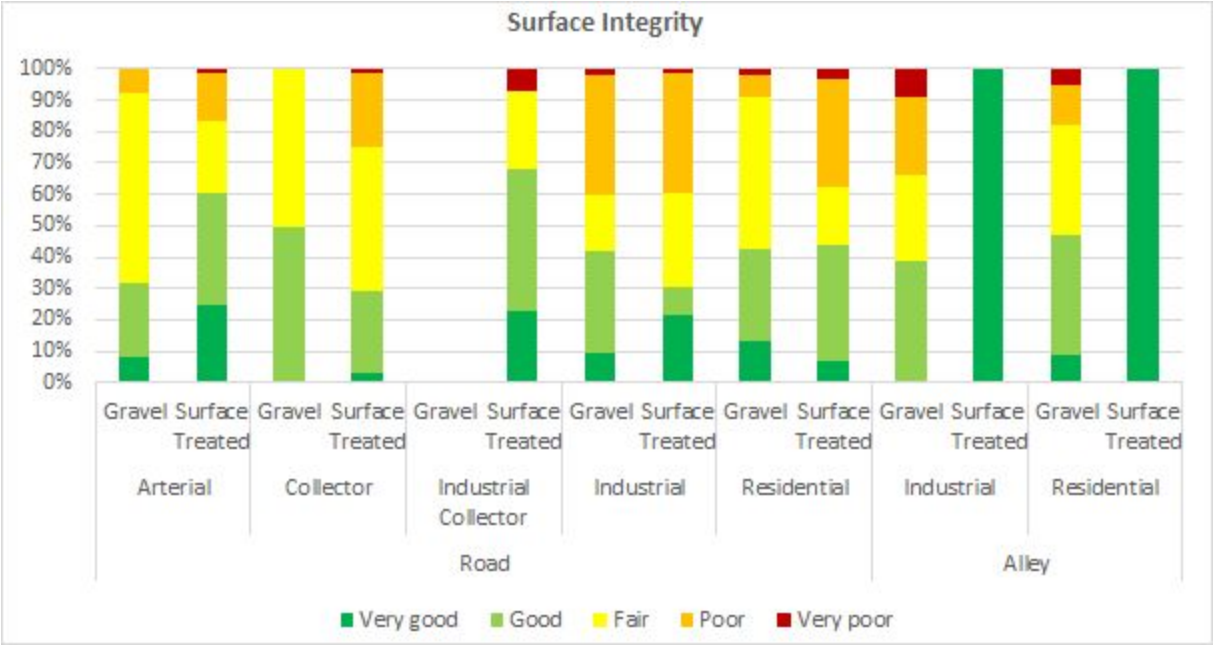


Figure 3.5 Surface Integrity Assessment Summary

Surface distress: A rating of the condition of the road's surface, based on the extent and severity of washboarding (gravel roads) and potholes/ravelling (surface treated roads). Results are summarized in Figure 3.6 below.

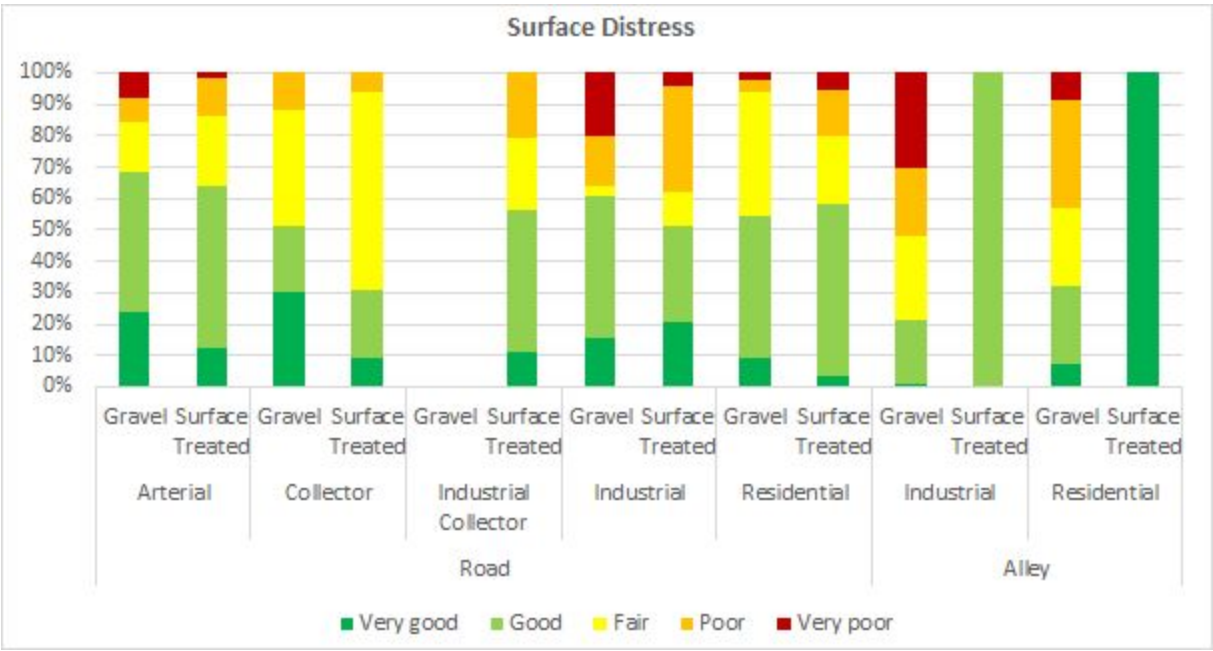


Figure 3.6 Surface Distress Assessment Summary

Base distress: A rating of the structural performance of the road, based on evidence of underlying issues such as potholes, soft areas and rutting. Results are summarized in Figure 3.7 below.

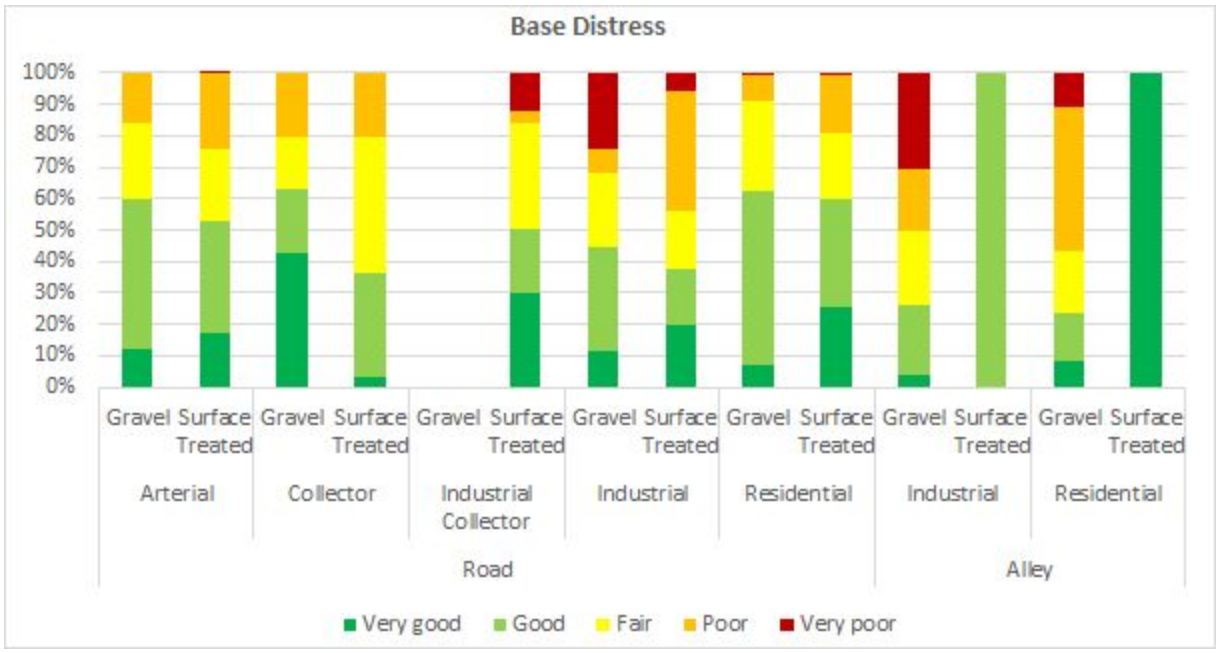


Figure 3.7 Base Distress Assessment Summary

Drainage: A rating of the condition and effectiveness of the road's drainage system, based on evidence of issues such as ditch blockages, ponding water, ditch siltation and obvious culvert problems. Results are summarized in Figure 3.8 below.

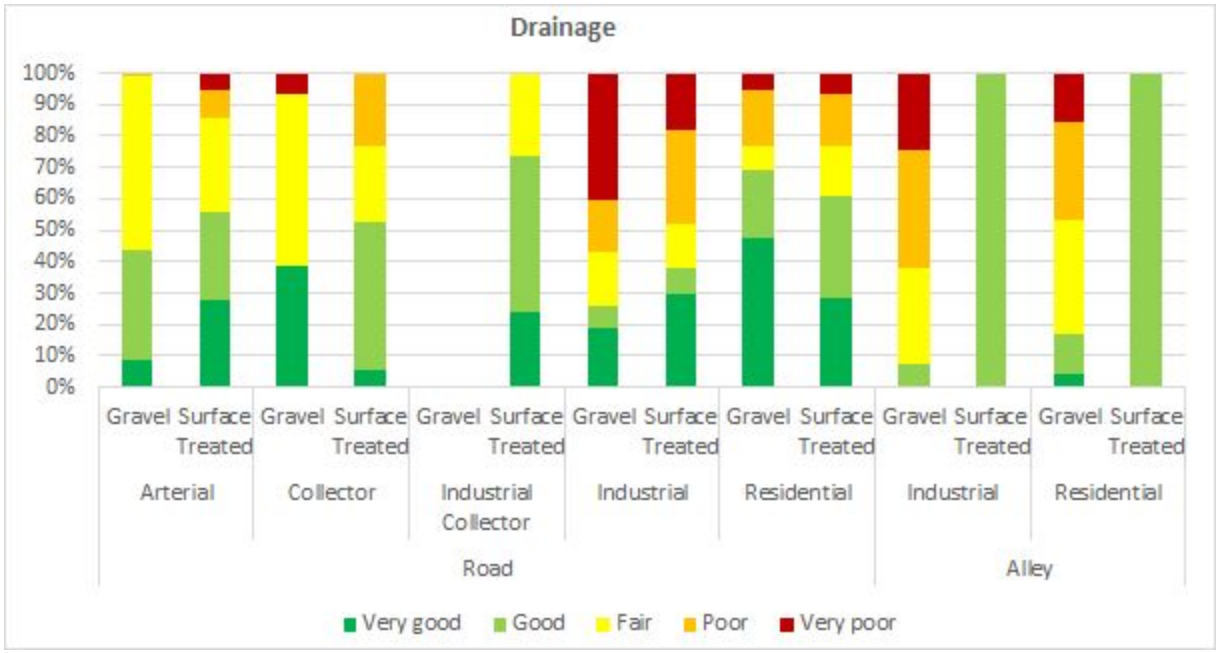


Figure 3.8 Drainage Assessment Summary

4. Levels of Service & Performance Tracking

This chapter documents service levels currently being delivered, how performance is being tracked and measured, and the process for how cost of service, service delivery and risk have been established for existing services and associated class.

Defining Levels of Service

A documented suite of Levels of Service measures enables a common understanding of what service levels customers currently receive and the associated cost of maintaining infrastructure assets to provide this service. Having these measures set at the appropriate levels within the City ensures alignment from the corporate performance vision to asset investment decisions and day-to-day operational activities.

Monitoring service performance enables the City to demonstrate transparency, equity and accountability in relation to service provision. With a common understanding of current Levels of Service and associated costs, the City will have better information to articulate the financial impacts of improving or reducing services, and to engage in "willingness to pay" discussions with customers.

Figure 4.1 shows the process that the City will use to start formally documenting the Levels of Service objectives and performance.

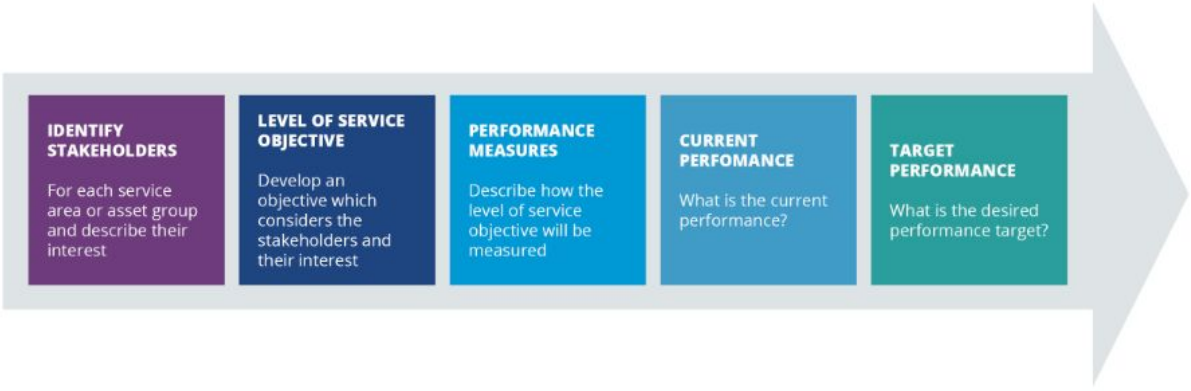


Figure 4.1 Levels of Service Development Process

Stakeholders and Their Needs

The City has identified key stakeholders for the services provided by the unpaved road asset class to help define service requirements, document how best to deliver services, and determine how to measure the achievement of service levels that the community requires. The City's Infrastructure Strategy identifies the following stakeholder groupings:

- **Service Recipients**: Stakeholders that use the municipal services supported by assets (e.g. the travelling public)
- **Other Service Providers:** Stakeholders that require the municipal service/assets to provide their own services (e.g. couriers and taxi services using the road network)
- **Regulatory Agencies:** Stakeholders that set standards, compliance regulations or other legislation that govern service delivery (e.g. Ministry of Environment and Parks)
- **The Wider Community**: Stakeholders that wish to influence decision-making but may or may not be users of the service (e.g. taxpayers funding services they may not use, City staff)
- **Neighboring Municipalities**: Other communities that are adjacent to Edmonton and are affected by or have an interest in City services (e.g. Leduc County).

The City has identified seven universal customer/stakeholder/citizen service values to consider when developing Customer Levels of Service measures. They help to group stakeholder interests to develop an overarching Levels of Service objective. The City's universal service values are:

- **Accessibility:** The ability for all possible customers of different abilities to access and use a service provided by the City, and in addition, to be able to access information about the service and the assets that exist to provide that service.
- **Reliability/Availability:** The frequency the service is available for use by the customer. This is closely related to how reliable the service is. If a customer has access to a service between certain hours on a daily basis, this is the availability; if the service is often overrun or late/early, this would be the reliability.
- **Quality:** The level of excellence in service delivery provided by the City.
- **Customer Service:** The service provided for interacting with the customer regarding the services provided. This service allows customers to provide feedback on the services.
- **Safety:** A measure of service that considers the amount of harm that could be incurred to the customer, bystanders, wildlife/pets, and the environment.
- **Sustainability:** This translates into striving for community well-being, a sustainable environment, a prosperous economy, and smart growth and mobility choices. It is achieved by having a balanced financial capacity and creating a sustainable corporation that will drive toward this vision and provide the services citizens need today and in the future.
- **Legislative:** Service provided by the City that must meet standards set by legislative assemblies such as Provincial or Federal standards.

Additional service values may be identified for different business units depending on the type of service provided and how the key customer groups relate to the services provided.

Table 4.1 provides a summary of high priority stakeholder interests and requirements.

Stakeholder group	Stakeholder	Interest / Requirement	Service Value
Service Recipients	Residents	Reliable access to and from home	Reliability / Availability
		Safe roads to travel on	Safety
		Response/updates for issues lodged with the City	Customer Service
Other Service Providers	Emergency Services	Safe roads	Safety
		Reliable access	Reliability / Availability
	Agricultural and horticultural contractors	Adequate road width and strength for movement of large vehicles and loads	Accessibility
		Reliable access	Reliability / Availability
	Commercials freight operators	Adequate road strength for movement of large vehicles and loads	Accessibility
	School Buses	Safe roads, especially when stopping for children	Safety
		Reliable access	Reliability / Availability
		Access to the right-of-way for their assets	Accessibility
Regulatory Agencies	Alberta Environment	Protection of waterways (from silt, salt, hydrocarbons, etc.)	Legislative
	Environment Canada	Protection of waterways (from silt, salt, hydrocarbons, etc.)	Legislative
	City of Edmonton	City bylaw requirements are met	Legislative
	Alberta Energy Regulator	Access to the right-of-way is provided for utilities	Legislative
	Canadian Radio-television and Telecommunications Commission	Access to the right-of-way is provided for utilities	Legislative
	Transportation Canada	Gravel road dust does not impact Edmonton International Airport	Legislative

Table 4.1 Levels of Service Stakeholder Interests & Requirements

Service levels and corresponding performance targets that are established and monitored over time should reflect these stakeholders' primary requirements.

Legislative Requirements

The services supported by City assets must meet legislative requirements at the municipal, provincial and federal levels. Key legislative requirements for the unpaved road asset class are summarized in Table 4.2.

Legislation	Requirement
City Policy C409J - Snow and Ice Control	Sets out the City's winter snow and ice control standards to provide for a safe and reliable transportation network while protecting the environment and providing excellent customer/citizen service.
City Bylaw 5590 - Traffic Bylaw	Regulates the use of highways (included unpaved roads) under the direction, control and management of the City and to regulate the parking of vehicles on such highways.
Municipal Government Act 2000	Sets out roles, purpose, responsibilities and powers of local governments. This includes the requirement for Alberta municipalities to complete annual audited financial statements which must be submitted to Municipal Affairs by May 1 of each year.
Traffic Safety Act	Sets out rules and regulations concerning driver training and certification, insurance regulations, cargo securement, offense procedures, commercial vehicle certification, dimension and weight regulations, traffic control device regulation, and vehicle equipment and inspection regulations.
Highways Development and Protection Act	Sets out roles and responsibilities for designation and control of provincial highway, grants authority to municipalities to pass bylaws for the control of streets within their jurisdiction, sets out regulations regarding access and use, and identifies responsibility of cities to prepare transportation studies.
Fisheries Act	The Fisheries Act sets out requirements by the Department of Fisheries and Oceans to avoid projects being conducted in or near waterbodies that support fish causing serious harm to fish.
Alberta Environment	TBC
Environment Canada	TBC
Alberta Transportation	TBC
Alberta Energy Regulator	TBC
Canadian Radio-television and Telecommunications Commission	TBC
Transportation Canada	TBC

Table 4.2 Legislation Requirements

Levels of Service Objectives

A suite of Levels of Service performance measures have been developed. These include some for immediate implementation, some for future implementation, and others recommended for further review. The tables below provide a summary of the service values identified in the Stakeholder assessment above, the associated Level of Service objectives, relevant asset groups, and their performance measurements.

These Levels of Service performance measures have also been identified by their key driver: Customer or Technical.

Customer performance measures: How the customer receives or experiences the service. Customer measures are generally those that would be used in public documents and should be aimed at a layperson.

Technical performance measures: What the City does to the delivery of service. These measures support customer measures and tend to be used internally to measure performance against service levels.

Service Value	Level of Service Objective	Relevant Asset Categories	Performance Measure	Customer or Technical
Customer Service	We will respond to customer service requests within a timely manner	All	The percentage of customer service requests investigated within the required timeframes	Customer
Customer Service	We will respond to customer service requests within a timely manner	All	The percentage of customer service requests responded to within the required timeframes	Customer
Legislative	We will meet all legislative environmental requirements	All	The number of non-compliance letters and/or fines	Technical
Legislative	We will adhere to applicable bylaws	All	The number of non-compliances issued due to a breach of City bylaw	Technical
Quality	We will minimize damage caused to vehicles as a result of road condition	All	The total number of customer damage claims received related to damage caused by road condition	Customer
Quality	We will minimize damage caused to vehicles as a result of road condition	All	The total value paid for customer damage claims related to damage caused by road condition	Customer
Quality	We will minimize damage caused to vehicles as a result of road condition	All	The percentage of road assessed as 'Very Poor' as part of the annual road condition rating	Technical
Reliability / Availability	We will ensure alleys are open and available for use	Alleys	The number of customer complaints where maximum alley snow pack depth exceeds standard	Technical

Service Value	Level of Service Objective	Relevant Asset Categories	Performance Measure	Customer or Technical
Reliability / Availability	We will enable efficient movement of standard commercial vehicles	Roads	The percentage of road, by class and length, with permanent (or annual) road bans applied	Technical
Reliability / Availability	We will enable efficient movement of standard commercial vehicles	Roads	The percentage of road, by class and length, with seasonal road bans applied	Technical
Reliability / Availability	We will enable efficient movement of standard commercial vehicles	Roads	The percentage of road, by class and length, with spring road bans applied	Technical
Reliability / Availability	We will enable efficient movement of standard commercial vehicles	Roads	The percentage of road not meeting minimum width standards	Technical
Safety	We will provide motorists with a safe driving surface	All	The 3-year rolling average of the number of fatal and serious vehicle collisions	Customer
Safety	We will provide motorists with a safe driving surface	All	The density of vehicle collisions (number per kilometer)	Customer
Safety	We will ensure safe driving visibility	Roads (gravel)	The number of complaints received regarding dust as a safety concern	Customer
Safety	We will enable safe travel during winter	Roads	The number of instances a road is not plowed within the required timeframes following a snow event	Customer
Sustainability	We will minimize nuisance dust for adjacent residents	Roads (gravel)	The number of complaints regarding dust as a nuisance for residents	Customer

Table 4.3a Levels of Service Performance Measures for Immediate Implementation

Service Value	Level of Service Objective	Relevant Asset Categories	Performance Measure	Customer or Technical
Reliability / Availability	We will provide access to information regarding any road restrictions	All	Restriction information is made available via 311	Customer
Reliability / Availability	We will minimise the impact to motorists of road restrictions	All	The detour length for seasonal road bans	Customer
Safety	We will provide for safe travel at the posted speed	Roads	The length of road where posted speed is higher than the design speed	Customer
Safety	We will provide for safe travel at the posted speed	All	The difference between posted speed and actual operating speed	Customer
Sustainability	We will ensure cost effective service provision	All	The ratio of proactive versus reactive maintenance expenditure	Technical
Sustainability	Roads are structurally sufficient in all weather	Gravel / Oiled	Drainage ditches formed adjacent to roads	Technical

Table 4.3b Levels of Service Performance Measures for Future Implementation

Service Value	Level of Service Objective	Relevant Asset Categories	Performance Measure	Customer or Technical
Legislative	We will meet Transportation Canada requirements for dust around airports	Gravel	The number of non-compliances issued	Technical
Reliability / Availability	We will ensure roads are open and available for use	All	The percentage of time roads are closed due to planned closures	Customer
Reliability / Availability	We will ensure roads are open and available for use	All	The percentage of time roads are closed due to unplanned closures	Customer

Table 4.3c Levels of Service Performance Measures for Further Review

Levels of Service Performance

This section summarizes the Levels of Service objectives and how the City is currently performing, as well as any performance targets that have been established (i.e. desired Levels of Service). This is for performance measures identified for immediate implementation. As this is the first Unpaved Road

Asset Management Plan, further assessment and analysis is required before current and target performance can be fully documented.

Level of Service Objective	Performance Measure	Current Performance	Target Performance	Data Source
Accessibility	The percentage of road, by class and length, with permanent (or annual) road bans applied	Analysis of Road Bans list to be completed	To be determined	Bylaw 5590 - Traffic Bylaw - Traffic Listings - Road Bans (List V)
Accessibility	The percentage of road, by class and length, with seasonal road bans applied	Analysis of Road Bans list to be completed	To be determined	Bylaw 5590 - Traffic Bylaw - Traffic Listings - Road Bans (List V)
Accessibility	The percentage of road, by class and length, with spring road bans applied	Analysis of Road Bans list to be completed	To be determined	Bylaw 5590 - Traffic Bylaw - Traffic Listings - Road Bans (List V)
Accessibility	The percentage of road not meeting minimum width standards	Analyse Inventory data	To be determined	IIS Asset database
Customer Service	The percentage of customer service requests investigated within the required timeframes	To be determined	95%	City 311 database
Customer Service	The percentage of customer service requests responded to within the required timeframes	To be determined	95%	City 311 database
Legislative	The number of non-compliance letters and/or fines	To be determined	0 per year	To be determined
Legislative	The number of non-compliances issued due to a breach of City bylaw	To be determined	0 per year	To be determined
Quality	The total number of customer damage claims received related to damage caused by road condition	To be determined	To be determined	To be determined
Level of Service Objective	Performance Measure	Current Performance	Target Performance	Data Source
Quality	The total value paid for customer damage claims related to damage caused by road condition	To be determined	To be determined	To be determined

Quality	The percentage of road assessed as 'Very Poor' as part of the annual road condition rating	To be determined following baseline assessment	To be determined following baseline assessment	IIS Asset database
Reliability / Availability	The number of customer complaints where maximum alley snow pack depth exceeds standard	To be determined	0 per year	City 311 database
Safety	The 3-year rolling average of the number of fatal and serious vehicle collisions		To be determined	City vehicle collision database
Safety	The density of vehicle collisions (number per kilometer)		To be determined	City vehicle collision database
Safety	The number of complaints received regarding dust as a safety concern	To be determined	No more than 12 per year	City 311 database
Safety	The number of instances a road is not plowed within the required timeframes following a snow event	To be determined	To be determined	To be determined
Sustainability	The number of complaints regarding dust as a nuisance for residents	To be determined	No more than 12 per year	City 311 database

Table 4.4 Levels of Service Current Performance and Future Target Performance

Continuous Improvement Indicator

Levels of Service: Establishing and tracking Levels of Service is critical to understanding service delivery. Continuous improvement performance trends can be tracked through the following indicators:

- Percentage of Levels of Service performance measures for which current performance is recorded
- Percentage of Levels of Service performance measures for which current performance meets target performance

Continuous Improvement Recommendation

Improving Levels of Service & Performance Tracking data includes:

- Review the levels of service measures and implement data collection to support the performance measurement processes.
- Establish levels of service targets based on measured current performance.

- Identify detailed costs for delivering current levels of service and use the information to support future decisions on changing levels of service targets and budget justification.
- Investigate development of operational levels of service (or general intervention strategies) to be used as a guide and communication tool to manage customer expectations. Consider involving stakeholder/customer groups in this process to ensure key needs are understood.
- Consider development of information to assist the City to communicate the matching of Level of Service needed by the community, service risks and consequences with the community's ability and willingness to pay for the service.

5. Growth & Future Demand

In order to understand the services supported by unpaved road assets' future requirements, the factors that affect demand and how they are likely to change must be understood. Shifts in demand tell us where increases or decreases in our Levels of Service might occur. This may include changes in to population, climate, industry / commercial development and technology. This chapter highlights future demands, existing & projected state, and their expected impact.

Demand Drivers

This section outlines the key drivers that may impact future demand for a service or asset group.

Demand driver	Present state	Anticipated trend	Impact on services
Population Growth	Increasing	Increasing	As the population increases, rural land will be developed for residential housing. This will result in land developers upgrading existing unpaved roads to paved roads. Long term, it may also result in the City annexing land from adjacent Counties, likely resulting in the City acquiring new unpaved road assets.
Traffic Growth	Unknown	Increasing, as population increases	Significant and/or sudden traffic growth, heavy vehicles in particular, can significantly increase road deterioration - especially on gravel roads.
Climate Change		Increasing higher temperatures, drier summers, more extreme precipitation events, more variable extreme weather events, and an overall warmer and drier climate[2]	Direct changes to weather patterns can impact unpaved road assets by accelerating weathering and deterioration. Changing precipitation that leads to flooding can have a direct impact on road pavements and surfaces. Conversely, dry conditions can lead to an inability to effectively maintain gravel roads.

			More intense and frequent weather events such as high winds, blizzards, and tornadoes can cause disruptions to transportation services by reducing availability, reliability and safety levels.

Table 5.1 Demand Drivers, Projections, and Impact on Services

Forecasting Demand

This section provides mechanisms for forecasting future changes resulting from the demand drivers identified above (e.g. master planning), and summarizes the predicted future demand.

Information reflecting the identified demand drivers above, should be collected in the long term to develop trends and improve understanding of future changes.

The City has various master plans and strategic plans that provide background information to inform demand forecasting for unpaved road assets. A summary of key outcomes from these plans is included in Table 5.2.

Plan	Description	Key outcomes impacting unpaved road assets
Climate Resilient Edmonton: Adaptation Strategy and Action Plan	Details the City's plan to adapt to climate change	To be determined
City Plan	A 30 year regional plan with a 50 year vision for a diverse, thriving and competitive metropolitan region. Guides Edmonton's growth and development. Sets the framework for how the City will address its current and future transportation needs.	The Plan provides strategic policy direction for urban form, growth and development based on a 30 year land development concept map.
Various Urban Planning and Design Plans (detailed below)	Various plans and land use studies that help guide development in our neighbourhoods and industrial areas	The plans will provide guidance as to what current areas will look like in the future and approximate development timeframes, indicating when unpaved road assets will likely be upgraded to paved.

Table 5.2 Strategy and Development Plans

The City of Edmonton has almost 180 urban planning and design plans. These include:

- ASP: Area Structure Plan
- NASP: Neighbourhood Area Structure Plan
- NSP: Neighbourhood Structure Plan
- ARP: Area Redevelopment Plan
- SCDB: Servicing Concept Design Brief

[2] "Climate Resilient Edmonton: Adaptation ... - City of Edmonton." https://www.edmonton.ca/city_government/documents/Climate_Resilient_Edmonton.pdf. Accessed 4 Feb. 2020.

- OP: Outline Plan

Appendix E shows the current plans in effect. The specific plans can be found on the City's website.

Demand Management Planning

A Demand Management Plan outlines:

- What the demand drivers are
- The future demand forecasts
- How future demands will impact our assets
- What we will do to manage these impacts

Having a Demand Management Plan is critical to making sure we have robust planning for future unpaved road requirements.

Demand can be managed through:

- Asset based solutions: Maintenance of existing assets, upgrading of existing assets and providing new assets to meet future demand.
- Non-asset based solutions for unpaved road assets as detailed in Table 5.3.

Demand component	Description	Methodology	Example of Specific Application
Operation	Control access, pressures (peak times)	Not applicable	Not applicable
Regulation	Restrict time of use, type of use and methodology	Road Bans	Permanent, seasonal and/or spring road bans can be applied, restricting the maximum vehicle weight allowed on the respective road
		Vehicle Speed	All roads have a posted speed limit, which can be changed if necessary (largely based around safety)
Incentive	Pricing structures, metered use, subsidies	Not applicable	Not applicable
Education	Change habits, increased understanding	Not applicable	Not applicable
Demand Substitution	Provide alternatives	Not applicable	Not applicable

Table 5.3 Non-asset Based Demand Solutions

Continuous Improvement Recommendation

Improving Growth & Future Demand management includes:

- Confirming the demand drivers relevant to roads.
- Developing a program for gathering the required data and demand information for each demand factor.

- Collecting data and completing future demand forecasting.
- Utilizing urban planning and design plans to estimate the timing of unpaved road upgrades and inform unpaved road investment decision making.
- Developing a Demand Management Plan, which will include any asset programs required to meet demand.

6. Asset Management Strategies

This chapter outlines the current business practices employed by City staff to manage assets throughout their life cycle. A life cycle strategy sets out the planned actions and intended methods of management for an asset throughout its life. The purpose of asset management strategies is to maintain the assets in an appropriate way that will deliver the required Level of Service for the least overall cost, while keeping risk within agreed boundaries.

This section outlines the current business practices used by City staff to manage assets throughout their life cycle.

Asset Life Cycle Planning

Life cycle planning is about understanding the life cycle behavior of the various types of assets and using this understanding to develop robust forecasts of the investment funding required for renewal of the existing asset base.

Life cycle optimization is about improving the overall life cycle performance, both cost and service delivery performance, of each of the asset categories. Once the existing life cycle behavior is understood it may be possible to develop alternative life cycle strategies to improve overall life cycle performance.

Life cycle management can be split into the following components:

- Identifying the Need
- Planning & Design
- New Assets Built
- Operation & Maintenance
- Renewal & Rehabilitation
- Disposal

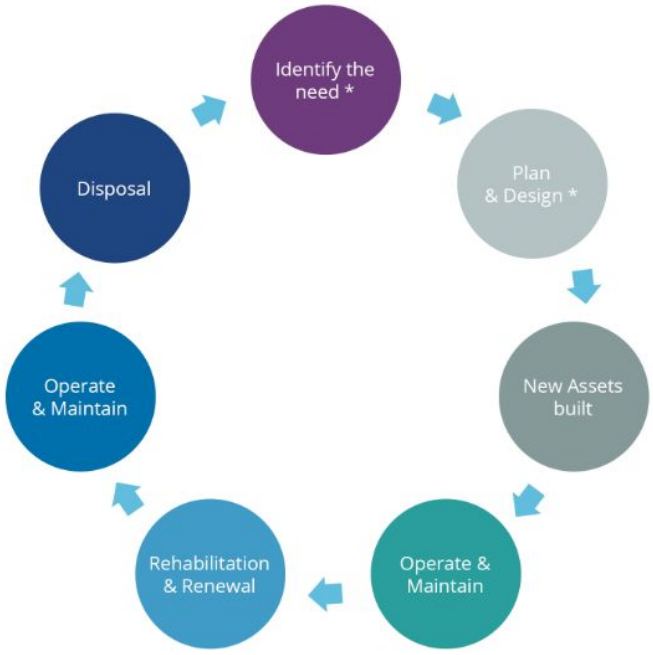


Figure 6.1 Asset Life Cycle

Figure 6.1 illustrates the phases an asset experiences throughout its life. The asset management strategies included in this chapter focus on the four phases from asset creation to disposal: New Assets built, Operation & Maintenance, Renewal & Rehabilitation and Disposal.

The City does not typically build new unpaved road assets, but rather acquires them through land annexations to support future metropolitan growth and maintains them until they are converted to paved road assets, either by the City (for alleys and some roads) or by land developers (for most roads). There are also a number of historic unpaved road assets within the City awaiting investment to be paved.

Figure 6.2 demonstrates typical deterioration curves for a roadway asset given different lifecycle strategies. These strategies include Preventive Maintenance, Rehabilitation and Reconstruction. As condition deteriorates over time, various opportunities for intervention are available to extend the service life of the roadway. Preventive maintenance treatments are less costly and more frequent than rehabilitation. Likewise, rehabilitation treatments are less costly and more frequent than full reconstruction.

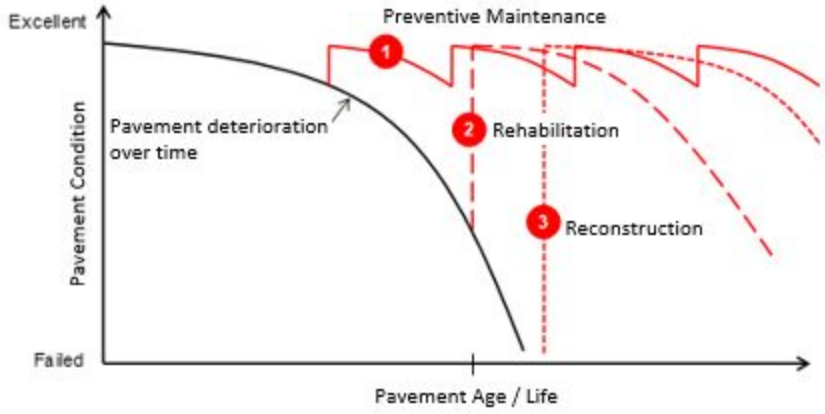


Figure 6.2 Typical Pavement Deterioration for Various Strategies

The City typically employs a 'run-to-fail' strategy, similar to strategy 2 (Rehabilitation), for unpaved road assets. In general, limited preventive (or planned) maintenance is completed and most work completed is triggered by customer service requests. Although no formal asset renewals are completed for unpaved road assets, rehabilitation or reconstruction will be completed when maintenance is no longer deemed feasible.

Operations & Maintenance Strategies

Operations and maintenance is a critical component of the asset life cycle. It is about ensuring that assets run effectively on a day-to-day basis to deliver value to customers. Typically, operations and maintenance activities do not increase the condition of an asset but are needed to provide a chosen standard of service.

The City has Asset Maintenance Plans for specific programs that provide a more detailed approach to planning and delivery of operations and Maintenance. This AMP provides an overarching summary of operations and maintenance strategies at an asset class level.

The overarching process for the City's operations and maintenance is shown in Figure 6.3. Each step in the process is covered in more detail in subsequent sections.

Figure 6.3 Operations & Maintenance Process

Managing unpaved roads often involves operational challenges because unpaved roads change rapidly and when defects appear they must be addressed within a short response time. For that reason, most routine maintenance is triggered from customer service requests, then planned and scheduled according to routine inspections and experience from road operators. More expensive and less frequent maintenance activities, however, such as re-gravelling and surfacing of unpaved roads, requires a more sophisticated process.

Situational Awareness

The purpose of maintenance activities is to preserve the road in a condition close to its intended or as-constructed state, or to provide an acceptable level of service. This section summarizes the key factors that can impact the delivery of maintenance activities from a technical and customer perspective.

The deterioration of unpaved roads is mainly due to traffic loading – especially heavy vehicles and climatic conditions (rain and dry periods). The rate of deterioration is due to other factors such as the geometry of the roadway, quality of road materials used, and construction and maintenance standards. As little can be done to influence traffic volumes and climatic conditions, efforts are concentrated on the other factors that contribute to deterioration. The aim is not to stop deterioration, but rather to reduce the rate of deterioration so that grading, for example, is extended (say) to every ten weeks rather than four weeks, and graveling (say) every six years instead of every three years.

By addressing, where possible, existing road deficiencies, we are able to influence the rate of deterioration, thereby prolonging the need for maintenance of the road surface.

Critical maintenance factors impact road condition and/or the delivery of unpaved road maintenance from a technical perspective. Listed below are the key factors for management of unpaved roads. They serve as a basis to assess existing roads, and to highlight what deficiencies exist and how any upgrading may best be achieved.

Geometric Road Requirements

Design Requirements

Most unpaved roads have developed over the years from routes that may have originally been built for the horse and cart, with little or no attention given to applying appropriate geometric designs to suit current motor vehicle requirements. Many of our unpaved roads have been ‘inherited’ through annexations, with little information regarding the respective standards used in historic design and construction. As a result, it is expected that there are geometric design deficiencies on existing roads that can lead to higher gravel loss, increased maintenance costs and poor safety.

Road Cross Section

Road widths across our unpaved roads vary anywhere between 4 and 23 metres. This is largely due to the standard the road was built to before being inherited by the City, but is also due to the type of traffic using the road.

In some cases, road widths are very high, especially where access for heavy agricultural machinery (e.g. harvesters) is required. This results in increased safety risk, increased deterioration, and increased maintenance costs due to high motorist travel speeds and greater exposure to climatic factors.

Where road widths are too narrow, the inside wheels of vehicles may travel on the same wheel path of the inside wheels of oncoming traffic. This will result in the road exhibiting a 'three wheel' effect, and higher road maintenance due to the road crown having double the wear.

Road Crossfall

For unpaved roads, especially gravel, it is critical that the road surface has a crossfall of between 4–6% in order to quickly shed water from the surface. If the crossfall is allowed to go flat (< 4%), water is likely to remain on the surface, and the resulting ponding will lead to a weakening of the structure and the rapid formation of potholes. Crossfall of higher than 6% can cause higher cross scour erosion and safety risks.

Maintaining roads with the required crossfall ensures better ride quality, lessens the risk of break-up of the road surface, and considerably reduces routine maintenance operations.

The crossfall or cross section profile (cross shape) is often a maintenance driver on gravel roads. In most cases the road's crossfall, or surface shape, is restored through maintenance grading.

Horizontal Alignment

Poor road alignment – in terms of tight curves, insufficient super-elevation and high vehicle speeds – means that vehicles exert greater sideways force around a curve and cause the road surface to break up. This creates loose gravel which is more prone to ravelling, erosion, dust emission and gravel loss through whip-off, wind and rain action. Such conditions also increase the risk of vehicle accidents.

Horizontal curves that do not match the prevailing operating speed of drivers are more prone to greater gravel loss. Such curves should be identified, and where minimum radius curves and associated super-elevation are below the minimum, alternatives such as increasing the radius of the curve, increased super-elevation, speed reduction or, in difficult cases, sealing the curve, should be considered. While sealing the pavement may be a high initial cost in terms of life-cycle costs, it may prove to be more cost effective, as ongoing maintenance is reduced considerably and road safety improved.

Vertical Alignment

Although only an issue on a few sections of unpaved roads on the City's unpaved road network, steep vertical grades (>8%) can present issues, especially on gravel roads. The road surface does not have the binding properties to withstand the acceleration and deceleration forces exerted by heavy vehicle drive axles. Steep grades can also lead to drainage channels being formed down a road, causing loose gravel to wash away.

Sections of gravel roads with steep gradients should be candidates for oiling or paving to reduce the whole of life costs and enable a decrease in routine maintenance cycles that would otherwise be dictated by such high-maintenance locations.

Alignment Combination

Another significant geometrical aspect is the importance of coordinating horizontal and vertical alignment. Flat areas, where the crossfall at a curve tangent point is flat and at the same point as a bottom of the sag curve, can cause wet areas and increased deterioration. When there is nowhere for the water to run off the road and disperse, it will lead to high gravel loss and a requirement for ongoing maintenance.

To overcome this problem, horizontal and vertical coordination needs to be arranged to allow the road to be self draining.

Continuous Improvement Recommendation

Improving Situational Awareness regarding geometric road requirements includes:

- Identify geometric and alignment deficiencies and develop a prioritized program to address these. Attention should be given to rectifying sections of road where there are significant design inconsistencies or 'surprises' for motorists. Consideration should also be made as to whether the deficiencies are resulting in increased maintenance needs, and whether oiling or paving will reduce whole of life costs.
- Identify instances where road width does not meet desired geometric design standards, by road class, and develop a prioritized program to address these to ensure efficient transport operations, improved safety and reduced maintenance requirements. Begin addressing deficiencies and areas of over-delivery through routine maintenance activities. Note: for roads carrying a high percentage of heavy vehicles – such as agricultural machinery – special road widening requirements may be necessary, and can be determined on a case by case basis.
- Implement routine verification of road crossfall following maintenance grading, with the use of a smart level (or similar). Address deficiencies through plant operator training (where issue is due to technique) or gravelling (where wearing course is not deep enough to maintain an adequate crossfall).

Drainage

The impact of drainage on unpaved road asset condition and deterioration is significant and should not be underestimated. Drainage is one of the most important and critical factors in the ability of an unpaved road to withstand traffic loads and reduce ongoing maintenance. Water or excessive moisture reduces the strength of many surfacing and road foundation materials, so rain and ground water need to be dispersed away from the roadway as efficiently as possible.

There are three key areas that need attention:

- Water that falls onto the road surface must be shed as quickly as possible by the use of a crowned crossfall of 4–6% on straight sections.
- Water collected alongside the road must be drained away from the road as soon as possible by the use of roadside ditches, cut-off drains and cross drains.
- Water flows approaching a road from any higher adjoining countryside must be intercepted before flowing toward the road by catch drains, diverted into natural watercourses and taken across the road by suitable culverts/floodways.

<u>The importance of drainage should be kept in mind at all times.</u>

The majority of the City's roadside drainage infrastructure is managed and maintained by EPCOR, however, exact responsibilities are not clear - especially for the recently annexed area near Leduc. This is currently being addressed through development of a formal memorandum of understanding between City Operations and EPCOR.

Continuous Improvement Recommendation

Improving Situational Awareness regarding drainage includes:

- Confirm and document clear roles and responsibilities with regard to the management of the City's drainage infrastructure, including roadside ditches, culverts, and other associated assets.

Road design and materials

Providing a base thickness appropriate to future traffic loading and subgrade support is essential in ensuring a longer pavement life and reduced incidence of rutting.

The desired make-up of an unpaved road should be based on providing a base course – which provides the structural strength – topped by a wearing course. To considerably reduce gravel loss, attention needs to be given to design requirements and the placement of a suitable wearing course.

Few unpaved roads are formally designed. Instead, they are typically built according to staff recommendations and the availability of material and other resources. This can sometimes lead to premature failure and higher maintenance requirements of reshaping the road, eliminating rutting and poor ride quality.

A key requirement for a gravel road is the provision of a wearing course to minimise ravelling, to better shed water run-off and to reduce gravel loss. The function of a wearing course is to provide a hard forming crust to resist wheel abrasion and minimise water penetration into the base course.

Continuous Improvement Recommendation

Improving Situational Awareness regarding pavement design and materials includes:

- Develop base pavement designs for unpaved roads, by class, to improve value from investment.
- Investigate development and implementation of technical specifications for unpaved road materials.
- Develop and implement a program to determine existing gravel depths and the strength of the underlying subgrade, enabling more effective treatment selection and investment decision making.

Construction

The prime objective in road construction is to compact gravel layers and subgrades so as to limit, and if possible prevent, loss of shape from further compaction by traffic after construction. Before any gravel layers are laid the formation should be prepared and any soft spots attended to.

Stabilisation

Pavement stabilisation is usually employed in unpaved roads to reduce maintenance costs, improve base course material properties and to provide a better all-weather surface. By rectifying deficiencies in materials, stabilisation allows otherwise unsuitable materials to be used to advantage in road pavements.

Stabilisation has the benefit of improved surface condition through less dust, rutting, potholes and corrugating. In addition to reduced maintenance costs, vehicle-operating costs may also be reduced.

Dust control and suppressants

Dust from unpaved gravel roads contributes significantly to total air-borne particulates. It can degrade agricultural produce, be a problem to households, affect health, reduce road safety, increase wear and tear on vehicles, and increase the rate of roadway deterioration.

Short-term or seasonal dust suppression may be affected by the application of dust palliatives to the road surface. Longer-term solutions involve either sealing the pavement, or using materials with

optimum plasticity limits to achieve cohesion in the wearing course material, without affecting its strength and resistance to skidding.

Continuous Improvement Recommendation

Improving Situational Awareness regarding pavement construction includes:

- Assess the success and whole of life cost for pavement stabilization and dust control investment to inform investment decision making.
- Investigate development and implementation of technical specifications, including quality controls, for unpaved road construction.

External Factors

External factors, those that impact unpaved road assets but are largely outside the control of the City, include the following.

Climate and Weather

Like all areas within Alberta, the climate significantly impacts the City's operations and maintenance activities, requiring different seasonal strategies.

- During winter, the ground freezes and maintenance activities are limited. Activities are predominantly operationally focussed on snow removal and ice control. Frozen roads and culverts can also inhibit drainage by not allowing water to properly flow through the drainage network.
- In spring, the melt of frozen roads significantly changes the material properties and drainage requirements. Maintenance needs focus on drainage initiatives like ditch clearing, and re-graveling.Pavement moisture contents are likely to be high, with soft spots developing, so heavy grading and reshaping is not advised.
- In summer and fall, conditions can be dry, so this is typically the most effective time to focus on dust control and keeping the surface free from surface defects such as washboarding and potholing.
- Throughout the seasons, rain can have a significant impact on unpaved road condition and maintenance activities.
    - Heavy rain can wash fine gravel particles off the road. The loss of this material, which binds the larger stones and sand together, can result in gravel loss and increased deterioration of the road.
    - Periods of wet weather can result in maintenance activities, especially gravel road grading, having a negative impact on the road. Water introduced to the gravel layers can increase deterioration and the risk of soft spots developing.
    - Periods of dry weather can also result in gravel road grading having a negative impact on the road, especially when combined with wind. Fine particles can be lost because of the activities, increasing deterioration. For best results, maintenance activities such as grading require the pavement to have optimum moisture content in the aggregates, and so need to be completed after a rain.

Traffic usage

Changing traffic demands impact on the suitability of the City's unpaved roads for road users. Some key traffic usage impacts that need to be considered in maintenance planning include:

- **Changing land-use:** development of land that has previously been pastoral or farm based, into acreages and residential areas creates more traffic from increased commuter activity.

- **Changing vehicle types:** with the change in land use, comes a change in the type of vehicles using unpaved roads. Generally road users associated with acreages drive conventional 'low riding' vehicles rather than 'farm' type vehicles, which increases demand for smoother riding roads.
- **Detours:** a key impact on the maintenance of unpaved roads in the City of Edmonton is detours set up by private contractors around new communities being developed. These contribute increased axle loads from large trucks and exemptions from road bans.
- **Hours of work:** working hours are often limited to off peak hours to reduce traffic disruption, which can also adversely affect physical works productivities and timelines to repair any issues.

Topography & Geology

The City's unpaved road assets are generally flat and straight. This flat formation often hinders roadside drainage, with small obstructions potentially impacting the effectiveness of the drains.

As many of the City's unpaved road assets are either very old and/or have been acquired by the City through annexation, little is known about the geology immediately beneath the pavement. This lack of information, especially for subgrade strength, impacts staff's ability to make the most effective decisions with regard to determining the root cause of failures and the optimal treatment to rectify them.

Customer expectations

From a customer perspective, the key service level objectives of unpaved roads that influence maintenance activities are to provide:

- A fit-for-purpose pavement giving affordable access to property and best whole-of-life performance.
- A smooth ride and safe travel for users, free from potholes and deficiencies like subsidences that could potentially cause damage to their vehicles.
- Limited disruption to customers' travel plans by ensuring maintenance work is not being conducted during peak hours.
- Limited air pollution and safety risk from dust.

As recently experienced following the annexation of land (and associated roads) from Leduc County, customers (specifically adjacent landowners) can have very different expectations of the road and how it is managed.

Strategies

The major challenge faced by staff responsible for unpaved roads is the on-going maintenance required to meet our customers expectations – usually on very limited budgets.

Maintenance can be defined as those activities that are intended to retain the serviceability of a road that may have deteriorated due to traffic and climate, at its original intended or as-built condition. However, as most unpaved roads have developed over time – probably originally from horse and cart tracks, with very little technical input to suit current motor vehicles – maintaining roads to original conditions is not necessarily appropriate. Instead, to make better use of available maintenance funding, it may be necessary to try and correct the many design and construction features that go beyond just maintenance requirements.

In order to address the many maintenance requirements of unpaved roads, it is important to recognise that maintenance is only the outcome of the adequacy of the many components that

make up a road. In other words, a road with little geometric design, poor use of local materials, and inadequate drainage and construction methods, will result in much greater maintenance demands than one designed in accordance with good practices. Therefore, in order to ensure that greater value is obtained from the limited funding available for maintenance, it is essential that deficiencies causing the problems are identified and remedied as resources become available, so that over time greater value is obtained from the funding allocated to maintenance.

Unpaved roads are, therefore, most susceptible to rapid deterioration as a result of loss of wearing course material and damage from water. Maintenance is carried out to ensure the safety of traffic, and to sustain the serviceability and appearance of the road. Maintenance can vary from on-demand maintenance when a defect arises, to preventive maintenance which attempts to predict defects in advance of their occurring, and taking action to eliminate or reduce the occurrence or frequency of the defect.

Road maintenance involves remedying the relatively minor defects that occur in the roadway from time to time (routine maintenance), and providing substantial treatments such as re-gravelling, which rectify major defects and help inhibit the rate of deterioration (periodic maintenance). Factors that significantly increase gravel loss and that can be reduced through improved maintenance practices include:

- drainage provisions
- wearing course specifications
- grading practices
- compaction requirements of the road surface.

The current operations and maintenance management strategies have been identified under the following work categories:

- **Inspections:** different types of inspections can occur throughout the life cycle of an asset. Some simply check that the asset is operating as planned and can provide early warning of conditions that may warrant treatment or further inspection. Other inspections measure or observe the condition of the assets, or measure performance. These provide information for planning renewals and determining if performance targets will be met. Inspections may also be required by legislation or departmental policy, or completed based on an industry standard or manufacturers recommendations.
- **Operations:** these are routine activities necessary for the operation of the assets to help it function as intended. They generally provide public health, safety and amenity, e.g. street sweeping, grass mowing, snow clearing etc. Operations activities will consume resources including manpower, energy and materials, but do not extend the overall life of the asset.
- **Preventive Maintenance:** these are regularly scheduled activities, completed while the asset is still in an “operational” condition. The purpose of Preventive Maintenance is to assist in maintaining the life of the asset, but does not yet represent a deficiency in the asset. Getting Preventive Maintenance right will both reduce total overall cost and improve service performance to customers.
- **Corrective Maintenance:** these activities are physical repairs to an asset that is not functioning as required. The repair reinstates the asset to its normal “operating” condition, but does not significantly extend the overall life of the asset (i.e. it is a repair not a full replacement or an upgrade or major rehabilitation). Corrective maintenance repairs are expected to increase as assets age, but can be considerably more expensive than planned maintenance and often this will have a direct impact on service to customers.

Table 6.1 outlines our operations and maintenance strategies for the unpaved road asset class.

Asset Category	Asset	Regular Inspections	Operations	Preventive Maintenance	Corrective Maintenance
Road	Gravel	Road checks Customer service request investigations	Snow plowing Vegetation control	Not applicable	Grading Spot gravelling Regravelling Pothole repairs Base repairs Ditch reshaping Dust abatement
	Oiled	Road checks Customer service request investigations	Snow plowing Vegetation control	Not applicable	Spot grading Base repairs Pothole repairs Zipping Ditch reshaping
Alley	Gravel	Customer service request investigations	Not applicable	Not applicable	Grading

Table 6.1 Operations & Maintenance Strategies

Critical Assets

Asset criticality is the consequence arising from the sudden and total loss of an asset (or asset component). Understanding asset criticality is essential, as assets support the core services provided by the City, but not all assets have the same impact on service provision, should they fail.

For the City, critical assets are assets identified where their financial, business or service level consequences of failure are sufficiently severe to justify proactive life cycle strategies. If critical assets fail, they cause significant impacts to the operations of the City and stakeholders. By identifying critical assets and critical failure modes, we can target and refine our inspections, maintenance plans and capital expenditure plans at the appropriate time.

When identifying critical assets considerations of the consequences of failure include but are not limited to:

- Financial
- Safety
- Meeting regulatory requirements
- Environmental
- Service provision
- The City's image and reputation

A formal process for determining critical unpaved road assets is not currently in place. In lieu of this, the functional classification of assets have been used when considering asset criticality. Identified critical assets within the unpaved road asset class have been included in Table 6.3.

Asset Category	Critical Asset	Why asset is critical	Specific Operations & Maintenance strategies
Road	Arterial	These roads carry the largest volumes of traffic for unpaved road assets	Shorter timeframe requirements for 'time to repair'

Table 6.3 Critical Assets Operations & Maintenance strategies

Continuous Improvement Recommendation

Improving Critical Assets management includes:

- Develop criteria for identifying critical assets to improve prioritizing operations and maintenance and manage associated risks.

Prioritization of Maintenance

Our decision approaches are kept simple, utilizing the knowledge of experienced City Operations staff alongside customer service requests.

Road Maintenance Supervisors carry out road checks on a routine basis, assessing and determining road needs for subsequent prioritization and works programming depending on budget availability. As part of the road check, site specific inspections will also be completed for customer service requests received by the City via 311. Corrective maintenance works may be programmed based on these inspections, while optimizing the use of available resources against the needs of both the unpaved road assets and other assets managed and maintained by the City's Parks and Road Services branch.

City Operations have set timeframe requirements for inspections and repair in response to customer service requests. These timeframes are shown in Table 6.4 below. Times to repair are in calendar days.

Asset Category	Time to Inspect	Time to Repair
Arterial Roads	24 hours	5 - 10 days
Collector Roads	24 hours	10 - 20 days
Local Roads	24 hours	20 - 60 days
Alleys	48 hours	60 - 180 days
Rural Roads	48 hours	20 - 60 days

Table 6.4 Customer Service Request Timeframes

Continuous Improvement Recommendation

Improving Prioritization of Maintenance includes:

- Review unpaved road classification and ensure appropriate classes have been applied (including roads recently acquired from Leduc County).
- Develop formal maintenance intervention strategies, detailing work identification and prioritization processes and intervention levels (incorporating road class).

Standards & Specifications

Work to implement existing life cycle strategies are carried out in accordance with the Standards and Specifications in Table 6.6.

Asset Category	Asset	Regulatory Requirement or Standard
All	All	City of Edmonton Complete Streets Design Standards - 2018 Construction Specifications

Table 6.6 Standards and Specifications

Other standards and specifications used as guides in managing the unpaved road assets include;

- Transportation Association Canada Guidelines
- Alberta Standard specifications for Highway Construction
- Highway Maintenance Specifications
- Manual of Uniform Traffic Control Devices for Canada
- Alberta Highway Geometric Design Guide

Renewal & Rehabilitation Strategies

Intervention Strategies

Renewal and Rehabilitation activities fully replace an asset with an equivalent new asset, or apply a treatment that reinstates the asset (or a component of the asset) to new or near new condition.

The City aims to maintain unpaved road assets in perpetuity until they are upgraded to paved roads, at which point they cease to be included in the unpaved road asset class.

Roads

There is no current plan for the City to rehabilitate or upgrade any of the gravel or oiled roads. In extraordinary circumstances, where maintenance activities cease to be effective in ensuring the road is meeting appropriate service levels, rehabilitation may be carried out on a reactive basis. Decisions regarding the rehabilitation of unpaved road assets are made by City Operations and Integrated Infrastructure Service staff on a case by case basis.

Upgrades to unpaved road assets, from unpaved to paved, are largely completed by private investment as part of the land development process, whereby rural land is converted to residential or industrial land for housing, etc. Exact time frames for roads to be upgraded are largely subject to the local economy and demand on housing.

Where required, gravel roads may be upgraded to oiled roads. The purpose of this surface treatment is to add strength to the road by binding the surface material, making it impermeable to surface water. Oiling will also reduce dust issues.

Alleys

In December 2018, the City approved the Alley Renewal Program to improve the conditions of paved and unpaved alleys across the City over the next 25 years.

The renewal and upgrade will result in a 4-metre wide (where possible) paved alley. Surface drainage issues will be addressed and lighting will be upgraded as part of the project.

Separate from the Alley Renewal Program, the Alley Reconstruction Local Improvement process will remain an option for residents who wish to accelerate the renewal of their alley. If an Alley Reconstruction Local Improvement initiative is successful, it is 100% property owner funded.

Additionally, alleys will continue to be reconstructed in the event of an emergency (water main or gas-line repair) by the City's utility partners.[3]

Continuous Improvement Recommendation

Improving Renewal and Rehabilitation Strategies includes:

- Confirm long term strategy with regards to existing unpaved roads unlikely to be upgraded by private land developers (e.g. Winterburn Road).
- Confirm approximate planned timing of non-City unpaved road upgrade projects (e.g. as part of land development process) and develop maintenance intervention strategies (considering classification and timing) to improve investment decision making.
- Confirm approximate planned timing of specific alley renewal projects (e.g. as part of Alley Renewal Program) to improve investment decision making.
- Develop formal process, linked to Levels of Service, to assess and inform decision making regarding the upgrade of gravel to oiled road.

Disposal of Assets Strategies

Disposal includes any activity associated with the disposal of a decommissioned asset including sale, demolition or relocation. It is important to identify any assets that need to be disposed of and any impacts on future annual savings from not having to fund operations and maintenance of the assets. Any costs or revenue gained from asset disposals will be accommodated in the long term financial plan.

Currently there is no definitive plan to 'dispose' of unpaved road assets, outside of replacement (and likely conversion to paved road) through future land development.

Continuous Improvement Recommendation

Improving Disposal of Assets Strategies includes:

- Consider development of process to determine uneconomic roads; those where the cost to maintain is higher than the benefits provided through traffic usage and socioeconomic functions. Use to inform potential asset disposal.

New Assets Strategies

The City does not typically build new unpaved road assets. They are usually acquired as part of a land annexation, whereby the City extends its boundaries, assuming responsibility of land previously managed by neighbouring municipalities, to support the continued growth of Edmonton.

This has presented challenges for City staff in the past, both with regards to the impact on maintenance budgets and managing stakeholder expectations.

[3] "Alley Renewal :: City of Edmonton." https://www.edmonton.ca/transportation/on_your_streets/alley-renewal.aspx. Accessed 7 Feb. 2020.

No further annexations are currently planned by the City.

Continuous Improvement Recommendation

Improving New Assets Strategies includes:

- As part of any future annexation, assess possible new assets and associated maintenance/capital requirements, to estimate implications on budgets.

7. Risk Based Decision Making

This chapter defines how risks should be identified, analyzed, monitored and controlled. It also identifies the higher priority risks and responses to reduce these risks.

Risk Management Processes

Inherent with delivering a wide range of services to the community, the City is exposed to a variety of internal and external factors that add uncertainty to the successful delivery of service. These uncertainties are termed “risks” and, unchecked, have the potential to adversely affect an organization’s ability to deliver services in an effective and efficient manner.

Risk is often defined by the following basic equation: **Risk = Likelihood x Consequence**

The City uses a five-step process to manage risks which includes:

1) **Risk Identification:** the process of identifying and recording any potential project risks that can affect the City’s service planning and delivery.
2) **Risk Assessment:** estimating the impact and likelihood of identified risks and prioritizing them according to their impact on services.
3) **Risk Response:** planning and implementing actions and plans in response to identified project risks to mitigate or avoid a risk before it happens. It also identifies a response plan if the risk can’t be avoided.
4) **Residual Risk Assessment:** assessing the risk after a response has been implemented. It recognizes that not all risks can be avoided.
5) **Risk Control:** implementing risk response plans, keeping track of identified risks, monitoring residual risks and identifying, analyzing, and planning risk responses for newly arising risks.

The objective of risk management is to assess which risks pose unacceptable threats to the organization and advance plans to address them. A risk-based approach to assessment and mitigation enables the City to make more informed, defensible decisions regarding the allocation of resources and planning future works, thereby enhancing the ability to deliver efficient and effective service.

Risk Identification

Risk identification is crucial for efficient risk management throughout the asset lifecycle. While many risks can be identified during the risk assessment process, there are typically some risks that are higher priority. Table 7.1 summarizes the High priority risks identified during the risk assessment.

Risk ID	Asset Providing Service	Risk Category	Risk Description	Risk Score
1	All	Environmental	**Severe weather event** resulting in: - Washouts - Road Closures - Loss of Structural Capacity - Risk to public safety - Risk to economy - Unplanned expenditures - Risk to customer satisfaction	High
2	All	Environmental	**Climate change**, including increased frequency and severity of weather events and increasing frequency of pavement freeze-thaw cycle resulting in: - Changes in road performance - Changes in maintenance and/or renewal investment requirements - Changes in resources required - Changes in legislative requirements	High
3	All	Economic	**Inadequate maintenance funding** resulting in: - Reduced service levels - Increased long term costs - Customer complaints and reputational damage - Risk to safety	High
4	All	Customers / Citizens	**Unrealistic service level** expectations (e.g. surface type, form, performance, maintenance standard) resulting in: - Customer complaints and escalation to Council - Unbudgeted reactive maintenance requirements - Reputation damage	High

Table 7.1 High Priority Risks

Risk Mitigation

Table 7.2 summarizes the risk responses for the identified High priority risks.

Risk ID	Risk Description	Risk Score	Response Description	Residual Risk
1	**Severe weather event** resulting in: - Washouts - Road Closures - Loss of Structural Capacity - Risk to public safety - Risk to economy - Unplanned expenditures - Risk to customer satisfaction	High	Possible preventive road bans before weather event	High
2	**Climate change,** including increased frequency and severity of weather events and increasing frequency of pavement freeze-thaw cycle resulting in: - Changes in road performance - Changes in maintenance and/or renewal investment requirements - Changes in resources required - Changes in legislative requirements	High	Seasonal road bans	High
3	**Inadequate maintenance funding** resulting in: - Reduced service levels - Increased long term costs - Customer complaints and reputational damage - Risk to safety	High	Improved asset management maturity and informed decision making, linking levels of service and cost	Medium
4	**Unrealistic service level expectations** (e.g. surface type, form, performance, maintenance standard) resulting in: - Customer complaints and escalation to Council - Unbudgeted reactive maintenance requirements - Reputation damage	High	TBC	High

Table 7.2 Summary of High Priority Risk Responses

Prioritizing Decisions Using Risk

The City uses the risk outcomes from the section above to plan and prioritize investment needs. These are incorporated into the overall plan and assessment of asset renewal need for the class as shown in Figure 7.1.

Figure 7.1 Planning for Asset Class Renewal Needs

Continuous Improvement Indicator

Risk Management: The number of risks mitigated reduces the impact and likelihood of a potential threat. Continuous improvement performance trends can be tracked through the following indicators:

- The count of risk by rating
- Total mitigation cost by risk rating

8. Financial Plan

A financial plan provides a long term financial forecast and funding plan for implementing the asset management strategies adopted by the City to provide its target Levels of Service. In future iteration of this plan, the following sections present the City's financial forecasts of cost and revenue for a 20-year period. However, based on current practices and available data, only the current year is reported.

Financial Forecasts

In future iterations of this plan, this section will present what is known and what has been forecasted from the current State of Infrastructure and Asset Management Strategies for the next 20-year period. It will be based on the best available information that the City has at this time.

There is insufficient data available to produce a robust 20-year financial forecast for unpaved road assets. This is due to the lack of information regarding expected operational level of service information, and completed work activities/costs due to the structure of information being collected changing several times in recent years.

Future development of needs based financial forecasts, based on robust asset data and linked to expected levels of service, are a recommended opportunity for improvement. It is expected that this will enable sustainable long-term service delivery through informed investment decision making, and will support more effective governance in terms of informed budget decision making.

Continuous Improvement Recommendation

Improving Financial Forecasts includes:

- Development of needs based financial forecasts, based on robust asset data and linked to expected levels of service

Operations & Maintenance Forecast

The City has set budgets for the 2020 financial year, with $5.672 million approved for unpaved road maintenance. Operations staff developed a work plan based on the approved budget, which has been distributed across various activities as summarized in Table 8.1 below. It should be noted that the current global COVID-19 pandemic is likely to affect this budget, however the impact is currently unknown.

Operations & Maintenance Activities/Programs	Forecast Annual Cost ($000)						
	2020	2021	2022	2023	2024	2025-2030	2030-2040
Base Repairs	320.3	TBD	TBD	TBD	TBD	TBD	TBD
Continuous Grading	498.5	TBD	TBD	TBD	TBD	TBD	TBD
Culvert Maintenance	388.2	TBD	TBD	TBD	TBD	TBD	TBD
Ditch Maintenance	146.8	TBD	TBD	TBD	TBD	TBD	TBD

Dust Abatement	744.7	TBD	TBD	TBD	TBD	TBD	TBD
Regravelling	804.1	TBD	TBD	TBD	TBD	TBD	TBD
Spot Grading	1,571.0	TBD	TBD	TBD	TBD	TBD	TBD
Zipping	498.7	TBD	TBD	TBD	TBD	TBD	TBD
Indirect Operating Costs	699.7	TBD	TBD	TBD	TBD	TBD	TBD
Total	5,672.0	TBD	TBD	TBD	TBD	TBD	TBD

Table 8.1 Operations and Maintenance Financial Forecast

Capital Renewal & Rehabilitation Forecast

Capital renewal and rehabilitation investment is not currently allocated for unpaved road assets. It is expected that investment in rehabilitation will be required during the 20 year planning period, however this is not currently quantifiable due to the lack of robust asset information.

Capital New Assets & Disposal Forecast

No budgets are required for new or disposed assets.

Financial Forecast Summary

Table 8.3 outlines the financial forecast summary for the next 20 years based on the operations and maintenance, and renewals and replacement outlined in the sections above. Figure 8.1 provides a graphical representation of the financial forecast for the next 20 years.

Lifecycle Activities	Forecast Annual Cost ($000)						
	2020	2021	2022	2023	2024	2025-2030	2030-2040
Operations & maintenance forecast	5,672.2	TBD	TBD	TBD	TBD	TBD	TBD
Total Operations & Maintenance	5,672.2	TBD	TBD	TBD	TBD	TBD	TBD
Capital renewal & rehabilitation forecast	0	TBD	TBD	TBD	TBD	TBD	TBD
Capital new assets & disposal forecast	0	TBD	TBD	TBD	TBD	TBD	TBD
Total Capital	0	TBD	TBD	TBD	TBD	TBD	TBD
Total	5,672.0	TBD	TBD	TBD	TBD	TBD	TBD

Table 8.3 Financial Forecast Summary

Continuous Improvement Indicator

Financial: Tracking financial performance in terms of forecast cost contributes to better understanding of financial sustainability. Continuous improvement performance trends can be tracked through the following indicators:

- Forecast Annual Expenditure
- Forecast Annual Revenue

Assumptions and Limitations

This section details the key assumptions made in completing the financial forecasts of required operating and capital expenditure and asset values, and carrying amount estimates.

Key assumptions made in this AMP and risks that these may change are shown in Table 8.4.

Key Assumptions	Risk of Change to Assumptions
Uses budget information provided by staff at time of plan development	Only current year budget for Operations and maintenance is available.
Unit rate costs for Operations and Maintenance activities have been estimated based on City Operations staff local knowledge	Changes to plant, labour and/or material costs may have a significant impact on the overarching investment requirements and/or budgets
No annexation of additional land from neighbouring municipalities will occur within the 20-year period	If annexations occur, additional unpaved road assets will likely become the City's responsibility. These are currently not budgeted for.

Table 8.4 Key Assumptions made in Financial Forecasting

Funding Requirements

Current Budgets

In the future, required investment levels will be better understood and will inform the development and setting of budgets. Comparing these forecast costs with the current budgeted expenditures for the 20-year period will help identify any possible funding shortfall or surplus. Shortfalls in funding on the maintenance program can lead to accelerated requirements for capital renewal support.

It is expected that the current annual budget set for unpaved roads will be sufficient in delivering appropriate levels of service.

Financial Risks

Table 8.5 lists potential risk issues or events that could impact the financial forecast for delivering the unpaved road service or the revenue available to support current Level of Service. The potential impact and mitigation measures proposed to try to prepare for and reduce any adverse impacts have also been included.

Risk Issue	Potential Impact	Mitigation Measure
External impacts affecting City revenue	Reduction in operations and maintenance budgets	Linking budgets to service levels, enabling budget scenario impacts to be understood.
Increased demand for conversion from unpaved to paved	Increasing capital improvements funding requirements, reduction on maintenance investment needs.	To be determined
Reduced land development	Reduced private investment in conversion of unpaved to paved roads	To be determined

Table 8.5 Financial Risks

9. Improvement Plan

Asset management for the Unpaved Road asset class is continually evolving and maturing. Continuous improvement is an important focus for the City and is a thread that runs through our entire asset management approach.

Improving asset management is a commitment to obtain the greatest benefit from the City's investments in infrastructure. This can be achieved by implementing a consistent and holistic approach to how the City manages our assets.

Improving the AMP

Table 9.1 lists the improvements identified as part of the AMP. Each task has a unique identification number and has been grouped by high, medium, and low priority, where:

- High – To be completed within 1 year
- Medium - To be completed within 1-3 years
- Low - To be completed within 3-5 years

Within those general groupings they are listed in order of the chapter in the AMP that they relate to and have not been further prioritized. More detailed prioritization and scheduling for these tasks is provided in a separate Implementation Strategy document (or appendix).

Task No.	Task Name	Description	Priority
1	Asset Condition	Implement the condition assessment methodology and regime for unpaved road assets.	High
2	Levels of Service Measures	Complete detailed review of initial levels of service measures, including the City's ability and methodology to measure / record data, and refine as needed	Medium
3	Road Geometry Assessment	In order to improve the geometric design features of many existing unpaved roads with the limited resources available, attention should be given to identifying, prioritizing and rectifying sections of road where there are significant design inconsistencies or 'surprises' for motorists.	Medium
4	Road Width Assessment	Improve alignment of road widths with desired geometric design standards, by road class, to ensure efficient transport operations, improved safety and reduced maintenance requirements. Begin addressing deficiencies and areas of over delivery through routine maintenance activities.	Medium
5	Road Crossfall Verification	Implement routine verification of road crossfall following maintenance grading, with the use of a smart level (or similar). Address deficiencies through plant operator training (where issue due to technique) or gravelling	High

		(where wearing course is not deep enough to maintain an adequate crossfall).	
6	Road Alignment Assessment	Assess road alignment to identify alignment deficiencies. Assess whether these are resulting in increased maintenance needs, and whether oiling or paving will reduce whole of life costs.	Medium
7	Roadside Drainage Management	Confirm and document clear roles and responsibilities with regard to the management of the City's drainage infrastructure, including roadside ditches, culverts, and other associated assets.	High
8	Pavement Design	Develop base pavement designs for unpaved roads, by class, to improve value from investment.	Medium
9	Traffic Volumes	Implement a traffic count and estimation program for unpaved road assets, to confirm traffic volumes, vehicle types and, eventually, trends over time.	Medium
10	Subgrade Strength Testing	Consider testing the subgrade strength of unpaved road assets, specifically those requiring extraordinary maintenance.	Medium
11	Operational Service Levels	Consider developing specific operational levels of service (or general intervention strategies) to be used as a guide and communication tool to manage customer expectations.	Medium
12	Critical Assets	Develop criteria for identifying critical assets, identify critical assets and complete a risk assessment to screen for vulnerability and importance.	Medium
13	Annexed Road Classification	Classify the annexed rural roads and manage consistently with roads of similar functional classification.	High
14	Maintenance Intervention Strategy	Develop formal maintenance intervention strategies, detailing work identification and prioritization processes and intervention levels (incorporating road class).	Medium
15	Surface Improvement Justification	Develop formal justification process, possibly linked to Levels of Service, to assess and ensure the upgrade of gravel to oiled road provides value for money.	Medium
16	Uneconomic Road Assessment	Consider process development for possible uneconomic roads; those where the cost to maintain is higher than the benefits provided through traffic usage and socioeconomic functions.	Low
17	Annexation Implications	As part of any future annexation, assess possible new assets and associated maintenance/capital requirements, to estimate implications on existing budgets.	Low

18	Future Development Timeframes	Confirm estimated timeframes for the future development of unpaved road assets (e.g. when they will likely be upgraded to paved road assets) and implement appropriate investment strategies based on timing.	Medium
19	Improvement Plan Implementation	Develop a plan for high priority improvement tasks, with defined budgets, timelines and accountability.	High
20	Improvement Plan Funding	Secure funding and approval of staff time (or external resources as appropriate) to implement high priority improvement tasks.	High
21	Roles and Responsibilities	Review key asset management roles and responsibilities and identify who will fulfill these, reflect in individual job descriptions	Medium
22	Asset Data Review	A full review of current datasets, software and tools, data completeness, accuracy and currency, will help determine what data gaps exist. A data capture plan can be developed for collecting the missing data.	Medium
23	Asset Rehabilitation Assessment	Review unit rates and asset lifespan for each asset group. Complete an assessment of the current total replacement cost of assets owned. Document theoretical useful lives and estimated specific useful lives to support a more accurate future needs assessment.	Medium
24	Data Updating	Design, document and implement procedure for returning field information to asset register and GIS when work is undertaken on any asset.	High
25	Capital Rehabilitation Decision Making	Review and document decision processes for all high priority decisions. Evaluate the decision process for fairness, transparency, repeatability, and robustness.	Medium
26	Funding Implications	Review of forecast expenditure vs funding/revenue streams to establish implications of possible under-funding and asset consumption	Medium
27	Flood Management	Develop forward-looking policies/plans for flood management in rural settings as part of overall City Flood Management Policy/Plans that aim to address the threats related to overland drainage.	Medium

Table 9.1 Improvement Plan

Performance Monitoring

Monitoring, evaluation and reporting on performance is both an opportunity to receive information required to manage assets effectively, and for teams to demonstrate achievement and identify gaps in performance.

Asset class objectives and Continuous Improvement Indicators have been identified within this AMP. Monitoring the performance of these indicators gives an overview of the overall asset management practices performance. Table 9.2 provides a summary of the Continuous Improvement Indicators and the monitoring plan for these.

AMP Section	Continuous Improvement Indicator	Monitoring Plan
Data Confidence	Average confidence grades for critical assets	TBC
Data Confidence	Existing confidence grades and target confidence grades for unpaved road assets	TBC
Asset Condition	Average condition state of assets	TBC
Asset Condition	Minimum condition state of assets	TBC
Asset Condition	Average Remaining Useful Life of assets	TBC
Levels of Service	Percentage of Levels of Service performance measures for which current performance is recorded	TBC
Levels of Service	Percentage of Levels of Service performance measures for which current performance meets target performance	TBC
Risk Management	Number of risks mitigated or removed	TBC
Financial	Forecast Annual Expenditure	TBC
Financial	Forecast Annual Revenue	TBC

Table 9.2 Continuous Improvement Performance Monitoring

The Continuous Improvement Indicators are monitored and reported on annually. Results will be reported as an annual summary against target outcomes.

Evaluation & Lessons Learned

As part of the Continuous Improvement Indicators annual reporting process, results are evaluated for gaps in performance and key lessons learned are developed. A summary of these outcomes is included in Table 9.3.

At the time of writing this iteration of the plan, improvement indicators have not been identified however the table is included as a place holder.

Continuous Improvement Indicator	Performance Gaps	Lessons Learned
Average confidence grades for critical assets	To be determined	To be determined
Existing confidence grades and target confidence grades for unpaved road assets	To be determined	To be determined
Average condition state of assets	To be determined	To be determined
Minimum condition state of assets	To be determined	To be determined
Average Remaining Useful Life of assets	To be determined	To be determined
Percentage of Levels of Service performance measures for which current performance is recorded	To be determined	To be determined
Percentage of Levels of Service performance measures for which current performance meets target performance	To be determined	To be determined
Number of risks mitigated or removed	To be determined	To be determined
Forecast Annual Expenditure	To be determined	To be determined
Forecast Annual Revenue	To be determined	To be determined

Table 9.3 Gap Analysis & Lessons Learned

Review of This Plan

This asset management plan is treated as a live document, and where applicable, it has been updated as changes occured. The AMP will be reviewed and finalized on a 4-year basis.

1. Appendices

Appendix A – Corporate Business Plan Service Objectives & Strategic Actions

Appendix B – Responsibility Assignment Matrix

Appendix C - Unpaved Roads Maintenance Guide (Draft)

Appendix D - Unpaved Road Condition Assessment Guide

Appendix E – Plans in Effect

Appendix F - Surface Selection Matrix (Draft)

Appendix F - Surface Selection Matrix (Draft)

A	B	C	D	E	F	G	Score
Functional Classification	**Traffic Volume**	**Truck Volume**	**Residential Access**	**Dust Nuisance**	**Maintenance Requirements**	**Traffic Environment**	
Industrial	<20	<5	<10	<5	Significantly less than average	Low Speed / Minimal Intersections	**1**
Residential	20-50	5-10	10-25	5-10	Less than average	Medium Speed / Minimal Intersections	**2**
	50-100	10-25	25-50	10-25	About average	High Speed / Minimal Intersections	**3**
Collector	100-250	25-50	50-100	25-50	More than average	Medium Speed / Frequent Intersections	**4**
Arterial	>250	>50	>100	>50	Significantly more than average	High Speed / Frequent Intersections	**5**

Total Score = A + B + C + D + E + F + G

If Total Score is less than 15, gravel surface is suitable

If Total Score is between 15 and 25, an oil surface is appropriate

If Total Score is greater than 25, a paved surface is appropriate

Definitions

- **Functional Classification;** the functional class of the road as per the City's existing classification
- **Traffic Volume;** the average annual daily traffic volume, based on count (where available) or estimate (where count not available)
- **Truck Volume;** the average annual daily truck (I.e. heavy commercial vehicle) volume, based on count (where available) or estimate (where count not available)

- **Residential Access;** the density (estimated number per kilometer) of residential houses (on both sides of the road) accessed from the road
- **Dust Nuisance;** the density (estimated number per kilometer) of residential houses, commercial premises, and community facilities (school, hall, etc.) within a 60m radius of the road
- **Maintenance Requirements;** a basic engineering assessment of the roads current maintenance needs (e.g. required grading frequency) when compared to other unpaved roads
- **Traffic Environment;** a basic engineering assessment of the speeds and frequency of intersections along the road being assessed