City of Royal Oak
2023 Transportation
Asset Management Plan

A plan describing the City of Royal Oak's transportation assets and conditions

Prepared by:
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CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

EXECUTIVE SUMMARY

As conduits for commerce and connections to vital services, roads and bridges are some of the most important assets in any community, and other assets like culverts, traffic signs, traffic signals, and utilities support and affect roads and bridges. The City of Royal Oak's (City) roads, and support systems are also some of the most valuable and extensive public assets, all of which are paid for with taxes collected from citizens and businesses. The cost of building and maintaining these assets, their importance to society, and the investment made by taxpayers all place a high level of responsibility on local agencies to plan, build, and maintain roads, bridges, and support assets in an efficient and effective manner. This asset management plan is intended to report on how the City is meeting its obligations to maintain the public assets for which it is responsible.

This plan identifies the City's assets and condition and how the City maintains and plans to improve the overall condition of those assets. An asset management plan is required by Michigan Public Act 325 of 2018, and this document represents fulfillment of some of the City's obligations towards meeting these requirements. However, this plan and its supporting documents are intended to be much more than a fulfillment of required reporting. This asset management plan helps to demonstrate the City's responsible use of public funds by providing elected and appointed officials as well as the general public with the inventory and condition information of the City's assets, and it gives taxpayers the information they need to make informed decisions about investing in the City's essential transportation infrastructure.

INTRODUCTION

Asset management is defined by Public Act 325 of 2018 as “an ongoing process of maintaining, preserving, upgrading, and operating physical assets cost effectively, based on a continuous physical inventory and condition assessment and investment to achieve established performance goals”. In other words, asset management is a process that uses data to manage and track assets, like roads and bridges, in a cost-effective manner using a combination of engineering and business principles. This process is endorsed by leaders in municipal planning and transportation infrastructure, including the Michigan Municipal League, County Road Association of Michigan, the Michigan Department of Transportation (MDOT), and the Federal Highway Administration (FHWA). The City of Royal Oak is supported in its use of asset management principles and processes by the Michigan Transportation Asset Management Council (TAMC), formed by the State of Michigan.

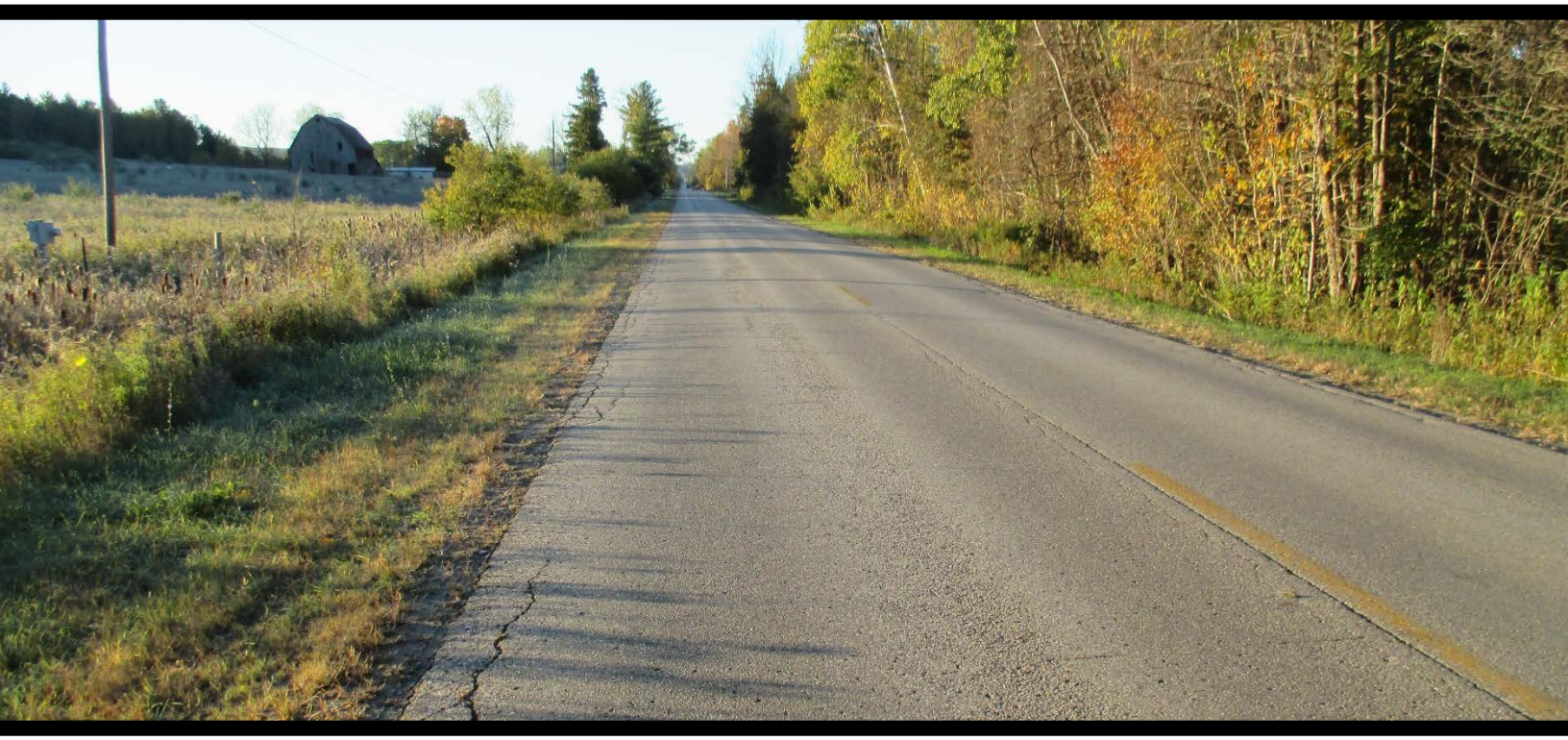
Asset management, in the context of this plan, ensures that public funds are spent as effectively as possible to maximize the condition of the road and bridge network. Asset management also provides a transparent decision-making process that allows the public to understand the technical and financial challenges of managing transportation infrastructure with a limited budget.

The City of Royal Oak (City) has adopted an “asset management” business process to overcome the challenges presented by having limited financial, staffing, and other resources while needing to meet road users’ expectations. The City is responsible for maintaining and operating over 217.783 centerline miles of roads and 0 bridge structures. It is also responsible for 0 culverts and 84 signals.

This 2023 plan identifies the City’s transportation assets and their condition as well as the strategy that the City uses to maintain and upgrade particular assets given the City’s condition goals, priorities of network’s road users, and resources. An updated plan is to be released approximately every three years both to comply with Public Act 325 and to reflect changes in road conditions, finances, and priorities.

Questions regarding the use or content of this plan should be directed to Holly Donoghue, P.E.at 203 S. Troy Street, Royal Oak, Michigan 48067 or at (248)246-3260 and/or engineering@romi.gov.

1. PAVEMENT ASSETS



The City is responsible for 220.575 centerline miles of public roads. An inventory of these miles divides them into different network classes based on road purpose/use and funding priorities as identified at the state level: city major road network, which is prioritized for state-level funding, and city local road network.

Inventory of Assets

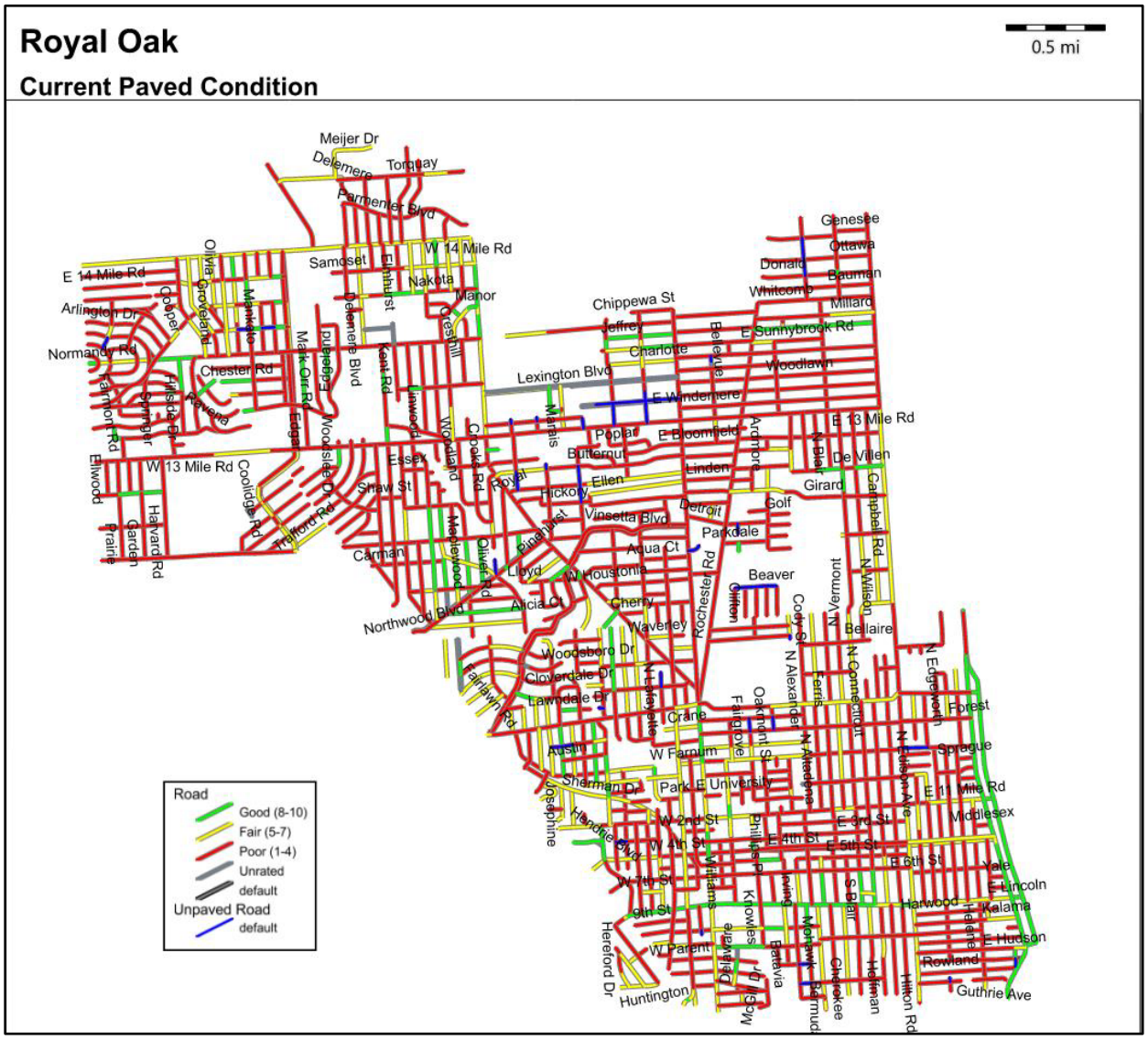


Figure 1: Map showing location or roads managed by the City and the current condition for paved roads in green for good (PASER 10, 9, 8), yellow for fair (PASER 7, 6, 5), and red for poor (PASER 4, 3, 2, 1) and for unpaved roads in blue

Of the City's 220.575 miles of road, 71.683 miles are classified as city major and 148.892 miles are classified as city local (Figure 1identifies these paved roads in green, yellow, and red with the colors

being determined based on the road segment's condition). The City also manages 12.385 miles that are classified as part of the National Highway System (NHS); the NHS is subject to special rules and regulations and has its own performance metrics dictated by the FHWA. In addition, the City has 3.05 miles of unpaved roads (Figure 1 identifies these unpaved roads in blue).

More detail about these road assets can be found in the City's Roadsoft database or by contacting the City.

Types

The City has multiple types of pavements in its jurisdiction, including asphalt, concrete, and undefined; it also has unpaved roads (i.e., gravel and/or earth). Figure 2 shows a breakdown of these pavement types for all of the City's road assets.

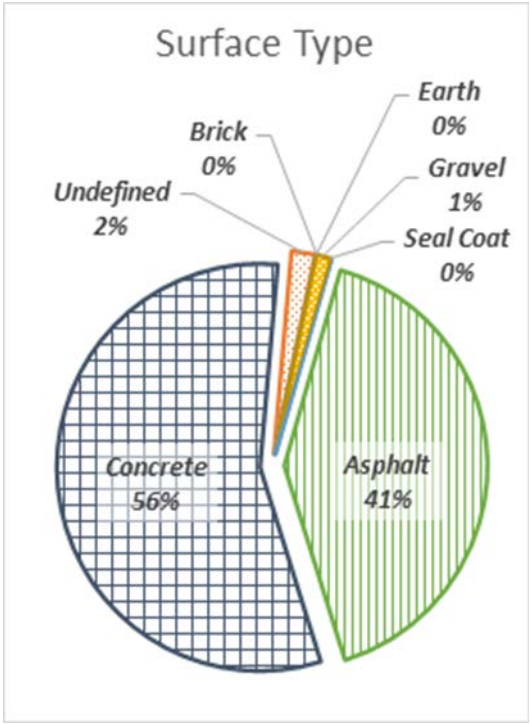


Figure 2: Pavement type by percentage maintained by the City. Undefined pavements have not been inventoried in the City's asset management system to date, but will be included as data becomes available.

Condition, Goals, and Trend

Paved Roads

Paved roads in Michigan are rated using the Pavement Surface Evaluation and Rating (PASER) system, which is a 1 to 10 scale with 10 being a newly constructed surface and 1 being a completely failed surface. PASER scores are grouped into TAMC definition categories of good (8-10), fair (5-7), and poor (1-4) categories. The City collects PASER data every two years on 100 percent of those portions of its city major and city local networks that are eligible for federal funding. In addition, the City uses its own staff and resources to collect PASER data on 100 percent of its city major and city local networks that are not eligible for federal funding.

Currently, the city major network has 14% of its roads in good condition, 32% in fair condition, and 55% in poor condition, and the city local network has 16% of its roads in good condition, 46% in fair condition, and 39% in poor condition (Figure 3 and Figure 4). The City's long-range goal for the city major network is to have 34% of roads in good condition, 14% in fair condition, and 52% in poor condition, and for the city local network is to have 10% of roads in good condition, 40% in fair condition, and 50% in poor condition (Figure 3 and Figure 4). Figure 3 and Figure 4 illustrate the historical and current condition (solid bars) of the City's city major and city local networks, respectively; they also illustrate the projected trend (shaded bars), the overall trend in condition (trendlines), and the City's goal (final solid bar).

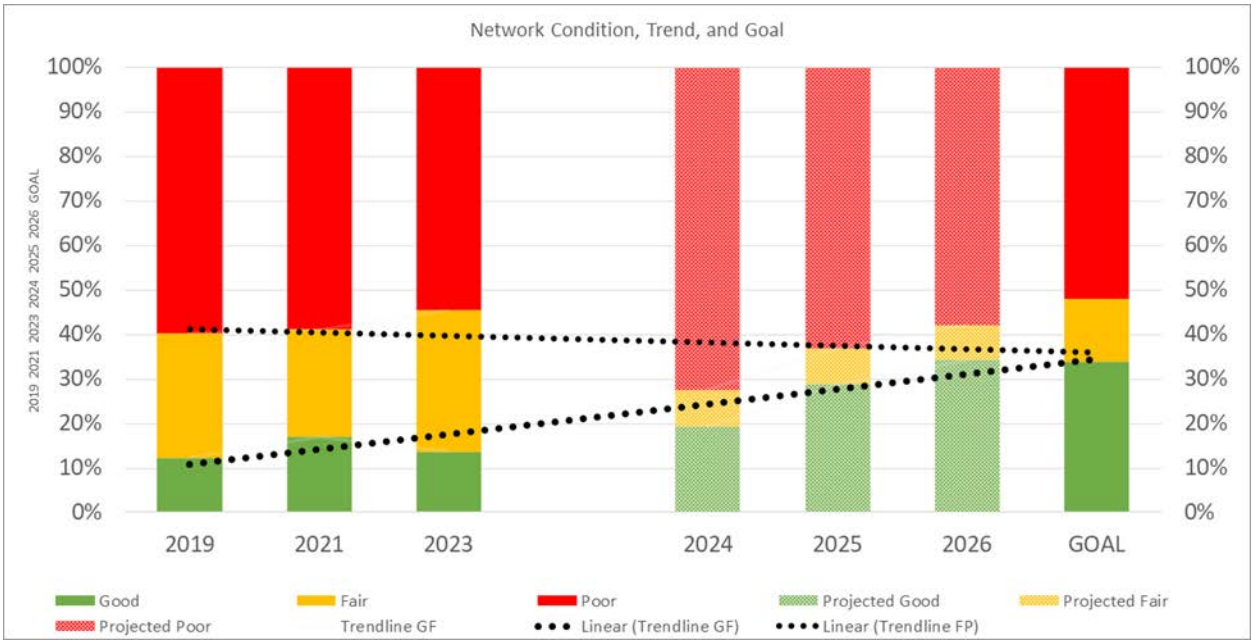


Figure 3: City major network condition, goals, and trend

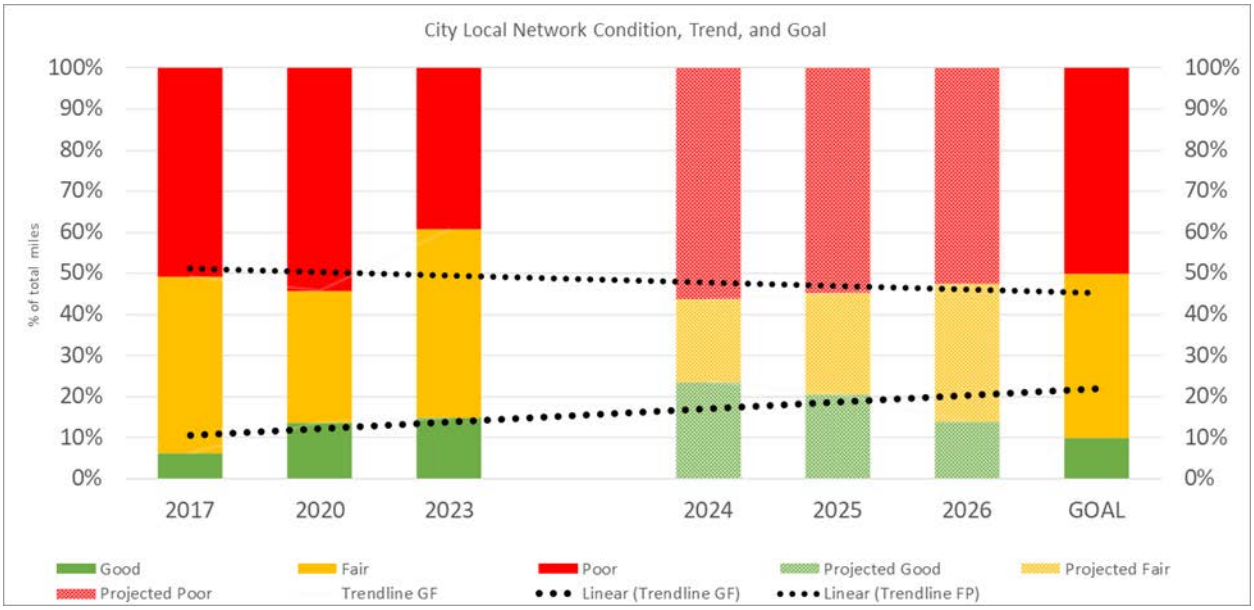


Figure 4: City local network condition, goals, and trend

Unpaved Roads

Unpaved roads rated with the Inventory-based Rating System™ receive an IBR number ranging from 1 to 10, with a 9 or 10 (less than one year old) having good surface width, good or fair drainage, and good structural adequacy and a 1 having poor surface width, poor drainage, and poor structural adequacy. IBR numbers can be grouped in a similar fashion as the TAMC definitions into good (8-10), fair (5-7), and poor (1-4) categories. Figure 5 illustrates the historical and/or current condition (solid bar[s]), the projected trend (shaded bars), and the City's goal (final solid bar).

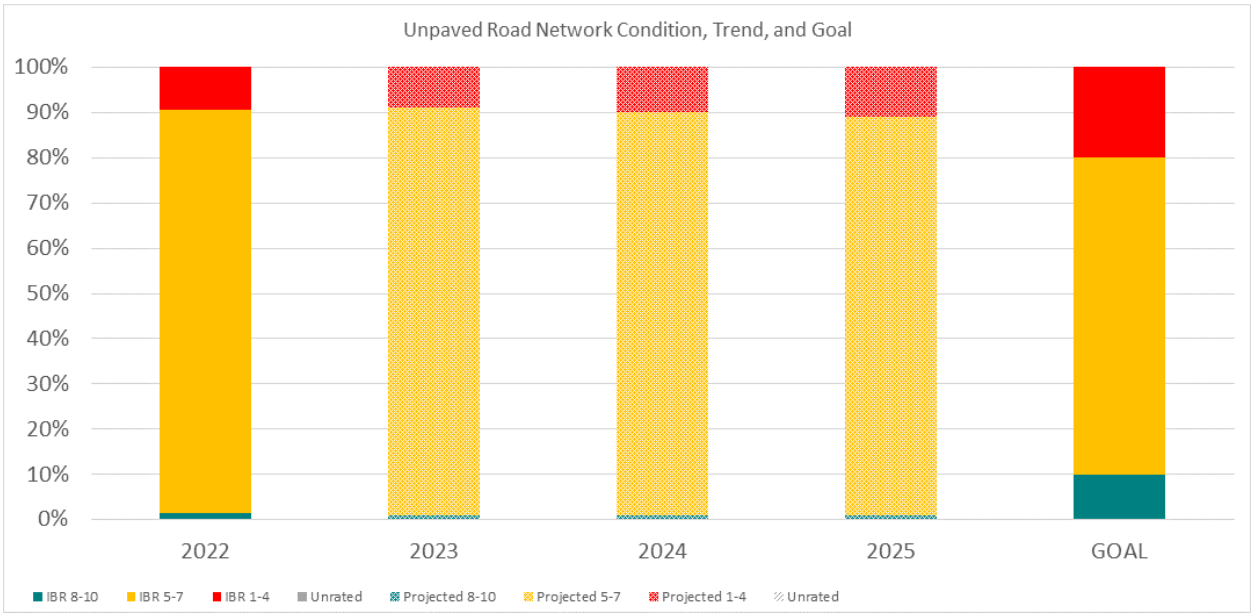


Figure 5: Distribution of IBR numbers for current condition (solid) and for goals (dotted)

Modelled Trends, Gap Analysis, and Planned Projects

Table 1: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for City's Road Assets

Major Roads (<70.342 miles)

Treatment	Annual Miles of Treatment	Years of Life	Trigger-Reset	Pavement Condition Forecast			
				Annual Miles of Treatment	Trigger-Reset	Annual Miles of Treatment	Trigger-Reset
Crack Seal	25	1	6, 7–7	25	6, 7–7	5	6, 7–7
Chip Seal	0	5	5, 6-8	0	5, 6-8	0	5, 6-8
Overlay	0	10	4, 5-9	0	4, 5-9	0	4, 5-9
Resurfacing	3	15	2, 3, 4-,9	3	2, 3, 4-,9	3	2, 3, 4-,9
Slab Repair	0	15	3, 4, 5, 6-8	0	3, 4, 5, 6-8	1	3, 4, 5, 6-8
Reconstruction	0	30	1, 2, 3-10	0	1, 2, 3-10	1	1, 2, 3-10

Local Roads (147.441 miles)

Treatment	Annual Miles of Treatment	Years of Life	Trigger-Reset	Pavement Condition Forecast		Additional Work Necessary to Overcome Deficit	
				Annual Miles of Treatment	Trigger-Reset	Annual Miles of Treatment	Trigger-Reset
Crack Seal	25	1	6, 7–7	25	6, 7–7	22	6, 7–7
Chip Seal	0	5	5, 6-8	0	5, 6-8	0	5, 6-8
Overlay	0	10	4, 5-9	0	4, 5-9	0	4, 5-9
Resurfacing	4	15	2, 3, 4-,9	4	2, 3, 4-,9	4	2, 3, 4-,9
Slab Repair	11	15	3, 4, 5, 6-8	11	3, 4, 5, 6-8	8	3, 4, 5, 6-8
Reconstruction	1	30	1, 2, 3-10	1	1, 2, 3-10	0	1, 2, 3-10

Modelled Trends & Gap Analysis

The Roadsoft network analysis of the City's planned projects for the city major and city local networks from the City's presumed budget (including the millage renewal) does allow the City to reach its pavement condition goals given the projects planned for the next three years.

Results from the Roadsoft for the city major and city local network condition models indicates that there is not a need for any additional work to meet the agency condition goal as long as the millage renewal is passed.

Unpaved Road Condition Trends

The City's unpaved road network is expected to remain in similar condition as only maintenance is planned to be performed except for some isolated instances where adjoining property owners petitioned to be specially assessed to pave those segments.

Planned Projects

The City has projects planned for the next three years. These projects are identified in Figure 6.

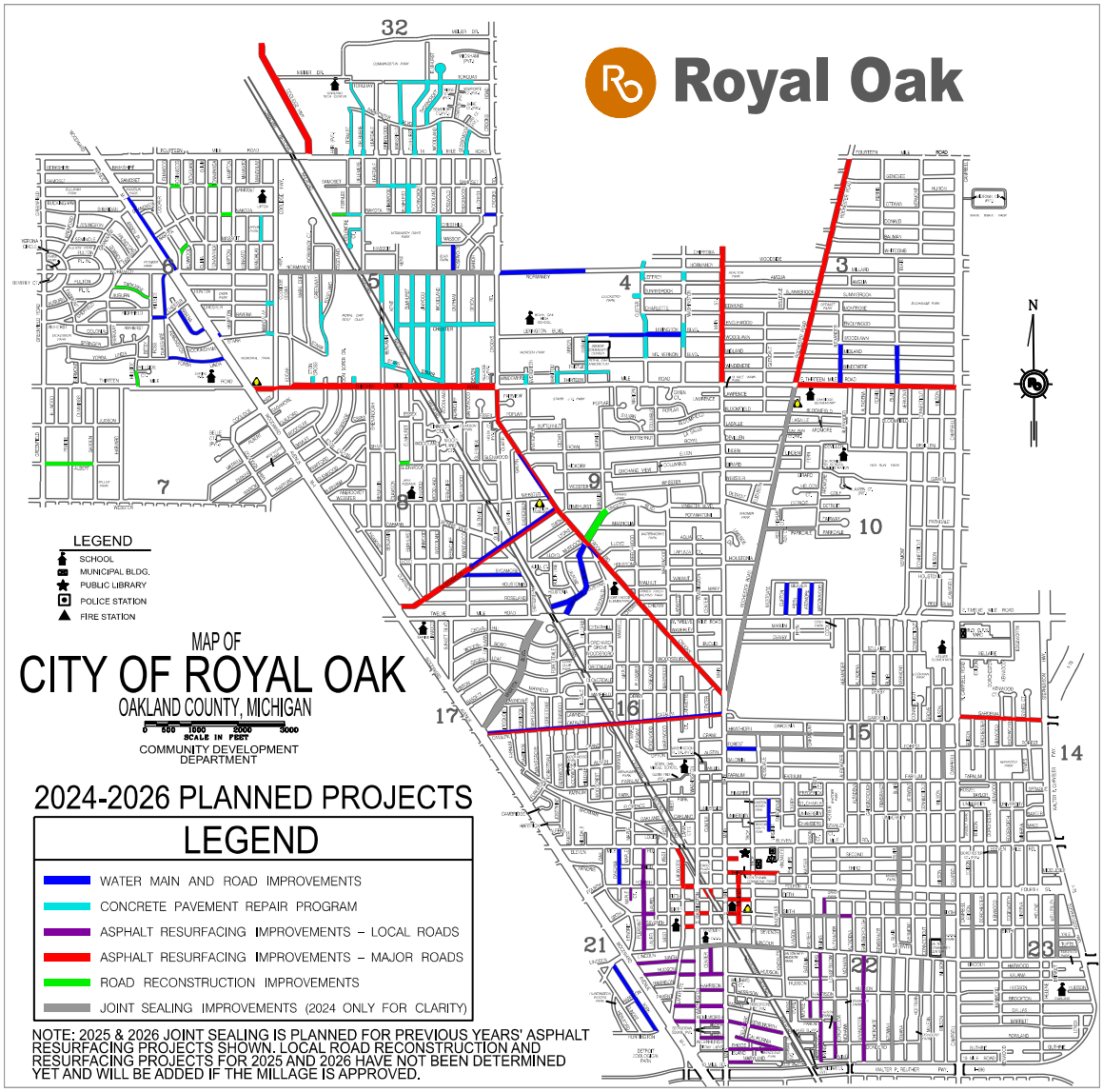


Figure 6: Map illustrating planned projects for pavement assets

The total cost of the projects illustrated in Figure 6 is approximately $36,565,000.

2. BRIDGE ASSETS

The City is not responsible for maintenance of any bridges. The only bridges in the city are on freeways (state jurisdiction) and at railroad crossings (railroad jurisdiction).

3. CULVERT ASSETS

The City is not responsible for maintenance of any culverts.

4. SIGNAL ASSETS

The City exercises awareness of its traffic sign and signal assets. Many of the City's signals are old and the City budgets for equipment replacements each year when issues arise.

Inventory of Assets

At present, the City tracks only inventory data for traffic signals. The City has inventoried 84 traffic signals, which is 100 percent of the actual 84 traffic signals that the City owns.

More detail about these traffic signal assets can be obtained by contacting the City.

Goals

The goal of the City's asset management program is the preservation of its traffic signals. The City is responsible for preserving 84 inventoried traffic signals as well as any un-inventoried traffic signals along its entire road network.

Planned Projects

The City's policy is to evaluate traffic signal assets based on condition assessment for replacement or repair during any reconstruction, rehabilitation, preventive maintenance, of schedule maintenance activities on the roadway affected by the particular signal. It also conducts replacements or repairs for those traffic signal assets reported as non-functional or as performing with reduced function. The City adheres to regular maintenance and servicing policies outlined in the *Michigan Manual of Uniform Traffic Control Devices*.

The City is nearing completion of traffic signal upgrades to 26 intersections and will begin work to install countdown pedestrian signal upgrades to 24 locations throughout the city this fall. These projects have respectively been primarily funded by Congestion Mitigation and Air Quality (CMAQ) grants, Highway Safety Improvement Program (HSIP) grants, Downtown Development Area taxes, and with some matching funds from the city's major road fund.

5. FINANCIAL RESOURCES

Public entities must balance the quality and extent of services they can provide with the tax resources provided by citizens and businesses, all while maximizing how efficiently funds are used. Therefore, the City will overview its general expenditures and financial resources currently devoted to transportation infrastructure maintenance. This financial information is not intended to be a full financial disclosure or a formal report. Full details of the City's financial status can be found by request submitted to our agency contact (listed in this plan).

Anticipated Revenues & Expenses

The City receives funding from the following sources:

- **State funds** – The City's principal source of transportation funding is received from the Michigan Transportation Fund (MTF). This fund is supported by vehicle registration fees and the state's per-gallon gas tax. Allocations from the MTF are distributed to state and local governmental units based on a legislated formula, which includes factors such as population, miles of certified roads, and vehicle registration fees for vehicles registered in the agency's jurisdiction. Examples of state grants also include local bridge grants, economic development funds, and metro funds.
- **Federal and state grants for individual projects** – These are typically competitive funding applications that are targeted at a specific project type to accomplish a specific purpose. These may include safety enhancement projects, economic development projects, or other targeted funding. Examples of federal funds include Surface Transportation Program (STP) funds, C and D funds, bridge funds, MDOT payments to private contractors, and negotiated contracts.

- **Local government entities or private developer contributions to construction projects for specific improvements** – This category includes funding received to mitigate the impact of commercial developments as a condition of construction of a specific development project, and can also include funding from a special assessment district levied by another governmental unit. Examples of contributions from local units include city, village, and township contributions to the county; special assessments; county appropriations; bond and note proceeds; contributions from counties to cities and villages; city general fund transfers; city municipal street funds; capital improvement funds; and tax millages (see below).

- **Local tax millages** – Many local agencies in Michigan use local tax millages to supplement their road-funding budget. These taxes can provide for additional construction and maintenance for new or existing roads that are also funded using MTF or MDOT funds. The City has local tax millages in its road-funding budget. The City of Royal Oak voters approved a 2.5-mil, 10-year road millage in 2014. The intent of the millage is to improve local roads from 2015 through 2024.

- **Interest** – Interest from invested funds.

- **Permit fees** – Generally, permit fees cover the cost of a permit application review.

- **Other** – Other revenues can be gained through salvage sales, property rentals, land and building sales, sundry refunds, equipment disposition or installation, private sources, and financing.

- **Charges for services** – Funds from partner agencies who contract with the City to construct or maintain its roads, or roads under joint or neighboring jurisdictions, including state trunkline maintenance and non-maintenance services and preservation.

The City is required to report transportation fund expenditures to the State of Michigan using a prescribed format with predefined expenditure categories. The definitions of these categories according to Public Act 51 of 1951 may differ from common pavement management nomenclature and practice. For the purposes of reporting under PA 51, the expenditure categories are:

- **Construction/Capacity Improvement Funds** – According to PA 51 of 1951, this financial classification of projects includes, "new construction of highways, roads, streets, or bridges, a project that increases the capacity of a highway facility to accommodate that part of traffic having neither an origin nor destination within the local area, widening of a lane width or more, or adding turn lanes of more than 1/2 mile in length."[1]

- **Preservation and Structural Improvement Funds** – Preservation and structural improvements are "activit[ies] undertaken to preserve the integrity of the existing roadway system."[2] Preservation includes items such as a reconstruction of an existing road or bridge, or adding structure to an existing road.

- **Routine and Preventive Maintenance Funds** – Routine maintenance activities are "actions performed on a regular or controllable basis or in response to uncontrollable events upon a

[1] Public Act 51 of 1951, 247.660c Definitions
[2] Public Act 51 of 1951, 247.660c Definitions

highway, road, street, or bridge".[3] Preventive maintenance activities are "planned strategy[ies] of cost-effective treatments to an existing roadway system and its appurtenances that preserve assets by retarding deterioration and maintaining functional condition without significantly increasing structural capacity".[4]

- **Winter Maintenance Funds** – Expenditures for snow and ice control.
- **Trunkline Maintenance Funds** – Expenditures spent under the City's maintenance agreement with MDOT for maintenance it performs on MDOT trunkline routes.
- **Administrative Funds** – There are specific items that can and cannot be included in administrative expenditures as specified in PA 51 of 1951. The law also states that the amount of MTF revenues that are spent on administrative expenditures is limited to 10 percent of the annual MTF funds that are received.
- **Other Funds** – Expenditures for equipment, capital outlay, debt principal payment, interest expense, contributions to adjacent governmental units, principal, interest and bank fees, and miscellaneous for cities and villages.

The Table (below) details the revenues and expenditures for the City.

Table 2: Annual Fiscal-Year Revenues & Expenditures per Fiscal Year

REVENUES			EXPENDITURES		
Item	**Estimated $**	**Percent of Total**	**Item**	**Estimated $**	**Percent of Total**
State funds	7,395,518	49.9	Construction & capacity improvement (CCI)	0	0.0
Federal funds	0	0.0	Preservation & structural improvement (PSI)	11,390,624	76.7
Contributions for local units	7,238,171	48.9	Routine maintenance	685,247	4.6
Interest, rents, and other	181,253	1.2	Winter maintenance	682,666	4.6
Charges for services	0	0.0	Trunkline maintenance	0	0.0
			Administrative	307,656	2.1
			Other	1,791,455	12.1
TOTAL	14,814,942	100	TOTAL	14,857,648	100

City's information can be found in the TAMC dashboard at https://www.mcgi.state.mi.us/mitrp/tamcDashboards.*
*(*latest available City data is from 2021).*

[3] Public Act 51 of 1951, 247.660c Definitions
[4] Public Act 51 of 1951, 247.660c Definitions

6. RISK OF FAILURE ANALYSIS

Transportation infrastructure is designed to be resilient. The system of interconnecting roads and bridges maintained by the City provides road users with multiple alternate options in the event of an unplanned disruption of one part of the system. There are, however, key links in the transportation system that may cause significant inconvenience to users if they are unexpectedly closed to traffic. Key transportation links include:

- **Geographic divides:** Areas where a geographic feature (river, lake, hilly terrain, or limited access road) limits crossing points of the feature; bridge failures, in particular, can create loss of access to entire regions of the state
- **Emergency alternate routes for high-volume roads and bridges:** Roads and bridges that are routinely used as alternate routes for high-volume assets are included in an emergency response plan
- **Limited access areas:** Roads and bridges that serve remote or limited access areas that result in long detours if closed
- **Main access to key commercial districts:** Areas with a large concentration of businesses or where large-size business will be significantly impacted if a road is unavailable
- Our road network includes the following critical assets: 11 Mile Road, 13 Mile Road, 14 Mile Road, Stephenson Highway, Campbell Road, and Main Street. Other critical assets include Woodward Avenue and a portion of 10 Mile Road (State jurisdictions) and Greenfield Road, 10 Mile Road, 12 Mile Rd, and a portion of 14 Mile Road (Oakland County jurisdictions). The City does not have any bridges within our boundaries, but bridges within Royal Oak exist under

MDOT or railroad jurisdictions. Figure 7 illustrates the key transportation links in the City's road and bridge network.

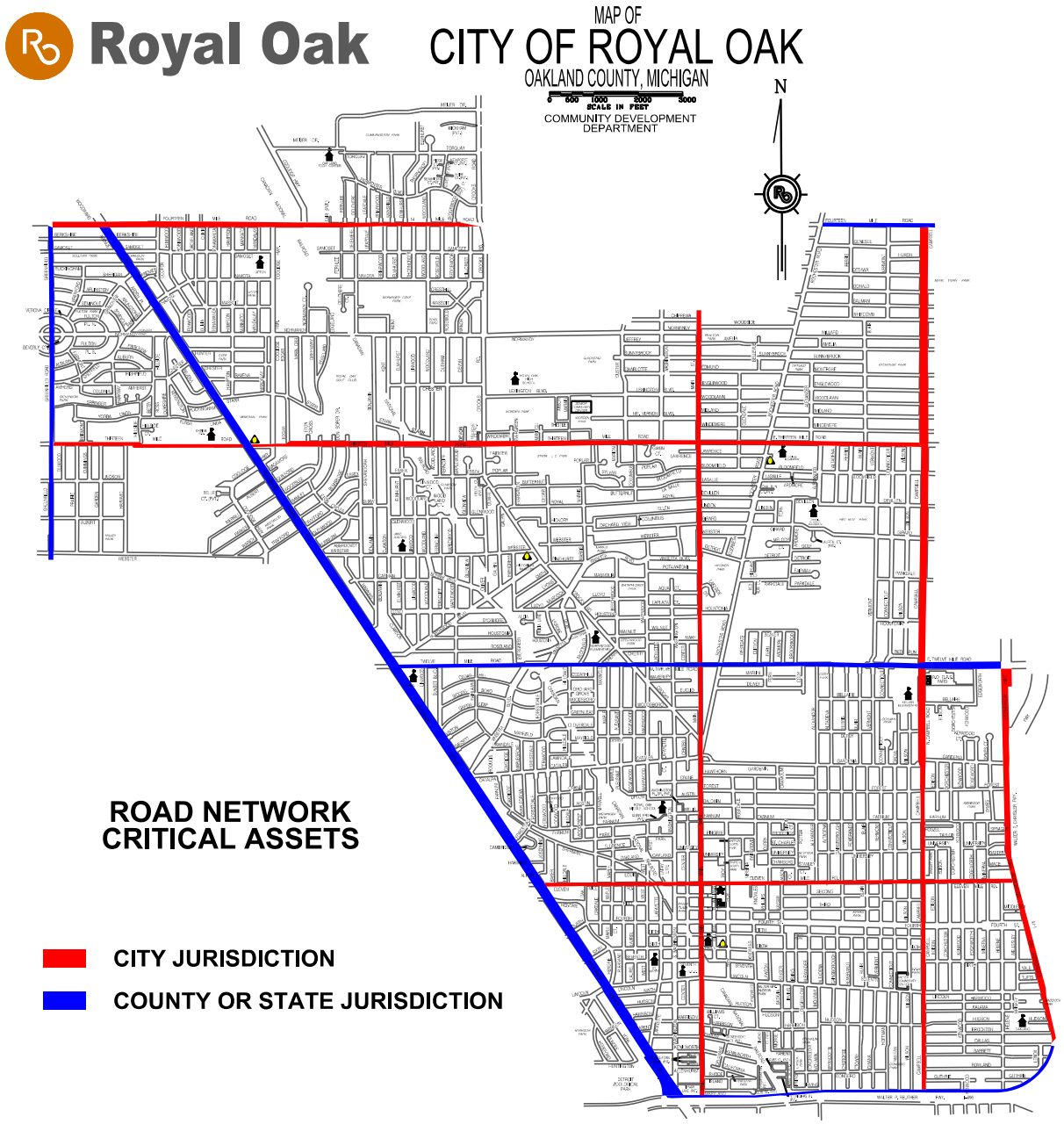


Figure 7: Key transportation links in the City's road and bridge network

7. COORDINATION WITH OTHER ENTITIES

An asset management plan provides a significant value for infrastructure owners because it serves as a platform to engage other infrastructure owners using the same shared right of way space. The City communicates with both public and private infrastructure owners to coordinate work in the following ways:

The Royal Oak Engineering Division works closely with the Royal Oak Department of Public Services (DPS) to identify problematic water and sewer locations within the city to ensure they are addressed prior to significant road work. Additionally, sewers are televised prior to road projects, and water mains are upgraded when appropriate and where recommended by the city's water asset management plan. The City also works with Consumers Energy Company to plan for future work as there are many gas mains and services that require upgrading within the City. The City works to coordinate sub-surface utility plans with transportation infrastructure plans to maximize value and minimize service disruptions and cost to the public.

The City takes advantage of coordinated infrastructure work to reduce cost and maximize value using the following policies:

- Roads which are in poor condition that have a subsurface infrastructure project planned which will destroy more than half the lane width will be rehabilitated or reconstructed full width using transportation funds to repair the balance of the road width.
- Subsurface infrastructure projects which will cause damage to pavements in good condition will be delayed as long as possible, or methods that do not require pavement cuts will be considered.
- Subsurface utility projects will be coordinated to allow all under pavement assets to be upgraded in the same project regardless of ownership.

- Subsurface utilities not owned by the City are directed to be installed within the greenbelt portion of roadways to avoid roadway disruption as much as possible.
- Road reconstruction projects will not be completed until agency owned sub surface utilities are upgraded to have at least a 40 years of remaining service life.

8. PROOF OF ACCEPTANCE

PUBLIC ACT 325

CERTIFICATION OF TRANSPORTATION ASSET MANAGEMENT PLAN

Certification Year: 2023

Local Road-owning Agency Name: City of Royal Oak

Beginning October 2019 and on a three-year cycle thereafter, certification must be made for compliance to Public Act 325. A local road-owning agency with 100 certified miles or more must certify that it has developed an asset management plan for the road, bridge, culvert, and traffic signal assets. Signing this form certifies that the hitherto referred agency meets with minimum requirements as outlined by Public Act 325 and agency-defined goals and objectives.

This form must be signed by the chairperson of the local road-owning agency or the county executive and chief financial officer of the local road-owning agency.

Signature	Signature Debra A. Lichtenberg
Printed Name Michael Fornier	Printed Name Debra Peck-Lichtenberg
Title Mayor	Title Finance Director
Date 9-25-23	Date 9-18-23

Due every three years based on agency submission schedule

Submittal Date: 9-25-23

See attached council meeting minutes and/or resolution at the end of Appendix A (2023 Pavement Asset Management Plan).

Royal Oak
Life Now Playing

At a Regular Meeting of the Royal Oak City Commission held on Monday September 25, 2023 in City Hall, 203 South Troy Street, the following Resolution was adopted:

Be it resolved, the city commission hereby approves the Royal Oak 2023 Transportation Asset Management Plan and directs staff to submit the plan to the transportation asset management council.

I hereby certify that the foregoing is a true and correct copy of a Resolution adopted by the Royal Oak City Commission at a meeting held on September 25, 2023.

Melanie Halas

Melanie Halas, City Clerk

A. PAVEMENT ASSET MANAGEMENT PLAN

An attached pavement asset management plan follows.

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2023 Pavement
Asset Management Plan

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Prepared by:
Stephen Johnson, P.E.
Civil Engineer III

City of Royal Oak
Engineering Division
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Royal Oak, MI 48067

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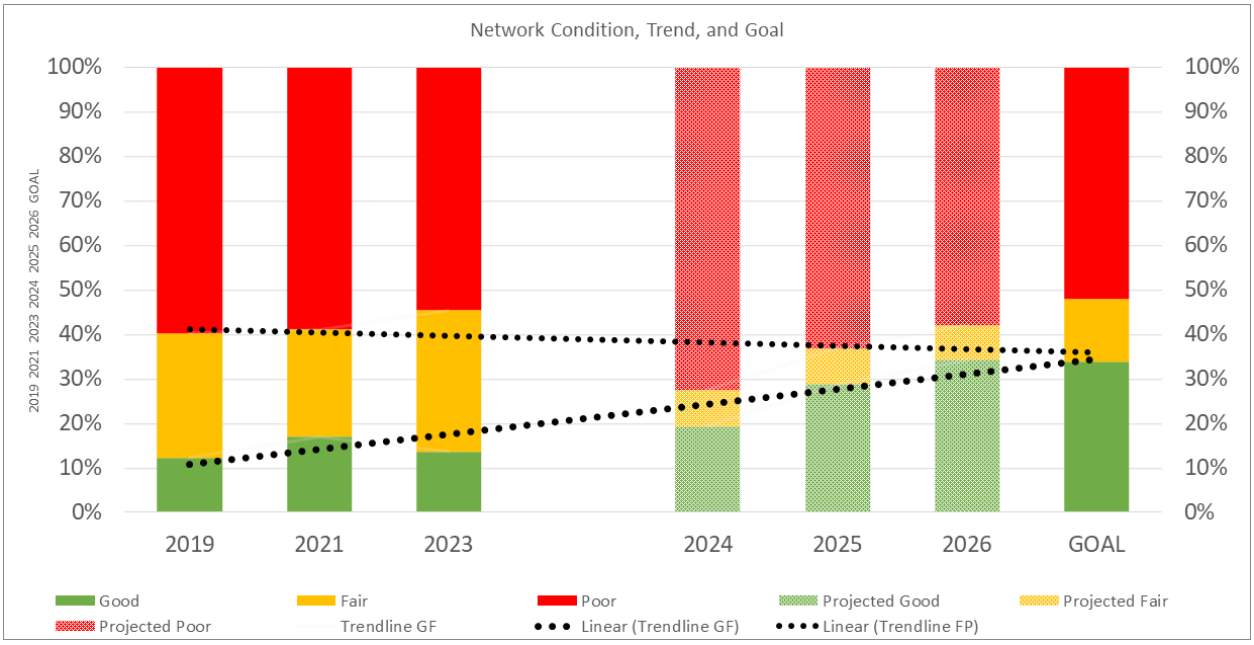
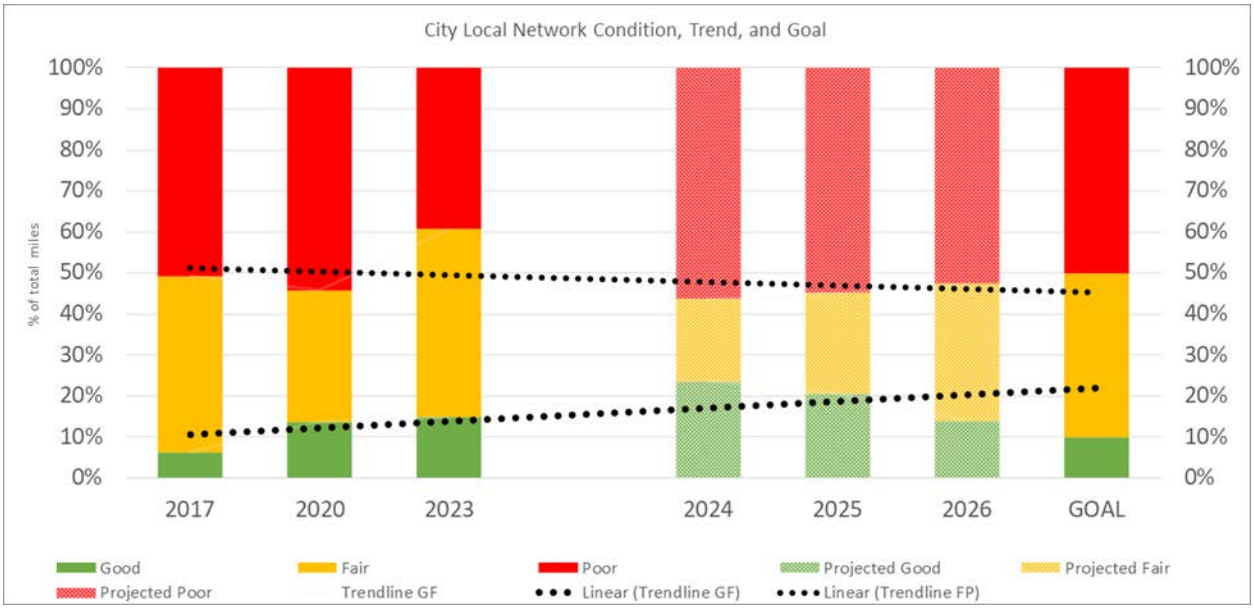
This plan overviews the City's road assets and condition, and explains how the City works to maintain and improve the overall condition of those assets. These explanations can help answer the following questions:

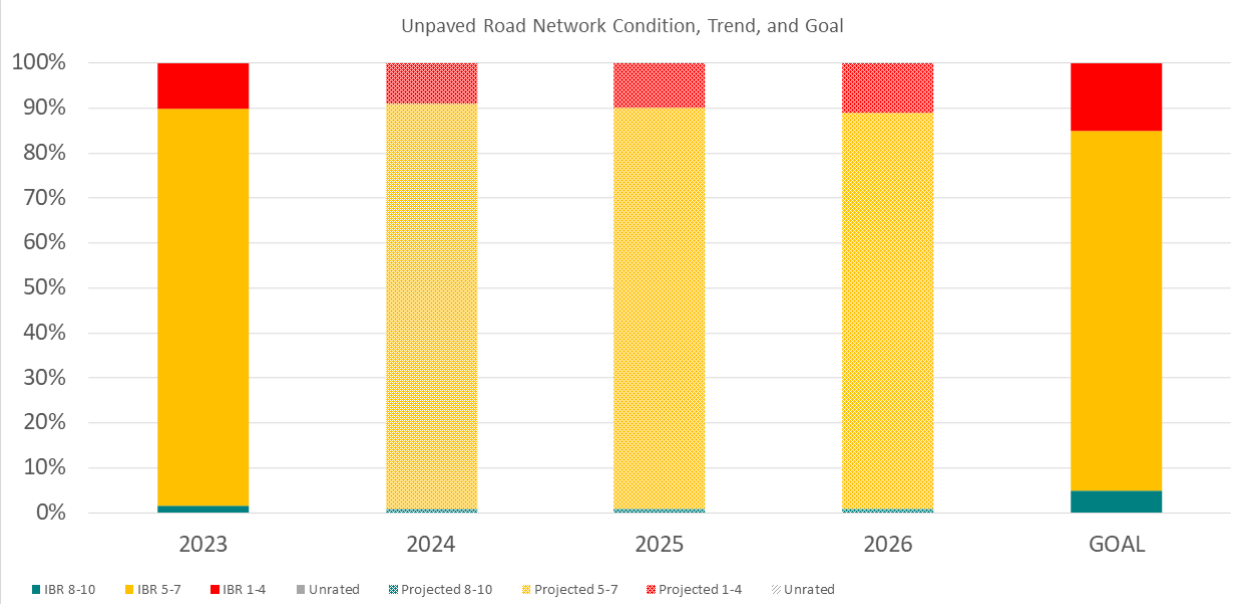
- What kinds of road assets the City has in its jurisdiction, who owns them, and the different options for maintaining these assets.
- What tools and processes the City uses to track and manage road assets and funds.
- What condition the City's road assets are in compared to statewide averages.
- Why some road assets are in better condition than others and the path to maintaining and improving road asset conditions through proper planning and maintenance.
- How agency transportation assets are funded and where those funds come from.
- How funds are used and the costs incurred during the City's road assets' normal life cycle.
- What condition the City can expect its road assets if those assets continue to be funded at the current funding levels
- How changes in funding levels can affect the overall condition of all of the City's road assets.

The City owns and/or manages 220.575 centerline of roads. This road network can be divided into the city major network, the city local network, the unpaved road network, and the National Highway System (NHS) network based on the different factors these roads have that influence asset management decisions. A summary of the City historical and current network conditions, projected trends, and goals for city major network and city local network can be seen in the two following figures:


Network Condition, Trend, and Goal
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2019 2021 2023 2024 2025 2026 GOAL
2019
2021
2023
2024
2025
2026
GOAL
Good
Fair
Poor
Projected Good
Projected Fair
Projected Poor
Trendline GF
Linear (Trendline GF)
Linear (Trendline FP)


City Local Network Condition, Trend, and Goal
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% of total miles
2017
2020
2023
2024
2025
2026
GOAL
Good
Fair
Poor
Projected Good
Projected Fair
Projected Poor
Trendline GF
Linear (Trendline GF)
Linear (Trendline FP)

A summary of the City historical and current network conditions, projected trend and goal for the unpaved road network can be seen in the figure, below:



An asset management plan is required by Michigan Public Act 325 of 2018, and this document represents fulfillment of some of the City's obligations towards meeting these requirements. This asset management plan also helps demonstrate the City's responsible use of public funds by providing elected and appointed officials as well as the general public with inventory and condition information of the City's road assets, and gives taxpayers the information they need to make informed decisions about investing in its essential transportation infrastructure.

INTRODUCTION

Asset management is defined by Public Act 325 of 2018 as “an ongoing process of maintaining, preserving, upgrading, and operating physical assets cost effectively, based on a continuous physical inventory and condition assessment and investment to achieve established performance goals”. In other words, asset management is a process that uses data to manage and track assets, like roads and bridges, in a cost-effective manner using a combination of engineering and business principles. This process is endorsed by leaders in municipal planning and transportation infrastructure, including the Michigan Municipal League, County Road Association of Michigan, the Michigan Department of Transportation (MDOT), and the Federal Highway Administration (FHWA). the City is supported in its use of asset management principles and processes by the Michigan Transportation Asset Management Council (TAMC), formed by the State of Michigan.

Asset management, in the context of this plan, ensures that public funds are spent as effectively as possible to maximize the condition of the road network. Asset management also provides a transparent decision-making process that allows the public to understand the technical and financial challenges of managing road infrastructure with a limited budget.

The City of Royal Oak (the City) has adopted an “asset management” business process to overcome the challenges presented by having limited financial, staffing, and other resources while needing to meet road users’ expectations. the City is responsible for maintaining and operating over 220.575 centerline of roads.

This plan outlines how the City determines its strategy to maintain and upgrade road asset condition given agency goals, priorities of its road users, and resources provided. An updated plan is to be released approximately every three years to reflect changes in road conditions, finances, and priorities.

Questions regarding the use or content of this plan should be directed to Holly Donoghue, P.E. at 203 S. Troy Street, Royal Oak, Michigan 48067 or at (248)246-3260 and/or engineering@romi.gov. Key terms used in this plan are defined in the City’s comprehensive transportation asset management plan (also known as the “compliance plan”) used for compliance with PA 325 or 2018.

Knowing the basic features of the asset classes themselves is a crucial starting point to understanding the rationale behind an asset management approach. The following primer provides an introduction to pavements.

Pavement Primer

Roads come in two basic forms—paved and unpaved. Paved roads have hard surfaces. These hard surfaces can be constructed from asphalt, concrete, composite (asphalt and concrete), sealcoat, and brick and block materials. On the other hand, unpaved roads have no hard surfaces. Examples of these surfaces are gravel and unimproved earth.

The decision to pave with a particular material as well as the decision to leave a road unpaved allows road-owning agencies to tailor a road to a particular purpose, environment, and budget. Thus, selecting a pavement type or leaving a road unpaved depends upon purpose, materials available, and budget. Each choice represents a trade-off between budget and costs for construction and maintenance.

Maintenance enables the road to fulfill its particular purpose. To achieve the maximum service for a pavement or an unpaved road, continual monitoring of a road's pavement condition is essential for choosing the right time to apply the right fix in the right place.

Here is a brief overview of the different types of pavements, how condition is assessed, and treatment options that can lengthen a road's service life.

Surfacing

Pavement type is influenced by several different factors, such as cost of construction, cost of maintenance, frequency of maintenance, and type of maintenance. These factors can have benefits affecting asset life and road user experience.

Paved Surfacing

Typical benefits and tradeoffs for hard surface types include:

- **Concrete pavement:** Concrete pavement, which is sometimes called a rigid pavement, is durable and lasts a long time when properly constructed and maintained. Concrete pavement can have longer service periods between maintenance activities, which can help reduce maintenance-related traffic disruptions. However, concrete pavements have a high initial cost and can be challenging to rehabilitate and maintain at the end of their service life. A typical concrete pavement design life will provide service for 30 years before major rehabilitation is necessary.
- **Hot-mix asphalt pavement (HMA):** HMA pavement, sometimes known as asphalt or flexible pavement, is currently less expensive to construct than concrete pavement (this is, in some part, due to the closer link between HMA material costs and oil prices that HMA pavements have in comparison with other pavement types). However, they require frequent maintenance activities to maximize their service life. A typical HMA pavement design life will provide service for 18 years before major rehabilitation is necessary. The vast majority of local-agency-owned pavements are HMA pavements.

- **Composite pavements:** Composite pavement is a combination of concrete and asphalt layers. Typically, composite pavements are old concrete pavements exhibiting ride-related issues that were overlaid by several inches of HMA in order to gain more service life from the pavement before it would need reconstruction. Converting a concrete pavement to a composite pavement is typically used as a "holding pattern" treatment to maintain the road in usable condition until reconstruction funds become available.
- **Sealcoat pavement:** Sealcoat pavement is a gravel road that have been sealed with a thin asphalt binder coating that has stone chips spread on top (not to be confused with a chip seal treatment over HMA pavement). This type of a pavement relies on the gravel layer to provide structure to support traffic, and the asphalt binder coating and stone chips shed water and eliminate the need for maintenance grading. Nonetheless, sealcoat pavement does require additional maintenance steps that asphalt and gravel do not require and does not last as long as HMA pavement, but it provides a low-cost alternative for lightly-trafficked areas and competes with asphalt for ride quality when properly constructed and maintained. Sealcoat pavement can provide service for ten or more years before the surface layer deteriorates and needs to be replaced.

Unpaved Surfacing

Typical benefits and tradeoffs for non-hard surfacing include:

- **Gravel:** Gravel is a low-cost, easy-to-maintain road surface made from layers of soil and aggregate (gravel). However, there are several potential drawbacks such as dust, mud, and ride smoothness when maintenance is delayed or traffic volume exceeds design expectations. Gravel roads require frequent low-cost maintenance activities. Gravel can be very cost effective for lower-volume, lower-speed roads. In the right conditions, a properly constructed and maintained gravel road can provide a service life comparable to an HMA pavement and can be significantly less expensive than the other pavement types.

Pavement Condition

Besides traffic congestion, pavement condition is what road users typically notice most about the quality of the roads that they regularly use—the better the pavement condition, the more satisfied users are with the service provided by the roadwork performed by road-owning agencies. Pavement condition is also a major factor in determining the most cost-effective treatment—that is, routine maintenance, capital preventive maintenance, or structural improvement—for a given section of pavement. As pavements age, they transition between "windows" of opportunity when a specific type of treatment can be applied to gain an increase in quality and extension of service life. Routine maintenance is day-to-day, regularly-scheduled, low-cost activity applied to "good" roads to prevent water or debris intrusion. Capital preventive maintenance (CPM) is a planned set of cost-effective treatments for "fair" roads that corrects pavement defects, slows further deterioration, and maintains the functional condition without increasing structural capacity. the City uses pavement condition and age to anticipate when a specific section of pavement will be a potential candidate for preventive maintenance. More detail on this topic is included in the *Pavement Treatment* section of this primer.

Pavement condition data is also important because it allows road owners to evaluate the benefits of preventive maintenance projects. This data helps road owners to identify the most cost-effective use of road construction and maintenance dollars. Further, historic pavement condition data can enable road owners to predict future road conditions based on budget constraints and to determine if a road network's condition will improve, stay the same, or degrade at the current or planned investment level. This analysis can help determine how much additional funding is necessary to meet a network's condition improvement goals.

Paved Road Condition Rating System

the City is committed to monitoring the condition of its road network and using pavement condition data to drive cost-effective decision-making and preservation of valuable road assets. the City uses the Pavement Surface Evaluation and Rating (PASER) system to assess its paved roads. PASER was developed by the University of Wisconsin Transportation Information Center to provide a simple, efficient, and consistent method for evaluating road condition through visual inspection. The widely-used PASER system has specific criteria for assessing asphalt, concrete, sealcoat, and brick and block pavements. Information regarding the PASER system and PASER manuals may be found on the TAMC website at: http://www.michigan.gov/tamc/0,7308,7-356-82158_82627---,00.html.

The TAMC has adopted the PASER system for measuring statewide pavement conditions in Michigan for asphalt, concrete, composite, sealcoat, and brick-and-block paved roads. Broad use of the PASER system means that data collected at the City is consistent with data collected statewide. PASER data is collected using trained inspectors in a slow-moving vehicle using GPS-enabled data collection software provided to road-owning agencies at no cost to them. The method does not require extensive training or specialized equipment, and data can be collected rapidly, which minimizes the expense for collecting and maintaining this data.

The PASER system rates surface condition using a 1-10 scale where 10 is a brand new road with no defects that can be treated with routine maintenance, 5 is a road with distresses but is structurally sound that can be treated with preventive maintenance, and 1 is a road with extensive surface and structural distresses that is in need of total reconstruction.

Roads with lower PASER scores generally require costlier treatments to restore their quality than roads with higher PASER scores. The cost effectiveness of treatments generally decreases the as the PASER number decreases. In other words, as a road deteriorates, it costs more dollars per mile to fix it, and the dollars spent are less efficient in increasing the road's service life. Nationwide experience and asset management principles tell us that a road that has deteriorated to a PASER 4 or less will cost more to improve and the dollars spent are less efficient. Understanding this cost principle helps to draw meaning from the current PASER condition assessment.

The TAMC has developed statewide definitions of road condition by creating three simplified condition categories—"good", "fair", and "poor"—that represent bin ranges of PASER scores having similar contexts with regard to maintenance and/or reconstruction. The definitions of these rating conditions are:

- "Good" roads, according to the TAMC, have PASER scores of 8, 9, or 10. Roads in this category have very few, if any, defects and only require minimal maintenance; they may be kept in this category longer using PPM. These roads may include those that have been recently seal coated or newly constructed. Figure 1 illustrates an example of a road in this category.
- "Fair" roads, according to the TAMC, have PASER scores of 5, 6, or 7. Roads in this category still show good structural support, but their surface is starting to deteriorate. Figure 1 illustrates two road examples in this category. CPM can be cost effective for maintaining the road's "fair" condition or even raising it to "good" condition before the structural integrity of the pavement has been severely impacted. CPM treatments can be likened to shingles on a roof of a house: while the shingles add no structural value, they protect the house from structural damage by maintaining the protective function of a roof covering.
- "Poor" roads, according to the TAMC, have PASER scores of 1, 2, 3, or 4. These roads exhibit evidence that the underlying structure is failing, such as alligator cracking and rutting. These roads must be rehabilitated with treatments like a heavy overlay, crush and shape, or total reconstruction. Figure 1 illustrates a road in this category.

Figure 1: *Top image, right*– PASER 8 road that is considered "good" by the TAMC exhibit only minor defects. *Second image, right*– PASER 5 road that is considered "fair" by the TAMC. Exhibiting structural soundness but could benefit from CPM. *Third image, right*– PASER 6 road that is considered "fair" by the TAMC. *Bottom image, right*– PASER 2 road that is considered "poor" by the TAMC exhibiting significant structural distress.

The TAMC's good, fair, and poor categories are based solely on the definitions, above. Therefore, caution should be exercised when comparing other condition assessments with these categories because other

condition assessments may have “good”, “fair”, or “poor” designations similar to the TAMC condition categories but may not share the same definition. Often, other condition assessment systems define the “good”, “fair”, and “poor” categories differently, thus rendering the data of little use for cross-system comparison. The TAMC’s definitions provide a statewide standard for all of Michigan’s road-owning agencies to use for comparison purposes.

PASER data is collected 100 percent every two years on all federal-aid-eligible roads in Michigan. The TAMC dictates and funds the required training and the format for this collection, and it shares the data regionally and statewide. In addition, the City collects 100 percent of its paved non-federal-aid-eligible network using its own staff and resources.

Unpaved Road Condition Rating System (IBR System™)

The condition of unpaved roads can be rapidly changing, which makes it difficult to obtain a consistent surface condition rating over the course of weeks or even days. The PASER system works well on most paved roads, which have a relatively-stable surface condition over several months, but it is difficult to adapt to unpaved roads. To address the need for a reliable condition assessment system for unpaved roads, the TAMC adopted the Inventory Based Rating (IBR) System™, and the City also uses the IBR System™ for rating its unpaved roads. Information about the IBR System™ can be found at http://ctt.mtu.edu/inventory-based-rating-system.

Figure 2: *Top*– Road with IBR number of 1 road that has poor surface width, poor drainage adequacy, and poor structural adequacy. *Middle*– Road IBR number of 7 that has fair surface width, fair drainage adequacy, and fair structural adequacy. *Bottom*– Road with IBR number of 9 road that has good surface width, good drainage adequacy, and good structural adequacy.

The IBR System™ gathers reliable condition assessment data for unpaved road by evaluating three features—surface width, drainage adequacy, and structural adequacy—in comparison to a baseline, or generally considered “good”, road. These three assessments come together to generate an overall 1-10 IBR number. A high IBR number reflects a road with wide surface width, good drainage, and a well-designed and well-constructed base, whereas a low IBR number reflects a narrow road with no ditches and little gravel. A good, fair, or poor assessment of each feature is not an endorsement or indictment of a road’s suitability for use but simply provides context on how these road elements compare to a baseline condition.

Figure 2 illustrates the range over which features may be assessed. The top example in Figure 2 shows an unpaved road with a narrow surface width, little or no drainage, and very little gravel thickness. Using the IBR System™, these assessments would yield an IBR number of “1” for this road. The middle example in Figure 2 shows a road with fair surface width, fair drainage adequacy, and fair

structural adequacy. These assessments would yield an IBR number of “7” for this road. The bottom example in Figure 2 shows a road with good surface width, good drainage adequacy, and good structural adequacy. These assessments would yield an IBR number of “9” for this road.

Unpaved roads are constructed and used differently throughout Michigan. A narrow, unpaved road with no ditches and very little gravel (low IBR number) may be perfectly acceptable in a short, terminal end of the road network, for example, on a road segment that ends at a lake or serves a limited number of unoccupied private properties. However, high-volume unpaved roads that serve agricultural or other industrial activities with heavy trucks and equipment will require wide surface width, good drainage, and a well-designed and well-constructed base structure (high IBR number). Where the unpaved road is and how it is used determines how the road must be constructed and maintained: just because a road has a low IBR number does not necessarily mean that it needs to be upgraded. The IBR number are not an endorsement or indictment of the road’s suitability for use but rather, an indication of a road’s capabilities to support different traffic volumes and types in all weather.

Pavement Treatments

Selection of repair treatments for roads aims to balance costs, benefits, and road life expectancy. All pavements are damaged by water, traffic weight, freeze/thaw cycles, and sunlight. Each of the following treatments and strategies—reconstruction, structural improvements, capital preventive maintenance, and others used by the City—counters at least one of these pavement-damaging forces.

Reconstruction

Pavement reconstruction treats failing or failed pavements by completely removing the old pavement and base and constructing an entirely new road (Figure 3). Every pavement has to eventually be reconstructed and it is usually done as a last resort after more cost-effective treatments are done, or if the road requires significant changes to road geometry, base, or buried utilities. Compared to the other treatments, which are all improvements of the existing road, reconstruction is the most extensive rehabilitation of the roadway and therefore, also the most expensive per mile and most disruptive to regular traffic patterns. Reconstructed pavement will subsequently require one or more of the previous maintenance treatments to maximize service life and performance. A reconstructed road lasts approximately 30 years and costs

Figure 3: Examples of reconstruction treatments—(left) reconstructing a road and (right) road prepared for full-depth repair.

$1,080,000 per lane mile. The following descriptions outline the main reconstruction treatments used by the City.

Full-depth Concrete Repair

A full-depth concrete repair removes sections of damaged concrete pavement and replaces it with new concrete of the same dimensions (Figure 3). It is usually performed on isolated deteriorated joint locations or entire slabs that are much further deteriorated than adjacent slabs. The purpose is to restore the riding surface, delay water infiltration, restore load transfer from one slab to the next, and eliminate the need to perform costly temporary patching. This repair lasts approximately fifteen years and typically costs $100,000 per lane mile.

Structural Improvement

Roads requiring structural improvements exhibit alligator cracking and rutting and rated poor in the TAMC scale. Road rutting is evidence that the underlying structure is beginning to fail and it must be either rehabilitated with a structural treatment. Examples of structural improvement treatments include HMA overlay with or without milling, and crush and shape (Figure 4). The following descriptions outline the main structural improvement treatments used by the City.

Figure 4: Examples of structural improvement treatments—(on left) HMA overlay on an unmilled pavement and (on right) milling of asphalt pavement.

Hot-mix Asphalt (HMA) Overlay with/without Milling

An HMA overlay is a layer of new asphalt (liquid asphalt and stones) placed on an existing pavement (Figure 4). Depending on the overlay thickness, this treatment can add significant structural strength. This treatment also creates a new wearing surface for traffic and seals the pavement from water, debris, and sunlight damage. Due to elevation constraints in this fairly flat city, milling is typically necessary in order to install new HMA. Many of the HMA roads have concrete base; after milling, the city replaces sections of concrete road base that are failing structurally prior to paving the HMA overlay. An HMA overlay lasts approximately eight to fifteen years and costs $425,000 to $700,000 per lane mile depending on the extent of the base and curbing repairs.

Capital Preventive Maintenance

Capital preventive maintenance (CPM) addresses pavement problems of fair-rated roads before the structural integrity of the pavement has been severely impacted. CPM is a planned set of cost-effective treatments applied to an existing roadway that slows further deterioration and that maintains or improves the functional condition of the system without significantly increasing the structural capacity. Examples of such treatments include crack seal, fog seal, chip seal, slurry seal, and microsurface (Figure 5). The purpose of the following CPM treatments is to protect the pavement structure, slow the rate of deterioration, and/or correct pavement surface deficiencies. The following descriptions outline the main CPM treatments used by the City.

Figure 5: Examples of capital preventive maintenance treatments—(from left) crack seal, fog seal, chip seal, and slurry seal/microsurface.

Crack Seal

Water that infiltrates the pavement surface softens the pavement structure and allows traffic loads to cause more damage to the pavement than in normal dry conditions. Crack sealing helps prevent water infiltration by sealing cracks in the pavement with asphalt sealant (Figure 5). the City seals pavement cracks early in the life of the pavement to keep it functioning as strong as it can and for as long as it can. Crack sealing lasts approximately two years and costs $5,400 per lane mile. Even though it does not last very long compared to other treatments, it does not cost very much compared to other treatments. This makes it a very cost effective treatment when the City looks at what crack filling costs per year of the treatment's life.

Fog Seal

Fog sealing sprays a liquid asphalt coating onto the entire pavement surface to fill hairline cracks and prevent damage from sunlight (Figure 5). Fog seals are best for good to very good pavements and last approximately two years at a cost of $5,000 per lane mile. The City does not use this method at this time as most of the roadways are not in a position where it is an applicable repair. We believe that many of our local (residential) asphalt streets have quite a bit of shade provided by trees and parked cars which helps slow the aging similarly to this type of surface treatment when compared to the cost savings and hassle to residents to perform this repair.

Chip Seal

A chip seal, also known as a sealcoat, is a two-part treatment that starts with liquid asphalt sprayed onto the old pavement surface followed by a single layer of small stone chips spread onto the wet liquid

asphalt layer (Figure 5). The liquid asphalt seals the pavement from water and debris and holds the stone chips in place, providing a new wearing surface for traffic that can correct friction problems and helping to prevent further surface deterioration. Chip seals are best applied to pavements that are not exhibiting problems with strength, and their purpose is to help preserve that strength. These treatments last approximately five years and cost $18,000 per lane mile. Similar to the fog seal surface treatment above, the City does not use this method at this time as most of the roadways are not in a position where it is applicable nor do we believe that it will successfully be able to be performed due to the excesive amount of car tire turning at driveways and intersections for it to efficiently be installed for the previous price.

Slurry Seal/Microsurface

A slurry seal or microsurface's purpose is to protect existing pavement from being damaged by water and sunlight. The primary ingredients are liquid asphalt (slurry seal) or modified liquid asphalt (microsurface), small stones, water and portland cement applied in a very thin (less than a half an inch) layer (Figure 5). The main difference between a slurry seal and a microsurface is the modified liquid asphalt used in microsurfacing provides different curing and durability properties, which allows microsurfacing to be used for filling pavement ruts. Since the application is very thin, these treatments do not add any strength to the pavement and only serves to protect the pavement's existing strength by sealing the pavement from sunlight and water damage. These treatments work best when applied before cracks are too wide and too numerous. A slurry seal treatment lasts approximately four years and costs $25,000 per lane mile, while a microsurface treatment tends to last for seven years and costs $60,000 per lane mile. Again, similar to the previous two surface treatments above, the City does not use this method at this time as most of the roadways are not in a position where it is applicable. As more major roads are improved over time, the city hopes to begin using this maintenance technique.

Partial-Depth Concrete Repair

A partial-depth concrete repair involves removing spalled (i.e., fragmented) or delaminated (i.e., separated into layers) areas of concrete pavement, usually near joints and cracks and replacing with new concrete (Figure 6). This is done to provide a new wearing surface in isolated areas, to slow down water infiltration, and to help delay further freeze/thaw damage. This repair lasts approximately five years and typically costs $45,000 per mile. The City does not perform this type of repair because most of our concrete roadways are local residential streets. However this could potentially be used for major roads in fair condition and will be considered if road millage funds are approved.

Maintenance Grading (for Unpaved Roads)

Maintenance grading involves regrading an unpaved road to remove isolated potholes, washboarding, and ruts then restoring the compacted crust layer (Figure 6). The City grades unimproved roads two times per year. As the City already spends a disproportionate amount of road dollars on this work, there is not a plan to use additional funding to make improvements to unimproved roads such as installation of ditches or raising the elevation of the road. Unimproved roads are paved by special assessment to the adjacent property owners upon request. The City typically spends approximately $20,000 per mile on gravel road grading each year.

Figure 6: Examples of capital preventive maintenance treatments, cont'd—(from left) concrete road prepared for partial-depth repair, and gravel road undergoing maintenance grading,

Maintenance

Maintenance is the most cost-effective strategy for managing road infrastructure and prevents good and fair roads from reaching the poor category, which require costly rehabilitation and reconstruction treatments to create a year of service life. It is most effective to spend money on routine maintenance and CPM treatments, first; then, when all maintenance project candidates are treated, reconstruction and rehabilitation can be performed as money is available. This strategy is called a "mix-of-fixes" approach to managing pavements.

1. PAVEMENT ASSETS

Building a mile of new road can cost over $2 million due to the large volume of materials and equipment that are necessary. The high cost of constructing road assets underlines the critical nature of properly managing and maintaining the investments made in this vital infrastructure. The specific needs of every mile of road within an agency's overall road network is a complex assessment, especially when considering rapidly changing conditions and the varying requisites of road users; understanding each road-mile's needs is an essential duty of the road-owning agency.

In Michigan, many different governmental units (or agencies) own and maintain roads, so it can be difficult for the public to understand who is responsible for items such as planning and funding construction projects, repairs, traffic control, safety, and winter maintenance for any given road. MDOT is responsible for state trunkline roads, which are typically named with "M", "I", or "US" designations regardless of their geographic location in Michigan. Cities and villages are typically responsible for all public roads within their geographic boundary with the exception of the previously mentioned state trunkline roads managed by MDOT and roads managed by Counties. County road commissions (or departments) are typically responsible for all public roads within the county's geographic boundary, with the exception of those managed by cities, villages, and MDOT.

In cases where non-trunkline roads fall along jurisdictional borders, local and intergovernmental agreements dictate ownership and maintenance responsibility. Quite frequently, roads owned by one agency may be maintained by another agency because of geographic features that make it more cost effective for a neighboring agency to maintain the road instead of the actual road owner. Other times, road-owning agencies may mutually agree to coordinate maintenance activities in order to create economies of scale and take advantage of those efficiencies.

The City is responsible for a total of 220.575 centerline of public roads, as shown in Figure 7.

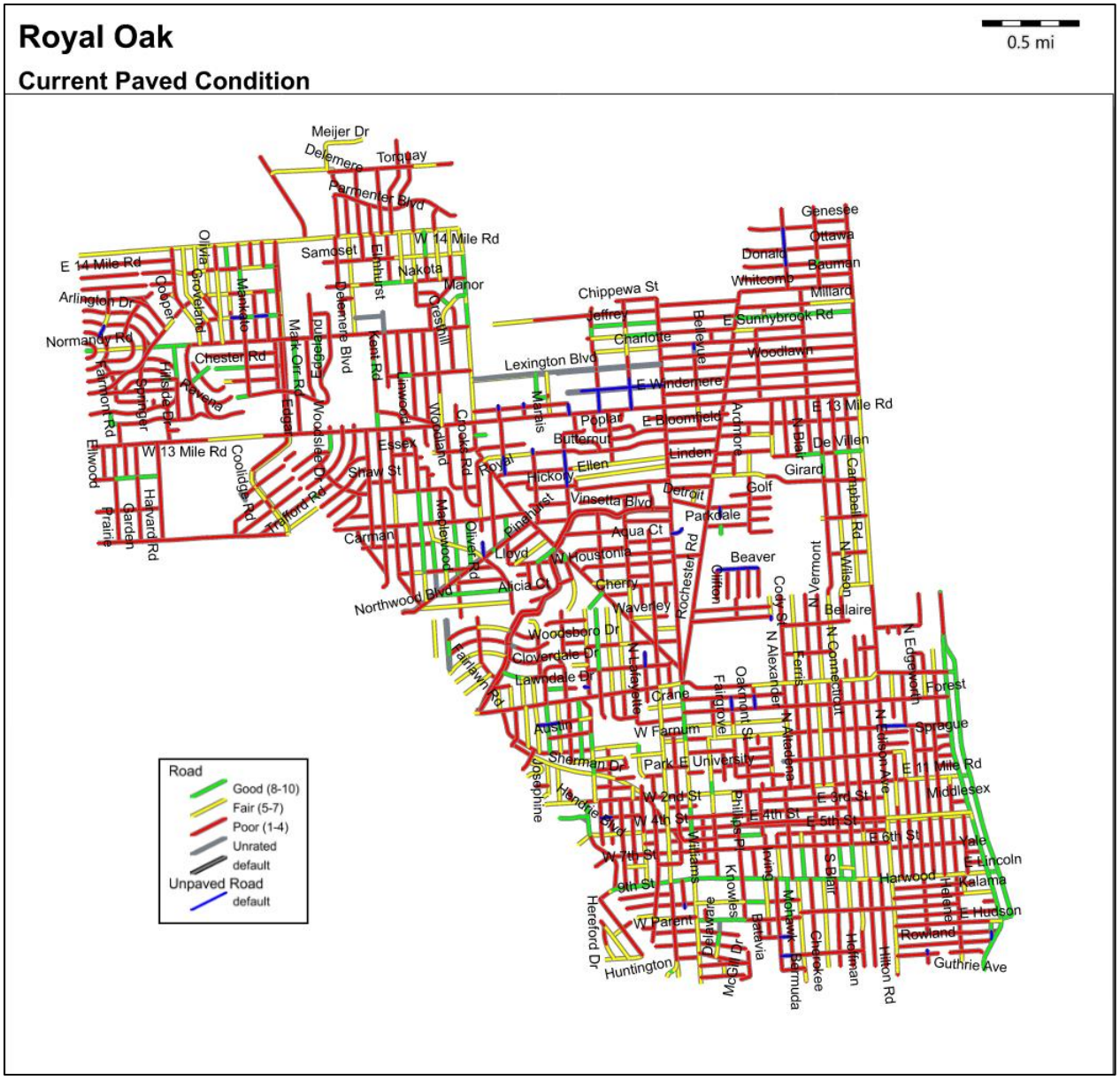


Figure 7: Map showing location of the City's paved roads (i.e., those managed by the City) and their current condition for paved roads with green for good (i.e., PASER 10, 9, 8), yellow for fair (i.e., PASER 7, 6, 5), and red for poor (i.e., PASER 4, 3, 2, 1), as well as the location of the City's unpaved roads in blue

Inventory

Michigan Public Act 51 of 1951 (PA 51), which defines how funds from the Michigan Transportation Fund (MTF) are distributed to and spent by road-owning agencies, classifies roads owned by the City as either city major or city local roads. State statute prioritizes expenditures on the city major road network.

Figure 8 illustrates the percentage of roads owned by the City that are classified as city major and city local roads.

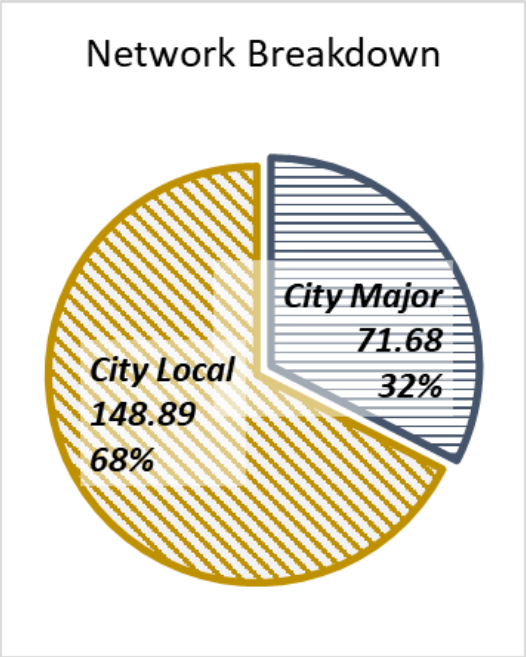


Figure 8: Percentage of city major and city local roads for the City.

The City manages 12.379 miles of roads that are part of the National Highway System (NHS)—in other words, those roads that are critical to the nation's economy, defense, and mobility—and monitors and maintains their condition. The NHS is subject to special rules and regulations and has its own performance metrics dictated by the FHWA. While most NHS roads in Michigan are managed by MDOT, the City manages a percentage of those roads located in its jurisdiction, as shown in Figure 9.

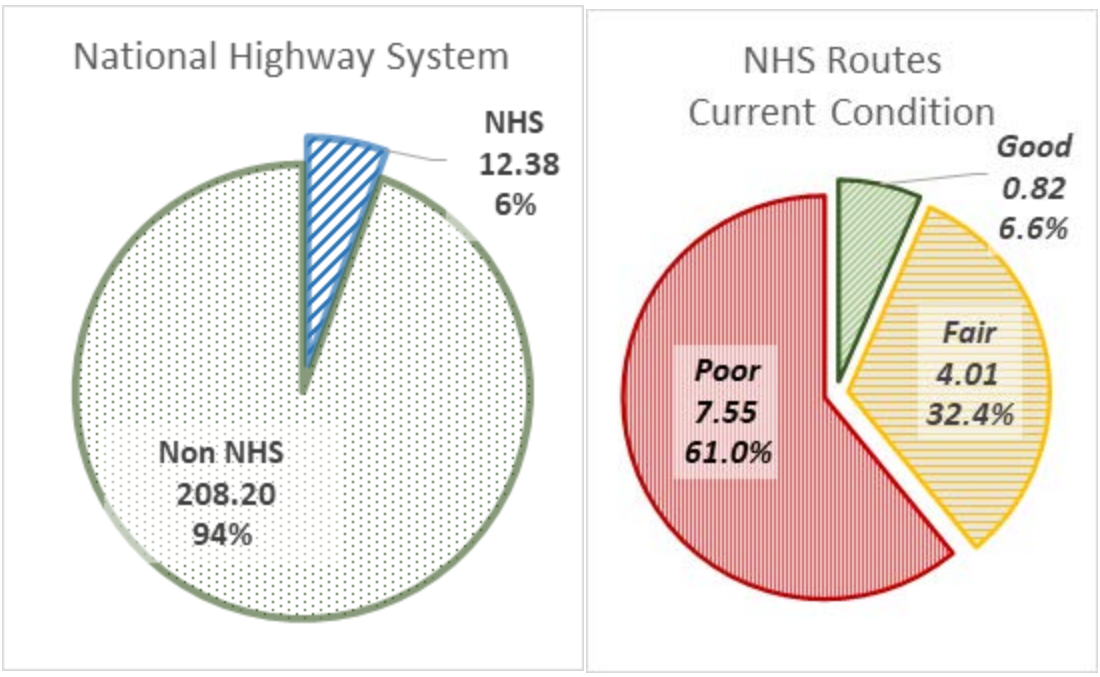


Figure 9: Miles of roads managed by the City that are part of the National Highway System and condition.

the City also owns and manages 3.05 miles of unpaved roads.

Types

the City has multiple types of pavements in its jurisdiction, including: asphalt, concrete, and undefined; it also has unpaved roads (i.e., gravel and/or earth). Factors influencing pavement type include cost of construction, cost of maintenance, frequency of maintenance, type of maintenance, asset life, and road user experience. More information on pavement types is available in the Introduction's Pavement Primer.

Figure 10 illustrates the percentage of various pavement types that the City has in its network. .

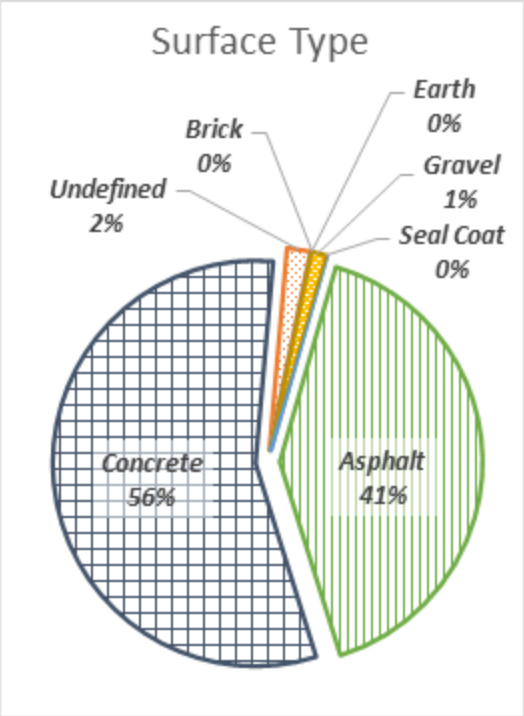


Figure 10: Pavement type by percentage maintained by the City Undefined pavements have not been inventoried in the City's asset management system to date, but will be included as data becomes available.

Locations

Locations and sizes of each asset can be found in the City's Roadsoft database. For more detail, please refer to the agency contact listed in the *Introduction* of this pavement asset management plan.

Condition

The road characteristic that road users most readily notice is pavement condition. Pavement condition is a major factor in determining the most cost-effective treatment—that is, routine maintenance, capital preventive maintenance, or structural improvement—for a given section of pavement. the City uses pavement condition and age to anticipate when a specific section of pavement will be a potential candidate for preventive maintenance. Pavement condition data enables the City to evaluate the benefits of preventive maintenance projects and to identify the most cost-effective use of road construction and maintenance dollars. Historic pavement condition data can be used to predict future road conditions based on budget constraints and to determine if a road network's condition will improve, stay the same, or degrade at the current or planned investment level. This analysis helps to determine how much additional funding is necessary to meet a network's condition improvement goals. More detail on this topic is included in the Introduction's *Pavement Primer*.

Paved Roads

the City is committed to monitoring the condition of its road network and using pavement condition data to drive cost-effective decision-making and preservation of valuable road assets. the City uses the

Pavement Surface Evaluation and Rating (PASER) system, which has been adopted by the TAMC for measuring statewide pavement conditions, to assess its paved roads. The PASER system provides a simple, efficient, and consistent method for evaluating road condition through visual inspection. More information regarding the PASER system can be found in the Introduction's Pavement Primer.

Oakland County Collects PASER data every two years on the city's major roads. The City collects PASER date every year on the city's local roads. As of the writing of this report, the most recent PASER data is from 2023 for major roads and 2022 for local roads.

The City's 2023 paved city major road network has 14 percent of roads in the TAMC good condition category, 22 percent in fair, and 55 percent in poor (Figure 11A). The paved city local road network has 15 percent in good, 66 percent in fair, and 39 percent in poor (Figure 11B).

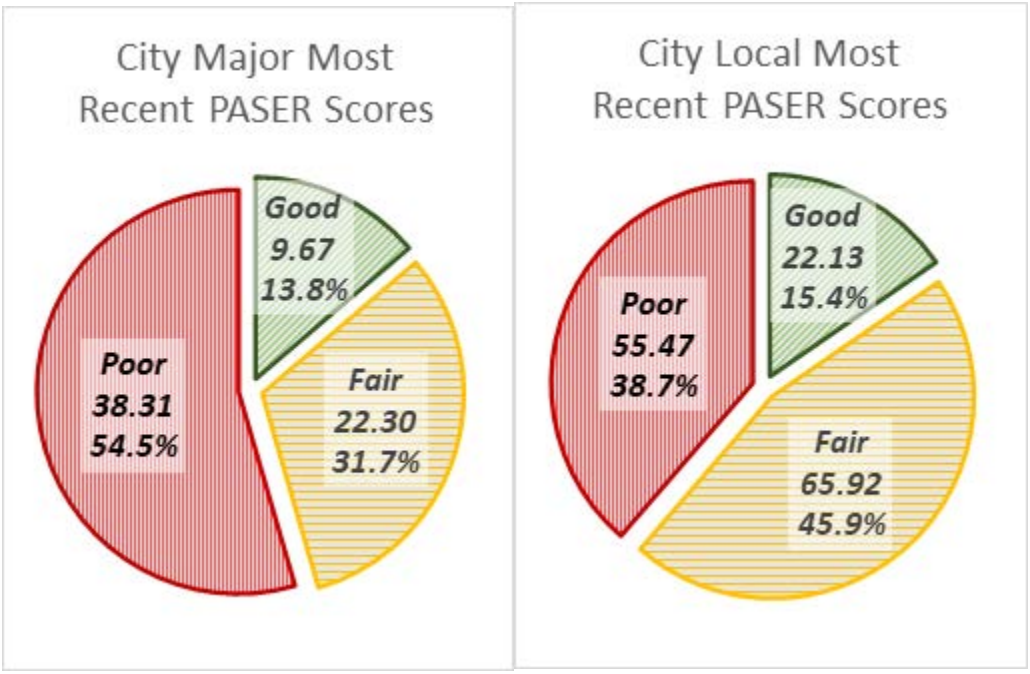


Figure 11: (A) Left: the City paved city major road network conditions by percentage of good, fair, or poor, and (B) Right: paved city local road network conditions by percentage of good, fair, or poor

In comparison, the statewide paved city major road network has 26 percent of roads in the TAMC good condition category, 42 percent in fair, and 32 percent in poor (Figure 12A). The statewide paved city local road network has 20 percent in good, 35 percent in fair, and 45 percent in poor (Figure 12B). Comparing Figure 11A and Figure 12A shows that the City's paved city major road network is worse than similarly-classified roads in the rest of the state, while Figure 11B and Figure 12B show that the City's paved city local road network is better than similarly-classified roads in the rest of the state. Other road condition graphs can be viewed on the TAMC pavement condition dashboard at: http://www.mcgi.state.mi.us/mitrp/Data/PaserDashboard.aspx.

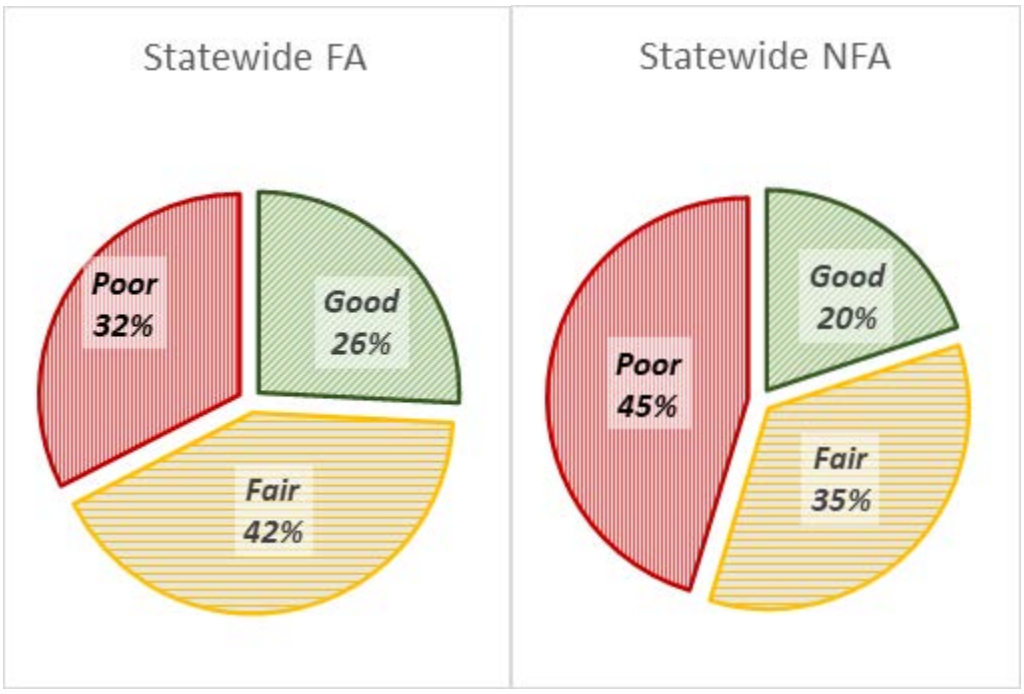


Figure 12: (A) Left: Statewide paved city major road network conditions by percentage of good, fair, or poor, and (B) Right: paved city local road network conditions by percentage of good, fair, or poor

Most of our major road network does not qualify for federal or state funding and therefore we only are able to spend minimal funds on maintenance (crack sealing and pothole patching) on those roadways while we watch them continue to deteriorate. Conversely, we are nearing the end of a 10-year millage which has allowed our local road network to improve slightly better than the state's network. We are seeking to renew this millage and apply those funds to improve our major road network and to maintain our local network.

Figure 13 and Figure 14 show the number of miles for the City's roads with PASER scores expressed in TAMC definition categories for the paved city major road network (Figure 13) and the paved city local road network (Figure 14). the City considers road miles on the transition line between good and fair (PASER 8) and the transition line between fair and poor (PASER 5) as representing parts of the road network where there is a risk of losing the opportunity to apply less expensive treatments that gain significant improvements in service life.

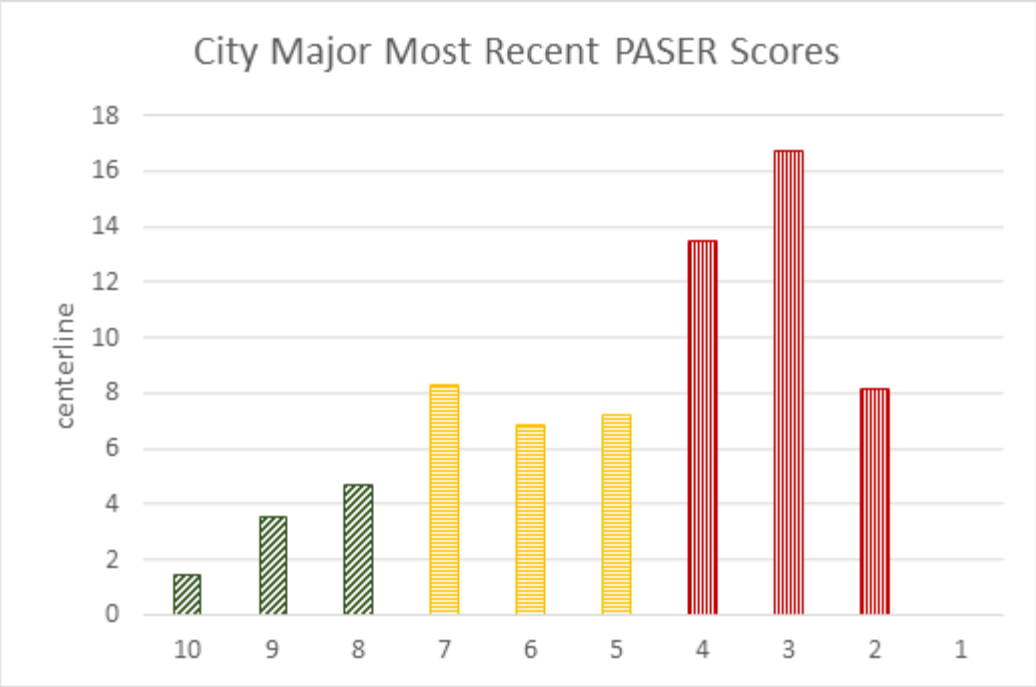


Figure 13: the City paved city major road network conditions. Bar graph colors correspond to good/fair/poor TAMC designations.

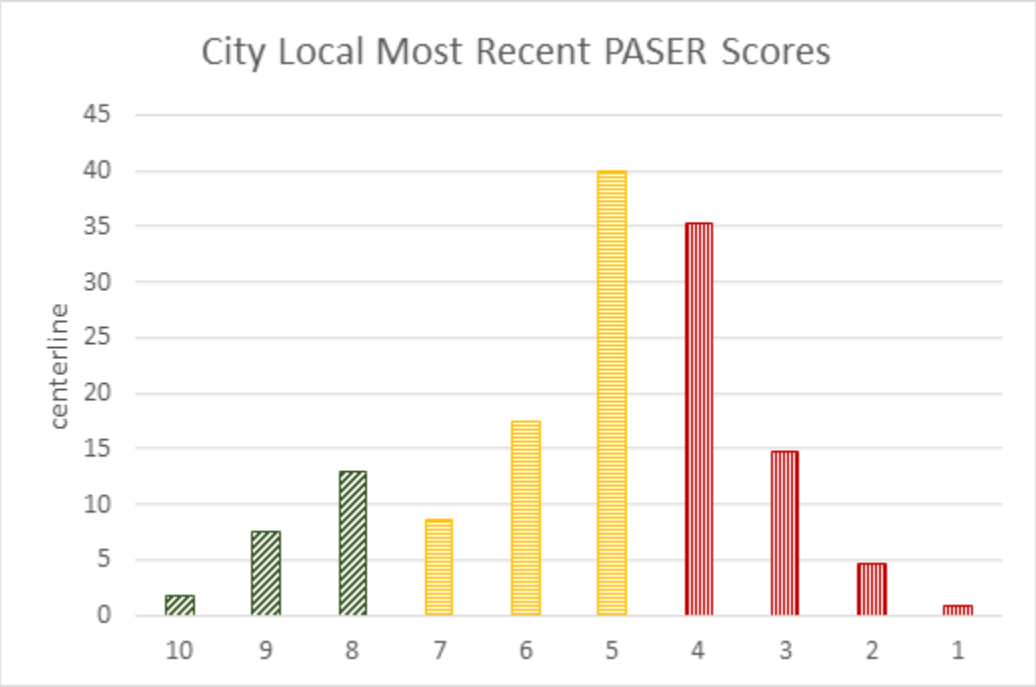


Figure 14: the City paved city local network condition by PASER rating. Bar graph colors correspond to good/fair/poor TAMC designations.

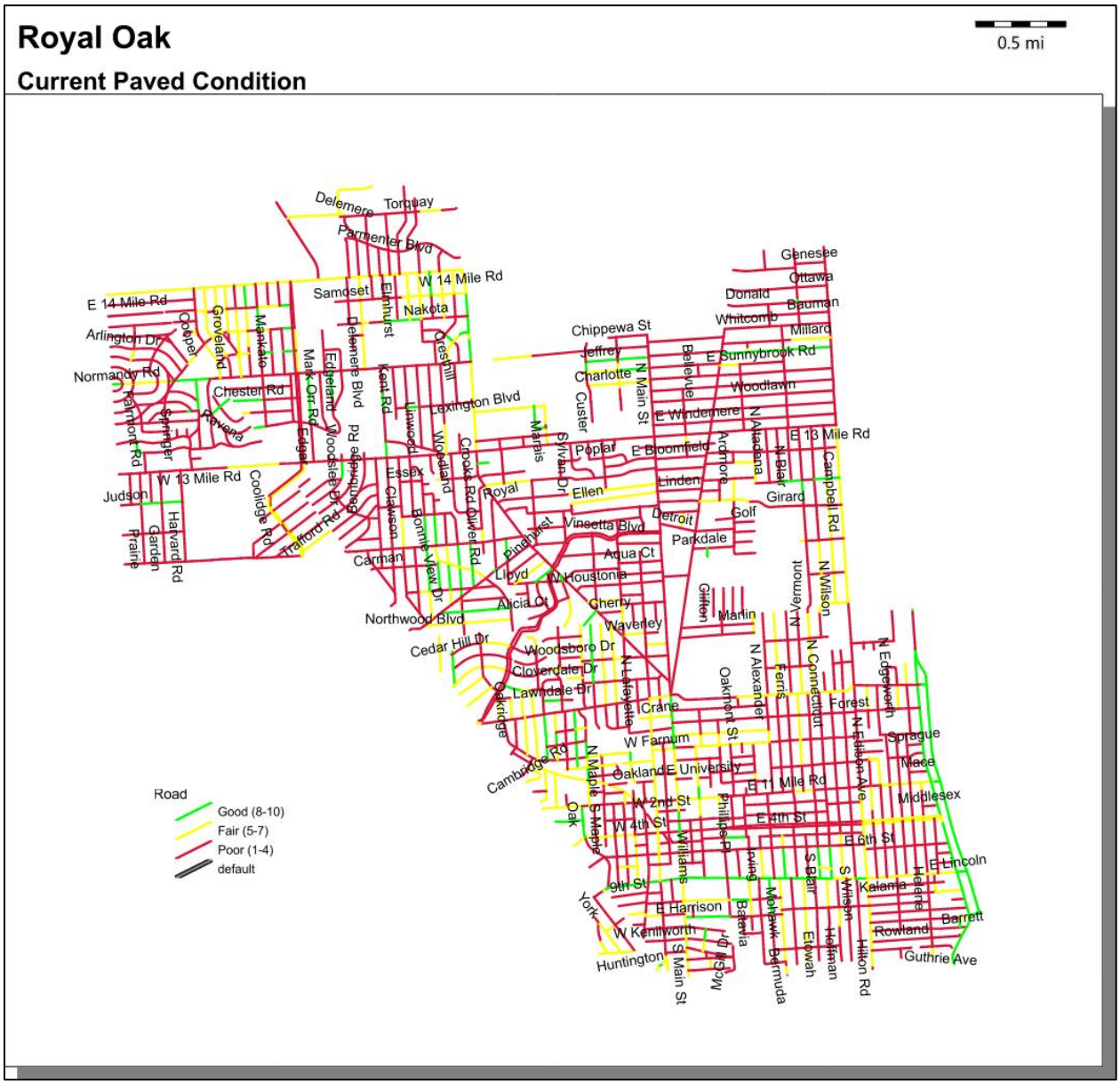


Figure 15: Map of the current paved road condition in good (PASER 10, 9, 8) shown in green, fair (PASER 7, 6, 5) shown in yellow, and poor (PASER 4, 3, 2, 1) shown in red. Only Roads owned by the City are shown.

The city's current goal for local roads is an average PASER of 5.0 by 2024. Through the local road millage, the city has exceeded this goal, though ever deteriorating roads makes sustaining the progress challenging. The city will need to continue investing in local road improvements in the coming years.

Historically, the overall quality of the City's paved city major roads has been decreasing, as can be observed in Figure 16. Historically, the city is able to fund one to two miles of improvements on major

roads each year and also includes crack seal recently improved roads. Considering there are 70 miles of major roads, this is not enough to improve and maintain the overall condition of the major road network.

Comparing the City's paved city major road condition trends illustrated in Figure 16 with overall statewide condition trends for similarly-classified roads, which are illustrated in Figure 17, shows a similar trend locally as in the rest of the state.

The change in overall condition of Royal Oak's paved major roads can be observed in Figure 16. Between 2017 and 2021 the percentage of roads in poor condition decreased slightly, from 67.6% of the network to 59.2% of the network. This is indicative of a few projects that were implemented. The percentage of fair roads decreased slightly during this same period, decreasing from 25.6% to 24.4%. This is a result of rehabilitation projects being applied to fair roadways. This class of roads requires attention before they transition into costlier reconstruct projects. During this time the number of maintenance, reconstruction, and rehabilitation projects were steady, indicating that funding levels are not sufficient to support the current paved major road network in its current state. Since 2018 the city has been performing annual joint sealing of major roads as a preventative maintenance technique in combination with occasional resurfacing projects, but additional funding is still needed to obtain our network goals.

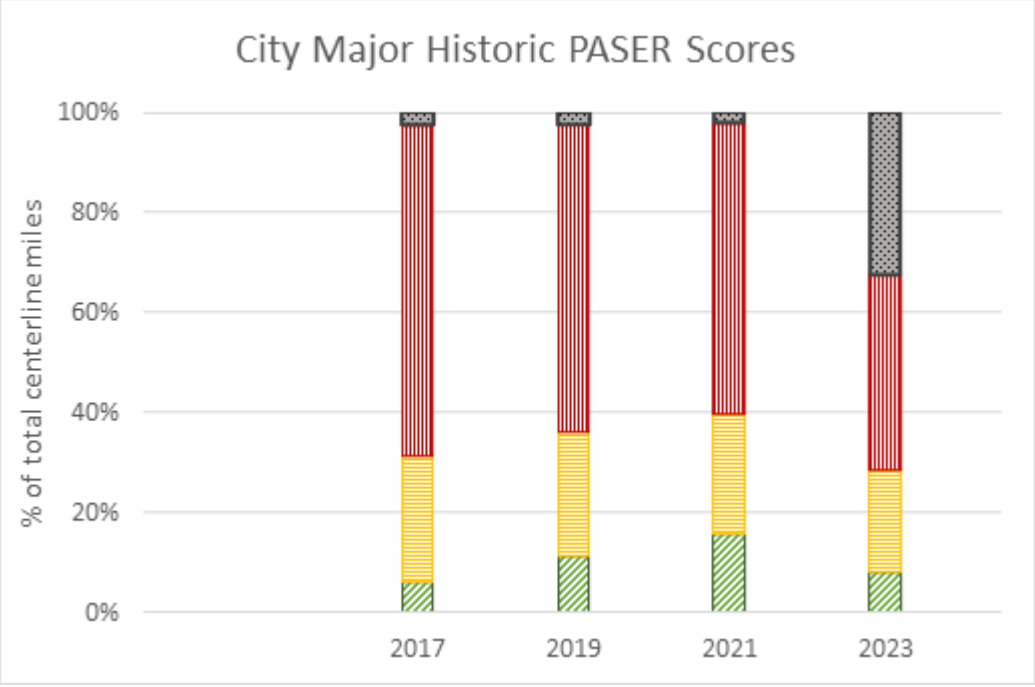


Figure 16: Historical the City paved city major road network condition trend

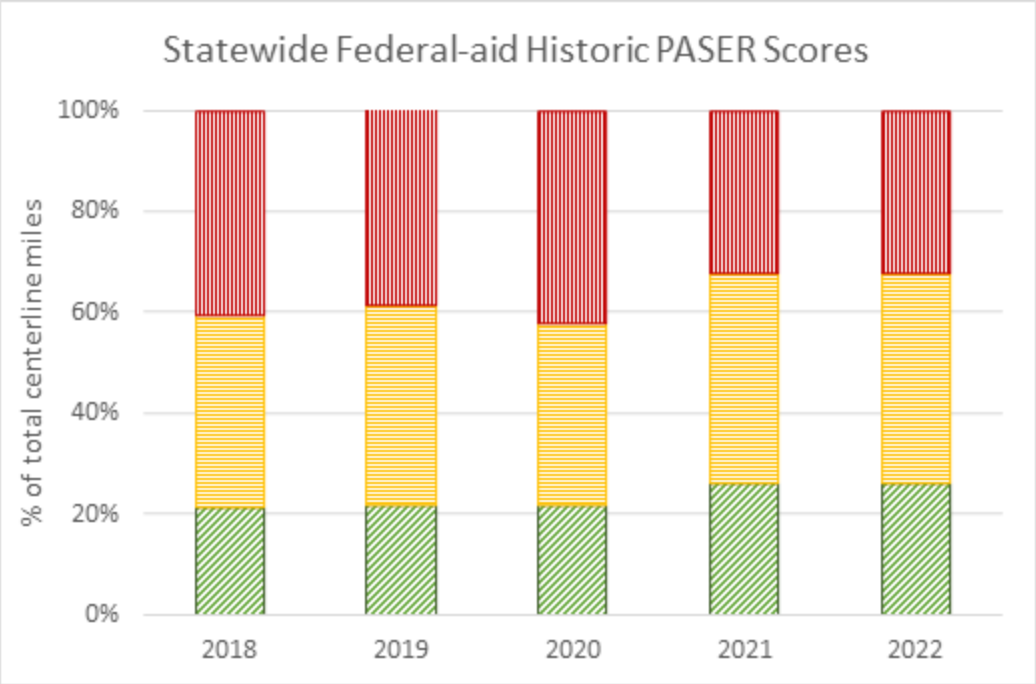


Figure 17: Historical statewide city major road network condition trend

Historically, the percentage of “good” miles has increased for the minor road network because the city has a locally funded road millage for improvements. Figure 18 illustrates the condition of the paved city local road network in the City while Figure 19 illustrates these conditions statewide.

Comparing the City’s paved city local road condition trends illustrated in Figure 18 with overall statewide condition trends for all paved city local roads illustrated in Figure 19 indicates a different trend locally as in the rest of the state. This is due to the local road millage which has been in effect since 2015 and is currently in the last couple years of implementation. The City is proposing a millage renewal that would allocate some funding to local roads for another 10 years. This investment would be much smaller than what is currently used annually on local roads, and so a slight decrease in PASER scores is anticipated.

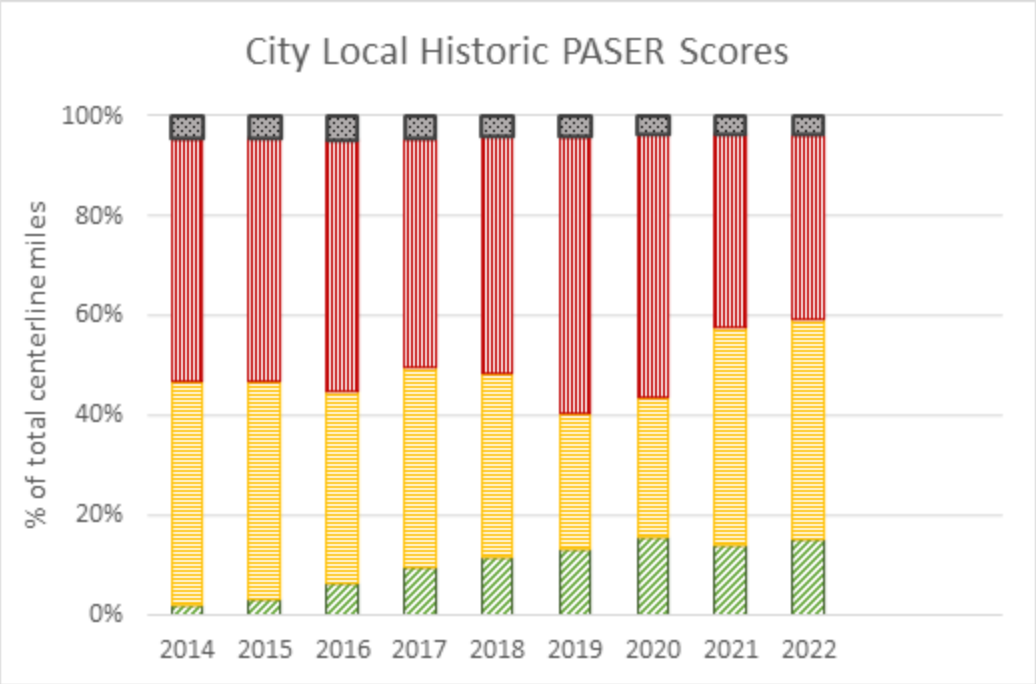


Figure 18: Historical City paved city local road network condition trend

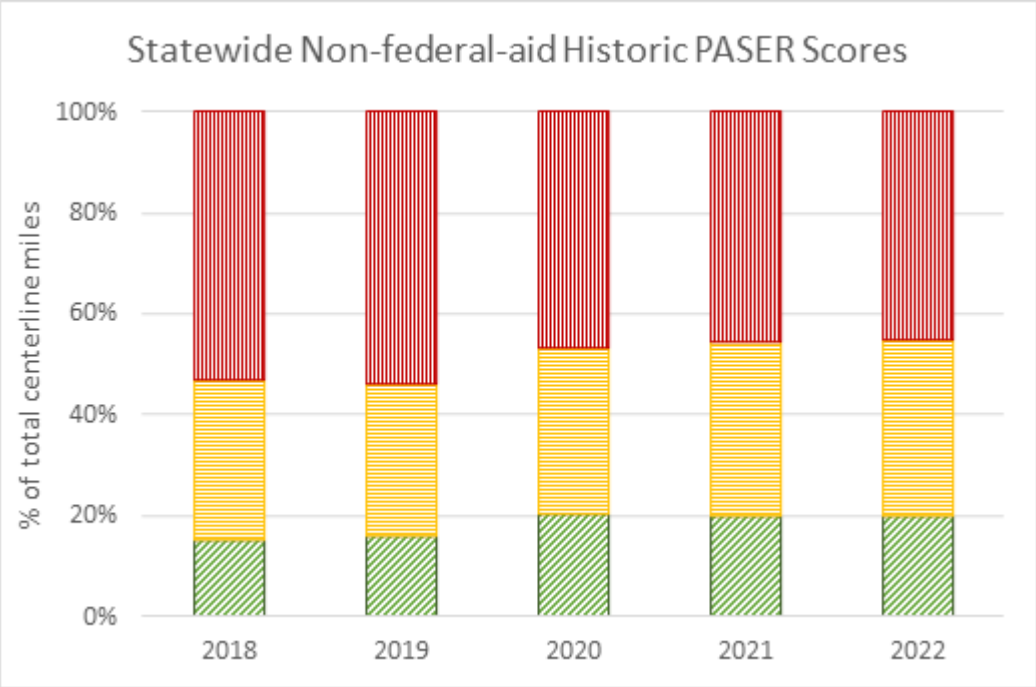


Figure 19: Historical statewide paved city local road network condition trend

Unpaved Roads

The condition of unpaved roads can be rapidly changing, which makes it difficult to obtain a consistent surface condition rating over the course of weeks or even days. The TAMC adopted the Inventory Based Rating (IBR) System™ for rating unpaved roads, and the City uses the IBR System™ for rating its unpaved roads. More information regarding the IBR System™ can be found in Introduction's Pavement Primer.

The 3.05 miles of unimproved roads in the city are all local residential streets and are not used for high volumes of traffic. The first-time paving of streets in Royal Oak is funded by the adjacent property owners. Generally the city does not move forward with paving of unimproved roads without at least half of the adjacent property owners in favor of the special assessment, and the process is typically started with a petition to the residents.

Unimproved roads require additional attention and maintenance compared to paved roads. The city would prefer to have a fully paved road network, but is not planning to move forward with forcing special assessments to pave the remaining unimproved roads at this time. The city offered a 50 percent cost sharing incentive program from 2015 through 2023 to help encourage paving projects. This program resulted in paving of 10 residential blocks for a total of 1.34 miles. We are hoping that the city will vote to renew the millage this year so that this 50 percent cost sharing incentive program can continue to help reach our goal of a fully paved road network for the next 10 year period until 2034.

Figure 20 shows the percentage of unpaved roads in each IBR number ranges of 10-8 (good); 7-5 (fair); and 4-1 (poor) for all roads.

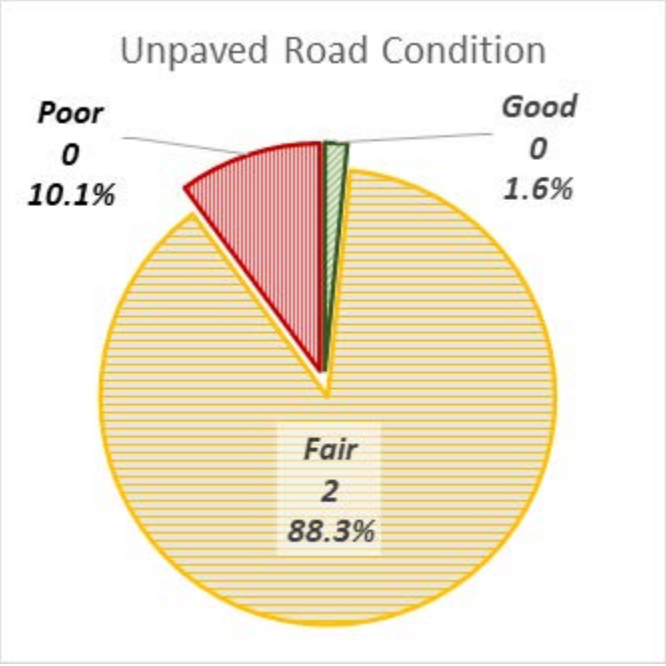


Figure 20: the City's unpaved road network condition by percentage of roads with IBR numbers of 10, 9, and 8; roads with IBR numbers of 7, 6, and 5; and IBR numbers of 4, 3, 2, and 1.

Goals

Goals help set expectations to how pavement conditions will change in the future. Pavement condition changes are influenced by water infiltration, soil conditions, sunlight exposure, traffic loading, and repair work performed. the City is not able to control any of these factors fully due to seasonal weather changes, traffic pattern changes, and its limited budget. In spite of the uncontrollable variables, it is still important to set realistic network condition goals that efficiently use budget resources to build and maintain roads meeting taxpayer expectations. An assessment of the progress toward these goals is provided in the *1. Pavement Assets*: *Gap Analysis* section of this plan.

Goals for Paved City Major Roads

The overall goal for the City's paved city major road network for the next three years is to improve road conditions network-wide as is illustrated in Figure 21.

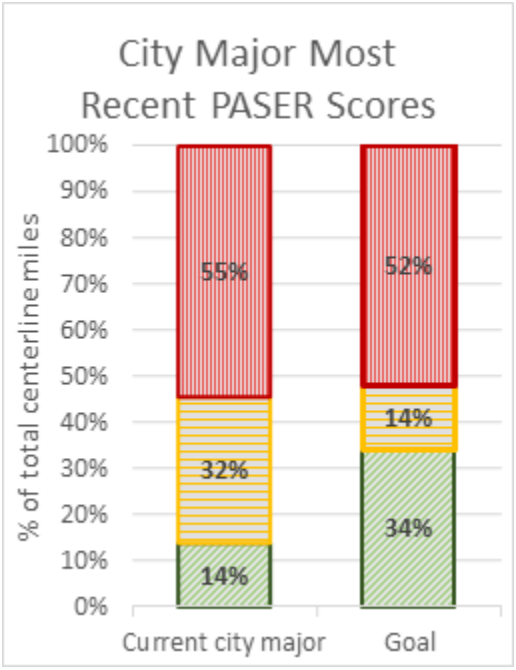


Figure 21: the City's 2023 city major road network condition by percentage of good/fair/poor

The City's network-level pavement condition strategy for paved city major roads is:

1. Resurface and reconstruct roads to get a higher percentage of “good” roads, understanding that these will move into the “fair” category within a few years.
2. Prevent its good and fair (PASER 10 - 5) paved city major from becoming poor (PASER 4 - 1).
3. Move 3 percent of paved city major roads out of the poor category.

Goals for Paved City Local Roads

The overall goal for the City’s paved city local road network is to maintain road conditions network-wide over the next three years as illustrated in Figure 22.

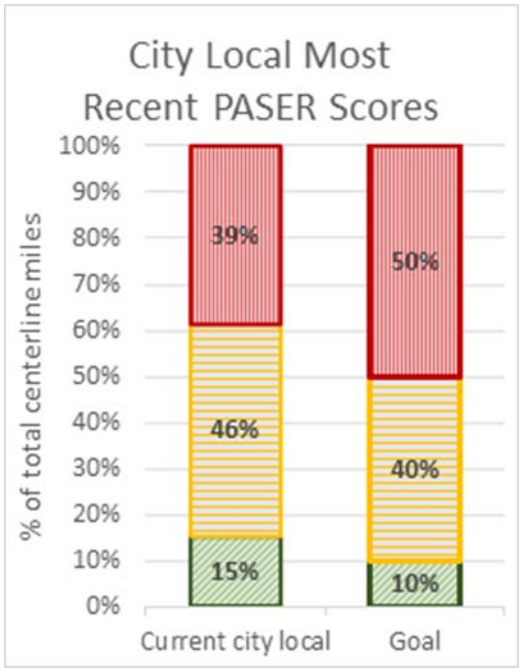


Figure 22: the City 2023 paved city local road network condition by percentage of good/fair/poor

the City’s network-level pavement condition strategy for paved city local roads is:

1. Prevent its good and fair (PASER 10 - 5) paved city local roads from becoming poor (PASER 4 - 1).

Goals for Unpaved Roads

The overall goal for the City’s unpaved road network is to maintain or improve road conditions network-wide at 2023 levels. The baseline condition for this goal is illustrated in Figure 23.

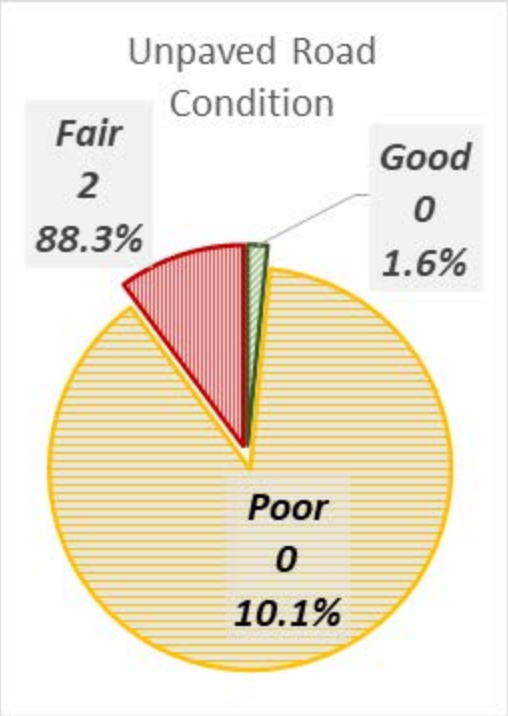


Figure 23: the City's 2023 unpaved road network condition by percentage of good/fair/poor

Our unpaved roads will be maintained at their current levels with no change to the structural or drainage adequacy at this time unless a special assessment to pave these is petitioned. Surface widths may be addressed on an as-needed basis to provide service or to address safety issues.

Modelled Trends

Roads age and deteriorate just like any other asset. All pavements are damaged by water, traffic weight, freeze/thaw cycles, sunlight, and traffic weight. To offset natural deterioration and normal wear-and-tear on the road, the City must complete treatment projects that either protect and/or add life to its pavements. The year-end condition of the whole network depends upon changes or preservation of individual road section condition that preservation treatments have affected.

the City uses many types of repair treatments for its roads, each selected to balance costs, benefits, and road life expectancy. When agency trends are modelled, any gap between goals and accomplishable work becomes evident. Financial resources influence how much work can be accomplished across the network within agency budget and what treatments and strategies can be afforded; a full discussion of the City's financial resources can be found in the *5. Financial Resources* section.

Treatments and strategies that counter pavement-damaging forces include reconstruction, structural improvement, capital preventive maintenance, innovative treatments, and maintenance. For a complete discussion on the pavement treatment tools, refer to the *1. Introduction*'s *Pavement Primer*.

Correlating with each PASER score are specific types of treatments best performed either to protect the pavement (CPM) or to add strength back into the pavement (structural improvement) (Table 1). MDOT provides guidance regarding when a specific pavement may be a candidate for a particular treatment. These identified PASER scores “trigger” the timing of projects appropriately to direct the right pavement fix at the right time, thereby providing the best chance for a successful project. The information provided in Table 1 is a guide for identifying potential projects; however, this table should not be the sole criteria for pavement treatment selection. Other information such as future development, traffic volume, utility projects, and budget play a role in project selection. This table should not be a substitute for engineering judgement. The City also considers grouping road projects geographically such that a single contractor can more efficiently work on the overall contract and as well as scheduling roadwork to reduce major disruptions to the overall city transportation network.

Table 1: Service Life Extension (in Years) for Pavement Types Gained by Fix Type[1]

Fix Type	Life Extension (in years)*			PASER
	Flexible	Composite	Rigid	
HMA crack treatment	1-3	1-3	N/A	6-7
Overband crack filling	1-2	1-2	N/A	6-7
One course non-structural HMA overlay	5-7	4-7	N/A	4-5****
Mill and one course non-structural HMA overlay	5-7	4-7	N/A	3-5
Single course chip seal	3-6	N/A	N/A	5-7†
Double chip seal	4-7	3-6	N/A	5-7†
Single course microsurface	3-5	**	N/A	5-6
Multiple course microsurface	4-6	**	N/A	4-6****
Ultra-thin HMA overlay	3-6	3-6	N/A	4-6****
Paver placed surface seal	4-6	**	N/A	5-7
Full-depth concrete repair	N/A	N/A	3-10	4-5***
Concrete joint resealing	N/A	N/A	1-3	5-8
Concrete spall repair	N/A	N/A	1-3	5-7
Concrete crack sealing	N/A	N/A	1-3	4-7
Diamond grinding	N/A	N/A	3-5	4-6
Dowel bar retrofit	N/A	N/A	2-3	3-5***
Longitudinal HMA wedge/scratch coat with surface treatment	3-7	N/A	N/A	3-5****
Flexible patching	**	**	N/A	N/A
Mastic joint repair	1-3	1-3	N/A	4-7
Cape seal	4-7	4-7	N/A	4-7
Flexible interlayer “A”	4-7	4-7	N/A	4-7
Flexible interlayer “B” (SAMI)	4-7	4-7	N/A	3-7
Flexible interlayer “C”	4-7	4-7	N/A	3-7
Fiber reinforced flexible membrane	4-7	4-7	N/A	3-7
Fog seal	**	**	N/A	7-10
GSB 88	**	**	N/A	7-10
Mastic surface treatment	**	**	N/A	7-10
Scrub seal	**	**	N/A	4-8

* The time range is the expected life extending benefit given to the pavement, not the anticipated longevity of the treatment.

** Data is not available to quantify the life extension.

*** The concrete slabs must be in fair to good condition.

**** Can be used on a pavement with a PASER equal to 3 when the sole reason for rating is rutting or severe raveling of the surface asphalt layer.

† For PASER 4 or less providing structural soundness exists and that additional pre-treatment will be required for example, wedging, bar seals, spot double chip seals, injection spray patching or other pre-treatments.

[1] Part of Appendix D-1 from *MDOT Local Agency Programs Guidelines for Geometrics on Local Agency Projects* 2017 Edition Approved Preventive Maintenance Treatments

Roadsoft Pavement Condition Forecast to Forecast Future Trends

The City uses Roadsoft, an asset management software suite, to manage road- and bridge-related infrastructure. Roadsoft is developed by Michigan Technological University and is available for Michigan local agencies at no cost to them. Roadsoft uses pavement condition data to drive network-level deterioration models that forecast future road conditions based on planned construction and maintenance work. A screenshot of Roadsoft's pavement condition model and the associated output for major roads is shown in Figure 24.

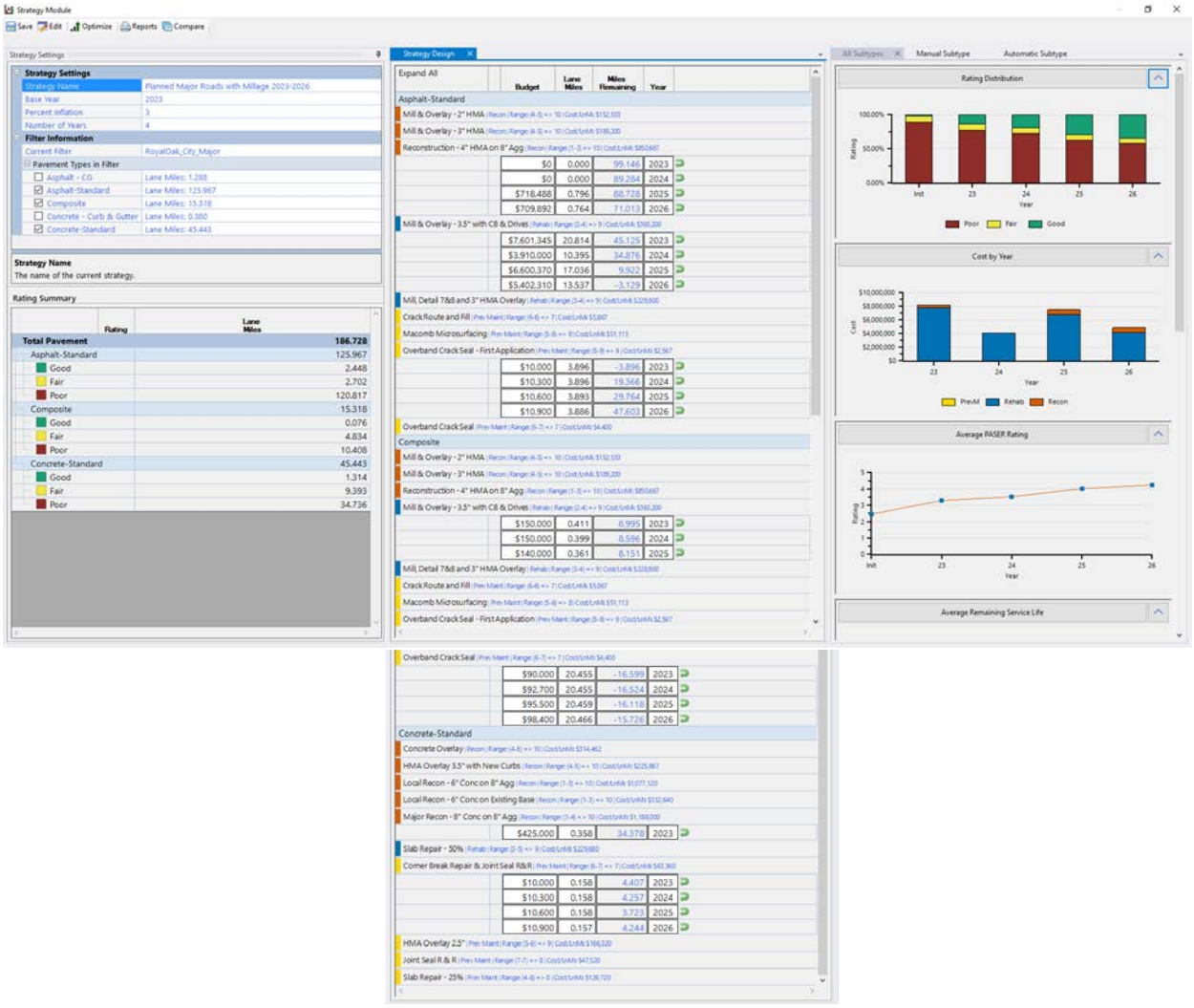


Figure 24: Pavement condition forecast model in the software program Roadsoft of major roads.

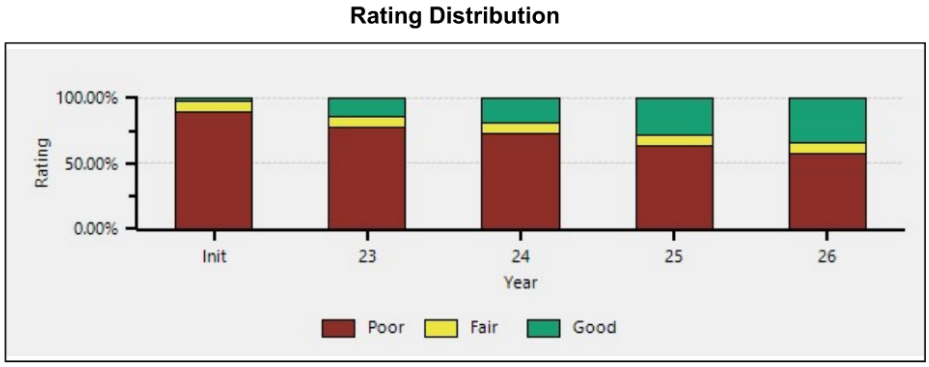
Paved City Major Roads

Table 2 illustrates the network-level model inputs for Roadsoft on the paved city major road network. The treatments outlined in Table 2 are the average treatment volume of planned projects scheduled to be completed annually. See Appendix A of this plan for details on planned projects. Full model inputs and outputs are included in Appendix D.

Table 2: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for City's Road Assets—Modelled Trends: Roadsoft Annual Work Program for the Paved City Major Road Network Forecast

Treatment Name	Annual Miles of Treatment	Years of Life	Trigger-Reset
Crack Seal	22	1	5, 6, 7–7
Chip Seal	0	5	5, 6-8
Overlay	0	10	4, 5-9
Resurfacing	3	15	2, 3, 4-,9
Slab Repair	0	15	3, 4, 5, 6-8
Reconstruction	0	30	1, 2, 3-10

Results from the Roadsoft network condition model for the city major roads are shown in Figure 25. The Roadsoft network analysis of the City's planned projects (if the road millage is renewed) does allow the City to reach its good pavement condition goal. The poor condition goal is not quite met over three years. However, the trend is in the correct direction and we expect to meet the goals by continuing investments throughout the road millage. We anticipate that the fairly high amount of good segments shown in the early years of the millage will trend into the fair category later in the 10-year millage timeframe allowing the City to meet the overall condition goal near the end of the millage.



Planned Major Roads with Millage 2023-2026

Figure 25: Forecast good/fair/poor changes to the City network condition from planned projects on the city major road network.

If the road millage is renewed, the city is on track to meet the goal conditions over the 10-year period.

Paved City Local Road

A screenshot of Roadsoft's pavement condition model and the associated output for local roads is shown in Figure 26.

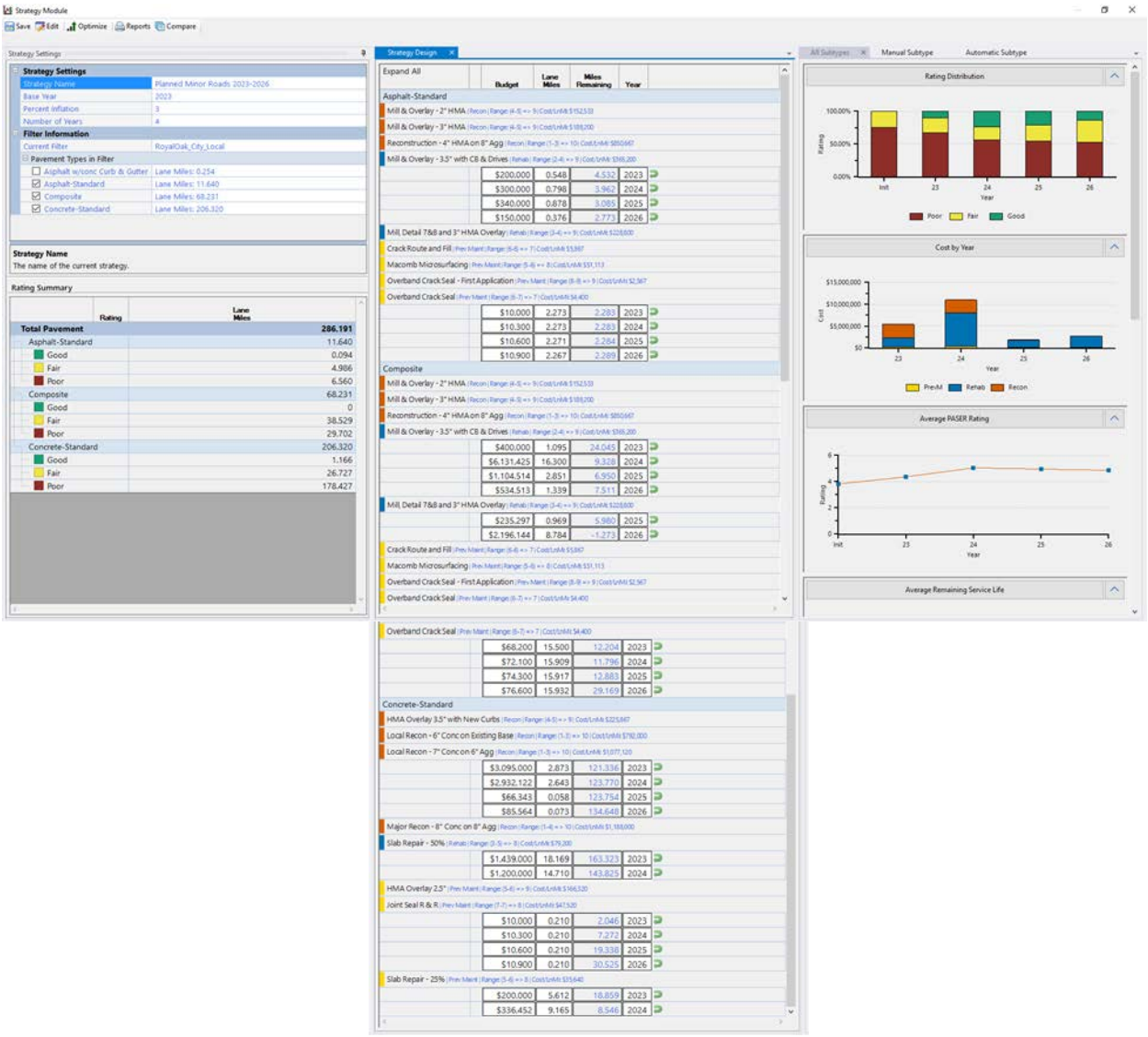


Figure 26: Pavement condition forecast model in the software program Roadsoft of local roads.

Table 3 illustrates the network-level model inputs for Roadsoft on the paved city local road network. The treatments outlined in Table 3 are the average treatment volume of planned projects scheduled to be completed in 2024-2026. Details on planned projects are included in Appendix A, and full model inputs and outputs are included in Appendix D.

Table 3: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for City's Road Assets—Modelled Trends: Roadsoft Annual Work Program for the Paved City Local Road Network Forecast

Treatment Name	Annual Miles of Treatment	Years of Life	Trigger-Reset
Crack Seal	50	1	5, 6, 7–7
Chip Seal	0	5	5, 6-8
Overlay	0	10	4, 5-9
Resurfacing	3	15	2, 3, 4-,9
Slab Repair	9	15	3, 4, 5, 6-8
Reconstruction	1	30	1, 2, 3-10

Results from the Roadsoft network condition model for the paved city local roads are shown in Figure 27. The Roadsoft network analysis of the City's planned projects from its currently available budget does allow the City to reach its pavement condition goal given the projects planned for the next three years.

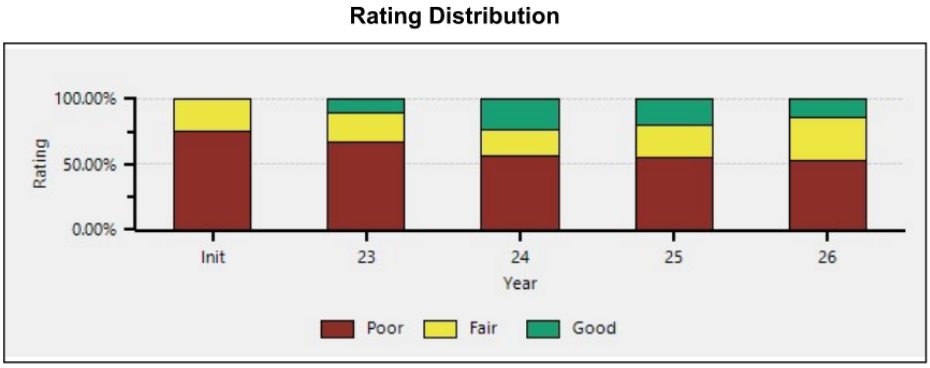


Figure 27: Forecast good/fair/poor changes to the City network condition from planned projects on the paved city local road network.

The Roadsoft analysis of the City's planned projects from its currently available budget and potential future budget (millage renewal) does allow the City to reach its pavement condition goals given the projects planned for the next three years. The City's current road millage has increased the overall local road rating as desired. If the millage is renewed for another 10 years, the City will continue to invest dollars into road reconstruction, asphalt resurfacing, joint sealing and pavement patching to maintain this progress.

Planned Projects

The City plans construction and maintenance projects several years in advance. A multi-year planning threshold is required due to the time necessary to plan, design, and finance construction and maintenance projects on the paved city major road network. This includes planning and programming requirements from state and federal agencies that must be met prior to starting a project and can include studies on environmental and archeological impacts, review of construction and design documents and plans, documentation of rights-of-way ownership, planning and permitting for storm water discharges, and other regulatory and administrative requirements.

Per PA 499 of 2002 (later amended by PA 199 of 2007), road projects for the upcoming three years are required to be reported annually to the TAMC. Planned projects represent the best estimate of future activity; however, changes in design, funding, and permitting may require the City to alter initial plans. Project planning information is used to predict the future condition of the road networks that the City maintains. The *1. Pavement Assets*: *Modelled Trends* section of this plan provides a detailed analysis of the impact of the proposed projects on their respective road networks.

For 2024-2026, the City plans to do the following projects:

Paved City Major Projects

the City is currently planning the construction and maintenance projects listed in Appendix A for the paved city major road network. The locations of these projects are shown in Figure 28, Figure 29, and Figure 30. The total cost of these projects is approximately $20,700,000.

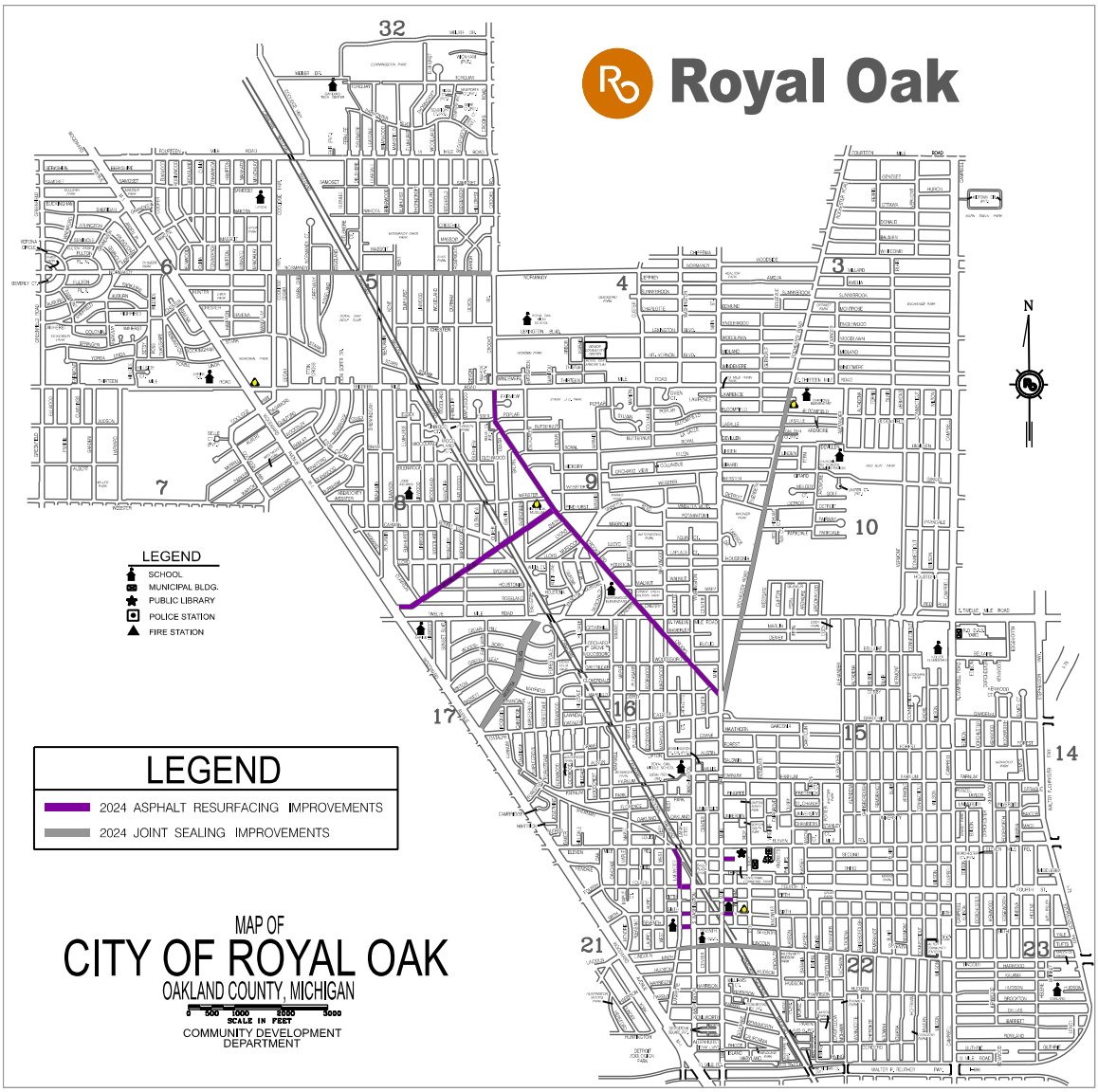


Figure 28: Map showing paved city major road projects planned for 2024.

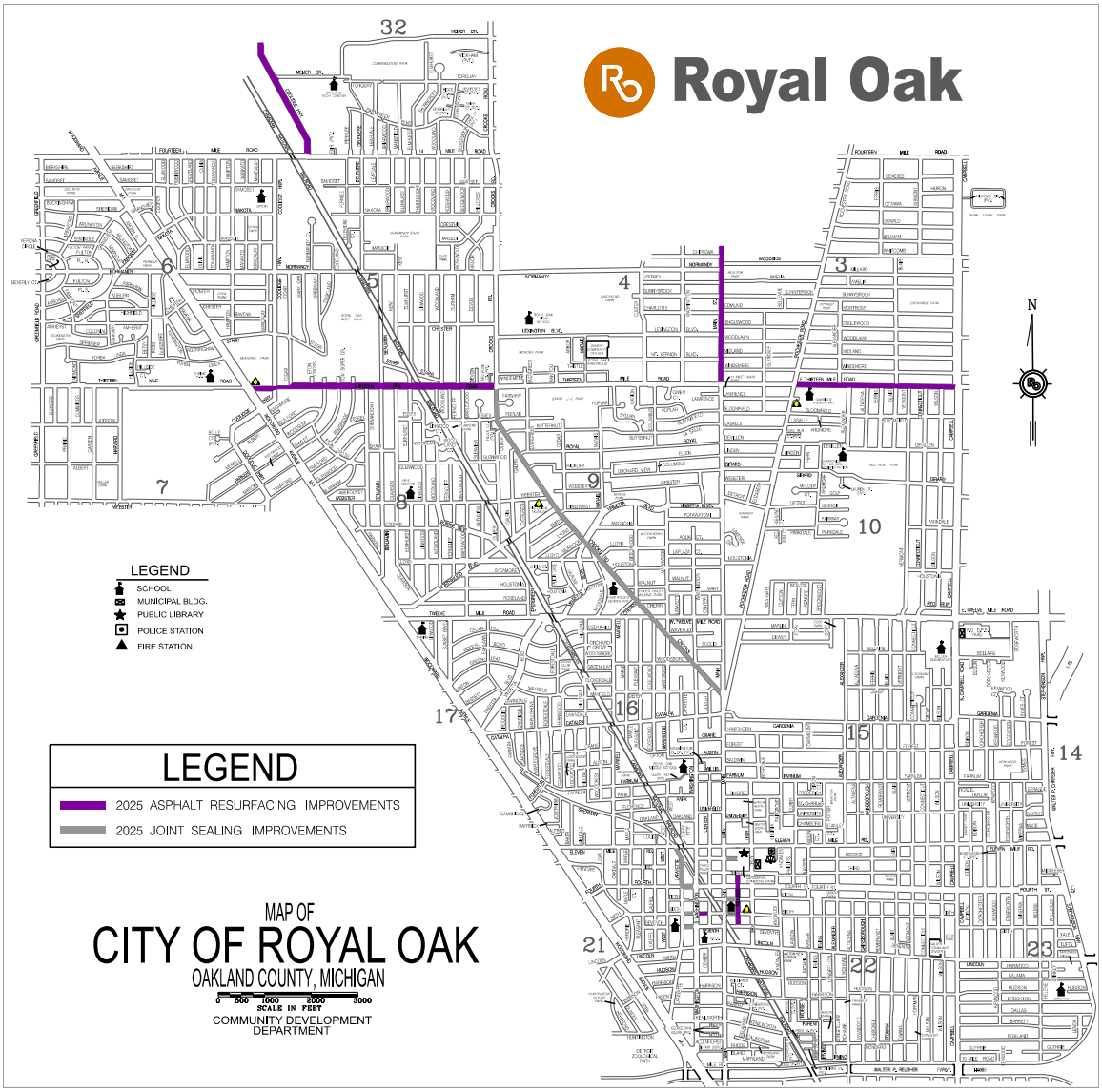


Figure 29: Map showing paved city major road projects planned for 2025.

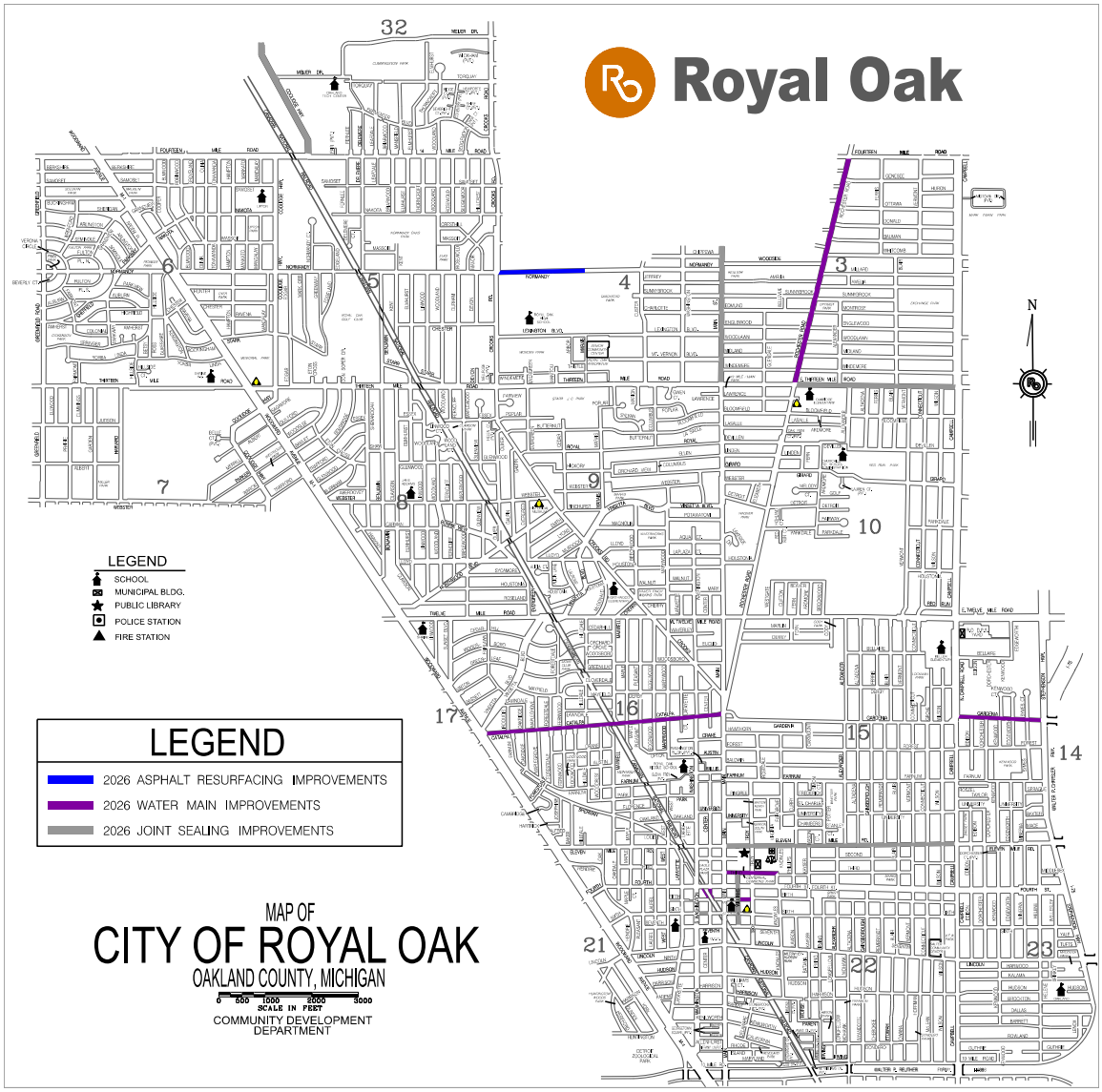


Figure 30: Map showing paved city major road projects planned for 2026.

Paved City Local Projects

the City is currently planning the construction and maintenance projects listed in Appendix B for the paved city local road network. The locations of these projects are shown in Figure 31, Figure 32, and Figure 33. The total cost of these projects is approximately $15,592,000.

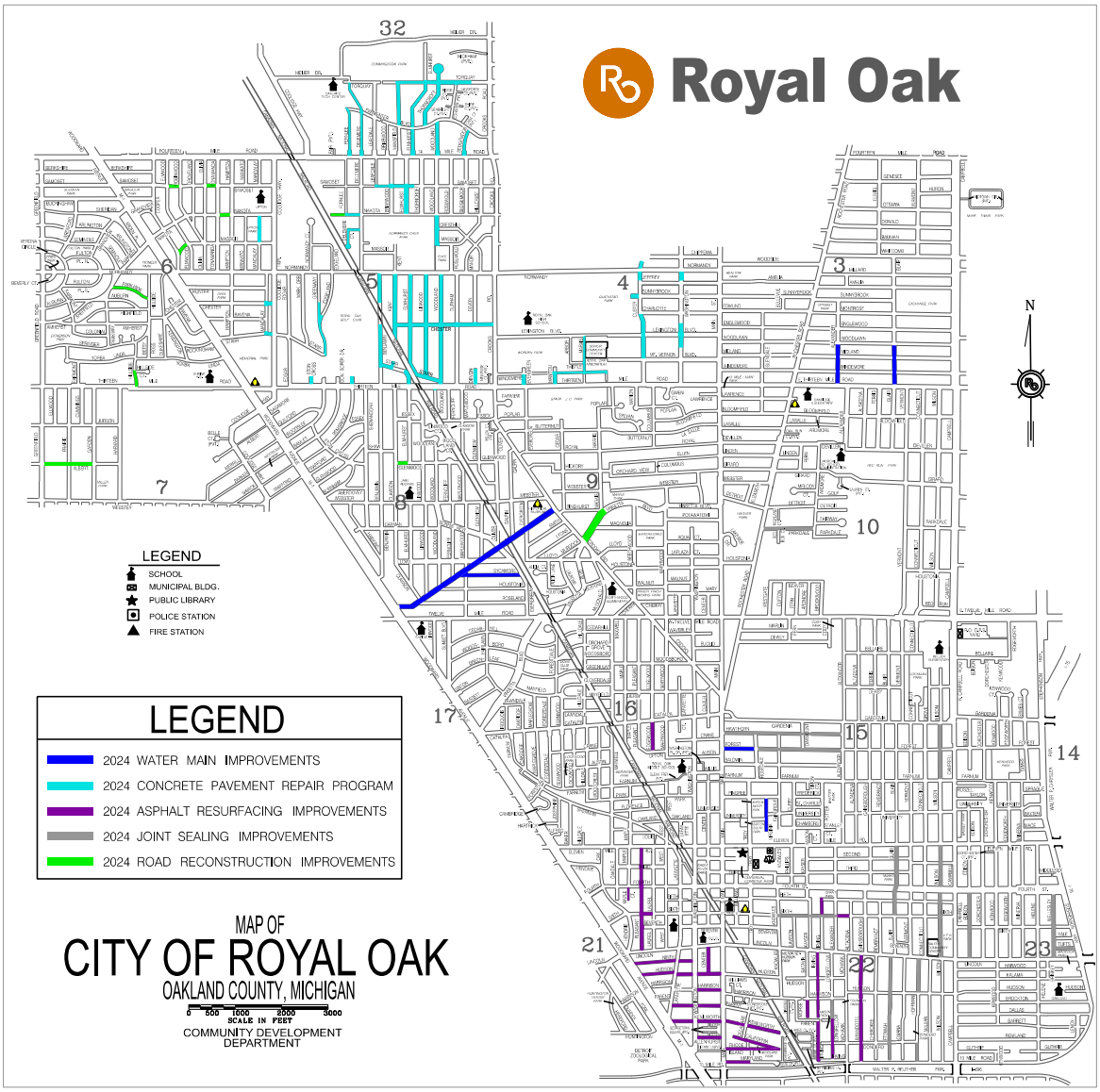


Figure 31: Map showing paved city local road projects planned for 2024.

Figure 32: Map showing paved city local road projects planned for 2025.

Figure 33: Map showing paved city local road projects planned for 2026.

Unpaved Road Projects

The City does not have plans for significant construction on unpaved roads other than one special assessment paving project in 2024 to pave one block of Massoit Road for $178,025. The Department of Public Services will continue annual maintenance of the unimproved roads each year as previously described. The location of these projects are shown in Figure 34. The total cost of these maintenance activities is approximately $57,000 over three years.

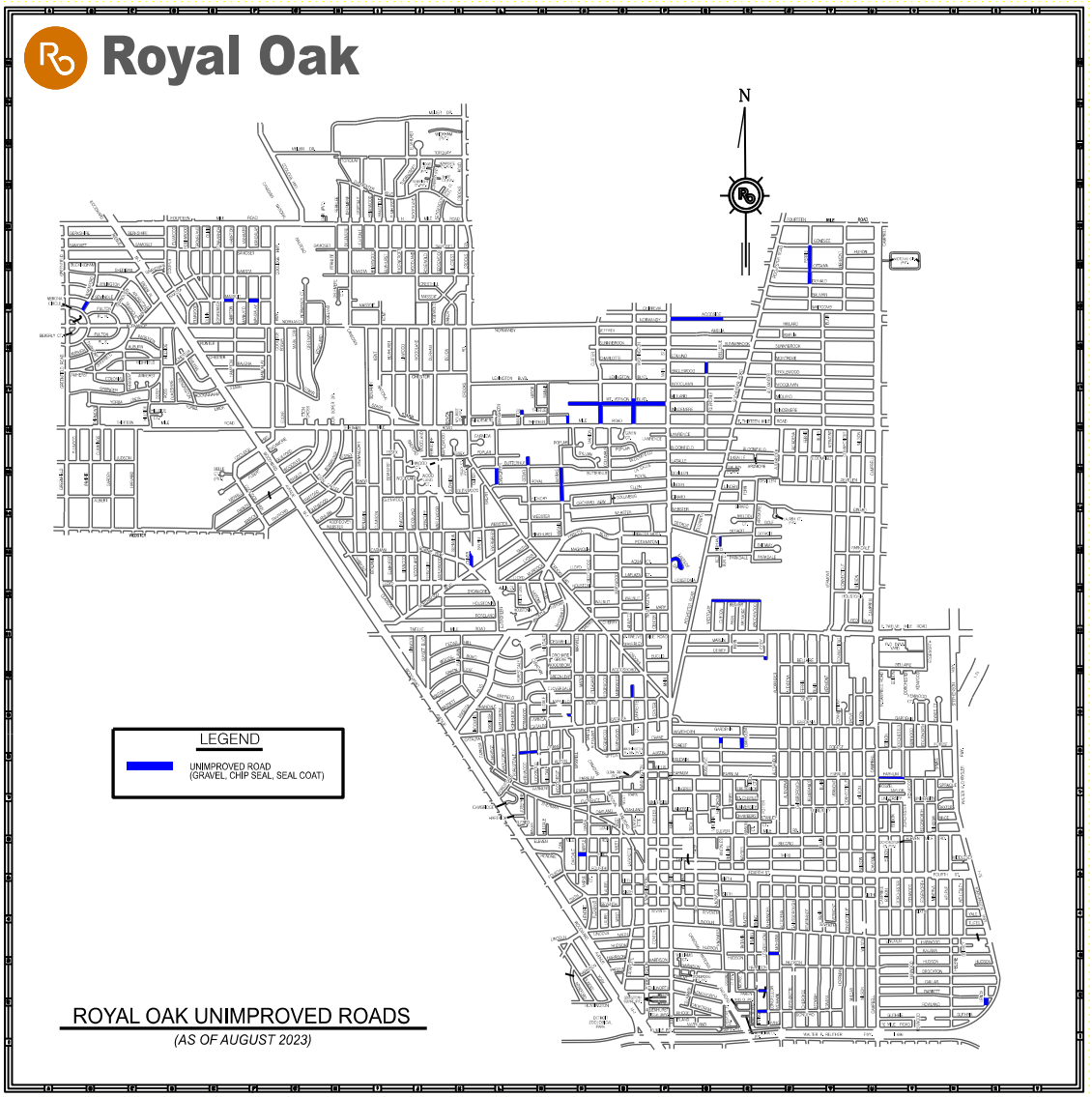


Figure 34: Map showing unpaved road maintenance planned for 2024-2026.

More detailed information on these projects can be found in Appendix A-C.

Gap Analysis

The current funding levels that the City receives appear to be sufficient to meet the goals for the paved city major road network and the unpaved road network while potentially being sufficient to meet the goals for the paved city local road network. The *1. Pavement Assets*: *Goals* section of this plan provides further detail about the goals and the *1. Pavement Assets*: *Modelled Trends* section provides further detail on the potential shortfall given the current budget. However, the City believes that the overall condition of this network can be maintained or improved with additional funding for construction and maintenance. An alternate strategy may be used to overcome the current shortfall and meet the goals on the paved city major road network, the paved city local road network, and the unpaved road network:

Roadsoft Pavement Condition Forecast for the Paved City Major and City Local Network

The City used Roadsoft to forecast the necessary additional construction and maintenance work for meeting agency goals on the paved city major and city local road networks. Table 4 and Table 5 illustrate the network-level model inputs used for this simulation. Full model inputs and outputs are included in Appendix D.

Table 4: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for City's Road Assets—Pavement Condition Forecast and Gap Analysis: Roadsoft Annual Work Program for Paved City Major Road Network Forecast

Pavement Condition Forecast

Treatment Name	Annual Miles of Treatment	Years of Life	Trigger-Reset
Crack Seal	25	1	5, 6, 7–7
Chip Seal	0	5	5, 6-8
Overlay	0	10	4, 5-9
Resurfacing	3	15	2, 3, 4-,9
Slab Repair	0	15	3, 4, 5, 6-8
Reconstruction	0	30	1, 2, 3-10

Additional Work Necessary to Overcome Deficit

Treatment	Annual Miles of Treatment	Years of Life	Trigger-Reset
Crack Seal	5	1	5, 6, 7–7
Chip Seal	0	5	5, 6-8
Overlay	0	10	4, 5-9
Resurfacing	3	15	2, 3, 4-,9
Slab Repair	1	15	3, 4, 5, 6-8
Reconstruction	1	30	1, 2, 3-10

Results for the paved city major road network from the Roadsoft network condition model given the inputs in Table 4 are shown in Figure 35 below. Results indicate that there is not any necessary additional work needed to meet the agency's condition goal for the next three years as planned with the presumed millage renewal allocation of funds.

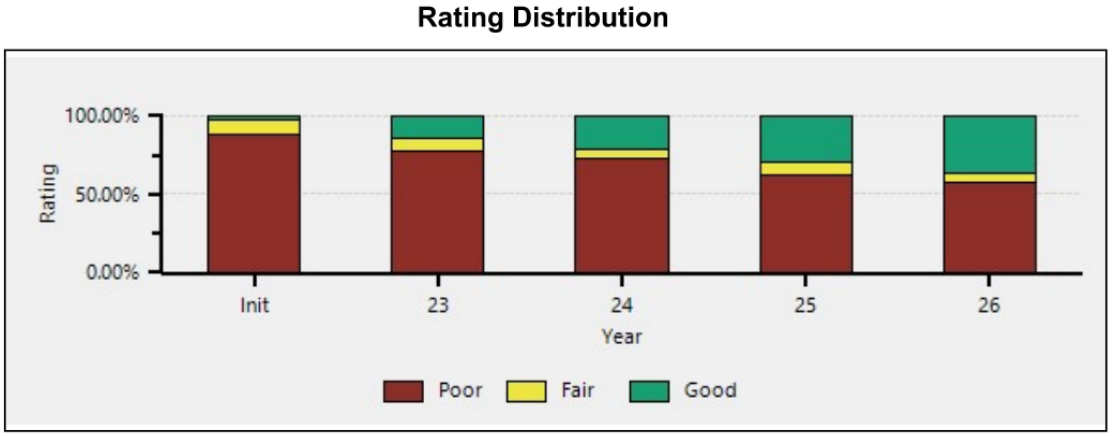


Figure 35: Forecast good/fair/poor Changes to the City Network Condition from planned projects on the city major paved road network.

Table 5: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for City's Road Assets—Pavement Condition Forecast and Gap Analysis: Roadsoft Annual Work Program for Paved City Local Road Network Forecast

Pavement Condition Forecast

Treatment Name	Annual Miles of Treatment	Years of Life	Trigger-Reset
Crack Seal	25	1	6, 7–7
Chip Seal	0	5	5, 6-8
Overlay	0	10	4, 5-9
Resurfacing	4	15	2, 3, 4-,9
Slab Repair	11	15	3, 4, 5, 6-8
Reconstruction	1	30	1, 2, 3-10

Additional Work Necessary to Overcome Deficit

Treatment	Annual Miles of Treatment	Years of Life	Trigger-Reset
Crack Seal	22	1	6, 7–7
Chip Seal	0	5	5, 6-8
Overlay	0	10	4, 5-9
Resurfacing	4	15	2, 3, 4-,9
Slab Repair	8	15	3, 4, 5, 6-8
Reconstruction	0	30	1, 2, 3-10

Results for the paved city local road network from the Roadsoft network condition model given the inputs in Table 5 are shown in Figure 36 below. Results indicate that there is not a significant amount of additional work needed to maintain the city's condition goal for the next three years.

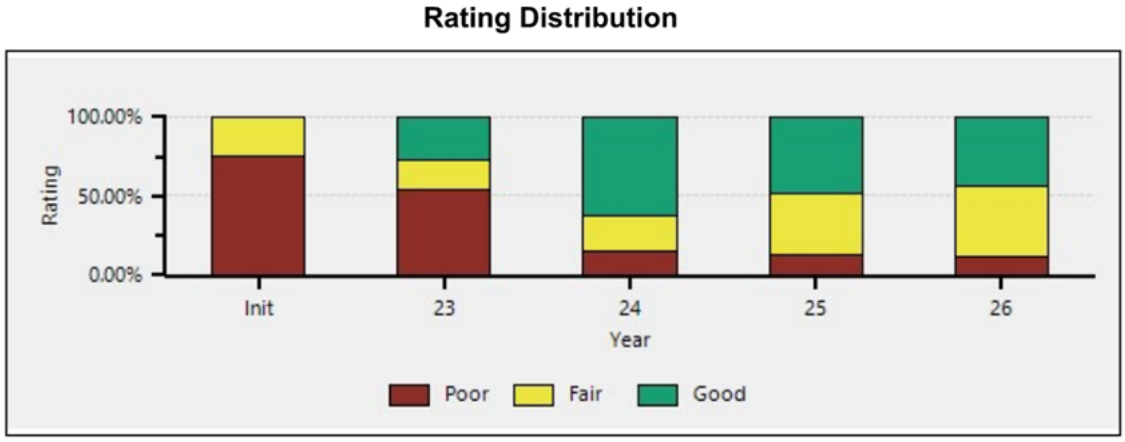


Figure 36: Forecast good/fair/poor Changes to the City Network Condition from planned projects on the city local paved road network.

2. FINANCIAL RESOURCES

Public entities must balance the quality and extent of services they can provide with the tax resources provided by citizens and businesses, all while maximizing how efficiently funds are used. The City will overview its general expenditures and financial resources currently devoted to pavement maintenance and construction. This financial information is not intended to be a full financial disclosure or a formal report. Michigan agencies are required to submit an Act 51 Report to the Michigan Department of Transportation each year; this is a full financial report that outlines revenues and expenditures. This report can be obtained by request submitted to our agency contact (listed in this plan).

Assuming the road millage is renewed, the City has a total budget for pavement and sidewalk asset management of $10.5M annually beginning in 2025. The city's budget for 2024 pavement projects is $14.8M.

City Major Network

Over the next three years, the City plans to spend $6.9M on average each year (if the millage renewal passes) on city major-network projects consisting of, but not limited to, reconstruction, overlay, culvert replacement, and preventive maintenance. Spending on projects depends on revenue from Michigan Transportation Fund (MTF), millages, federal/state programs, and hopefully the renewal of the 2.5 mil, 10-year current road millage later this year. The intent of the millage is to improve primarily major roads from 2025 through 2034 along with maintaining local roads during that same timeframe.

City Local Network

Over the next three years, the City plans to spend $5.2M on average each year (if the millage renewal passes) on city local-network projects consisting of, but not limited to, reconstruction, overlay, and preventive maintenance. Spending on projects depends on revenue from Michigan Transportation Fund (MTF), millages, and federal/state programs. Many local agencies in Michigan use local tax millages and special assesments to supplement their road-funding budget. These taxes can provide for additional construction and maintenance for new or existing roads that are also funded using MTF or MDOT funds. The City has a local tax millage in its road-funding budget.The City of Royal Oak voters approved a 2.5-mil, 10-year road millage in 2014. The intent of the millage is to improve local roads from 2015 through 2024. A renewal of the millage for 2025-2034 is on the November 2023 ballot.

3. RISK OF FAILURE ANALYSIS

Transportation infrastructure is designed to be resilient. The system of interconnecting roads and bridges maintained by the City provides road users with multiple alternate options in the event of an unplanned disruption of one part of the system. There are, however, key links in the transportation system that may cause significant inconvenience to users if they are unexpectedly closed to traffic. Figure 36 illustrates the key transportation links in the City's road network, including those that meet the following types of situations:

- **Geographic divides:** Areas where a geographic feature (river, lake, mountain or limited access road) limits crossing points of the feature
- **Emergency alternate routes for high-volume roads:** Roads which are routinely used as alternate routes for high volume roads or roads that are included in an emergency response plan
- **Limited access areas:** Roads that serve remote or limited access areas that result in long detours if closed
- **Main access to key commercial districts:** Areas where large number or large size business will be significantly impacted if a road is unavailable.

Our road network includes the following critical assets: 11 Mile Road, 13 Mile Road, 14 Mile Road, Stephenson Highway, Campbell Road, and Main Street. Other critical assets include Woodward Avenue and a portion of 10 Mile Road (State jurisdictions) and Greenfield Road, 10 Mile Road, 12 Mile Rd, and a portion of 14 Mile Road (Oakland County jurisdictions). The City does not have any bridges within our boundaries, but bridges within Royal Oak exist under MDOT or railroad jurisdictions. (see Figure 36).

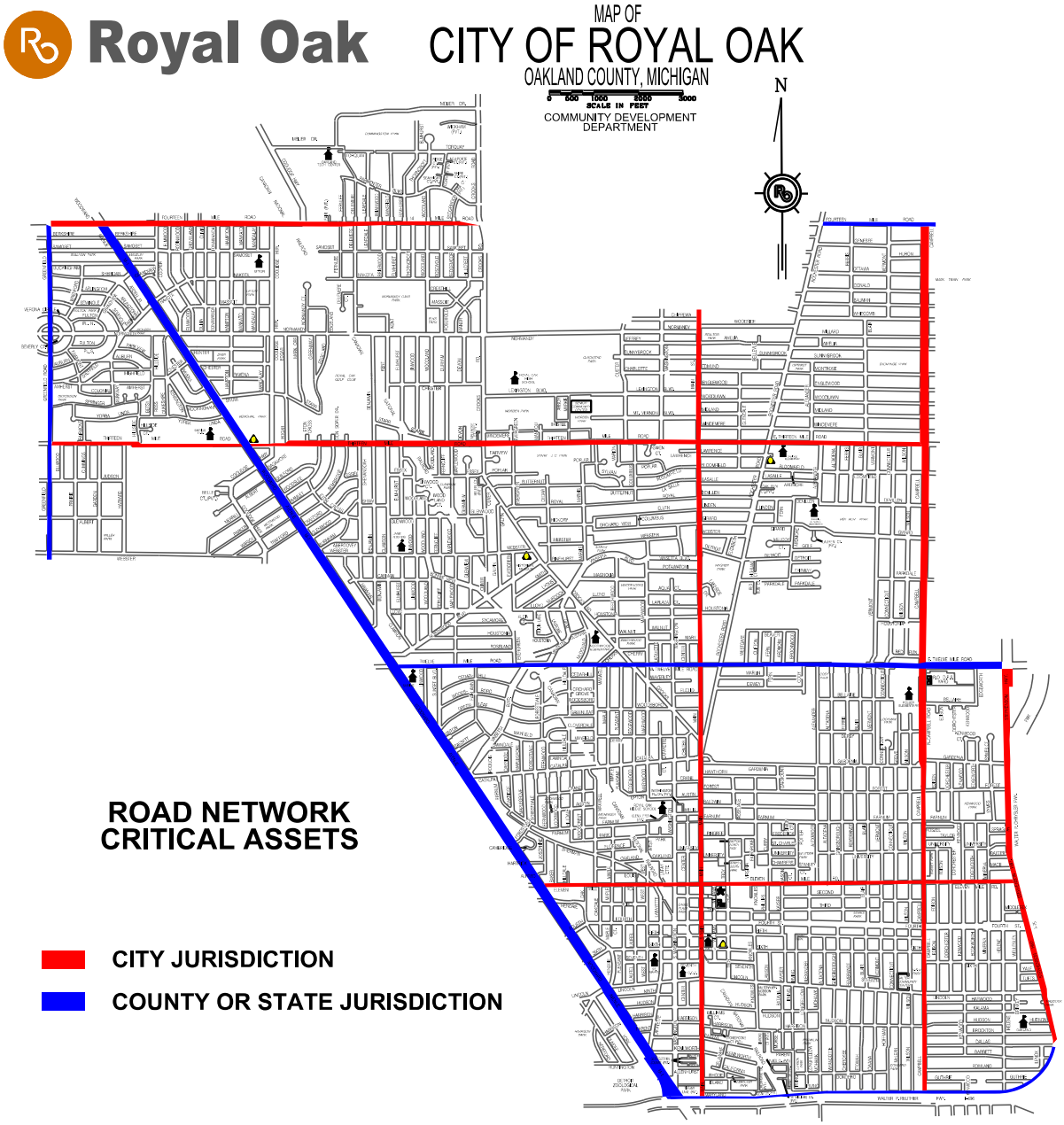


Figure 37: Key transportation links in the City's road network

4. COORDINATION WITH OTHER ENTITIES

An asset management plan provides a significant value for infrastructure owners because it serves as a platform to engage other infrastructure owners using the same shared right of way space. the City communicates with both public and private infrastructure owners to coordinate work in the following ways:

The City maintains drinking water, sanitary, storm, and combined sewer assets in addition to transportation assets.

The Royal Oak Engineering Division works closely with the Royal Oak Department of Public Services (DPS) to identify problematic water and sewer locations within the city to ensure they are addressed prior to significant road work. Additionally, sewers are televised prior to road projects, and water mains are upgraded when appropriate and where recommended by the city's water asset management plan. The City also works with Consumers Energy Company to plan for future work as there are many gas mains and services that require upgrading within the City. The City works to coordinate sub-surface utility plans with transportation infrastructure plans to maximize value and minimize service disruptions and cost to the public.

The City takes advantage of coordinated infrastructure work to reduce cost and maximize value using the following policies:

- Roads which are in poor condition that have a subsurface infrastructure project planned which will destroy more than half the lane with will be rehabilitated or reconstructed full width using transportation funds to repair the balance of the road width.
- Subsurface infrastructure projects which will cause damage to pavements in good condition will be delayed as long as possible, or will consider methods that do not require pavement cuts.

- Subsurface utility projects will be coordinated to allow all under pavement assets to be upgraded in the same project regardless of ownership.
- Subsurface utilities not owned by the City are directed to be installed within the greenbelt portion of roadways to avoid roadway disruption as much as possible.
- Road reconstruction projects will not be completed until agency owned sub surface utilities are upgraded to have at least a 40 years of remaining service life.

APPENDIX A: 2024 – 2026 PAVED CITY MAJOR ROAD PLANNED PROJECTS

Tentative Scheduled Construction	Street	From	To	Average PASER rating	Total Project Cost Estimate	Total Annual Cost Estimate
2024	Northwood Blvd.	Woodward	Crooks Rd	2	$2,552,833	
2024	Crooks Rd	N Main	W Webster Rd	3	$1,513,496	
2024	Crooks Rd	W Webster Rd	W 13 Mile Rd	2	$1,196,400	
2024	W 4th St	S Lafayette	S Washington	1	$145,321	
2024	S Lafayette	Sherman Dr	W 11 Mile Rd	2	$154,009	
2024	S Lafayette	W 4th St	Sherman Dr	2	$269,022	
2024	E 2nd St	W 2nd St & S Main	Dead End or Start	2	$80,559	
2024	E 5th St	S Main & W 5th St	Williams	2	$108,399	
2024	W 6th St	S Lafayette	S Washington	1	$146,901	
2024	E 6th St	S Main & W 6th St	Williams	2	$108,399	
2024	W 7th St	S Lafayette	S Washington	1	$140,780	**$6,416,119**
2025	E 13 Mile Rd	Campbell Rd	Rochester Rd	3	$1,124,612	
2025	W 13 Mile Rd	Crooks Rd	Woodward Ave	5	$3,193,636	
2025	N Main	E 13 Mile Rd	City/Twp Line	4	$1,018,889	
2025	Coolidge Rd	W 14 Mile Rd	City/Twp Line	2	$1,723,569	
2025	W 6th St	S Washington	S Center	2	$114,752	
2025	Williams	E 7th St	E 3rd St	2	$578,387	**$7,753,845**
2026	Rochester Rd	E 13 Mile Rd	E 14 Mile Rd	2	$1,800,000	
2026	Catalpa Dr	Woodward Ave	N Main St	2	$2,045,495	
2026	Gardenia	Campbell	N Stephenson	2	$663,608	
2026	E 3rd St	S Main	Knowles	2	$1,044,033	
2026	E 5th St	Williams	S Troy	2	$210,007	
2026	S Center	W 5th St - W of RR	W 4th St - W of RR	2	$40,952	
2026	S Center	W 5th St - E of RR	W 4th St - E of RR	2	$115,004	
2026	Normandy Rd	Crooks Rd	Quickstad Park	5	$117,497	
2026	Campbell Rd	12 Mile Rd	13 Mile Rd	6	$497,185	**$6,533,779**
					Three Year Total Cost:	**$20,703,743**

APPENDIX B: 2024 - 2026 PAVED CITY LOCAL ROAD PLANNED PROJECTS

Royal Oak COMMUNITY DEVELOPMENT

Appendix B
City of Royal Oak
Local Road Improvement Schedule

2024 (preliminary)

Street:	From:	To:	Section		Funding sources	
					Local Roads	Water and Sewer
2024 Road Reconstruction Improvements						
Albert	Albert Ave & Greenfield Rd	Prairie	NW	7	$235,604.16	
Albert	Prairie	Garden	NW	7	$241,971.84	
Hillside Dr	John B Poole Dr & W 13 Mile Rd	Hillside Ct	SW	6	$148,657.81	
Samoset	Olivia	Tonawanda	NE	6	$108,250.56	
Nakota	Dead End or Start	Fernlee	NW	5	$158,405.87	
Nakota	Tonawanda	Hampton Blvd	NE	6	$155,968.85	
Samoset	Elmwood	Robinwood	NE	6	$120,985.92	
Massoit Rd	Cooper	Elmwood	NE	6	$133,721.28	
Glenwood Rd	Clawson	Elmhurst	NE	8	$131,598.72	
Vinsetta Blvd (north lane)	E. of Crooks	Marais	SW	9	$254,943.04	$97,500.00
Vinsetta Blvd (south lane)	E. of Crooks	Pinehurst	SW	9	$247,710.61	$117,000.00
Parkview Dr	Sheffield Rd & Parkway Dr	Hillside Dr	SW	6	$384,183.36	$310,596.00
2024 Concrete Street Repair Improvements						
Custer	Mount Vernon Blvd	Lexington Blvd	SE	4	$14,386.81	
Custer	Lexington Blvd	Charlotte	SE	4	$50,096.94	
Custer	Jeffrey	Normandy Rd	SE	4	$5,223.78	
Custer	Normandy Rd	City/Twp Line	SE	4	$26,975.27	
Chippewa St	City/Twp Line	S Washington & N Washington	SE	4	$10,533.20	
Chippewa St	S Washington & N Washington	N Main & S Main	SE	4	$44,701.88	
Evergreen Dr	W 13 Mile Rd	W Windemere	SW	4	$2,397.80	
Manitou Blvd	W 13 Mile Rd	W Windemere	SW	4	$2,354.98	
Marais	W Windemere	Mount Vernon Blvd	SW	4	$2,703.87	
Marais	Mount Vernon Blvd	Lexington Blvd	SW	4	$5,604.39	
N Washington	Lexington Blvd	pavement change	SE	4	$9,248.67	
N Washington	Jeffrey	Normandy Rd	SE	4	$12,845.37	
N Washington	pavement change	Lexington Blvd	SE	4	$5,223.78	
W Sunnybrook Rd	Custer	Dead End or Start	SE	4	$3,468.25	
W Windemere	Manitou Blvd	Marais	SW	4	$27,831.63	
W Windemere	Marais	pavement change	SE	4	$8,563.58	
Bembridge Rd	W 13 Mile Rd	Dead End or Start	SW	5	$5,014.45	
Benjamin	Starr Rd	Pavement Change	SW	5	$17,796.39	
Benjamin	Pavement Change	Normandy Rd	SW	5	$25,172.17	
Chester Rd	Kent Rd	Elmhurst	SE	5	$11,132.65	
Chester Rd	Linwood	Woodland	SE	5	$8,349.49	
Chester Rd	Woodland	Durham Rd	SE	5	$8,734.85	
Chester Rd	Durham Rd	Devon Rd	SE	5	$19,781.87	
Chester Rd	Devon Rd	Crooks Rd	SE	5	$39,392.46	
Chester Rd	Mandalay	Coolidge Rd	SW	5	$599.45	
Chester Rd	Mandalay	Coolidge Rd	SW	5	$1,284.54	
Delemere Ct	Delemere Blvd	Dead End or Start	NW	5	$20,352.77	
Devon Rd	W 13 Mile Rd	Dead End or Start	SE	5	$50,636.13	
Elmhurst	Nakota	Samoset	NE	5	$41,206.99	
Elmhurst	Pavement change	Chester Rd	SE	5	$28,759.35	
Elmhurst	Chester Rd	Normandy Rd	SE	5	$22,515.87	
Eton Cross	W 13 Mile Rd	Dead End or Start	SW	5	$1,425.68	
Greenway	Starr Rd	Edgeland	SW	5	$100,289.03	
Greenway	Edgeland	Pavement Change	SW	5	$56,781.29	

Royal Oak COMMUNITY DEVELOPMENT

Appendix B
City of Royal Oak
Local Road Improvement Schedule

2024 (preliminary)

Street:	From:	To:	Section		Funding sources	
					Local Roads	Water and Sewer
Kent Rd	Chester Rd	Normandy Rd	SE	5	$11,307.10	
Kent Rd	Chester Rd	Dead End or Start	SE	5	$2,483.44	
Linwood	Starr Rd	Chester Rd	SE	5	$33,331.35	
Linwood	Chester Rd	Normandy Rd	SE	5	$22,712.52	
Mandalay	Massoit Rd	Nakota	NW	5	$6,194.32	
Nakota	Fernlee	Delemere Blvd	NW	5	$10,028.90	
Samoset	Leafdale	Briarwood	NW	5	$26,975.27	
Samoset	Briarwood	Elmhurst	NE	5	$18,934.07	
Samoset	Elmhurst	Pavement Change	NE	5	$6,337.05	
Starr Rd	Benjamin	Pavement Change	SE	5	$7,569.25	
Starr Rd	Elmhurst	Linwood	SE	5	$3,441.29	
Starr Rd	Pavement Change	Kent Ct	SE	5	$3,539.61	
Starr Rd	Kent Ct	Pavement Change	SE	5	$5,899.35	
Starr Rd	Pavement Change	W 13 Mile Rd & Elmhurst	SE	5	$11,651.23	
Starr Rd	Woodland	W 13 Mile Rd	SE	5	$3,736.26	
Starr Rd	Mandalay	Coolidge Rd	SW	5	$2,949.68	
Starr Rd	Linwood	Woodland	SE	5	$6,882.58	
Starr Rd	Mandalay	Coolidge Rd	SW	5	$1,081.55	
Woodland		Dead End or Start	SE	5	$2,569.07	
Woodland	Starr Rd	Chester Rd	SE	5	$53,094.19	
Woodland	W 13 Mile Rd	Dead End or Start	SE	5	$25,809.68	
Woodland	Chester Rd	Normandy Rd	SE	5	$29,415.89	
Woodland	Massoit Rd	Cresthill	NE	5	$5,395.05	
Woodland	Cresthill	Nakota	NE	5	$5,395.05	
Delemere	W 14 Mile Rd	Parmenter Blvd	SE	32	$37,362.58	
Delemere	Parmenter Blvd	Torquay	SW	32	$19,172.90	
Fernlee	W 14 Mile Rd	Parmenter Blvd	SW	32	$32,004.00	
Mansfield	Parmenter Blvd	Torquay	SE	32	$49,407.09	
Elmhurst	W 14 Mile Rd	Parmenter Blvd	SE	32	$26,761.19	
Elmhurst	Parmenter Blvd	Torquay	SE	32	$49,454.67	
Sedgemoor	W 14 Mile Rd	Parmenter Blvd	SE	32	$52,666.01	
Thorncroft	Parmenter Blvd	Torquay	SE	32	$47,956.04	
Thorncroft	Torquay	Dead End or Start	SE	32	$12,674.10	
Torquay	Mansfield	Elmhurst	SE	32	$27,284.51	
Torquay	Elmhurst	Thorncroft	SE	32	$13,519.35	
Torquay	Thorncroft	Pavement Change	SE	32	$7,374.19	
Woodland	W 14 Mile Rd	Parmenter Blvd	SE	32	$76,200.00	
2024 Asphalt Resurfacing Improvements						
Williams Ct	E Harrison	Dead End or Start	SW	22	$31,619.43	
W Maryland	S Main	Delaware & E Maryland	SW	22	$72,717.48	
Rhode Island	Delaware	Delaware	SW	22	$13,653.54	
Rhode Island	Delaware	California	SW	22	$72,818.89	
E Kenilworth	Delaware	Dead End or Start	SW	22	$89,827.06	
Rhode Island	S Main	Delaware	SW	22	$48,478.95	
Rhode Island	California	McGill Dr	SW	22	$11,052.87	
California	Road Ends	Delaware	SW	22	$35,365.62	
California	Delaware	Delaware	SW	22	$11,976.94	
California	Delaware	Rhode Island	SW	22	$82,042.04	
E Kenilworth	W Kenilworth & S Main	Delaware	SW	22	$65,016.86	
Batavia	Pavement Change	E Harrison	SW	22	$53,706.44	

Royal Oak COMMUNITY DEVELOPMENT

Appendix B
City of Royal Oak
Local Road Improvement Schedule

2024 (preliminary)

Street:	From:	To:	Section		Funding sources	
					Local Roads	Water and Sewer
Irving	Anne Dr	Dondero Ave	SW	22	$27,906.79	
Irving	Dondero Ave	E Parent	SW	22	$43,168.31	
Irving	E Parent	E Harrison	SW	22	$61,115.85	
Irving	E Harrison	E Hudson	SW	22	$59,815.51	
Irving	E Hudson	E Lincoln	SW	22	$80,380.65	
Irving	E 6th St	E 5th St	NW	22	$33,859.71	
Longfellow	Irving	Dondero Ave	SW	22	$49,891.44	
Longfellow	Dondero Ave	E Parent	SW	22	$72,099.05	
E 6th St	S Alexander	S Altadena	NE	22	$36,464.00	
Wyandotte	E 10 Mile Rd	Dondero Ave	SE	22	$37,935.79	
Wyandotte	Dondero Ave	E Hudson	SE	22	$125,527.79	
Wyandotte	E Hudson	E Lincoln	SE	22	$98,895.77	
Allenhurst	S Washington	S Main	SE	21	$67,191.28	
W Harrison	S Washington	S Main	SE	21	$77,370.07	
W Hudson	S Lafayette	S Washington	SE	21	$79,178.96	
W Hudson	S Center	E Hudson & S Main	SE	21	$56,219.39	
W Hudson	Woodward Ave	S Lafayette	SE	21	$114,034.22	
W Hudson	S Washington	S Center	SE	21	$58,125.13	
W Parent	S Lafayette	S Washington	SE	21	$67,139.01	
Ninth St	Woodward Ave	S Lafayette	SE	21	$145,486.08	
Ninth St	S Lafayette	S Washington	SE	21	$59,080.64	
S Center	W Hudson	W Lincoln	SE	21	$113,017.38	
S Pleasant	W Lincoln	W 7th St	NE	21	$105,690.30	
S Pleasant	W 7th St	W 6th St	NE	21	$55,269.24	
S Pleasant	W 6th St	W 4th St	NE	21	$113,447.38	
S Pleasant	W 4th St	W 3rd St	NE	21	$84,358.31	
S Pleasant	W 3rd St	W 11 Mile Rd	NE	21	$87,267.22	
W 6th St	S Pleasant	S Laurel	NE	21	$39,005.65	
S Maple	W 4th St	Dead End or Start	NE	21	$11,969.72	
W Kenilworth	W M 1 Service Drive	S Washington	SE	21	$68,267.71	
W Kenilworth	S Washington	S Main & E Kenilworth	SE	21	$77,370.07	
W Parent	S Washington	E Parent & S Main	SE	21	$76,600.43	
W 4th St	S Lafayette	S Washington	NE	21	$130,843.43	
S Lafayette	Sherman Dr	W 11 Mile Rd	NE	21	$140,295.26	
S Lafayette	W 4th St	Sherman Dr	NE	21	$208,449.00	
W 6th St	S Lafayette	S Washington	NE	21	$190,368.93	
E 2nd St	W 2nd St & S Main	Dead End or Start	NW	22	$69,314.67	
E 5th St	S Main & W 5th St	Williams	NW	22	$86,453.56	
W 7th St	S Lafayette	S Washington	NE	21	$145,395.90	
E 6th St	S Main & W 6th St	Williams	NW	22	$92,796.10	
2024 Joint Sealing Improvements						
Sealing 2023 asphalt resurfaced streets					$52,449.73	
Sealing 2019 asphalt resurfaced streets					$60,850.27	
2024 Water Main Improvements						
Crooks	Webster	Royal	NW	9		$418,750.00
Crooks	Vinsetta	Lloyd	NW	9		$154,100.00
Northwood Blvd	Maplewood	Crooks Rd	SE	8	$1,317,070.39	$799,180.80
Northwood Blvd	Woodward Business Route	Roseland	SE	8	$69,612.60	
Northwood Blvd	Roseland	Clawson	SE	8	$64,043.59	

Royal Oak COMMUNITY DEVELOPMENT

Appendix B
City of Royal Oak
Local Road Improvement Schedule

2024 (preliminary)

Street:	From:	To:	Section		Funding sources	
					Local Roads	Water and Sewer
Northwood Blvd	Linwood	W Houstonia & Woodland	SE	8	$197,699.78	
Northwood Blvd	W Houstonia & Woodland	Ferncliff	SE	8	$175,423.75	
Northwood Blvd	Ferncliff	Sycamore	SE	8	$80,750.62	
Northwood Blvd	Sycamore	Maplewood	SE	8	$119,733.67	
Northwood Blvd	Clawson	Linwood	SE	8	$103,026.65	
Maplewood	Sycamore	Northwood Blvd	SE	8	$22,071.14	
Sycamore	Maplewood	Bonnie View Dr	SW	9	$198,640.25	$426,610.17
Forest	N Main	Rosedale	SW	15	$97,525.30	$253,440.00
Virginia	Dead End or Start	E University	SW	15	$23,563.65	$89,548.80
Virginia	E University	E University	SW	15	$10,670.33	$40,550.40
Virginia	E University	Pingree Blvd	SW	15	$36,012.37	$136,857.60
N Alexander	E Windemere	Midland Blvd	SE	3	$5,395.05	$106,444.80
N Alexander	Midland Blvd	Woodlawn	SE	3	$2,783.16	$109,824.00
N Alexander	E 13 Mile Rd	E Windemere	SE	3	$5,223.78	$103,065.60
N Blair	E Windemere	Midland Blvd	SE	3	$8,349.49	$109,824.00
N Blair	E 13 Mile Rd	E Windemere	SE	3	$7,835.67	$103,065.60
N Blair	Midland Blvd	Woodlawn	SE	3	$8,221.04	$108,134.40

Total: $10,879,918
(local road funds)

Royal Oak COMMUNITY DEVELOPMENT

Appendix B
City of Royal Oak
Local Road Improvement Schedule

2025 (preliminary)

Street:	From:	To:	Section		Funding sources	
					Local Roads	Water and Sewer
2025 Road Reconstruction Improvements						
Girard	Lauren Ct	410 feet east	NW	10	$ 168,100.00	$ 32,446.45
Austin	Lockwood Rd	Hilldale Dr	SW	16	$ 116,899.20	$ 92,664.00
2025 Joint Sealing Improvements						
Sealing 2024 & 2020 asphalt resurfaced streets					$ 116,700.00	
2025 Water Main Improvements (TBD)						
Woodward	Buckingham	Normandy Rd	NW	6		$ 675,675.00
Woodward	north of Starr Rd	the 12" main that crosses Woodward	SE	6		$ 50,715.00
Chester Rd	Hillside Dr	Dukeshire Hwy & Kensington Dr	SE	6	$ 23,635.48	$ 116,582.40
Dukeshire Hwy	Ravena	Normandy Rd	SE	6	$ 25,151.58	$ 70,963.20
Dukeshire Hwy	Chester Rd & Kensington Dr	Ravena	SE	6	$ 118,448.45	$ 272,025.60
Ravena	Woodward Ave	Chester Rd	SE	6	$ 100,349.88	$ 287,232.00
Yorba Linda Blvd	Dukeshire Hwy	Kensington Dr	SE	6	$ 300,000.00	$ 190,924.80
Yorba Linda Blvd	Kensington Dr	Woodward Ave	SE	6	$ 462,482.24	
York	W Harrison	City/Twp Line	SE	21	$ 12,845.00	$ 253,440.00
York	Huntington	W Harrison	SE	21	$ 15,072.00	$ 297,369.60
Oakdale	W 4th St	W 3rd St	NE	21	$ 11,303.92	$ 148,684.80
Oakdale	W 3rd St	W 11 Mile Rd	NE	21	$ 7,707.22	$ 152,064.00
Rosewold	Normandy Rd	Massoit Rd		5	$ 11,132.65	$ 219,648.00
Nakota	Hillcrest & Massoit Rd	Crooks Rd	NE	5	$ 55,934.84	$ 114,892.80
Lexington Blvd	Custer	N Washington	SE	4	$ 16,484.89	$ 278,784.00
Lexington Blvd	Marais	Custer	SE	4	$ 17,184.25	$ 435,916.80

A total budget of $1,746,000 is programmed for local road improvements in 2025 (if the road millage is renewed). Additional road projects will be added to this list to meet this proposed budget.

Royal Oak COMMUNITY DEVELOPMENT

Appendix B
City of Royal Oak
Local Road Improvement Schedule

2026 (preliminary)

Street:	From:	To:	Section		Funding sources	
					Local Roads	Water and Sewer
2026 Joint Sealing Improvements						
Sealing 2025 & 2021 asphalt resurfaced streets					$ 120,200.00	
2026 Water Main Improvements						
Clifton	E 12 Mile Rd	Beaver	SW	10	$ 105,227.00	$ 345,030.75
Fern	E 12 Mile Rd	Beaver	SW	10	$ 95,442.00	$ 354,092.00
Ardmore	E 12 Mile Rd	Beaver	SW	10	$ 150,060.50	$ 408,450.50
Vinsetta Blvd	W 12 Mile Rd	Crooks Rd	SW	9		$ 897,407.20

A total budget of $2,966,000 is programmed for local road improvements in 2026 (if the road millage is renewed). Additional road projects will be added to this list to meet this proposed budget.

APPENDIX C: UNPAVED ROAD PLANNED PROJECTS

The City plans to pave Masssoit Rd. from Tonawanda Ave to Hampton Blvd by a Special Assesment in 2024. The total cost is expected to be $178,025.

APPENDIX D

A Quick Check of Your Highway Network Health

By Larry Galehouse, Director, National Center for Pavement Preservation
and

Jim Sorenson, Team Leader, FHWA Office of Asset Management

Historically, many highway agency managers and administrators have tended to view their highway systems as simply a collection of projects. By viewing the network in this manner, there is a certain comfort derived from the ability to match pavement actions with their physical/functional needs. However, by only focusing on projects, opportunities for strategically managing entire road networks and asset needs are overlooked. While the "bottom up" approach is analytically possible, managing networks this way can be a daunting prospect. Instead, road agency administrators have tackled the network problem from the "top down" by allocating budgets and resources based on historical estimates of need. Implicit in this approach, is a belief that the allocated resources will be wisely used and prove adequate to achieve desirable network service levels.

Using a quick checkup tool, road agency managers and administrators can assess the needs of their network and other highway assets and determine the adequacy of their resource allocation effort. A quick checkup is readily available and can be usefully applied with minimum calculations.

It is essential to know whether present and planned program actions (reconstruction, rehabilitation, and preservation) will produce a net improvement in the condition of the network. However, before the effects of any planned actions on the highway network can be analyzed, some basic concepts should be considered.

Assume every lane-mile segment of road in the network was rated by the number of years remaining until the end of life (terminal condition). Remember that terminal condition does not mean a failed road. Rather, it is the level of deterioration that management has set as a minimum operating condition for that road or network. Consider the rated result of the current network condition as shown in Figure 1.

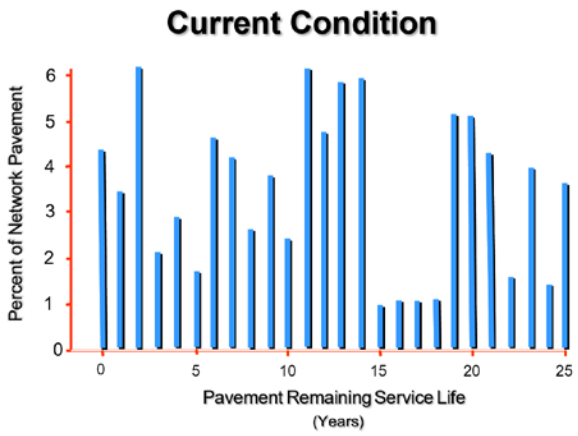


Figure 1 – Current Condition

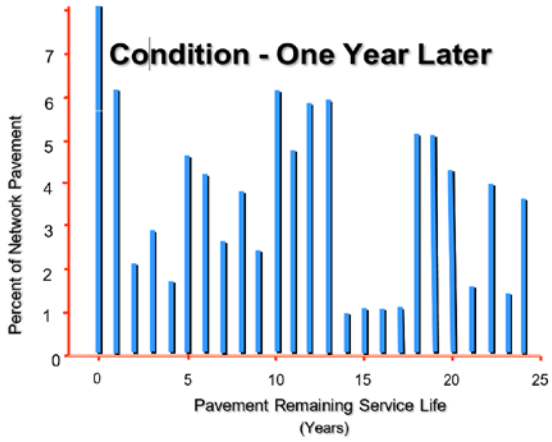


Figure 2 – Condition 1-Year Later

If no improvements are made for one year, then the number of years remaining until the end of life will decrease by one year for each road segment, except for those stacked at zero. The zero- stack will increase significantly because it maintains its previous balance and also becomes the recipient of those roads having previously been stacked with one year remaining. Thus, the entire network will age one year to the condition shown in Figure 2, with the net lane-miles in the zero stack raised from 4% to 8% of the network.

Some highway agencies still subscribe to the old practice of assigning their highest priorities to the reconstruction or rehabilitation of the worst roads. This practice of "worst first", i.e., continually addressing only those roads in the zero-stack, is a proven death spiral strategy because reconstruction and rehabilitation are the most expensive ways to maintain or restore serviceability. Rarely does sufficient funding exist to sustain such a strategy.

The measurable loss of pavement life can be thought of as the network's total lane-miles multiplied by 1 year, i.e., lane-mile-years. Consider the following quantitative illustration. Suppose your agency's highway network consisted of 4,356 lane-miles. Figure 3 shows that without intervention, it will lose 4,356 lane-mile-years per year.

Agency Highway Network = 4,356 lane miles

Each year the network will lose

4,356 lane-mile-years

Figure 3 – Network Lane Miles

To offset this amount of deterioration over the entire network, the agency would need to annually perform a quantity of work equal to the total number of lane-mile-years lost just to maintain the status quo. Performing work which produces fewer than 4,356 lane-mile-years would lessen the natural decline of the overall network, but still fall short of maintaining the

status quo. However, if the agency produces more than 4,356 lane-mile-years, it will improve the network.

In the following example, an agency can easily identify the effect of an annual program consisting of reconstruction, rehabilitation, and preservation projects on its network. This assessment involves knowing the only two components for reconstruction and rehabilitation projects: lane-miles and design life of each project fix. Figure 4 displays the agency's programmed activities for reconstruction and Figure 5 displays it for rehabilitation.

Reconstruction Evaluation

Projects this Year = 2

Project	Design Life	Lane Miles	Lane Mile Years	Lane Mile Cost	Total Cost
No. 1	25 yrs	22	550	$463,425	$10,195,350
No. 2	30 yrs	18	540	$556,110	$10,009,980
	Total	=	**1,090**		$20,205,330

Figure 4 - Reconstruction

Rehabilitation Evaluation

Projects this Year = 3

Project	Design Life	Lane Miles	Lane Mile Years	Lane Mile Cost	Total Cost
No. 10	18 yrs	22	396	$263,268	$5,791,896
No. 11	15 yrs	28	420	$219,390	$6,142,920
No. 12	12 yrs	32	384	$115,848	$3,707,136
	Total	=	**1,200**		$15,641,952

Figure 5 – Rehabilitation

When evaluating pavement preservation treatments in this analysis, it is appropriate to think in terms of "extended life" rather than design life. The term design life, as used in the reconstruction and rehabilitation tables, relates better to the new pavement's structural adequacy to handle repetitive loadings and environmental factors. This is not the goal of pavement preservation. Each type of treatment/repair has unique benefits that should be targeted to the specific mode of pavement deterioration. This means that life extension depends on factors such as type and severity of distress, traffic volume, environment, etc. Figure 6 exhibits the agency's programmed activities for preservation.

Preservation Evaluation

Project	Life Extension	Lane Miles	Lane Mile Years	Lane Mile Cost	Total Cost
No. 101	2 yrs	12	24	$2,562	$30,744
No. 102	3 yrs	22	66	$7,743	$170,346
No. 103	5 yrs	26	130	$13,980	$363,480
No. 104	7 yrs	16	112	$29,750	$476,000
No. 105	10 yrs	8	80	$54,410	$435,280
Total		=	**412**		$1,475,850

Figure 6 – Preservation

To satisfy the needs of its highway network, the agency must accomplish 4,356 lane-mile-years of work per year. The agency's program will derive 1,090 lane-mile-years from reconstruction, 1,200 lane-mile-years from rehabilitation, and 412 lane-mile-years from pavement preservation, for a total of 2,702 lane-mile-years. Thus, these programmed activities fall short of the minimum required to maintain the status quo, and hence would contribute to a net loss in network pavement condition of 1,653 lane-mile-years. The agency's programmed tally is shown in Figure 7.

Network Trend

Programmed Activity	Lane-Mile-Years	Total Cost
Reconstruction	1,090	$20,205,330
Rehabilitation	1,200	$15,641,952
Preservation	412	$1,475,850
Total	**2,702**	**$37,323,132**
Network Needs (Loss)	(-) 4,356	
Deficit =	**- 1,654**	

Figure 7 – Programmed Tally

This exercise can be performed for any pavement network to benchmark its current trend. Using this approach, it is possible to see how various long-term strategies could be devised and evaluated against a policy objective related to total-network condition.

Once the pavement network is benchmarked, an opportunity exists to correct any shortcomings in the programmed tally. A decision must first be made whether to improve the

network condition or just to maintain the status quo. This is a management decision and system goal.

Continuing with the previous example, a strategy will be proposed to prevent further network deterioration until additional funding is secured.

The first step is to modify the reconstruction and rehabilitation (R&R) programs. An agonizing decision must be made about which projects to defer, eliminate, or phase differently with multi- year activity. In Figure 8, reductions are made in the R&R programs to recover funds for less costly treatments in the pavement preservation program. The result of this decision recovered slightly over $6 million.

Program Modification

Programmed Activity	Lane-Mile-Years	Cost Savings
Reconstruction ***31 lane miles*** ~~(40 lane-miles)~~	***820*** ~~(1,090)~~	**$5,004,990**
Rehabilitation ***77 lane miles*** ~~(82 lane-miles)~~	***1,125*** ~~(1,200)~~	**$1,096,950**
Pavement Preservation (84 lane-miles)	(412)	**0**
Total =	***2,357*** **(2,702)**	**$6,101,940**

Figure 8 – Revised R & R Programs

Modifying the reconstruction and rehabilitation programs has reduced the number of lane-mile- years added to the network from 2,702 to 2,357 lane-mile-years. However, using less costly treatments elsewhere in the network to address roads in better condition will increase the number of lane-mile-years added to the network. A palette of pavement preservation treatments, or mix of fixes, is available to address the network needs at a much lower cost than traditional methods.

Preservation treatments are only suitable if the right treatment is used on the right road at the right time. In Figure 9, the added treatments used include concrete joint resealing, thin hot-mix asphalt (HMA) overlay (≤ 1.5”), microsurfacing, chip seal, and crack seal. By knowing the cost per lane-mile and the treatment life-extension, it is possible to create a new strategy (costing $36,781,144) that satisfies the network need. In this example, the agency saved in excess of $500,000 from traditional methods (costing $37,323,132), while erasing the 1,653 lane-mile-year deficit produced by the initial program tally. Network Strategy

Programmed Activity		Lane Mile Years	Total Cost
Reconstruction	(31 lane-miles)	820	$15,200,340
Rehabilitation	(77 lane-miles)	1,125	$14,545,002
Pavement Preservation	(84 lane-miles)	412	$1,475,850
Concrete Resealing	(4 years x 31 lane-miles)	124	$979,600
Thin HMA Overlay	(10 years x 16 lane-miles)	160	$870,560
Microsurfacing	(7 years x 44 lane-miles)	308	$1,309,000
Chip Seal	(5 years x 79 lane-miles)	395	$1,104,420
Crack Seal	(2 years x 506 lane-miles)	1,012	$1,296,372
	Total =	4,356	$36,781,144

Figure 9 – New Program Tally

In a real-world situation, the highway agency would program its budget to achieve the greatest impact on its network condition. Funds allocated for reconstruction and rehabilitation projects must be viewed as investments in the infrastructure. Conversely, funds directed for preservation projects must be regarded as protecting and preserving past infrastructure investments.

Integrating reconstruction, rehabilitation, and preservation in the proper proportions will substantially improve network conditions for the taxpayer while safeguarding the highway investment.

APPENDIX E: ROADSOFT NETWORK-LEVEL MODEL INPUTS AND OUTPUTS

Minor Roads - Gap Analysis

Optimized Major Roads 2023-2026

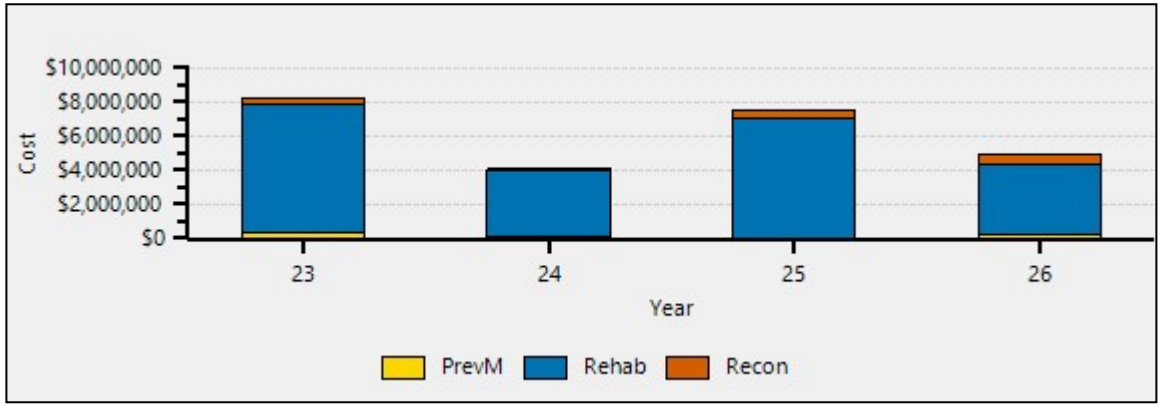
Base Year	2023
Percent Inflation	3
Number of Years	4
Optimized	Yes
Current Filter	RoyalOak_City_Major

Subtype	Treatment	Trigger	Reset	Cost/Ln Mile	Budget	Lane Miles	Year
Asphalt - CG	PM (CPM) Crack Route and Fill	5 - 6	7	$6,570.67			
					$4,245	0.646	2023
					$1,000	0.148	2024
					$1,000	0.143	2025
					$1,000	0.139	2026
	PM (CPM) Overband Crack Seal	6 - 7	7	$5,075.84			
					$2,539	0.500	2024
					$2,638	0.505	2025
					$2,739	0.509	2026
Asphalt-Standard	RC (SI) Reconstruction - 4" HMA on 8" Agg	1 - 3	10	$850,666.67			
					$300,000	0.353	2023
					$500,000	0.554	2025
					$550,000	0.592	2026
	RH (SI) Mill & Overlay - 3.5" with CB & Drives	2 - 4	9	$365,200.00			
					$7,591,471	20.787	2023
					$3,923,097	10.429	2024
					$4,871,359	12.573	2025
					$3,484,350	8.731	2026
	PM (CPM) Crack Route and Fill	5 - 6	7	$5,866.67			
					$8,753	1.492	2023
					$2,254	0.373	2024
					$6,361	1.022	2025
					$6,026	0.940	2026
Composite	RH (SI) Mill & Overlay - 3.5" with CB & Drives	2 - 4	9	$387,440.68			
					$2,096,054	5.410	2025
					$642,493	1.610	2026

Minor Roads - Gap Analysis

	PM (CPM) Crack Route and Fill	5 - 6	7	$5,866.67			
					$5,738	0.978	2023
	PM (CPM) Overband Crack Seal	6 - 7	7	$4,400.00			
					$16,966	3.856	2023
					$22,248	4.909	2024
					$22,910	4.908	2025
					$23,598	4.908	2026
Concrete-Standard	PM (CPM) Corner Break Repair & Joint Seal R&R	6 - 7	7	$63,360.00			
					$236,840	3.738	2023
					$64,666	0.934	2026
	PM (CPM) Joint Seal R & R	7 - 7	8	$47,520.00			
					$39,299	0.827	2023
					$147,277	3.009	2024
					$133,139	2.564	2026

Cost Distribution



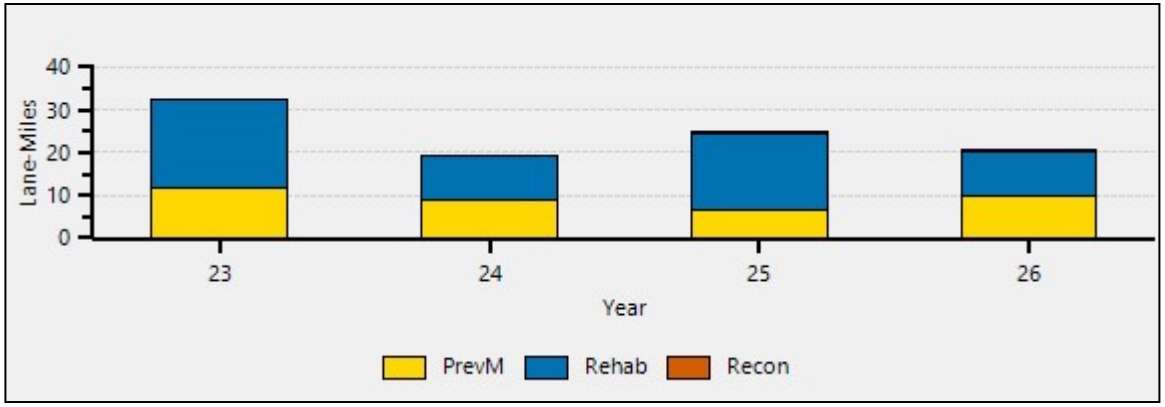
Minor Roads - Gap Analysis

Optimized Major Roads 2023-2026

Maintenance Type	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Prev Maint	$311,840	$175,318	$32,909	$231,168						
Rehab	$7,591,471	$3,923,097	$6,967,413	$4,126,843						
Recon	$300,000	$0	$500,000	$550,000						
Total	$8,203,311	$4,098,415	$7,500,322	$4,908,011						

Minor Roads - Gap Analysis

Maintenance Performed

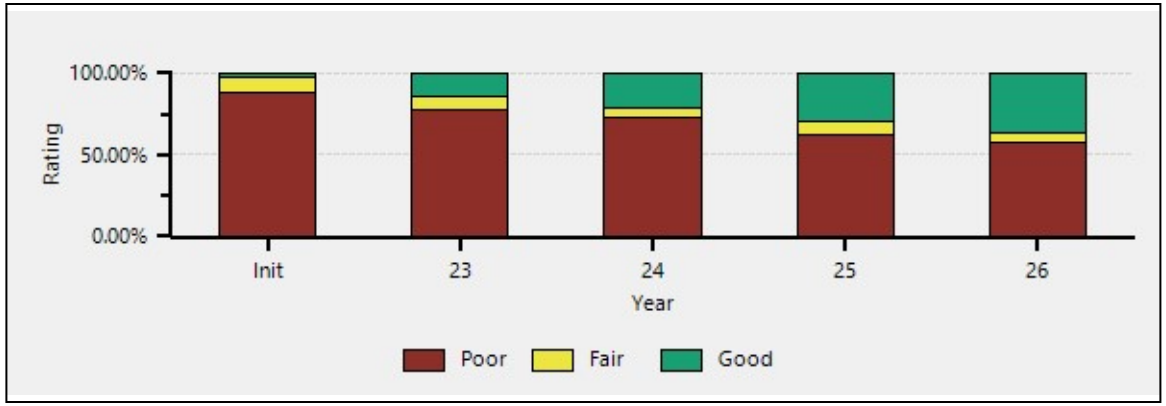


Optimized Major Roads 2023-2026

Maintenance Type in Lane Miles	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Prev Maint	11.537	8.939	6.578	9.994						
Rehab	20.787	10.429	17.983	10.341						
Recon	0.353	0.000	0.554	0.592						
Total	32.677	19.368	25.115	20.927						

Minor Roads - Gap Analysis

Rating Distribution

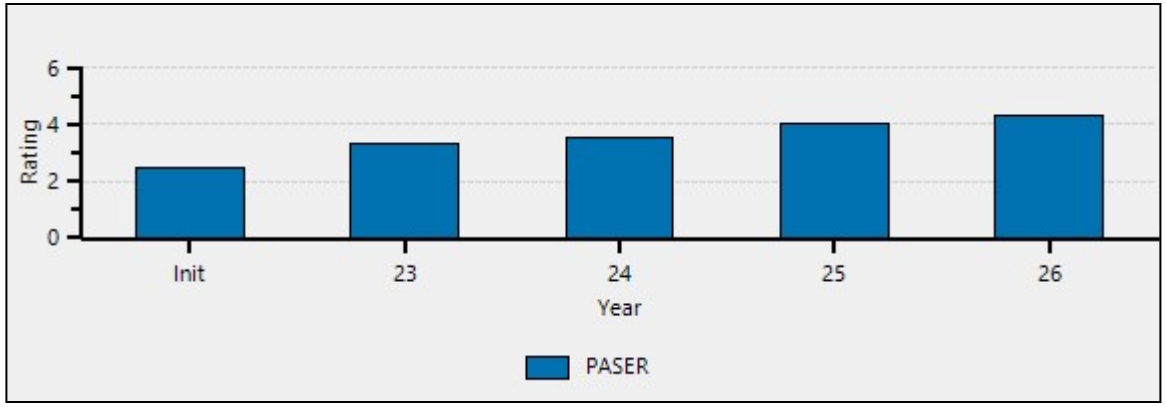


Optimized Major Roads 2023-2026

Initial Values																	
Lane Miles	**%**	**Rating**	**2023**		**2024**		**2025**		**2026**		**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
4.218	2.2	Good	26.186	13.9	38.960	20.7	56.414	29.9	68.430	36.3						
17.575	9.3	Fair	16.747	8.9	12.863	6.8	13.452	7.1	11.779	6.3						
166.603	88.4	Poor	145.463	77.2	136.570	72.5	118.529	62.9	108.188	57.4						
188.396	100.0	Total														

Minor Roads - Gap Analysis

PASER Distribution



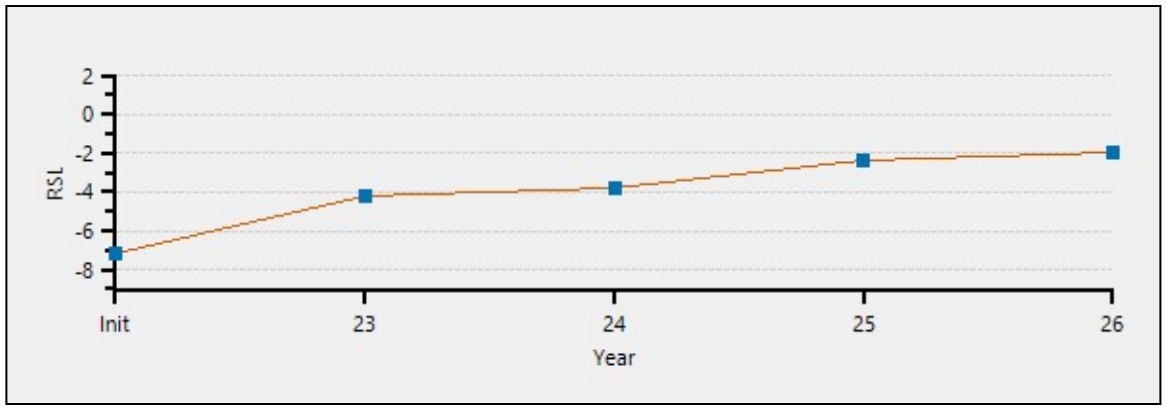
Optimized Major Roads 2023-2026

Initial Value

Lane Miles	PASER	2023	2024	2025	2026
2.448	10	2.801	0.000	0.554	0.592
0.488	9	21.275	13.718	17.983	10.895
1.282	8	2.110	25.242	37.877	56.943
2.705	7	11.919	8.637	9.722	9.575
7.786	6	0.000	0.934	0.934	0.000
7.084	5	4.828	3.292	2.796	2.204
15.013	4	15.013	12.446	9.514	6.835
25.242	3	25.242	24.990	21.022	17.316
63.671	2	42.884	35.921	14.709	10.401
62.677	1	62.324	63.212	73.284	73.636
2.473	Average	3.332	3.544	4.044	4.306

Minor Roads - Gap Analysis

RSL Distribution



Optimized Major Roads 2023-2026

Initial Value					
Lane Miles	**RSL**	**2023**	**2024**	**2025**	**2026**
0.488	**22**	0.488	0.000	0.000	0.000
0.000	**21**	0.000	0.488	0.000	0.000
0.180	**20**	0.387	0.752	0.488	0.641
0.522	**19**	0.729	1.139	0.752	1.129
0.124	**18**	0.331	1.481	1.139	1.393
0.000	**17**	0.207	1.083	1.481	1.780
0.000	**16**	0.934	0.000	1.083	0.234
2.448	**15**	3.735	0.000	5.964	2.436
0.076	**14**	21.797	13.230	12.573	14.929
1.241	**13**	2.925	22.423	14.866	14.443
0.152	**12**	1.611	2.950	22.423	14.866
1.590	**11**	1.611	1.636	2.950	22.423
1.810	**10**	0.809	0.093	0.256	0.615
0.518	**9**	0.753	1.064	0.511	0.653
2.480	**8**	1.091	0.846	1.320	0.746
1.122	**7**	0.535	1.184	1.102	1.555
2.402	**6**	1.168	0.162	0.162	0.162
1.476	**5**	0.608	1.006	0.000	0.000
0.590	**4**	0.590	0.608	1.006	0.000
1.510	**3**	0.592	0.590	0.608	1.006
1.252	**2**	0.496	0.592	0.590	0.608
1.812	**1**	1.536	0.496	0.592	0.590
4.729	**0**	4.729	1.536	0.496	0.592
2.993	**-1**	2.993	4.729	1.536	0.496
3.721	**-2**	3.721	2.993	4.729	1.536

Minor Roads - Gap Analysis

7.138	**-3**	7.138	3.721	2.993	4.729
9.869	**-4**	9.869	7.138	3.721	2.993
5.448	**-5**	5.448	9.869	7.138	3.721
7.829	**-6**	7.829	5.448	9.869	7.138
6.892	**-7**	6.892	7.829	3.520	5.404
11.389	**-8**	11.389	6.892	5.668	2.401
21.002	**-9**	18.976	11.389	2.418	1.799
19.503	**-10**	0.742	8.546	1.969	1.530
13.461	**-11**	13.461	0.742	8.546	1.969
17.822	**-12**	17.822	13.461	0.742	8.546
13.806	**-13**	13.806	17.822	13.461	0.742
5.280	**-14**	5.280	13.806	17.822	13.461
7.931	**-15**	7.931	5.280	13.806	17.822
3.718	**-16**	3.718	7.931	5.280	13.806
1.452	**-17**	1.452	3.718	7.931	5.280
0.350	**-18**	0.245	1.452	3.718	7.931
0.460	**-19**	0.336	0.245	1.143	3.513
0.938	**-20**	0.814	0.336	0.000	0.757
0.348	**-21**	0.348	0.814	0.336	0.000
0.188	**-22**	0.188	0.348	0.814	0.336
0.000	**-23**	0.000	0.188	0.348	0.814
0.000	**-24**	0.000	0.000	0.188	0.348
0.336	**-25**	0.336	0.000	0.000	0.188
0.000	**-26**	0.000	0.336	0.000	0.000
0.000	**-27**	0.000	0.000	0.336	0.000
0.000	**-28**	0.000	0.000	0.000	0.336
-7.208	Average	-4.201	-3.769	-2.383	-1.947

Minor Roads - Gap Analysis

Planned Major Roads with Millage 2023-2026

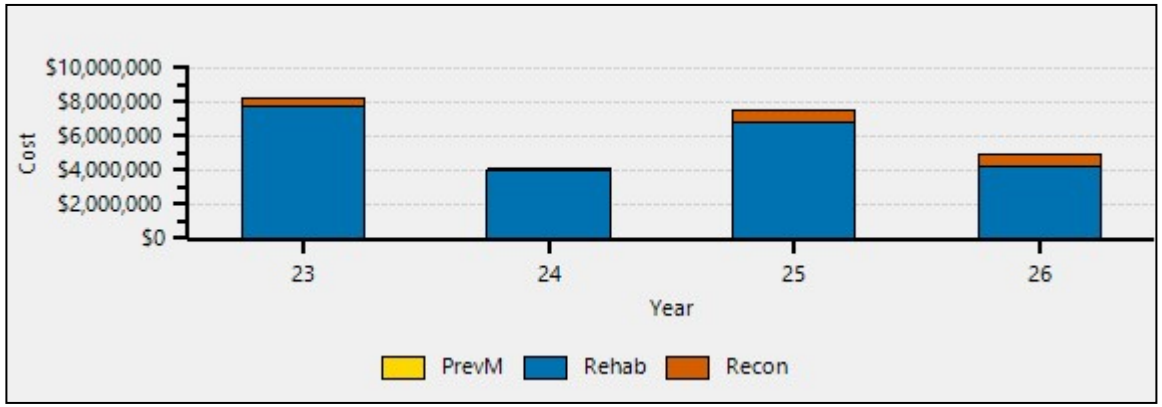
Base Year	2023
Percent Inflation	3
Number of Years	4
Optimized	No
Current Filter	RoyalOak_City_Major

Subtype	Treatment	Trigger	Reset	Cost/Ln Mile	Budget	Lane Miles	Year
Asphalt-Standard	RC (SI) Reconstruction - 4" HMA on 8" Agg	1 - 3	10	$902,472.27			
					$718,458	0.796	2025
					$709,895	0.764	2026
	RH (SI) Mill & Overlay - 3.5" with CB & Drives	2 - 4	9	$365,200.00			
					$7,601,346	20.814	2023
					$3,909,991	10.395	2024
					$6,600,362	17.036	2025
					$5,402,328	13.538	2026
	PM (CPM) Overband Crack Seal - First Application	8 - 9	9	$2,566.67			
					$10,000	3.896	2023
					$10,300	3.896	2024
					$10,600	3.893	2025
					$10,900	3.886	2026
Composite	RC (SI) Reconstruction - 4" HMA on 8" Agg	1 - 3	10	$850,666.67			
					$0	0.000	2023
	RH (SI) Mill & Overlay - 3.5" with CB & Drives	2 - 4	9	$365,200.00			
					$149,988	0.411	2023
					$150,011	0.399	2024
					$139,982	0.361	2025
	PM (CPM) Overband Crack Seal	6 - 7	7	$4,400.00			
					$90,000	20.455	2023
					$92,700	20.455	2024
					$95,500	20.459	2025
					$98,400	20.466	2026
Concrete-Standard	RC (SI) HMA Overlay 3.5" with New Curbs	4 - 5	9	$225,866.67			
					$0	0.000	2023

Minor Roads - Gap Analysis

RC (SI) Major Recon - 8" Conc on 8" Agg	1 - 4	10	$1,188,000.00			
				$424,948	0.358	2023
RH (SI) Slab Repair - 50%	3 - 5	8	$79,200.00			
				$0	0.000	2023
PM (CPM) Corner Break Repair & Joint Seal R&R	6 - 7	7	$63,360.00			
				$9,998	0.158	2023
				$10,298	0.158	2024
				$10,600	0.158	2025
				$10,898	0.157	2026

Cost Distribution

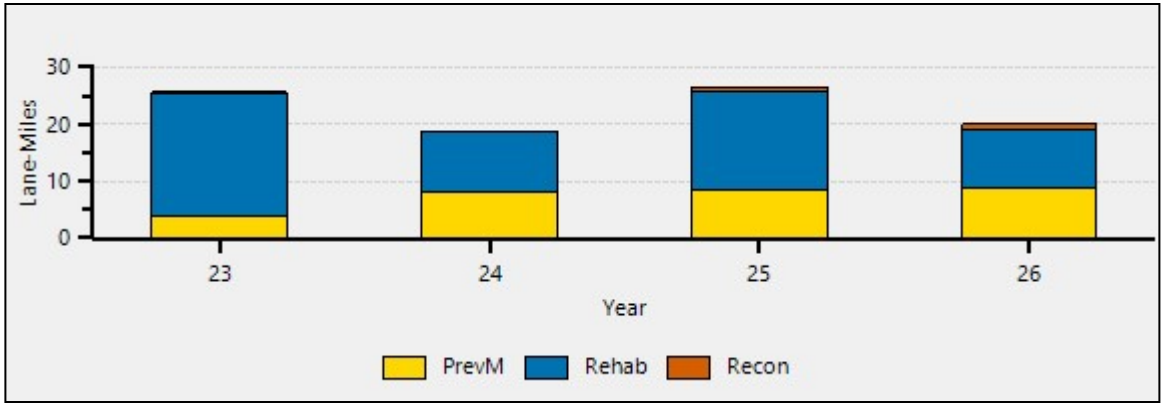


Planned Major Roads with Millage 2023-2026

Maintenance Type	2023	2024	2025	2026
Prev Maint	$26,965	$38,413	$41,464	$44,588
Rehab	$7,751,333	$4,060,002	$6,740,344	$4,153,537
Recon	$424,948	$0	$718,458	$709,895
Total	$8,203,246	$4,098,415	$7,500,266	$4,908,020

Minor Roads - Gap Analysis

Maintenance Performed



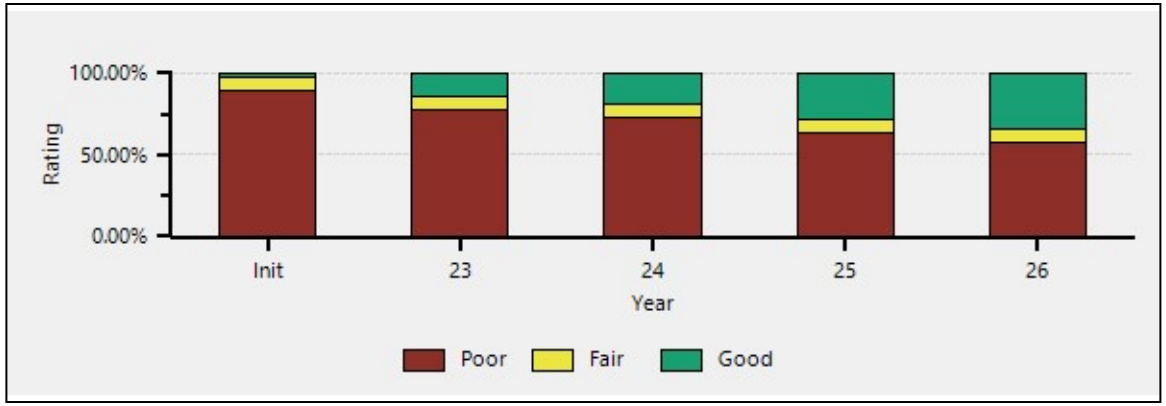
Planned Major Roads with Millage 2023-2026

Maintenance Type in Lane Miles	2023	2024	2025	2026
Prev Maint	4.014	7.985	8.392	8.784
Rehab	21.225	10.793	17.397	10.408
Recon	0.358	0.000	0.796	0.764
Total	25.597	18.778	26.585	19.956

77

Minor Roads - Gap Analysis

Rating Distribution

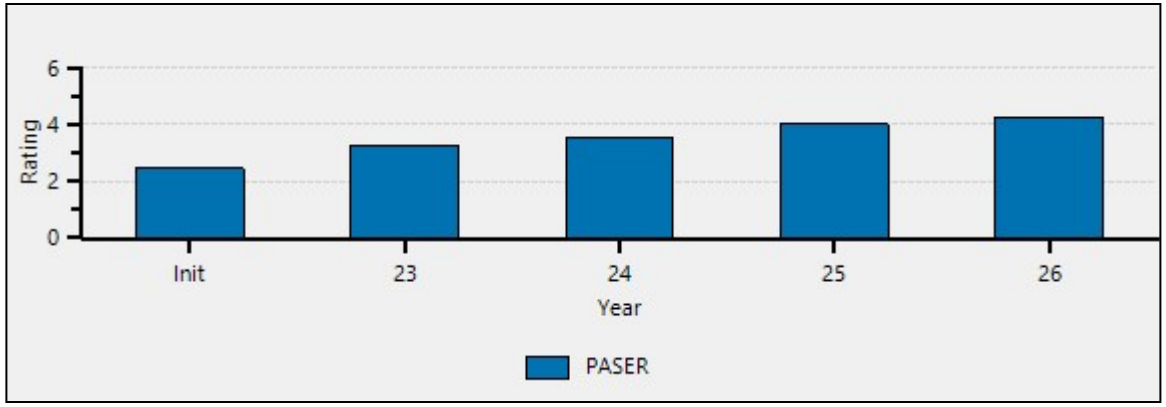


Planned Major Roads with Millage 2023-2026

Initial Values										
Lane Miles	%	Rating	2023		2024		2025		2026	
3.838	2.1	Good	25.421	13.6	36.139	19.4	53.797	28.8	64.048	34.3
16.929	9.1	Fair	16.926	9.1	15.317	8.2	15.115	8.1	14.524	7.8
165.961	88.9	Poor	144.378	77.3	135.267	72.4	117.810	63.1	108.148	57.9
186.728	100.0	Total								

Minor Roads - Gap Analysis

PASER Distribution



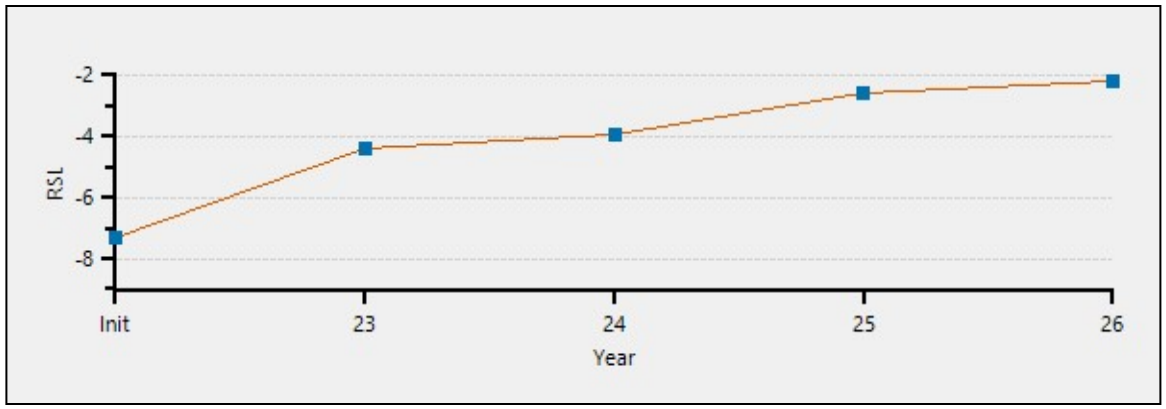
Planned Major Roads with Millage 2023-2026

Initial Value

Lane Miles	PASER	2023	2024	2025	2026
2.448	10	2.806	0.000	0.796	0.764
0.488	9	21.713	17.984	21.648	15.448
0.902	8	0.902	18.155	31.353	47.836
2.705	7	6.048	5.413	5.470	6.212
7.786	6	4.440	5.000	4.258	4.138
6.438	5	6.438	4.904	5.386	4.174
14.579	4	14.579	12.158	9.466	7.507
25.034	3	25.034	24.990	21.022	16.025
63.671	2	42.446	34.944	15.087	11.241
62.677	1	62.319	63.175	72.235	73.375
2.449	Average	3.280	3.514	4.005	4.244

Minor Roads - Gap Analysis

RSL Distribution



Planned Major Roads with Millage 2023-2026

Initial Value

Lane Miles	RSL	2023	2024	2025	2026
0.000	24	0.358	0.000	0.000	0.000
0.000	23	0.000	0.358	0.000	0.000
0.488	22	0.488	0.000	0.358	0.000
0.000	21	0.000	0.488	0.000	0.358
0.180	20	0.180	0.000	0.488	0.000
0.522	19	0.522	0.180	0.000	0.488
0.124	18	0.124	0.522	0.180	0.000
0.000	17	0.000	0.124	0.522	0.180
0.000	16	0.039	0.039	0.163	0.561
2.448	15	2.898	0.477	1.235	0.966
0.076	14	20.929	17.228	21.445	15.568
0.861	13	2.151	18.306	18.303	22.665
0.152	12	1.437	2.176	14.550	18.436
1.590	11	2.241	1.462	2.313	10.797
1.810	10	1.810	0.956	0.152	0.866
0.518	9	0.354	1.810	0.956	0.152
2.480	8	1.370	0.354	1.788	0.956
1.122	7	0.148	1.212	0.218	1.631
2.402	6	1.304	0.148	1.212	0.218
1.476	5	1.476	1.304	0.148	1.212
0.590	4	0.590	1.476	1.304	0.148
1.510	3	1.510	0.590	1.476	1.304
0.736	2	0.736	1.510	0.590	1.476
1.682	1	1.682	0.736	1.510	0.590
4.295	0	4.295	1.682	0.736	1.024

80

Minor Roads - Gap Analysis

2.993	**-1**	2.993	4.295	1.682	0.736
3.721	**-2**	3.721	2.993	4.295	1.536
7.138	**-3**	7.138	3.721	2.993	4.211
9.869	**-4**	9.869	7.138	3.721	2.753
5.240	**-5**	5.240	9.869	7.138	3.188
7.829	**-6**	7.829	5.240	9.869	3.570
6.892	**-7**	6.892	7.829	5.240	5.931
11.389	**-8**	11.010	6.892	4.254	4.121
21.002	**-9**	18.917	10.612	2.490	3.960
19.503	**-10**	0.742	8.522	1.192	2.490
13.461	**-11**	13.461	0.742	8.522	1.192
17.822	**-12**	17.822	13.461	0.742	8.522
13.806	**-13**	13.806	17.822	13.461	0.742
5.280	**-14**	5.280	13.806	17.822	13.461
7.931	**-15**	7.931	5.280	13.806	17.822
3.718	**-16**	3.718	7.931	5.280	13.806
1.452	**-17**	1.452	3.718	7.931	5.280
0.350	**-18**	0.350	1.452	3.718	7.931
0.460	**-19**	0.460	0.350	1.254	3.451
0.938	**-20**	0.938	0.460	0.000	0.757
0.348	**-21**	0.348	0.938	0.336	0.000
0.188	**-22**	0.166	0.348	0.814	0.336
0.000	**-23**	0.000	0.166	0.348	0.814
0.000	**-24**	0.000	0.000	0.166	0.348
0.336	**-25**	0.000	0.000	0.000	0.166
-7.299	Average	-4.398	-3.963	-2.570	-2.212

Minor Roads - Gap Analysis

Optimized Minor Roads 2023-2026

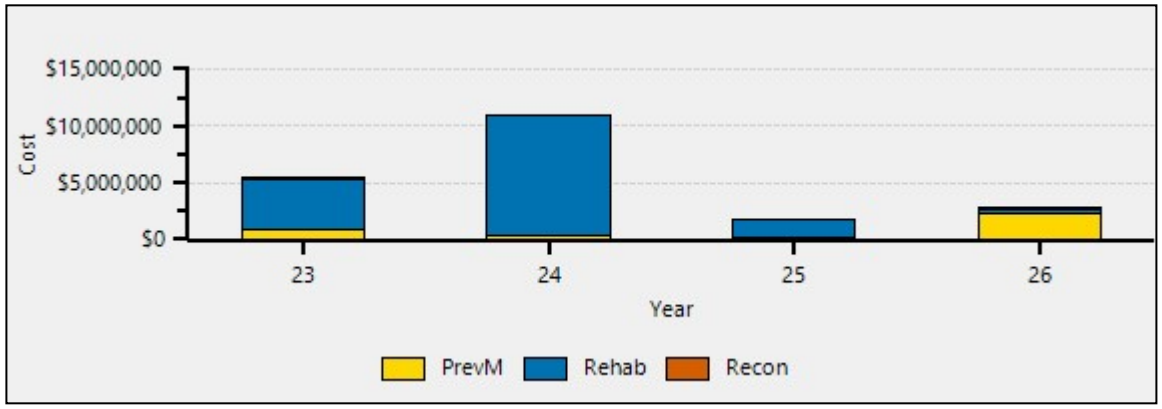
Base Year	2023
Percent Inflation	3
Number of Years	4
Optimized	Yes
Current Filter	RoyalOak_City_Local

Subtype	Treatment	Trigger	Reset	Cost/Ln Mile	Budget	Lane Miles	Year
Asphalt-Standard	RH (SI) Mill, Detail 7&8 and 3" HMA Overlay	3 - 4	9	$242,733.92			
					$397,598	1.638	2025
					$177,511	0.710	2026
	PM (CPM) Overband Crack Seal	6 - 7	7	$4,400.00			
					$4,479	1.018	2023
					$20,639	4.554	2024
					$21,249	4.552	2025
					$21,886	4.552	2026
Composite	RH (SI) Mill, Detail 7&8 and 3" HMA Overlay	3 - 4	9	$235,664.00			
					$2,036,341	8.641	2024
					$1,220,359	5.028	2025
					$343,916	1.376	2026
	PM (CPM) Crack Route and Fill	5 - 6	7	$5,866.67			
					$63,507	10.825	2023
	PM (CPM) Overband Crack Seal	6 - 7	7	$4,400.00			
					$77,898	17.704	2023
					$174,604	38.527	2024
					$179,838	38.526	2025
					$61,744	12.842	2026
Concrete-Standard	RH (SI) Slab Repair - 50%	3 - 5	8	$79,200.00			
					$4,605,108	58.145	2023
					$8,525,809	104.514	2024
	PM (CPM) Joint Seal R & R	7 - 7	8	$51,926.39			
					$2,106,763	40.572	2026

Minor Roads - Gap Analysis

PM (CPM) Slab Repair - 25%	5 - 6	8	$35,640.00			
				$671,208	18.833	2023
				$235,306	6.410	2024
				$22,611	0.598	2025
				$34,505	0.886	2026

Cost Distribution

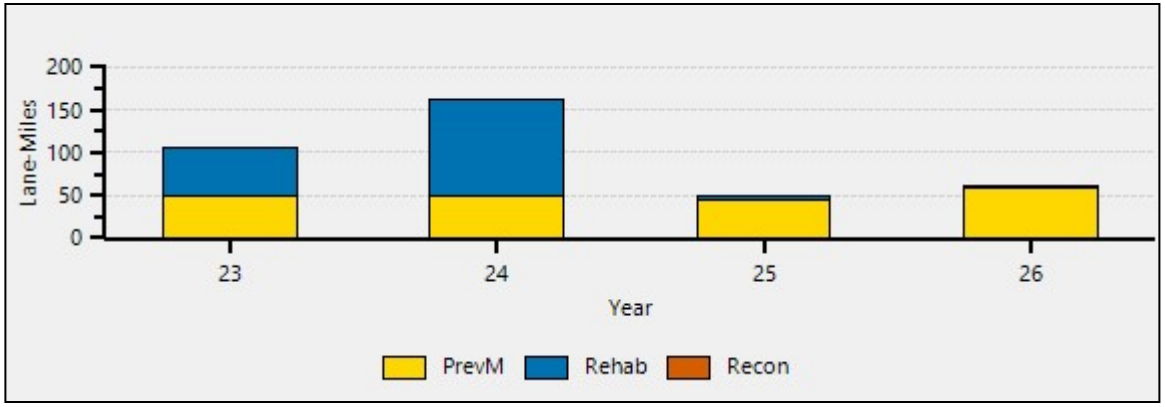


Optimized Minor Roads 2023-2026

Maintenance Type	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Prev Maint	$817,092	$430,549	$223,697	$2,224,899						
Rehab	$4,605,108	$10,562,150	$1,617,957	$521,427						
Recon	$0	$0	$0	$0						
Total	$5,422,200	$10,992,699	$1,841,654	$2,746,326						

Minor Roads - Gap Analysis

Maintenance Performed

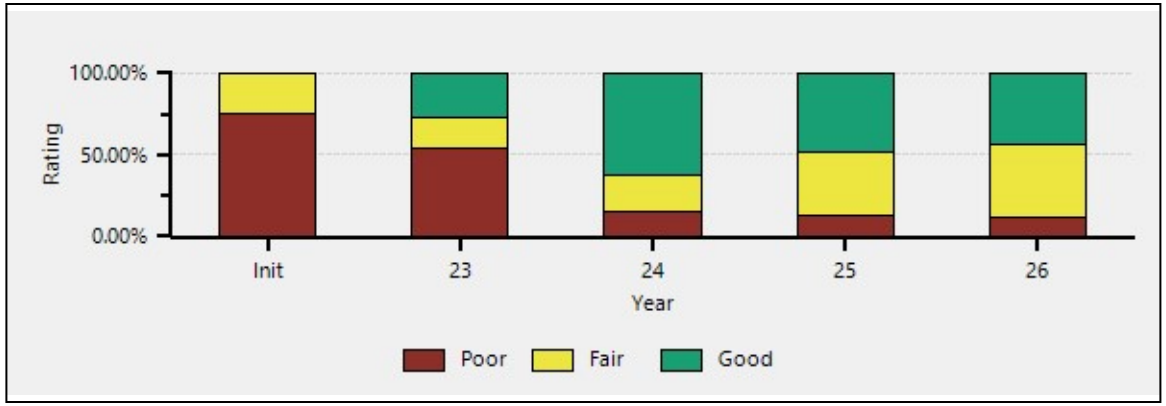


Optimized Minor Roads 2023-2026

Maintenance Type in Lane Miles	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Prev Maint	48.380	49.491	43.676	58.852						
Rehab	58.145	113.155	6.666	2.086						
Recon	0.000	0.000	0.000	0.000						
Total	106.525	162.646	50.342	60.938						

Minor Roads - Gap Analysis

Rating Distribution

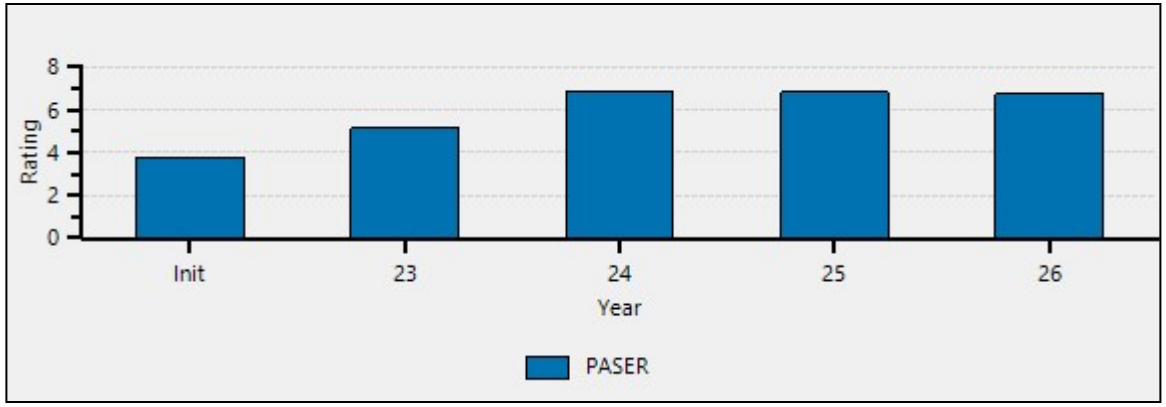


Optimized Minor Roads 2023-2026

Initial Values			2023		2024		2025		2026		2027	2028	2029	2030	2031	2032
Lane Miles	%	Rating														
1.260	0.4	Good	78.236	27.3	178.553	62.4	138.201	48.3	125.982	44.0						
70.242	24.5	Fair	51.405	18.0	63.870	22.3	110.890	38.8	125.134	43.7						
214.689	75.0	Poor	156.544	54.7	43.755	15.3	37.090	13.0	35.068	12.3						
286.191	100.0	Total														

Minor Roads - Gap Analysis

PASER Distribution



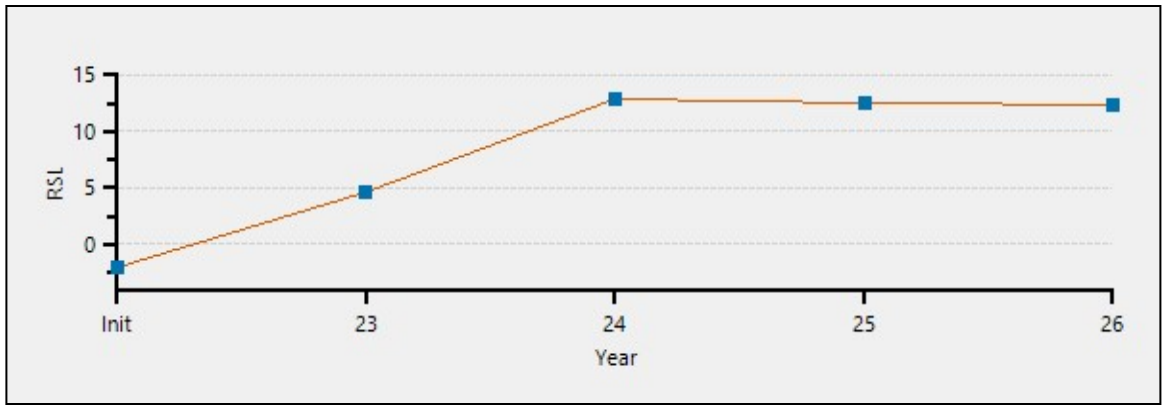
Optimized Minor Roads 2023-2026

Initial Value

Lane Miles	PASER	2023	2024	2025	2026
0.000	10	0.000	0.000	0.000	0.000
0.616	9	0.616	8.641	6.666	2.086
0.644	8	77.620	169.912	131.535	123.896
15.794	7	45.337	63.806	110.826	125.134
24.360	6	5.638	0.000	0.000	0.000
30.088	5	0.430	0.064	0.064	0.000
63.271	4	63.271	6.370	2.022	0.000
119.940	3	61.795	2.485	0.000	0.000
24.550	2	24.550	25.936	23.120	16.856
6.928	1	6.928	8.964	11.948	18.212
3.797	Average	5.152	6.911	6.830	6.771

Minor Roads - Gap Analysis

RSL Distribution



Optimized Minor Roads 2023-2026

Initial Value						
Lane Miles	**RSL**	**2023**	**2024**	**2025**	**2026**
0.522	**21**	0.522	0.000	0.000	0.000
0.000	**20**	19.244	28.252	0.150	10.365
0.000	**19**	19.244	46.974	28.402	10.515
0.644	**18**	19.888	46.974	47.124	38.767
0.000	**17**	19.244	47.618	47.124	57.489
0.000	**16**	0.000	19.244	47.618	47.124
0.886	**15**	0.886	8.641	24.272	27.666
0.692	**14**	0.692	0.886	10.279	5.738
3.636	**13**	13.145	13.534	13.728	14.560
2.614	**12**	12.123	12.842	12.936	17.123
7.592	**11**	17.101	12.842	12.842	17.217
1.732	**10**	1.910	1.138	1.138	1.138
4.034	**9**	2.328	1.138	1.138	1.138
4.470	**8**	1.208	1.138	1.138	1.138
10.494	**7**	1.676	1.138	1.138	1.138
3.810	**6**	0.000	0.000	0.000	0.000
7.006	**5**	0.000	0.000	0.000	0.000
4.669	**4**	0.000	0.000	0.000	0.000
5.166	**3**	0.064	0.000	0.000	0.000
4.264	**2**	0.000	0.064	0.000	0.000
9.271	**1**	0.366	0.000	0.064	0.000
6.373	**0**	6.373	0.366	0.000	0.000
13.436	**-1**	13.436	1.120	0.366	0.000
17.823	**-2**	17.823	2.470	1.120	0.000
26.069	**-3**	26.069	3.070	0.536	0.000

Minor Roads - Gap Analysis

36.566	**-4**	36.566	1.661	0.000	0.000
27.666	**-5**	21.701	0.168	0.000	0.000
32.420	**-6**	3.922	0.324	0.168	0.000
19.882	**-7**	4.574	3.922	0.324	0.168
10.954	**-8**	2.580	4.574	3.922	0.324
10.292	**-9**	10.292	2.580	4.574	3.922
5.360	**-10**	5.360	10.292	2.580	4.574
3.358	**-11**	3.358	5.360	10.292	2.580
1.884	**-12**	1.884	3.358	5.360	10.292
1.030	**-13**	1.030	1.884	3.358	5.360
0.500	**-14**	0.500	1.030	1.884	3.358
0.212	**-15**	0.212	0.500	1.030	1.884
0.174	**-16**	0.174	0.212	0.500	1.030
0.000	**-17**	0.000	0.174	0.212	0.500
0.000	**-18**	0.000	0.000	0.174	0.212
0.000	**-19**	0.000	0.000	0.000	0.174
0.116	**-20**	0.116	0.000	0.000	0.000
0.000	**-21**	0.000	0.116	0.000	0.000
0.000	**-22**	0.000	0.000	0.116	0.000
0.000	**-23**	0.000	0.000	0.000	0.116
0.000	**-24**	0.000	0.000	0.000	0.000
0.000	**-25**	0.000	0.000	0.000	0.000
0.000	**-26**	0.000	0.000	0.000	0.000
0.000	**-27**	0.000	0.000	0.000	0.000
0.000	**-28**	0.000	0.000	0.000	0.000
0.000	**-29**	0.000	0.000	0.000	0.000
0.000	**-30**	0.000	0.000	0.000	0.000
0.000	**-31**	0.000	0.000	0.000	0.000
0.000	**-32**	0.000	0.000	0.000	0.000
0.000	**-33**	0.000	0.000	0.000	0.000
0.000	**-34**	0.000	0.000	0.000	0.000
0.000	**-35**	0.000	0.000	0.000	0.000
0.574	**-36**	0.574	0.000	0.000	0.000
0.000	**-37**	0.000	0.574	0.000	0.000
0.000	**-38**	0.000	0.000	0.574	0.000
0.000	**-39**	0.000	0.000	0.000	0.574
-2.124	Average	4.622	12.866	12.466	12.284

88

Minor Roads - Gap Analysis

Planned Minor Roads 2023-2026

Base Year	2023
Percent Inflation	3
Number of Years	4
Optimized	No
Current Filter	RoyalOak_City_Local

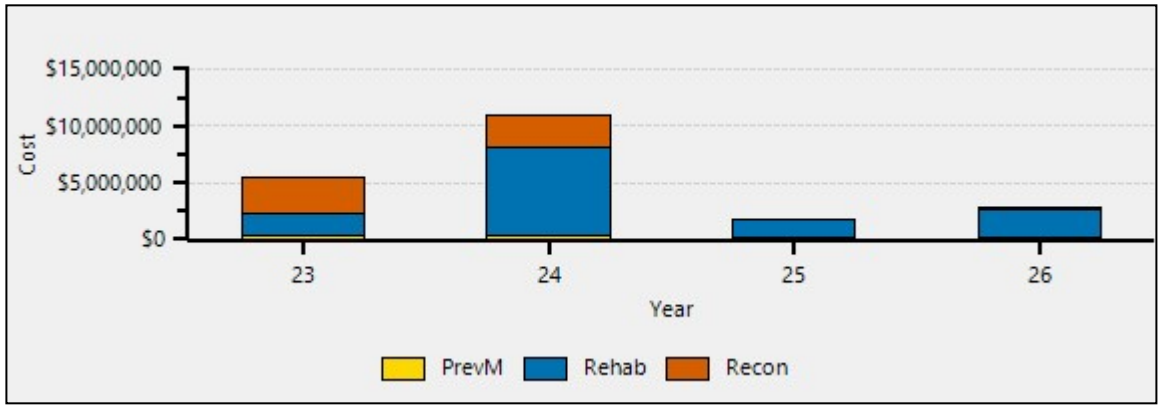
Subtype	Treatment	Trigger	Reset	Cost/Ln Mile	Budget	Lane Miles	Year
Asphalt-Standard	RH (SI) Mill & Overlay - 3.5" with CB & Drives	2 - 4	9	$365,200.00			
					$199,984	0.548	2023
					$299,984	0.798	2024
					$340,018	0.878	2025
					$150,008	0.376	2026
	PM (CPM) Overband Crack Seal	6 - 7	7	$4,400.00			
					$10,000	2.273	2023
					$10,300	2.273	2024
					$10,600	2.271	2025
					$10,900	2.267	2026
Composite	RH (SI) Mill & Overlay - 3.5" with CB & Drives	2 - 4	9	$365,200.00			
					$400,004	1.095	2023
					$6,131,418	16.300	2024
					$1,104,516	2.851	2025
					$534,506	1.339	2026
	RH (SI) Mill, Detail 7&8 and 3" HMA Overlay	3 - 4	9	$242,733.92			
					$235,306	0.969	2025
					$2,196,140	8.784	2026
	PM (CPM) Overband Crack Seal	6 - 7	7	$4,400.00			
					$68,200	15.500	2023
					$72,100	15.909	2024
					$74,300	15.917	2025
					$76,600	15.932	2026

Minor Roads - Gap Analysis

Concrete-Standard	RC (SI) Local Recon - 7" Conc on 6" Agg	1 - 3	10	$1,077,120.00			
					$3,094,997	2.873	2023
					$2,932,122	2.643	2024
					$66,392	0.058	2025
					$85,568	0.073	2026
	RH (SI) Slab Repair - 50%	3 - 5	8	$79,200.00			
					$1,439,001	18.169	2023
					$1,199,999	14.710	2024
	PM (CPM) Joint Seal R & R	7 - 7	8	$47,520.00			
					$9,998	0.210	2023
					$10,298	0.210	2024
					$10,602	0.210	2025
					$10,899	0.210	2026
	PM (CPM) Slab Repair - 25%	5 - 6	8	$35,640.00			
					$200,001	5.612	2023
					$336,451	9.165	2024

90

Cost Distribution



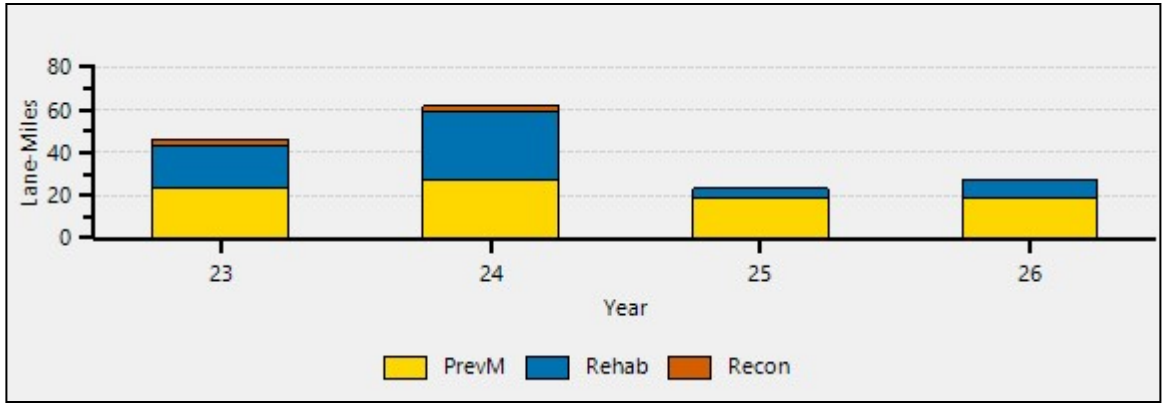
Minor Roads - Gap Analysis

Planned Minor Roads 2023-2026

Maintenance Type	2023	2024	2025	2026
Prev Maint	$288,199	$429,149	$95,502	$98,400
Rehab	$2,038,988	$7,631,402	$1,679,840	$2,562,359
Recon	$3,094,997	$2,932,122	$66,392	$85,568
Total	$5,422,184	$10,992,673	$1,841,734	$2,746,327

Minor Roads - Gap Analysis

Maintenance Performed

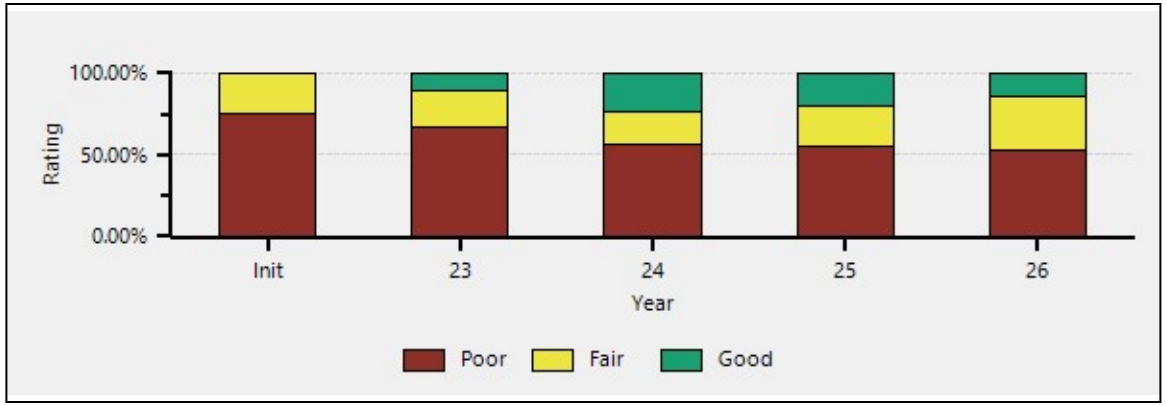


Planned Minor Roads 2023-2026

Maintenance Type in Lane Miles	2023	2024	2025	2026
Prev Maint	23.595	27.558	18.398	18.409
Rehab	19.812	31.808	4.698	9.226
Recon	2.873	2.643	0.058	0.073
Total	46.280	62.009	23.154	27.708

Minor Roads - Gap Analysis

Rating Distribution



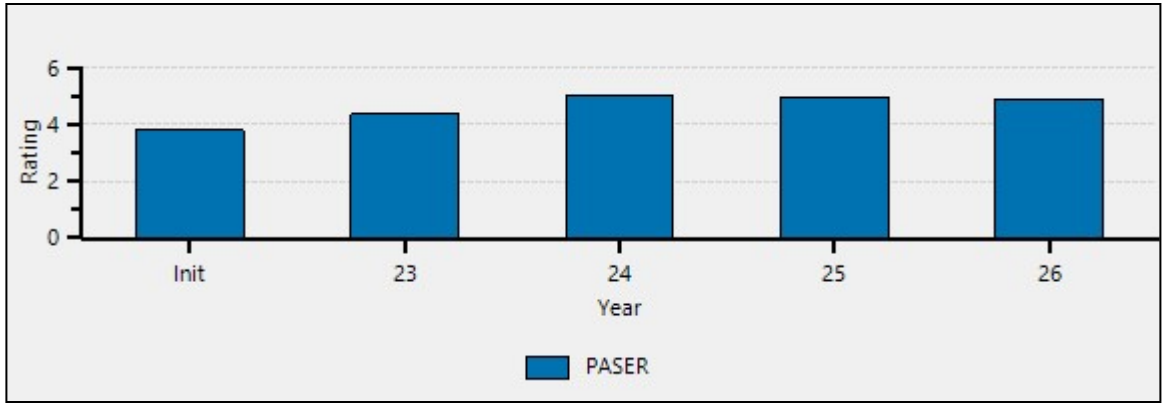
Planned Minor Roads 2023-2026

Initial Values

Lane Miles	%	Rating	2023		2024		2025		2026	
1.260	0.4	Good	29.768	10.4	67.599	23.6	58.808	20.6	39.942	14.0
70.242	24.5	Fair	64.420	22.5	57.382	20.1	70.461	24.6	95.693	33.4
214.689	75.0	Poor	192.004	67.1	161.212	56.3	156.928	54.8	150.563	52.6
286.191	100.0	Total								

Minor Roads - Gap Analysis

PASER Distribution



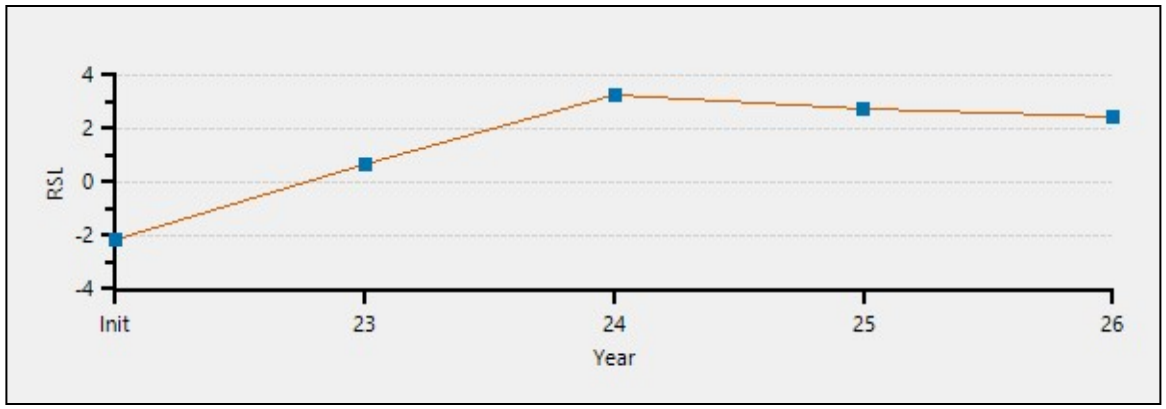
Planned Minor Roads 2023-2026

Initial Value

Lane Miles	PASER	2023	2024	2025	2026
0.000	10	2.873	2.643	0.058	0.073
0.616	9	2.259	19.971	10.214	14.800
0.644	8	24.636	44.985	48.536	25.069
15.794	7	32.102	39.531	52.694	80.184
24.360	6	7.842	5.376	5.355	5.941
30.088	5	24.476	12.476	12.412	9.568
63.271	4	63.271	40.635	23.388	7.392
119.940	3	101.771	102.634	116.365	106.714
24.550	2	20.920	11.762	10.995	30.277
6.928	1	6.042	6.180	6.180	6.180
3.797	Average	4.356	5.023	4.943	4.877

Minor Roads - Gap Analysis

RSL Distribution



Planned Minor Roads 2023-2026

Initial Value

Lane Miles	RSL	2023	2024	2025	2026
0.000	**24**	2.873	2.643	0.058	0.073
0.000	**23**	0.000	2.873	2.643	0.058
0.000	**22**	0.000	0.000	2.873	2.643
0.522	**21**	0.522	0.000	0.000	2.873
0.000	**20**	5.998	6.544	0.053	0.052
0.000	**19**	5.998	12.020	6.597	0.105
0.644	**18**	6.642	12.020	12.073	6.649
0.000	**17**	5.998	12.664	12.073	12.125
0.000	**16**	0.000	5.998	12.664	12.073
0.886	**15**	1.981	16.300	9.818	21.514
0.692	**14**	1.240	2.779	17.178	9.984
3.636	**13**	8.593	6.333	7.875	22.489
2.614	**12**	7.781	13.896	11.639	13.186
7.592	**11**	12.759	11.682	12.353	12.809
1.732	**10**	2.300	1.024	3.182	1.129
4.034	**9**	4.491	2.792	1.592	3.749
4.470	**8**	1.144	1.963	3.360	2.159
10.494	**7**	1.392	0.976	0.828	2.398
3.810	**6**	0.730	0.824	0.408	0.090
7.006	**5**	6.268	0.730	0.824	0.408
4.669	**4**	4.389	5.689	0.730	0.824
5.166	**3**	5.166	1.827	5.689	0.730
4.264	**2**	4.264	2.934	1.827	5.689
9.271	**1**	3.659	0.472	2.934	1.827
6.373	**0**	6.373	3.659	0.472	0.064

Minor Roads - Gap Analysis

13.436	**-1**	13.436	6.373	3.659	0.000
17.823	**-2**	17.823	13.436	6.373	2.075
26.069	**-3**	26.069	17.823	13.436	5.533
36.566	**-4**	36.566	26.069	16.575	11.518
27.666	**-5**	27.666	34.003	23.676	15.409
32.420	**-6**	32.420	22.930	33.823	23.676
19.882	**-7**	10.087	20.125	22.930	33.823
10.954	**-8**	2.045	0.172	19.610	22.863
10.292	**-9**	9.732	0.191	0.000	19.301
5.360	**-10**	4.812	9.288	0.000	0.000
3.358	**-11**	2.665	2.794	9.288	0.000
1.884	**-12**	1.380	2.040	2.736	9.288
1.030	**-13**	0.240	1.380	2.040	2.663
0.500	**-14**	0.000	0.240	1.380	2.040
0.212	**-15**	0.000	0.000	0.240	1.380
0.174	**-16**	0.000	0.000	0.000	0.240
0.000	**-17**	0.000	0.000	0.000	0.000
0.000	**-18**	0.000	0.000	0.000	0.000
0.000	**-19**	0.000	0.000	0.000	0.000
0.116	**-20**	0.116	0.000	0.000	0.000
0.000	**-21**	0.000	0.116	0.000	0.000
0.000	**-22**	0.000	0.000	0.116	0.000
0.000	**-23**	0.000	0.000	0.000	0.116
0.000	**-24**	0.000	0.000	0.000	0.000
0.000	**-25**	0.000	0.000	0.000	0.000
0.000	**-26**	0.000	0.000	0.000	0.000
0.000	**-27**	0.000	0.000	0.000	0.000
0.000	**-28**	0.000	0.000	0.000	0.000
0.000	**-29**	0.000	0.000	0.000	0.000
0.000	**-30**	0.000	0.000	0.000	0.000
0.000	**-31**	0.000	0.000	0.000	0.000
0.000	**-32**	0.000	0.000	0.000	0.000
0.000	**-33**	0.000	0.000	0.000	0.000
0.000	**-34**	0.000	0.000	0.000	0.000
0.000	**-35**	0.000	0.000	0.000	0.000
0.574	**-36**	0.574	0.000	0.000	0.000
0.000	**-37**	0.000	0.574	0.000	0.000
0.000	**-38**	0.000	0.000	0.574	0.000
0.000	**-39**	0.000	0.000	0.000	0.574
-2.124	Average	0.664	3.294	2.740	2.426

APPENDIX F: MEETING MINUTES VERIFYING PLAN ACCEPTANCE BY GOVERNING BODY

B. BRIDGE ASSET MANAGEMENT PLAN

(Not Used)

C. CULVERT ASSET MANAGEMENT PLAN SUPPLEMENT

(Not Used)

D. TRAFFIC SIGNALS ASSET MANAGEMENT PLAN SUPPLEMENT

Traffic Signals Primer

Types

Electronic traffic control devices come in a large array of configurations, which include case signs (e.g., keep right/left, no right/left turn, reversible lanes), controllers, detection (e.g., cameras, push buttons), flashing beacons, interconnects (e.g., DSL, fire station, phone line, radio), pedestrian heads (e.g., hand-man), and traffic signals. This asset management plan is only concerned with traffic signals (Figure D-1) as a functioning unit and does not consider other electronic traffic control devices.

Figure D-1: Example of traffic signals

Condition

Traffic signal assessment considers the functioning of basic tests on a pass/fail basis. These tests include battery backup testing, components testing, conflict monitor testing, radio testing, and underground detection.

Treatments

Traffic signals are maintained in accordance with the *Michigan Manual on Uniform Traffic Control Devices*. Maintenance of traffic signals includes regular maintenance of all components, cleaning and servicing to prevent undue failures, immediate maintenance in the case of emergency calls, and provision of stand-by equipment. Timing changes are restricted to authorized personnel only.

E. GLOSSARY & ACRONYMS

Glossary

Alligator cracking: Cracking of the surface layer of an asphalt pavement that creates a pattern of interconnected cracks resembling alligator hide. This is often due to overloading a pavement, sub-base failure, or poor drainage.[5]

Asset management: A process that uses data to manage and track road assets in a cost-effective manner using a combination of engineering and business principles. Public Act 325 of 2018 provides a legal definition: "an ongoing process of maintaining, preserving, upgrading, and operating physical assets cost effectively, based on a continuous physical inventory and condition assessment and investment to achieve established performance goals".[6]

Biennial inspection: Inspection of an agency's bridges every other year, which happens in accordance with National Bridge Inspection Standards and Michigan Department of Transportation requirements.

Bridge inspection program: A program implemented by a local agency to inspect the bridges within its jurisdiction systematically in order to ensure proper functioning and structural soundness.

Capital preventative maintenance: Also known as CPM, a planned set of cost-effective treatments to address of fair-rated infrastructure before the structural integrity of the system has been severely impacted. These treatments aim to slow deterioration and to maintain or improve the functional condition of the system without significantly increasing the structural capacity. Light capital preventive maintenance is a set of treatments designed to seal isolated areas of the pavement from water, such as crack and joint sealing, to protect and restore pavement surface from oxidation with limited surface thickness material, such as fog seal; generally, application of a light CPM treatment does not provide a corresponding increase in a segment's PASER score. Heavy capital preventive maintenance is a set of surface treatments designed to protect pavement from water intrusion or environmental weathering without adding significant structural strength, such as slurry seal, chip seal, or thin (less than 1.5-inch) overlays for bituminous surfaces or patching or partial-depth (less than 1/3 of pavement depth) repair for concrete surfaces.

Chip seal: An asphalt pavement treatment method consisting of, first, spraying liquid asphalt onto the old pavement surface and, then, a single layer of small stone chips spread onto the wet asphalt layer.

City major: A road classification, defined in Michigan Public Act 51, that encompasses the generally more important roads in a city or village. City major roads are designated by a municipality's governing body and are subject to approval by the State Transportation Commission. These roads do not include roads under the jurisdiction of a county road commission or trunkline highways.

City minor: A road classification, defined in Michigan Public Act 51, that encompasses the generally less important roads in a city or village. These roads include all city or village roads that are not city major road and do not include roads under the jurisdiction of a county road commission.

[5] https://en.wikipedia.org/wiki/Crocodile_cracking
[6] Inventory-based Rating System for Gravel Roads: Training Manual

Composite pavement: A pavement consisting of concrete and asphalt layers. Typically, composite pavements are old concrete pavements that were overlaid with HMA in order to gain more service life.

Concrete joint resealing: Resealing the joints of a concrete pavement with a flexible sealant to prevent moisture and debris from entering the joints. When debris becomes lodged inside a joint, it inhibits proper movement of the pavement and leads to joint deterioration and spalling.

Concrete pavement: Also known as rigid pavement, a pavement made from portland cement concrete. Concrete pavement has an average service life of 30 years and typically does not require as much periodic maintenance as HMA.

Cost per lane mile: Associated cost of construction, measured on a per lane, per mile basis. Also see *lane-mile segment.*

County local: A road classification, defined in Michigan Public Act 51, that encompasses the generally less important and low-traffic roads in a county. This includes all county roads that are not classified as county primary roads.

County primary: A road classification, defined in Michigan Public Act 51, that encompasses the generally more important and high-traffic roads in a county. County primary roads are designated by board members of the county road commissions and are subject to approval by the State Transportation Commission.

CPM: See *Capital preventive maintenance.*

Crack and seat: A concrete pavement treatment method that involves breaking old concrete pavement into small chunks and leaving the broken pavement in place to provide a base for a new surface. This provides a new wear surface that resists water infiltration and helps prevent damaged concrete from reflecting up to the new surface.

Crack seal: A pavement treatment method for both asphalt and concrete pavements that fills cracks with asphalt materials, which seals out water and debris and slows down the deterioration of the pavement. Crack seal may encompass the term “crack filling”.

Crush and shape: An asphalt pavement treatment method that involves pulverizing the existing asphalt pavement and base and then reshaping the road surface to correct imperfections in the road’s profile. Often, a layer of gravel is added along with a new wearing surface such as an HMA overlay or chip seal.

Crust: A very tightly compacted surface on an unpaved road that sheds water with ease but takes time to be created.

Culvert: A pipe or structure used under a roadway that allows cross-road drainage while allowing traffic to pass without being impeded; culverts span up to 20 feet.[7]

Dowel bar retrofit repair: A concrete pavement treatment method that involves cutting slots in a cracked concrete slab, inserting steel bars into the slots, and placing concrete to cover the new bars and fill the slots. It aims to reinforce cracks in a concrete pavement.

[7] Adapted from Inventory-based Rating System for Gravel Roads: Training Manual

Dust control: A gravel road surface treatment method that involves spraying chloride or other chemicals on the gravel surface to reduce dust loss, aggregate loss, and maintenance. This is a relatively short-term fix that helps create a crusted surface.

Expansion joint: Joints in a bridge that allow for slight expansion and contraction changes in response to temperature. Expansion joints prevent the build up of excessive pressure, which can cause structural damage to the bridge.

Federal Highway Administration: Also known as FHWA, this is an agency within the U.S. Department of Transportation that supports state and local governments in the design, construction, and maintenance of the nation's highway system.[8]

Federal-aid network: Portion of road network that is comprised of federal-aid routes. According to Title 23 of the United States Code, federal-aid-eligible roads are "highways on the federal-aid highways systems and all other public roads not classified as local roads or rural minor collectors".[9] Roads that are part of the federal-aid network are eligible for federal gas-tax monies.

FHWA: See *Federal Highway Administration*.

Flexible pavement: See *hot-mix asphalt pavement*.

Fog seal: An asphalt pavement treatment method that involves spraying a liquid asphalt coating onto the entire pavement surface to fill hairline cracks and prevent damage from sunlight and oxidation. This method works best for good to very good pavements.

Full-depth concrete repair: A concrete pavement treatment method that involves removing sections of damaged concrete pavement and replacing it with new concrete of the same dimensions in order to restore the riding surface, delay water infiltration, restore load transfer from one slab to the next, and eliminate the need to perform costly temporary patching.

Geographic divides: Areas where a geographic feature (e.g., river, lake, mountain) limits crossing points of the feature.

Grants: Competitive funding gained through an application process and targeted at a specific project type to accomplish a specific purpose. Grants can be provided both on the federal and state level and often make up part of the funds that a transportation agency receives.

Gravel surfacing: A low-cost, easy-to-maintain road surface made from aggregate and fines.

Heavy capital preventive maintenance: See *Capital preventive maintenance*.

HMA: See *hot-mix asphalt pavement*.

Hot-mix asphalt overlay: Also known as HMA overlay, this a surface treatment that involves layering new asphalt over an existing pavement, either asphalt or concrete. It creates a new wearing surface for traffic and to seal the pavement from water, debris, and sunlight damage, and it often adds significant structural strength.

Hot-mix asphalt pavement: Also known as HMA pavement, this type of asphalt creates a flexible pavement composed of aggregates, asphalt binder, and air voids. HMA is heated for placement and

[8] Federal Highway Administration webpage https://www.fhwa.dot.gov/
[9] Inventory-based Rating System for Gravel Roads: Training Manual

compaction at high temperatures. HMA is less expensive to construct than concrete pavement, however it requires frequent maintenance activities and generally lasts 18 years before major rehabilitation is necessary. HMA makes up the vast majority of local-agency-owned pavements.

IBR: See *IBR element*, *IBR number*, and/or *Inventory-based Rating System*™.

IBR element: A feature used in the IBR System™ for assessing the condition of roads. The system relies on assessing three elements: surface width, drainage adequacy, and structural adequacy.[10]

IBR number: The 1-10 rating determined from assessments of the weighted IBR elements. The weighting relates each element to the intensity road work needed to improve or enhance the IBR element category.[11]

Interstate highway system: The road system owned and operated by each state consisting of routes that cross between states, make travel easier and faster. The interstate roads are denoted by the prefix "I" or "U.S." and then a number, where odd routes run north-south and even routes run east-west. Examples are I-75 or U.S. 2.[12]

Inventory-based Rating System™: Also known as the IBR System™, a rating system designed to assess the capabilities of gravel and unpaved roads to support intended traffic volumes and types year round. It assesses roads based on how three IBR elements, or features—surface width, drainage adequacy, and structural adequacy—compare to a baseline, or "good", road.[13]

Investment Reporting Tool: Also known as IRT, a web-based system used to manage the process for submitting required items to the Michigan Transportation Asset Management Council. Required items include planned and completed maintenance and construction activity for roads and bridges and comprehensive asset management plans.

IRT: See *Investment Reporting Tool*.

Jurisdiction: Administrative power of an entity to make decisions for something. In Michigan, the three levels of jurisdiction classification for transportation assets are state highways, county roads, and city and village streets. State highways are under the jurisdiction of the Michigan Department of Transportation, county roads are under the jurisdiction of the road commission for the county in which the roads are located, and city and village streets are under the jurisdiction of the municipality in which the roads are located.

Jurisdictional borders: Borders between two road-owning-agency jurisdictions, or where the roads owned by one agency turn into roads owned by another agency. Examples of jurisdictional borders are township or county lines.

Lane-mile segment: A segment of road that is measured by multiplying the centerline miles of a roadway by the number of lanes present.

Lane-mile-years: A network's total lane-miles multiplied by one year; a method to quantify the measurable loss of pavement life.

[10] Inventory-based Rating System for Gravel Roads: Training Manual
[11] Inventory-based Rating System for Gravel Roads: Training Manual
[12] https://www.fhwa.dot.gov/interstate/faq.cfm#question3
[13] Adapted from Inventory-based Rating System for Gravel Roads: Training Manual

Light capital preventive maintenance: See *Capital preventive maintenance*.

Limited access areas: Areas—typically remote areas—serviced by few or seasonal roads that require long detours routes if servicing roads are closed.

Main access to key commercial districts: Areas where large number or large size business will be significantly impacted if a road is unavailable.

Maintenance grading: A surface treatment method for unpaved roads that involves re-grading the road to remove isolated potholes, washboarding, and ruts, and then restoring the compacted crust layer.

MDOT: See *Michigan Department of Transportation*.

MDOT's Local Bridge Program Call for Projects: A call for project proposals for replacement, rehabilitation, and/or preventive maintenance of local bridges that, if granted, receives bridge funding from the Michigan Department of Transportation. The Call for Projects is made by the Local Bridge Program.

MGF: See *Michigan Geographic Framework*.

Michigan Department of Transportation: Also known as MDOT, this is the state of Michigan's department of transportation, which oversees roads and bridges owned by the state or federal government in Michigan.

Michigan Geographic Framework: Also known as MGF, this is the state of Michigan's official digital base map that contains location and road information necessary to conduct state business. The Michigan Department of Transportation uses the MGF to link transportation assets to a physical location.

Michigan Public Act 51 of 1951: Also known as PA 51, this is a Michigan legislative act that served as the foundation for establishing a road funding structure by creating transportation funding distribution methods and means. It has been amended many times.[14]

Michigan Public Act 325 of 2018: Also known as PA 325, this legislation modified PA 51 of 1951 in regards to asset management in Michigan, specifically 1) re-designating the TAMC under Michigan Infrastructure Council (MIC); 2) promoting and overseeing the implementation of recommendations from the regional infrastructure asset management pilot program; 3) requiring local road three-year asset management plans beginning October 1, 2023; 4) adding asset classes that impact system performance, safety or risk management, including culverts and signals; 5) allowing MDOT to withhold funds if no asset management plan submitted; and 6) prohibiting shifting finds from a country primary to a county local, or from a city major to a city minor if no progress toward achieving the condition goals described in its asset plan.[15]

Michigan Public Act 499 of 2002: Also known as PA 499, this legislation requires road projects for the upcoming three years to be reported to the TAMC.

Michigan Transportation Asset Management Council: Also known as the TAMC, a council comprised of professionals from county road commissions, cities, a county commissioner, a township official, regional and metropolitan planning organizations, and state transportation department personnel. The

[14] Inventory-based Rating System for Gravel Roads: Training Manual
[15] Inventory-based Rating System for Gravel Roads: Training Manual

council reports directly to the Michigan Infrastructure Council.[16] The TAMC provides resources and support to Michigan's road-owning agencies, and serves as a liaison in data collection requirements between agencies and the state.

Michigan Transportation Fund: Also known as MTF, this is a source of transportation funding supported by vehicle registration fees and the state's per-gallon gas tax.

Microsurface treatment: An asphalt pavement treatment method that involves applying modified liquid asphalt, small stones, water, and portland cement for the purpose of protecting a pavement from damage caused by water and sunlight.

Mill and hot-mix asphalt overlay: Also known as a mill and HMA overlay, this is a surface treatment that involves the removal of the top layer of pavement by milling and the replacement of the removed layer with a new HMA layer.

Mix-of-fixes: A strategy of maintaining roads and bridges that includes generally prioritizes the spending of money on routine maintenance and capital preventive maintenance treatments to impede deterioration and then, as money is available, performing reconstruction and rehabilitation.

MTF: See *Michigan Transportation Fund*.

National Bridge Inspection Standards: Also known as NBIS, standards created by the Federal Highway Administration to locate and evaluate existing bridge deficiencies in the federal-aid highway system to ensure the safety of the traveling public. The standards define the proper safety for inspection and evaluation of all highway bridges.[17]

National Center for Pavement Preservation: Also known as the NCPP, a center that offers education, research, and outreach in current and innovative pavement preservation practices. This collaborative effort of government, industry, and academia entities was established at Michigan State University.

National Functional Class: Also known as NFC, a federal grouping system for public roads that classifies roads according to the type of service that the road is intended to provide.

National highway system: Also known as NHS, this is a network of roads that includes the interstate highway system and other major roads managed by state and local agencies that serve major airports, marine, rail, pipelines, truck terminals, railway stations, military bases, and other strategic facilities.

NBIS: See *National Bridge Inspection Standards*.

NCPP: See *National Center for Pavement Preservation*.

NCPP Quick Check: A system created by the National Center for Pavement Preservation that works under the premise that a one-mile road segment loses one year of life each year that it is not treated with a maintenance, rehabilitation, or reconstruction project.

NFC: See *National Functional Class*.

Non-trunkline: A local road intended to be used over short distances but not recommended for long-distance travel.

[16] Inventory-based Rating System for Gravel Roads: Training Manual
[17] https://www.fhwa.dot.gov/bridge/nbis/

Other funds: Expenditures for equipment, capital outlay, debt principal payment, interest expense, contributions to adjacent governmental units, principal, interest and bank fees, and miscellaneous for cities and villages.

PA: See *Michigan Public Act 51, Michigan Public Act 325,* and/or *Michigan Public Act 499.*

Partial-depth concrete repair: A concrete pavement treatment method that involves removing spalled or delaminated areas of concrete pavement, usually near joints and cracks, and replacing with new concrete. This is done to provide a new wearing surface in isolated areas, to slow down water infiltration, and to help delay further freeze-thaw damage.

PASER: See *Pavement Surface Evaluation and Rating system.*

Pavement reconstruction: A complete removal of the old pavement and base and construction of an entirely new road. This is the most expensive rehabilitation of the roadway and also the most disruptive to traffic patterns.

Pavement Surface Evaluation and Rating system: Also known as the PASER system, the PASER system rates surface condition on a 1-10 scale, where 10 is a brand new road with no defects, 5 is a road with distress but that is structurally sound and requires only preventative maintenance, and 1 is a road with extensive surface and structural distresses that is in need of total reconstruction. This system provides a simple, efficient, and consistent method for evaluating the condition of paved roads.[18]

Pothole: A defect in a road that produces a localized depression.[19]

Preventive maintenance: Planned treatments to an existing asset to prevent deterioration and maintain functional condition. This can be a more effective use of funds than the costly alternative of major rehabilitation or replacement.

Proactive preventive maintenance: Also known as PPM, a method of performing capital preventive maintenance treatments very early in a pavement's life, often before it exhibits signs of pavement defect.

Public Act 51: See *Michigan Public Act 51 of 1951*

Public Act 325: See *Michigan Public Act 325 of 2018*

Public Act 499: See *Michigan Public Act 499 of 2002*

Reconstruction and rehabilitation programs: Programs intended to reconstruct and rehabilitate a road.

Restricted load postings: A restriction enacted on a bridge structure when is incapable of transporting a state's legal vehicle loads.

Rights-of-way ownership: The owning of the right-of-way, which is the land over which a road or bridge travels. In order to build a road, road agencies must own the right-of-way or get permission to build on it.

Rigid pavement: See *concrete pavement*.

[18] Adapted from Inventory-based Rating System for Gravel Roads: Training Manual
[19] Inventory-based Rating System for Gravel Roads: Training Manual

Road infrastructure: An agency's road network and assets necessary to make it function, such as traffic signage and ditches.

Road: The area consisting of the roadway (i.e., the travelled way or the portion of the road on which vehicles are intended to drive), shoulders, ditches, and areas of the right of way containing signage.[20]

Roadsoft: An asset management software suit that enables agencies to manage road and bridge related infrastructure. The software provides tools for collecting, storing, and analyzing data associated with transportation infrastructure. Built on an optimum combination of database engine and GIS mapping tools, Roadsoft provides a quick, smooth user experience and almost unlimited data handling capabilities.[21]

Ruts/rutting: Deformation of a road that usually forms as a permanent depression concentrated under the wheel path parallel to the direction of travel.[22]

Scheduled maintenance: Low-cost, day-to-day activities applied to bridges on a scheduled basis that mitigates deterioration.[23]

Sealcoat pavement: A gravel road that has been sealed with a thin asphalt binder coating that has stone chips spread on top.

Service life: Time from when a road or treatment is first constructed to when it reaches a point where the distresses present change from age-related to structural-related (also known as the critical distress point).[24]

Slurry seal: An asphalt pavement treatment method that involves applying liquid asphalt, small stones, water, and portland cement in a very thin layer with the purpose of protecting an existing pavement from being damaged by water and sunlight.

Structural improvement: Pavement treatment that adds strength to the pavement. Roads requiring structural improvement exhibit alligator cracking and rutting and are considered poor by the TAMC definitions for condition.

Subsurface infrastructure: Infrastructure maintained by local agencies that reside underground, for example, drinking water distribution systems, wastewater collection systems, and storm sewer systems.

TAMC: See *Michigan Transportation Asset Management Council*.

TAMC pavement condition dashboard: Website for viewing graphs of pavement and bridge conditions, traffic and miles travelled, safety statistics, maintenance activities, and financial data for Michigan's cities and villages, counties, and regions, as well as the state of Michigan.

TAMC's good/fair/poor condition classes: Classification of road conditions defined by the Michigan Transportation Asset Management Council based on bin ranges of PASER scores and similarities in defects and treatment options. Good roads have PASER scores of 8, 9, or 10, have very few defects, and require minimal maintenance. Fair roads have PASER scores of 5, 6, or 7, have good structural support but a deteriorating surface, and can be maintained with CPM treatments. Poor roads have PASER scores

[20] Inventory-based Rating System for Gravel Roads: Training Manual
[21] Inventory-based Rating System for Gravel Roads: Training Manual
[22] Paving Class Glossary
[23] Inventory-based Rating System for Gravel Roads: Training Manual
[24] Inventory-based Rating System for Gravel Roads: Training Manual

of 1, 2, 3, or 4, exhibit evidence that the underlying structure is failing, such as alligator cracking and rutting. These roads must be rehabilitated with treatments like heavy overlay, crush and shape, or total reconstruction.

Tax millages: Local tax implemented to supplement an agency's budget, such as road funding.

Thin hot-mix asphalt overlay: Application of a thin layer of hot-mix asphalt on an existing road to re-seal the road and protect it from damage caused by water. This also improves the ride quality and provides a smoother, uniform appearance that improves visibility of pavement markings.[25]

Transportation infrastructure: All of the elements that work together to make the surface transportation system function including roads, bridges, culverts, traffic signals, and signage.

Trigger: When a PASER score gives insight to the preferred timeline of a project for applying the correct treatment at the correct time.

Trunkline abbreviations: The prefixes *M-*, *I-*, and *US* indicate roads in Michigan that are part of the state trunkline system, the Interstate system, and the US Highway system. These roads consist of anything from 10-lane urban freeways to two-lane rural highways and even one non-motorized highway; they cover 9,668 centerline miles. Most of the roads are maintained by MDOT.

Trunkline bridges: Bridge present on a trunkline road, which typically connects cities or other strategic places and is the recommended rout for long-distance travel.[26]

Trunkline maintenance funds: Expenditures under a maintenance agreement with MDOT for maintenance activities performed on MDOT trunkline routes.

Trunkline: Major road that typically connects cities or other strategic places and is the recommended route for long-distance travel.[27]

Washboarding: Ripples in the road surface that are perpendicular to the direction of travel.[28]

Wedge/patch sealcoat treatment: An asphalt pavement treatment method that involves correcting the damage frequently found at the edge of a pavement by installing a narrow, 2- to 6-foot-wide wedge along the entire outside edge of a lane and layering with HMA. This extends the life of an HMA pavement or chip seal overlay by adding strength to significantly settled areas of the pavement.

Worst-first strategy: Asset management strategy that treats only the problems, often addressing the worst problems first, and ignoring preventive maintenance. This strategy is the opposite of the "mix of fixes" strategy. An example of a worst-first approach would be purchasing a new automobile, never changing the oil, and waiting till the engine fails to address any deterioration of the car.

List of Acronyms

CPM: capital preventive maintenance

[25] [second sentence] http://www.kentcountyroads.net/road-work/road-treatments/ultra-thin-overlay
[26] https://en.wikipedia.org/wiki/Trunk_road
[27] https://en.wikipedia.org/wiki/Trunk_road
[28] Inventory-based Rating System for Gravel Roads: Training Manual

FHWA: Federal Highway Administration

HMA: hot-mix asphalt

I: trunkline abbreviation for routes on the Interstate system

IBR: Inventory-based Rating

M: trunkline abbreviation for Michigan state highways

MDOT: Michigan Department of Transportation

MTF: Michigan Transportation Fund

NBIS: National Bridge Inspection Standards

NCPP: National Center for Pavement Preservation

NHS: National Highway System

PA 51: Michigan Public Act 51 of 1951

PASER: Pavement Surface Evaluation and Rating

R&R: reconstruction and rehabilitation programs

TAMC: (Michigan) Transportation Asset Management Council

US: trunkline abbreviation for routes on the US Highway system