City of Troy
2023 Transportation
Asset Management Plan

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

Prepared by:
G. Scott Finlay, P.E.
City Engineer
CityEngineer@troymi.gov

CONTENTS

Table of Figures i

Table of Tables ii

Executive Summary iii

Introduction 1

1. Pavement Assets 3

Inventory of Assets 4
Condition, Goals, and Trend 5
Modelled Trends, Gap Analysis, and Planned Projects 8

2. Bridge Assets 11

Inventory of Assets 12
Condition, Goals, and Trend 13
Programmed/Funded Projects, Gap Analysis, and Planned Projects 14

3. Culvert Assets 15

Inventory of Assets 16
Goals 16
Planned Projects 16

4. Signal Assets 17

Inventory of Assets 18
Goals 18
Planned Projects 18

5. Financial Resources 19

Anticipated Revenues & Expenses 19

6. Risk of Failure Analysis 22

7. Coordination with Other Entities 23

Coordinated Planning 23
Summit 24

8. Proof of Acceptance & Meeting Minutes Verifying Plan Acceptance by Governing Body 25

A. Pavement Asset Management Plan 27

B. Bridge Asset Management Plan 28

C. Culvert Asset Management Plan Supplement 29

Culvert Primer 29

D. Traffic Signals Asset Management Plan Supplement 31

Traffic Signals Primer 31

E. Glossary & Acronyms 32

Glossary 32
List of Acronyms 40

TABLE OF FIGURES

Figure 1: Map showing location or roads managed by Troy 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 4

Figure 2: Pavement type by percentage maintained by Troy. Undefined pavements have not been inventoried in Troy's asset management system to date, but will be included as data becomes available. 5

Figure 3: city major network condition, goals, and trend 6

Figure 4: city minor network condition, goals, and trend 6

Figure 5: Distribution of PASER numbers for current condition (solid) and for goals (dotted)....7

Figure 6: Map illustrating planned projects for pavement assets....9

Figure 7: Map illustrating locations of Troy's bridge assets....12

.Figure 8: Condition, projected trend, and goal for Troy's good/fair and structurally deficient bridges....14

Figure C-1: Diagram of a culvert structure....29

Figure C-2: Examples of culverts. Culverts allow water to pass under the roadway (left), they are straight-line conduits with no intermediate drainage structures (middle), and they come in various materials (left: metal; middle and right: concrete) and shapes (left: arch; middle: round; right: box). 29

Figure D-1: Example of traffic signals 31

TABLE OF TABLES

Table 1: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for Troy's Road Assets 8
Table 2: Type, Size, and Condition of Troy's Bridge Assets..13
Table 3: Annual Fiscal-Year Revenues & Expenditures per Fiscal Year...21

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 Troy's (Troy) roads, bridges, and support systems are also some of the most valuable and extensive public assets, all of which are paid for with taxes collected from ordinary 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 Troy is meeting its obligations to maintain the public assets for which it is responsible.

This plan identifies Troy's assets and condition and how Troy 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 Troy'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 Troy'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 Troy's assets, and it gives taxpayers the information they need to make informed decisions about investing in Troy'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 Troy 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.

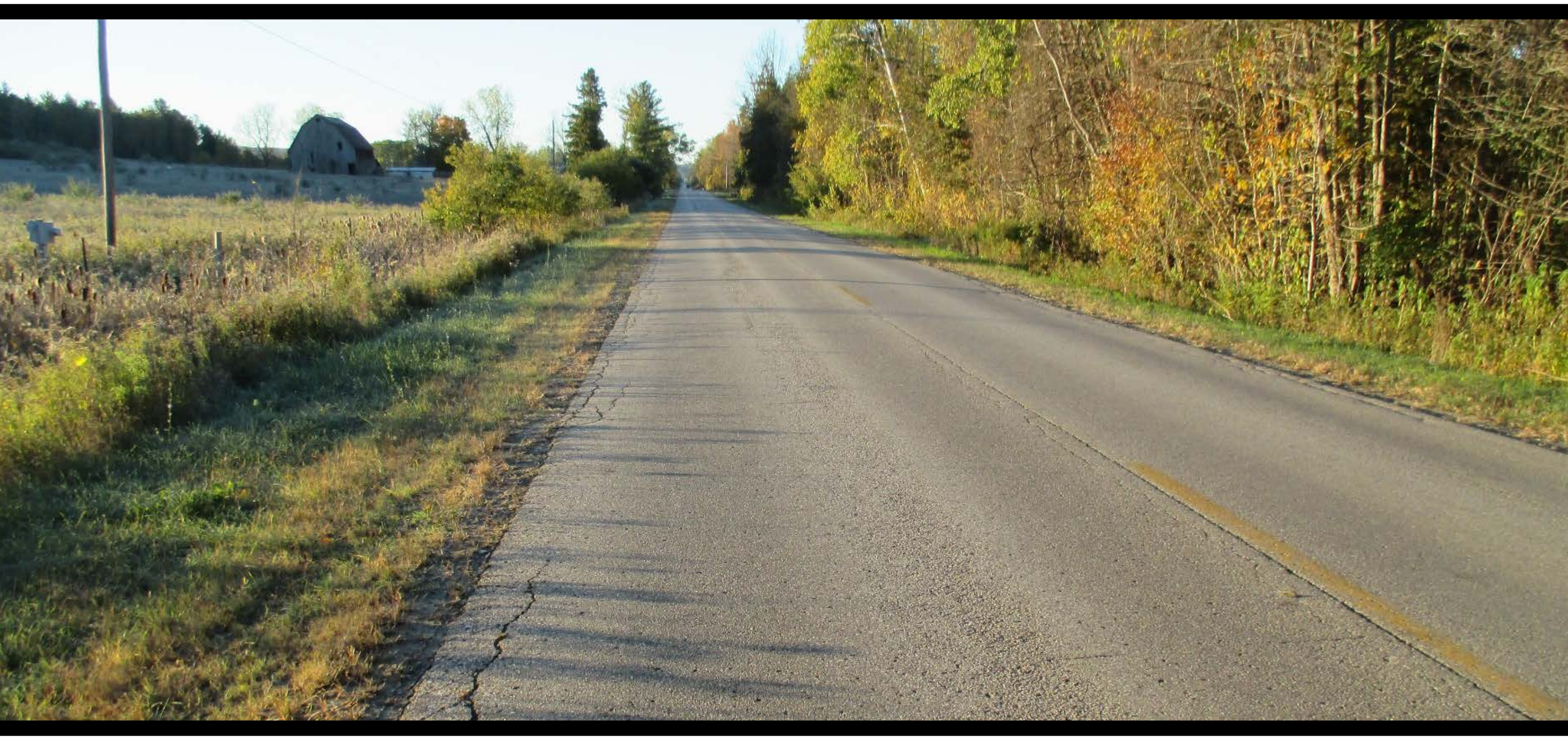
Asset management, in the context of this plan, ensures that public funds are spent as effectively as possible to maximize the condition of the road and bridge network. Asset management also provides a transparent decision-making process that allows the public to understand the technical and financial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

The City of Troy (Troy) 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. Troy is responsible for maintaining and operating over 337.68 centerline miles of roads and 12 bridge structures. It is also responsible for 92 culverts and 0 signals. Traffic signals in Troy are operated and maintained by the Road Commission for Oakland County (RCOC) under local agreements between the agencies. Troy pays its proportionate share of traffic signals that involve city roads to the RCOC.

This 2023 plan identifies Troy’s transportation assets and their condition as well as the strategy that Troy uses to maintain and upgrade particular assets given Troy’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 G. Scott Finlay, P.E. at 500 W Big Beaver, Troy, Michigan 48084 or at (248)-524-3383 and/or CityEngineer@troymi.gov. A copy of this plan can be accessed on our website at https://troymi.gov/departments/engineering/index.php.

1. PAVEMENT ASSETS



Troy is responsible for 337.68 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 minor road network.

Inventory of Assets

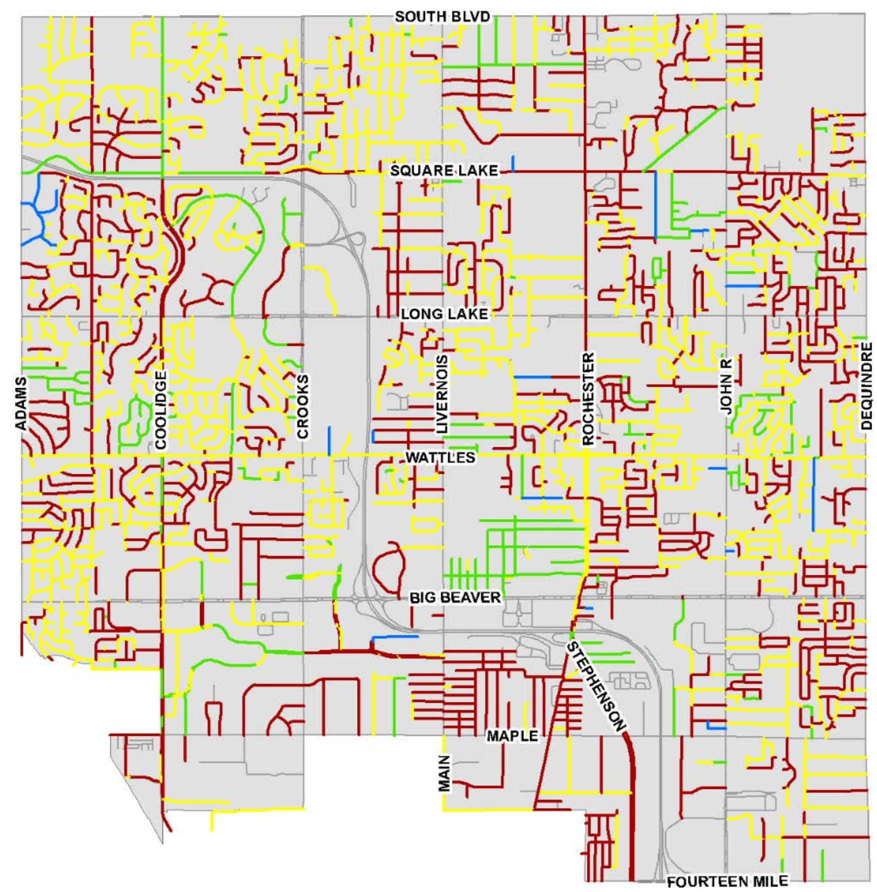


Figure 1: Map showing location or roads managed by Troy and the current condition for paved roads in green for good (PASER 10, 9, 8), yellow for fair (PASER 7, 6, 5), and red for poor (PASER 4, 3, 2, 1) and for unpaved roads in blue

Of Troy's 337.68 miles of road, 70.91 miles are classified as city major and 266.77 miles are classified as city minor (Figure 1 identifies these paved roads in green, yellow, and red with the colors being determined based on the road segment's condition). Troy also manages 8.242 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, Troy has 3.98 miles of unpaved roads (Figure 1 identifies these unpaved roads in blue).

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

Types

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

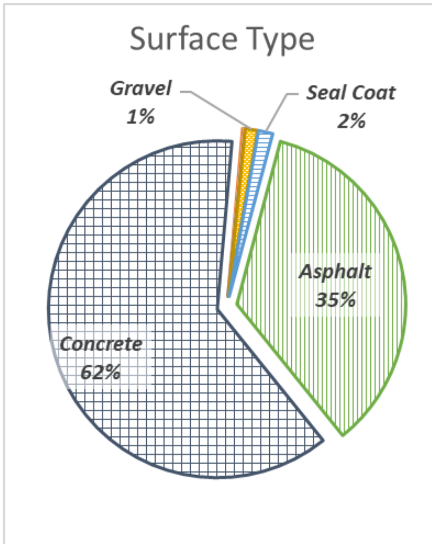


Figure 2: Pavement type by percentage maintained by Troy. Undefined pavements have not been inventoried in Troy's asset management system to date, but will be included as data becomes available.

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. Troy collects 100 percent of its PASER data every year on all roads, including federal-aid-eligible in our network using our own staff and consultant resources

Currently, the city major network has 16% of its roads in good condition, 34% in fair condition, and 50% in poor condition, and the city minor network has 21% of its roads in good condition, 49% in fair condition, and 43% in poor condition (Figure 3 and Figure 4). Troy's long-range goal for the city major network is to have 20% of roads in good condition, 40% in fair condition, and 40% in poor condition, and for the city minor network is to have 20% of roads in good condition, 40% in fair condition, and 40% in poor condition (Figure 3 and Figure 4). Figure 3 and Figure 4 illustrate the historical and current condition (solid bars) of Troy's city major and city minor networks, respectively; they also illustrate the projected trend (shaded bars), the overall trend in condition (trendlines), and Troy's goal (final solid bar).

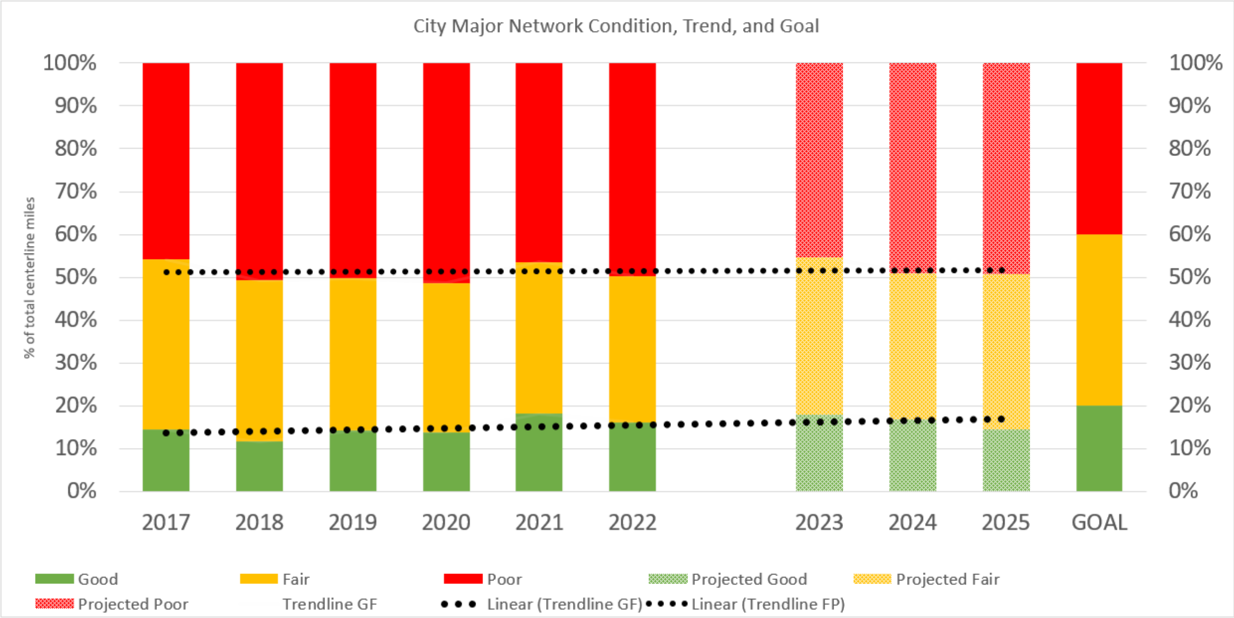


Figure 3: city major network condition, goals, and trend

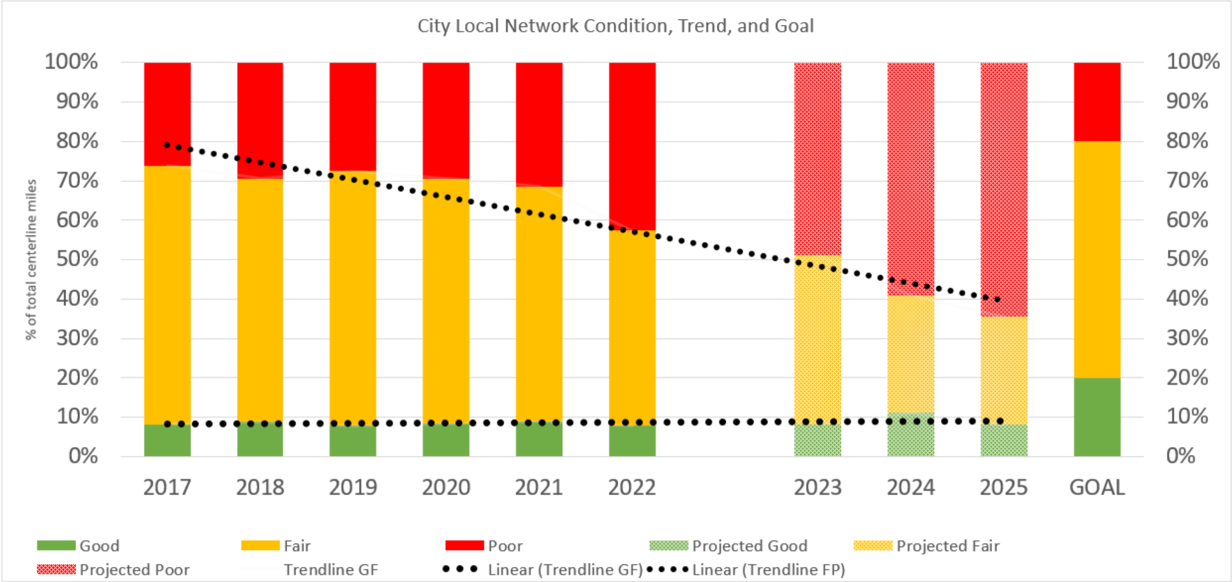


Figure 1: city minor network condition, goals, and trend

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. Troy uses PASER ratings for gravel roads to be consistent with our overall PASER rating process for all roads, regardless of material type.

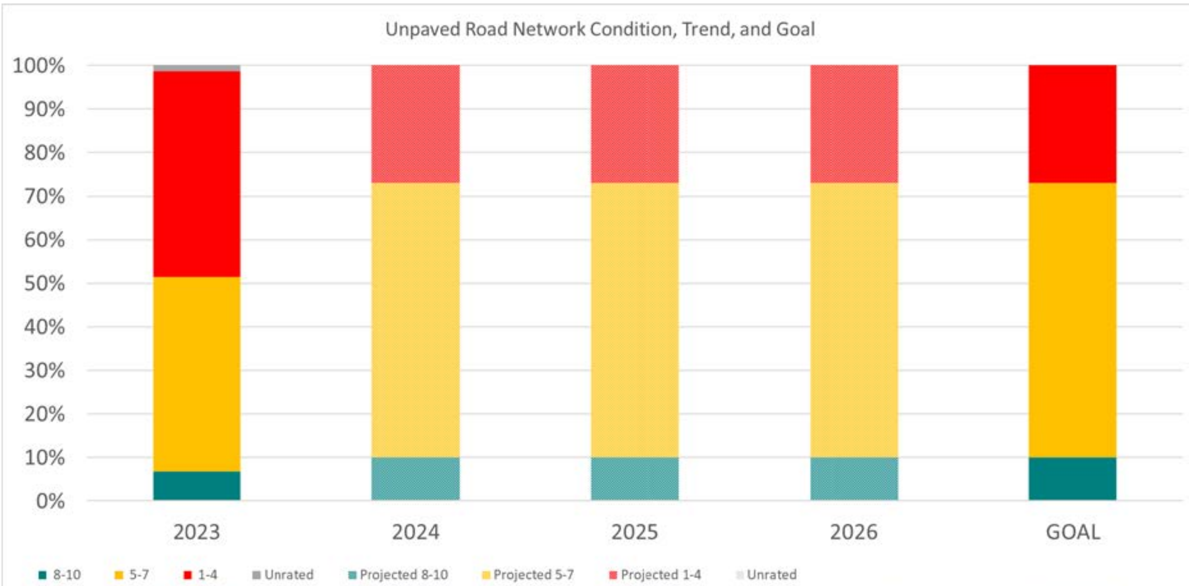


Figure 5: Distribution of PASER numbers for current condition (solid) and for goals (dotted)

Modelled Trends, Gap Analysis, and Planned Projects

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

Paved City Major Road Network (70.91 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
Joint Seal Remove & Replace	3	3	5,8	3	7–7	6	7–7
Overlay	3	15	3, 9	3	3, 4-9	6	3, 4-9
Reconstruction	1	20	1, 10	1	1, 2, 3-10	3	1, 2, 3-10
Slab Replacement	3	15	1-4, 7	3	1-4,7	9	1-4,7

Paved City Minor Road Network (266.77 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
Joint Seal Remove & Replace	4	3	7–7	4	7–7	8	7–7
Overlay	7	15	3, 4-9	7	3, 4-9	14	3, 4-9
Reconstruction	0	20	1, 2, 3-10		1, 2, 3-10		1, 2, 3-10
Slab Replacement	3	20	1-4, 7	3	1-4,7	9	1-4,7
Chip Seal	3	5	5-6, 8	3	5-6, 8		5-6, 8

Modelled Trends & Gap Analysis

The Roadsoft network analysis of Troy's planned projects for the city major and city minor networks from Troy's currently available budget allow Troy to reach its pavement condition goals given the projects planned for the next three years.

Unpaved Road Condition Trends

There are approximately 4 miles of unpaved roads in Troy. Unpaved roads are paved under a Special Assessment District (SAD) initiated by residents in the project area.

The process involves a resident request; mail poll to gauge general interest in paving; if 50% or more of the affected area have interest an informational meeting is set; project information, including a cost estimate and individual amortization schedules, is discussed at the meeting; residents then must circulate a petition that is to be signed by property owners; petitions are filed with the City Clerk; signatures are verified by the City Assessor; if 50% or more of the affected property owners are in favor of a SAD for paving, Resolutions # 1, 2, and 3 (Cost estimates, Informational Meeting and Petition Analysis) are prepared for City Council approval; if Resolutions # 1, 2 and 3 are passed, the City Assessor schedules a public hearing before City Council; Resolution #4 approves the project; and then project design, contract preparation and bidding may proceed.

Assuming bids come in within 5% of the cost estimate then a bid award is sent to City Council for approval. After City Council approval the paving project may proceed.

Planned Projects

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

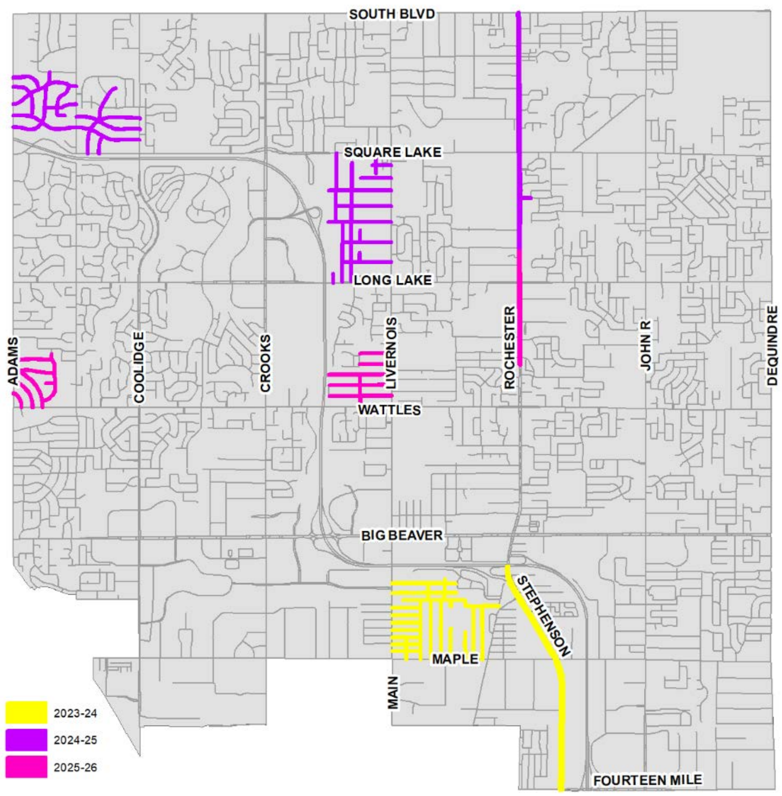


Figure 6: Map illustrating planned projects for pavement assets

The total cost of the projects illustrated in Figure 6 is approximately $25,310,000.00 (not all work is specifically identified on the map as work such as concrete slab replacement is identified annually and work locations are then grouped geographically).

2. BRIDGE ASSETS

Troy is responsible for 12 bridges that provide safe service to road users across the agency network. Troy seeks to implement a cost-effective program of preventive maintenance to maximize the useful service life and safety of the local bridges under its jurisdiction.

Inventory of Assets

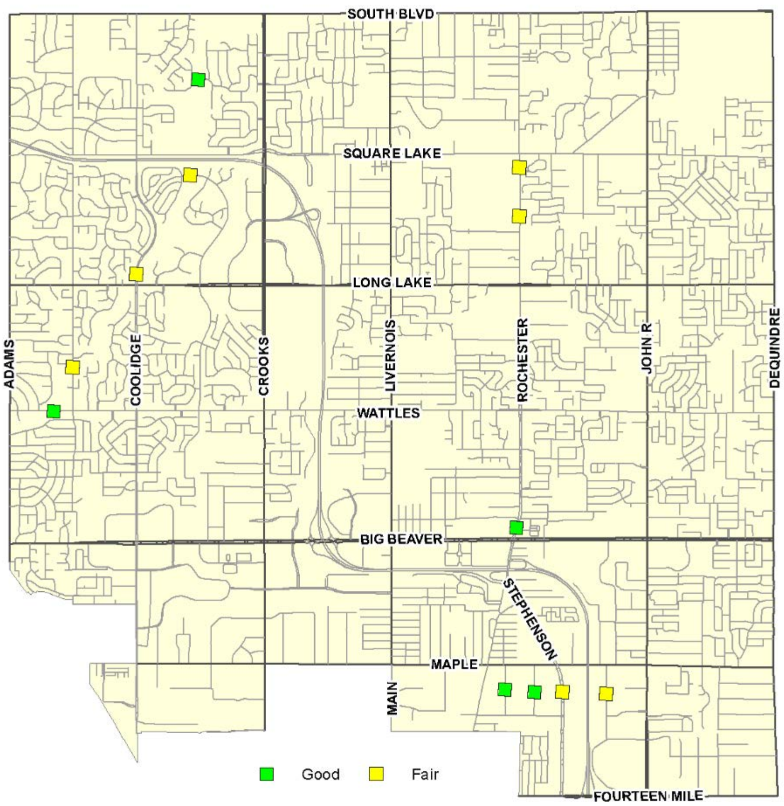


Figure 2: Map illustrating locations of Troy's bridge assets

Troy has 12 total bridges in its road and bridge network; these bridges connect various points of the road network, as illustrated in Figure 7. These bridge structures can be summarized by type, size, and condition, which are detailed in Table 2. More information about each of these structures can be found in Troy's MiBRIDGE database or by contacting Troy.

Table 2: Type, Size, and Condition of Troy's Bridge Assets								
Bridge Type	**Total Number of Bridges**	**Total Deck Area (sq ft)**	**Condition: Structurally Deficient, Posted, or Closed**			**2023 Condition**		
			Struct. Deficient	**Posted**	**Closed**	**Poor**	**Fair**	**Good**
Concrete – Culvert	3	13,695	0	0	0	0	2	1
Concrete continuous – Culvert	6	19,113	0	0	0	0	4	2
Prestressed concrete – Box beam/girders—multiple	1	958	0	0	0	0	1	0
Steel – Culvert	1	1,274	0	0	0	0	0	1
Timber – Slab	1	1,389	0	0	0	0	0	1
Total SD/Posted/Closed			**0**	**0**	**0**			
Total	**12**	**36,429**				**0**	**7**	**5**
Percentage (%)			**0%**	**0**	**0**	**0**	**58**	**42**

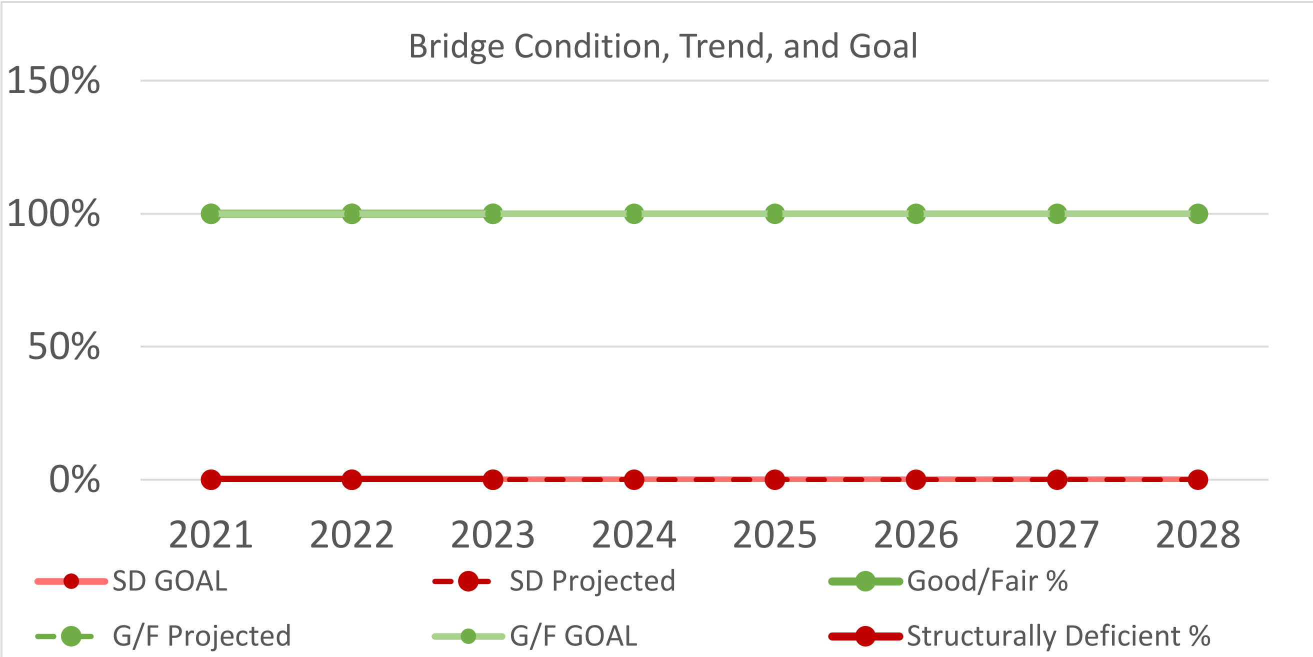
Condition, Goals, and Trend

Bridges in Michigan are given a good, fair, or poor rating based on the National Bridge Inspection Standards (NBIS) rating scale, which was created by the Federal Highway Administration to evaluate a bridge's deficiencies and to ensure the safety of road users. The current condition of Troy's bridge network based on the NBIS is 5 structures rated good, 7 structures rated fair, and 0 structures rated poor (Table 2).

Bridges are designed to carry legal loads in terms of vehicles and traffic. Due to a decline in condition, a bridge may be "posted" with a restriction for what would be considered safe loads passing over the bridge. On occasion, posting a bridge may also restrict other load-capacity-related elements like speed and number of vehicles on the bridge, but this type of posting designates the bridge differently. Troy has 0 structures that are posted for load restriction (Table 2). Designating a bridge as "posted" has no influence on its condition rating. A "closed" bridge is one that is closed to all traffic. Closing a bridge is contingent upon its ability to carry a set minimum live load. Troy has 0 structures that are closed (Table 2).

The goal of the program is the preservation and safety of Troy's bridge network.

Figure 8 illustrates the baseline condition, projected trend, and goal that Troy has for its good/fair and its structurally deficient bridges.



.Figure 8: Condition, projected trend, and goal for Troy's good/fair and structurally deficient bridges

Programmed/Funded Projects, Gap Analysis, and Planned Projects

Troy allocated approximately $10,000 in total funding for the years 2023-2024. Preventive maintenance is a more effective use of these funds than the costly alternative of major rehabilitation or replacement. Since Troy recognizes that limited funds are available for improving the bridge network, it seeks to identify those bridges that will benefit from a planned maintenance program, and it plans to spend $10,000 per year for the next three years on preventive maintenance of bridges. Troy does not anticipate replacing any bridges. By performing the aforementioned preventive maintenance, Troy will achieve its goal of keeping its overall bridge network at the same condition.

At this time and over the time period covered by this plan, Troy does not have any planned projects beyond routine maintenance as identified by our bi-annual inspections. We have completed several projects over the years, beyond normal maintenance, and typically identify, scope and fund the project as a Capital Improvement Project in our 6-Year CIP as part of our annual budget process.

3. CULVERT ASSETS

Troy is responsible for 92 culverts that traverse our roads. Troy seeks to implement a cost-effective program of preventive maintenance to maximize the useful service life and safety of the culverts under its jurisdiction.

Inventory of Assets

Troy plans to track the inventory of its culvert assets using CityWorks and our GIS system. Over the next three years, Troy anticipates inspecting 100% of its culverts under its jurisdiction to be able to report the condition of all culverts. Presently, Troy repairs or replaces culverts as part of other capital improvements or when issues are discovered during routine maintenance or inspection of culvert assets. (see Appendix C *Culvert Asset Management Plan Supplement*).

More detail about these culvert assets can be found in Troy's Roadsoft database or by contacting Troy.

Goals

The goal of Troy's asset management program is the preservation of its culvert network. Troy is responsible for preserving 92 inventoried culverts as well as any un-inventoried culverts that underlie its entire road network.

Planned Projects

Troy's policy is to repair or replace culvert assets concurrent with projects affecting road segments carried by the particular culverts. Troy also includes culvert assets in scheduled maintenance projects affecting road segments carried by the particular culverts.

4. SIGNAL ASSETS

Troy owns 34 traffic signals; however, unless privately owned, all traffic signals in Troy are operated and maintained by the Road Commission for Oakland County (RCOC) under local agreements between the agencies. Troy pays its proportionate share of traffic signals that involve city roads to the RCOC.

Inventory of Assets

Troy does not maintain an inventory of traffic signals due to the aforementioned agreements with the RCOC. Troy does maintain a database of monthly invoices for traffic signal maintenance.

Goals

Troy participates in traffic signal modernization projects with the RCOC on an annual basis and budgets accordingly for traffic signal upgrades. Traffic signals are also included in road widening/reconstruction projects.

Planned Projects

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

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, Troy 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 Troy's financial status can be found on our website at https://troymi.gov or by request submitted to our agency contact (listed in this plan).

Anticipated Revenues & Expenses

Troy receives funding from the following sources:

- **State funds** – Troy'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.
- **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, Category C funds, enhancement grants or CMAQ funds.
- **Other Agencies** – Troy works with other agencies like the Road Commission for Oakland County (Tri-Party, Local Road Improvement Fund, etc) or neighboring communities on joint

projects along border roads or County Roads where each agency contributes funds towards the project.

- **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.

Troy 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 "activities 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 highway, road, street, or bridge".[3] Preventive maintenance activities are "planned strategies 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.
- **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.

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

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

Table 3: Annual Fiscal-Year Revenues & Expenditures per Fiscal Year

REVENUES			EXPENDITURES		
Item	**Estimated $**	**Percent of Total**	**Item**	**Estimated $**	**Percent of Total**
State funds	$9,469,218	85.3%	Construction & capacity improvement (CCI)	$714,553	5.5%
Federal funds	$0	0%	Preservation & structural improvement (PSI)	$9,510,237	72.9%
Contributions for local units	$1,666,483	15%	Routine maintenance	$498,338.00	3.8%
Interest, rents, and other	-$39,555	-0.4%	Winter maintenance	$849,363.00	6.5%
Charges for services	$0	0%	Trunkline maintenance	$0	0%
			Administrative	$545,069	4.2%
			Other	$935,974	7.2%
TOTAL	$11,096,146	99.9%	TOTAL	$13,053,534	100.1%

Verify the information in this table. You can find your agency's information in the TAMC dashboard at https://www.mcgi.state.mi.us/mitrp/tamcDashboards.

6. RISK OF FAILURE ANALYSIS

Transportation infrastructure is designed to be resilient. The system of interconnecting roads and bridges maintained by Troy 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

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. Troy communicates with both public and private infrastructure owners to coordinate work in the following ways:

Coordinated Planning

Troy maintains drinking water, sanitary and storm sewer assets in addition to transportation assets. Troy follows an asset management process for all of its assets by coordinating the upgrade, maintenance, and operation of all major assets.

Planned projects for subsurface infrastructure that Troy owns are listed in the following asset management plans: drinking water distribution system asset management plan, wastewater collection system asset management plan, storm sewer system asset management plan. These three sub-surface utility plans are coordinated with the transportation infrastructure plans to maximize value and minimize service disruptions and cost to the public.

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

1. 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.
2. 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.

3. Subsurface utility projects will be coordinated to allow all under pavement assets to be upgraded in the same project regardless of ownership.

4. 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.

Summit

Troy meets with multiple agencies, including MDOT, SEMCOG and neighboring communities to share project related information in an effort to coordinate traffic and minimize inconvenience to the motoring public.

Meetings with private utility companies are becoming more common but work remains on establishing meaningful meetings with all of the major utility companies on an annual basis.

8. PROOF OF ACCEPTANCE & MEETING MINUTES VERIFYING PLAN ACCEPTANCE BY GOVERNING BODY

PUBLIC ACT 325

CERTIFICATION OF TRANSPORTATION ASSET MANAGEMENT PLAN

Certification Year: 2023

Local Road-owning Agency Name: City of Troy

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	
Printed Name Mark F. Miller		Printed Name Robert C. Maleszyk	
Title City Manager	Date SEP 22 2023	Title CFO	Date 9/22/2023

Due every three years based on agency submission schedule

Submittal Date: 9/29/2023

See attached council meeting minutes and/or resolution.

WHEREAS, The Oakland County Incident Management Team (OCIMT) is a multi-agency incident support team that utilizes members from all aspects of public safety throughout Oakland County, including, Police, Fire, EMS, Communications, Public Health and Public Works. The purpose of the Incident Management Team is to assist a community whose incident overwhelms their local and surrounding resources; and,

WHEREAS, Troy Police Department provides members of their department to be requested upon to fill operational, logistical, and support type roles when the Incident Management Team is requested and deployed for either on sight functions or training exercises; and,

WHEREAS, Through an Interlocal Agreement between Oakland County and City of Troy, the parties understand that the OCIMT is an all-hazard approach to managing incidents or supporting Unified Commands with personnel trained and qualified in the National Incident Management System (“NIMS”), Incident Command System (“ICS”), and specific ICS positions;

THEREFORE, BE IT RESOLVED, That Troy City Council hereby **APPROVES** the Oakland County Incident Management Team Interlocal Agreement between Oakland County (Emergency Management Division) and City of Troy.

BE IT FURTHER RESOLVED, That Troy City Council hereby **AUTHORIZES** City of Troy Mayor, Ethan D Baker, to sign the OCIMT Interlocal Agreement between Oakland County and City of Troy, a copy of which shall be **ATTACHED** to the original Minutes of this meeting and also retained by the Troy City Clerk.

J-6 Request for Acceptance of a Permanent Easement, Eureka Building Company, Sidwell #88-20-10-101-018

Resolution #2023-09-139-J-6

RESOLVED, That Troy City Council hereby **ACCEPTS** a permanent easement for water mains from Eureka Building Company, owner of the property having Sidwell #88-20-10-101-018.

BE IT FURTHER RESOLVED, That the City Clerk is hereby **DIRECTED TO RECORD** the permanent easement with Oakland County Register of Deeds, a copy of which shall be **ATTACHED** to the original Minutes of this meeting.

J-7 City of Troy 2023 Transportation Asset Management Plan

Resolution #2023-09-139-J-7

BE IT RESOLVED, That Troy City Council hereby **ACCEPTS** and **APPROVES** the City of Troy 2023 Transportation Asset Management Plan.

BE IT FURTHER RESOLVED, That Troy City Council **AUTHORIZES** the City Manager and Chief Financial Officer to certify the City of Troy 2023 Transportation Asset Management Plan for compliance to Public Act 325.

BE IT FINALLY RESOLVED, That the City of Troy 2023 Asset Management Plan be **SUBMITTED** to the Transportation Asset Management Council (TAMC) prior to October 1, 2023 in accordance with Public Act 325, copies of which shall be **ATTACHED** to the original Minutes of this meeting.

J-8 Amendment #1 – Preliminary Engineering Agreement with HRC for Engineering Services for the Reconstruction and Widening of Rochester Road, from Barclay to Trinway, Project No. 02.206.5

Resolution #2023-09-139-J-8

RESOLVED, That Troy City Council hereby **APPROVES** Amendment #1 to the 3rd Party Agreement (Subcontract No. 16-5591/S1) with Hubbell, Roth & Clark, Inc. for preliminary engineering services for the reconstruction and widening of Rochester, from Barclay to Trinway in the amount of $484,241.69 at a cost to the City of approximately $97,559, and the Mayor and City Clerk are **AUTHORIZED** to execute Amendment #1, a copy of which shall be **ATTACHED** to the original Minutes of this meeting.

J-9 West Maple Realty Partners, LLC v C.E. Gleeson Constructors, Inc. et. al

Resolution #2023-09-139-J-9

RESOLVED, That Troy City Council hereby **AUTHORIZES** and **DIRECTS** the City Attorney to defend the City of Troy in the matter of *West Maple Realty Partners, LLC v. C.E. Gleeson Constructors, Inc. et. al.* (Oakland County Circuit Court, Case No. 2023-202508-CB), and **AUTHORIZES** the City Attorney to pay necessary costs and expenses and to retain any necessary expert witnesses required to adequately represent the City.

K. MEMORANDUMS AND FUTURE COUNCIL AGENDA ITEMS:

K-1 Announcement of Public Hearings: None Submitted

K-2 Memorandums (Items submitted to City Council that may require consideration at some future point in time): None Submitted

L. PUBLIC COMMENT FOR ITEMS NOT ON THE AGENDA FROM TROY RESIDENTS AND BUSINESSES:

M. CITY COUNCIL/CITY ADMINISTRATION RESPONSE/REPLY TO PUBLIC COMMENT FOR ITEMS NOT ON THE AGENDA FROM TROY RESIDENTS AND BUSINESSES:

N. COUNCIL REFERRALS:

Items Advanced to the City Manager by the Mayor and City Council Members for Placement on the Agenda

N-1 No Council Referrals Submitted

A. PAVEMENT ASSET MANAGEMENT PLAN

An attached pavement asset management plan follows.

B. BRIDGE ASSET MANAGEMENT PLAN

An attached bridge asset management plan follows.

C. CULVERT ASSET MANAGEMENT PLAN SUPPLEMENT

Culvert Primer

Culverts are structures that lie underneath roads, enabling water to flow from one side of the roadway to the other (Figure C-1 and Figure C-2). The important distinguishing factor between a culvert and a bridge is the size. Culverts are considered anything under 20 feet while bridges, according to the Federal Highway Administration, are 20 feet or more. While similar in function to storm sewers, culverts differ from storm sewers in that culverts are open on both ends, are constructed as straight-line conduits, and lack intermediate drainage structures like manholes and catch basins. Culverts are critical to the service life of a road because of the important role they play in keeping the pavement layers well drained and free from the forces of water building up on one side of the roadway.

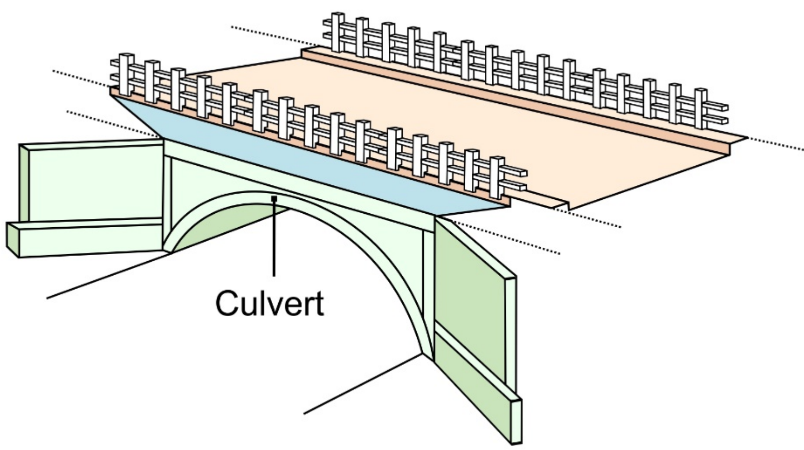

Figure C-1: Diagram of a culvert structure

Figure C-2: Examples of culverts. Culverts allow water to pass under the roadway (left), they are straight-line conduits with no intermediate drainage structures (middle), and they come in various materials (left: metal; middle and right: concrete) and shapes (left: arch; middle: round; right: box).

Culvert Types

Michigan conducted its first pilot data collection on local agency culverts in the state in 2018. Of almost 50,000 culverts inventoried as part of the state-wide pilot project, the material type used for constructing culverts ranged from (in order of predominance) corrugated steel, concrete, plastic, aluminum, and masonry/tile, to timber materials. The shapes of the culverts were (in order of predominance) circular, pipe arch, arch, rectangular, horizontal ellipse, or box. The diameter for the majority of culverts ranged from less than 12 inches to 24 inches; a portion, however, ranged from 30 inches to more than 48 inches.

Culvert Condition

Several culvert condition assessment practices exist. The FHWA has an evaluation method in its 1986 *Culvert Inspection Manual*. In conjunction with descriptions and details in the Ohio Department of Transportation's 2017 *Culvert Inspection Manual* and Wisconsin DOT's *Bridge Inspection Field Manual*, the FHWA method served as the method for evaluating Michigan culverts in the pilot. In 2018, Michigan local agencies participated in a culvert pilot data collection, gathering inventory and condition data; full detail on the condition assessment system used in the data collection can be found in Appendix G of the final report (https://www.michigan.gov/documents/tamc/TAMC_2018_Culvert_Pilot_Report_Complete_634795_7.pdf).

The Michigan culvert pilot data collection used a 1 through 10 rating system, where 10 is considered a new culvert with no deterioration or distress and 1 is considered total failure. Each of the different culvert material types requires the assessment of features unique to that material type, including structural deterioration, invert deterioration, section deformation, blockage(s) and scour. Corrugated metal pipe, concrete pipe, plastic pipe, and masonry culverts require an additional assessment of joints and seams. Slab abutment culverts require an additional assessment of the concrete abutment and the masonry abutment. Assessment of timber culverts only relied on blockage(s) and scour. The assessments come together to generate condition rating categories of good (rated as 10, 9, or 8), fair (rated as 7 or 6), poor (rated as 5 or 4), or failed (rated as 3, 2, or 1).

Culvert Treatments

The *MDOT Drainage Manual* addresses culvert design and treatments. Of most importance to the longevity of culverts is regular cleaning to prevent clogs. More extensive treatments may include re-positioning the pipe to improve its grade and lining a culvert to achieve more service life after structural deterioration has begun.

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.

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[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, 2020; 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.

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[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*.

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[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

City of Troy
2023 Pavement
Asset Management Plan

A plan describing the City of Troy's roadway assets and conditions

Prepared by:
G. Scott Finlay, P.E.
City Engineer
CityEngineer@troymi.gov

TABLE OF CONTENTS

Table of Figures ii
Table of Tables iv
Executive Summary v
Introduction 1
Pavement Primer *2*
1. Pavement Assets 11
Inventory *12*
Goals *22*
Modelled Trends *26*
Planned Projects *31*
Gap Analysis *34*
2. Financial Resources 37
City Major Network *37*
City Local Network *37*
3. Risk of Failure Analysis 38
4. Coordination with Other Entities 39
Appendix A: Paved City Major Road Planned Projects 41
Appendix B: Paved City Local Road Planned Projects 42
Appendix C: Unpaved Road Planned Projects 43
Appendix D: A Quick Check of Your Highway Network Health 44
Appendix E: Roadsoft Network-level Model Inputs and Outputs 50

TABLE OF FIGURES

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

Figure 2: Examples of reconstruction treatments—(left) reconstructing a road and (right) road prepared for full-depth repair. 6

Figure 3: Examples of structural improvement treatments—(from left) HMA overlay on an unmilled pavement, milling asphalt pavement, and pulverization of a road during a crush-and-shape project. 7

Figure 4: Examples of capital preventive maintenance treatments—(from left) crack seal, fog seal, chip seal, and slurry seal/microsurface. 8

Figure 5: Examples of capital preventive maintenance treatments, cont'd—(from left) concrete road prepared for partial-depth repair, gravel road undergoing maintenance grading, and gravel road receiving dust control application (dust control photo courtesy of Weld County, Colorado, weldgov.com). 10

Figure 6: Map showing location of Troy's paved roads (i.e., those managed by Troy) and its 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 Troy's unpaved roads in blue 12

Figure 7: Percentage of city major and city local roads for Troy. 13

Figure 8: Miles of roads managed by Troy that are part of the National Highway System and condition. 13

Figure 9: Pavement type by percentage maintained by Troy Undefined pavements have not been inventoried in Troy's asset management system to date, but will be included as data becomes available. 14

Figure 10: (A) Left: Troy 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 15

Figure 11: (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 16

Figure 12: Troy paved city major road network conditions. Bar graph colors correspond to good/fair/poor TAMC designations. 16

Figure 13: Troy paved city local network condition by PASER rating. Bar graph colors correspond to good/fair/poor TAMC designations. 17

Figure 14: 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 Troy are shown. 18

Figure 15: Historical Troy paved city major road network condition trend 19

Figure 16: Historical statewide city major road network condition trend 19

Figure 17: Historical Troy paved city local road network condition trend 20

Figure 18: Historical statewide paved city local road network condition trend 20

Figure 19: Troy's unpaved road network condition by percentage of roads with PASER numbers of 10, 9, and 8; roads with PASER numbers of 7, 6, and 5; and PASER numbers of 4, 3, 2, and 1 21
Figure 20: Map of the geographic location and PASER rating for unpaved roads. 22
Figure 21: Troy's 2023 city major road network condition by percentage of good/fair/poor 23
Figure 22: Troy 2023 paved city local road network condition by percentage of good/fair/poor 24
Figure 23: Troy's 2023 unpaved road network condition by percentage of good/fair/poor 25
Figure 24: Pavement condition forecast model in the software program Roadsoft. 28
Figure 25: Forecast good/fair/poor changes to Troy network condition from planned projects on the city major road network. 29
Figure 26: Pavement condition forecast model in the software program Roadsoft. 30
Figure 27: Forecast good/fair/poor changes to Troy network condition from planned projects on the paved city local road network. 31
Figure 28: Map showing paved city major road projects planned for FY2024-2026. 32
Figure 29: Map showing paved city local road projects planned for FY2024-2026. 33

TABLE OF TABLES

Table 1: Service Life Extension (in Years) for Pavement Types Gained by Fix Type[1] 27

Table 2: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for Troy's Road Assets—Modelled Trends: Roadsoft Annual Work Program for the Paved City Major Road Network Forecast 29

Table 3: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for Troy's Road Assets—Modelled Trends: Roadsoft Annual Work Program for the Paved City Local Road Network Forecast 30

Table 4: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for Troy's Road Assets—Pavement Condition Forecast and Gap Analysis: Roadsoft Annual Work Program for Paved City Major Road Network Forecast....35

Table 5: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for Troy's Road Assets—Pavement Condition Forecast and Gap Analysis: Roadsoft Annual Work Program for Paved City Local Road Network Forecast 36

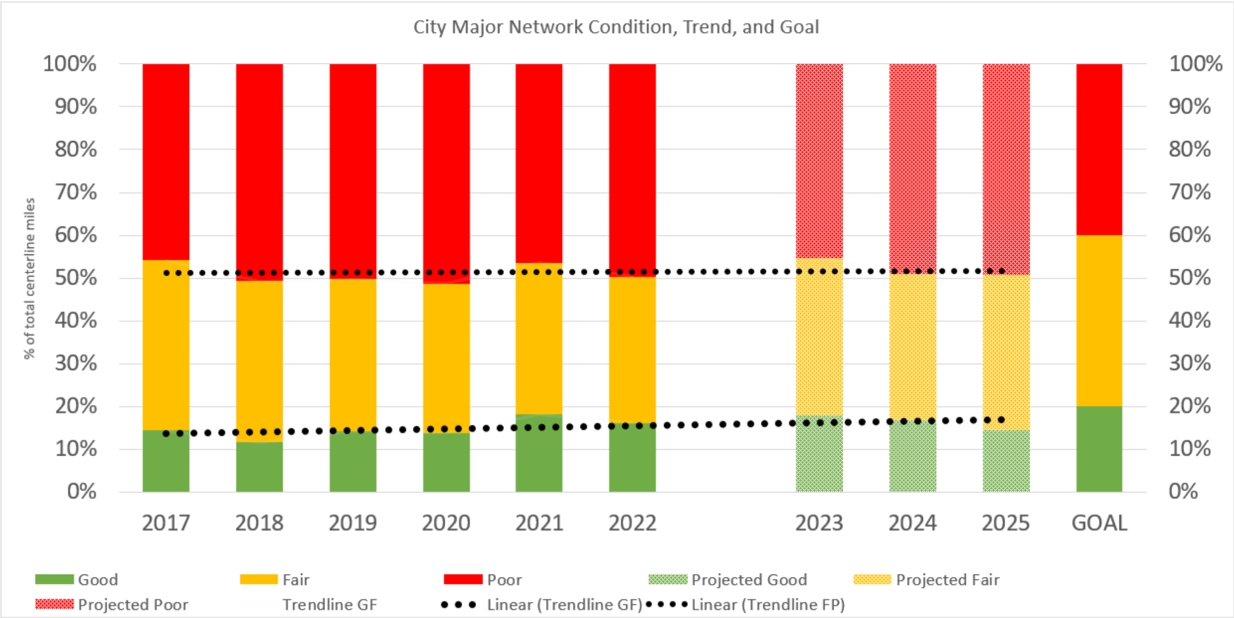
EXECUTIVE SUMMARY

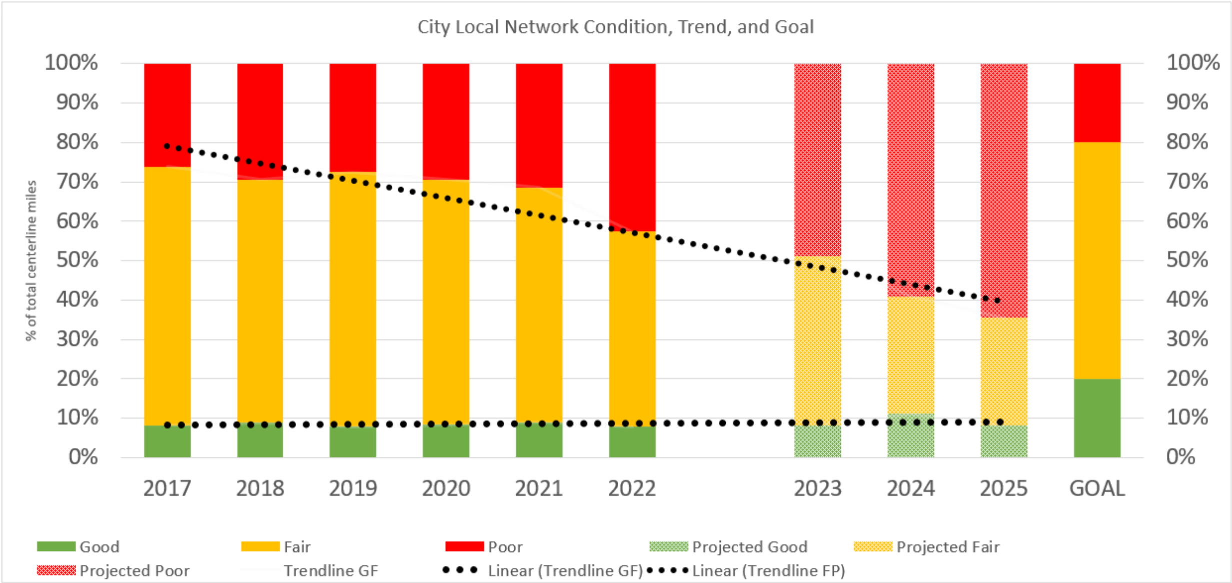
As conduits for commerce and connections to vital services, roads are among the most important assets in any community along with other assets like bridges, culverts, traffic signs, traffic signals, and utilities that support and affect roads. The City of Troy's roads, other transportation assets, and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

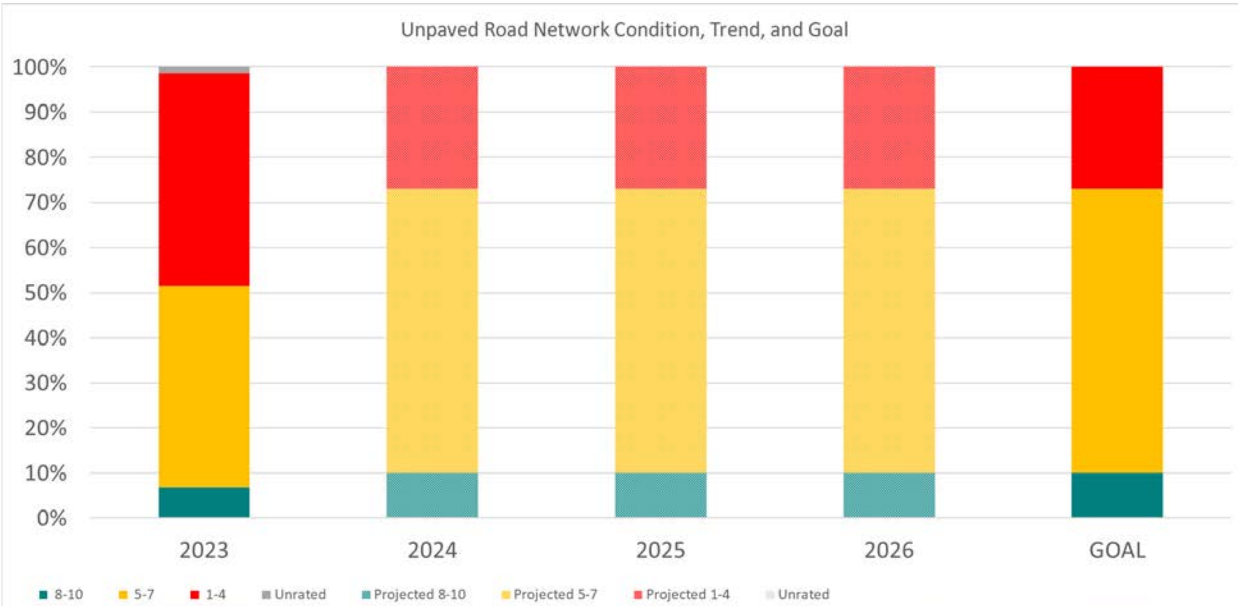
This plan overviews Troy's road assets and condition, and explains how Troy works to maintain and improve the overall condition of those assets. These explanations can help answer the following questions:

- What kinds of road assets Troy has in its jurisdiction, who owns them, and the different options for maintaining these assets.
- What tools and processes Troy uses to track and manage road assets and funds.
- What condition Troy'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 Troy's transportation assets are funded and where those funds come from.
- How funds are used and the costs incurred during the normal life cycle of Troy's road assets.
- What condition expectation Troy can assume of its road assets if funding levels stay the same.
- How changes in funding levels can affect the overall condition of all of Troy's road assets.

Troy owns and/or manages 337.68 centerline miles 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 Troy historical and current network conditions, projected trends, and goals for city major network, city local network and unpaved network can be seen in the following figures:


City Major Network Condition, Trend, and Goal
% of total centerline miles
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2017
2018
2019
2020
2021
2022
2023
2024
2025
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
% of total centerline miles
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2017
2018
2019
2020
2021
2022
2023
2024
2025
GOAL
Good
Fair
Poor
Projected Good
Projected Fair
Projected Poor
Trendline GF
Linear (Trendline GF)
Linear (Trendline FP)



An asset management plan is required by Michigan Public Act 325 of 2018, and this document represents fulfillment of some of Troy's obligations towards meeting these requirements. This asset management plan also helps demonstrate Troy's responsible use of public funds by providing elected and appointed officials as well as the general public with inventory and condition information of Troy's road assets, and provides 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. Leaders in municipal planning and transportation infrastructure; endorse this process including the Michigan Municipal League, County Road Association of Michigan, the Michigan Department of Transportation (MDOT), and the Federal Highway Administration (FHWA). The Michigan Transportation Asset Management Council (TAMC), formed by the State of Michigan, supports Troy in its use of asset management principles and processes.

Asset management, in the context of this plan, ensures that public funds are spent as effectively as possible to maximize the acceptable 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 Troy (Troy) has adopted an "asset management" business process to overcome the challenges presented by having limited financial, staffing, and other resources while meeting road users' expectations. Troy is responsible for maintaining and operating over 337.68 centerline miles of roads.

This plan outlines how Troy 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 Scott Finlay at 500 W Big Beaver, Troy, Michigan 48084 or at (248)-524-3383 and/or CityEngineer@troymi.gov. A copy of this plan can be accessed on our website at https://troymi.gov/departments/engineering/index.php. Key terms used in this plan are defined in Troy's comprehensive transportation asset management plan (also known as the "compliance plan") used for compliance with PA 325 of 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 appropriate repair in the right place.

Listed is a brief overview of the different types of pavements, how its 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 longer 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 its service life. A typical concrete pavement design life may 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 its service life. A typical HMA pavement design life may provide service for 18 years before major rehabilitation is necessary.

- **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 has 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 low traffic volume areas and competes with asphalt for ride quality when properly constructed and maintained. Sealcoat pavement can provide service for up to ten or more years before the surface layer deteriorates requiring replacement.

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 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 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. Troy uses pavement condition and age to anticipate when a specific section of pavement will be a potential candidate for preventive maintenance. Further 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 funds. 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

Troy 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. Troy 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 Troy 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 requires total reconstruction.

Roads with lower PASER scores generally require higher cost treatments to restore its quality than roads with higher PASER scores. The cost effectiveness of treatments generally decreases 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 its 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* – PASER 5 road that is considered "fair" by the TAMC. Exhibiting structural soundness but could benefit from CPM. *Third image* – PASER 6 road that is considered "fair" by the TAMC. *Bottom image* – 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.

Troy collects 100 percent of its PASER data every year on all roads, including federal-aid-eligible roads in its network by using city employees and consultant resources. The TAMC dictates and funds the required training and the format for this collection, and it shares the data regionally and statewide.

Unpaved Road Condition Rating 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. Troy uses PASER ratings for gravel roads to be consistent with our overall PASER rating process for all roads, regardless of material type.

Pavement Treatments

Selection of repair treatments for roads aims balances 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 Troy—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 2). 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 20 years and costs vary

Figure 2: Examples of reconstruction treatments—(left) reconstructing a road and (right) road prepared for full-depth repair.

drastically on the type of road that is built (i.e. 3-lane vs 5-lane vs boulevard) and typically involves federal funds. The following descriptions outline the main reconstruction treatments used by Troy.

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 2). 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 twelve years and typically costs $300,000 per lane mile, depending on the percentage of concrete pavement removed and replaced.

Ditching (for Unpaved Roads)

Water needs to drain away from any roadway to delay softening of the pavement structure, and proper drainage is critical for unpaved roads where there is no hard surface on top to stop water infiltration into the road surface and base. To improve drainage, new ditches are dug or old ones are cleaned out. Unpaved roads typically need to be re-ditched every 15 years at a cost of $18,000 per lane mile.

Gravel Overlay (for Unpaved Roads)

Unpaved roads will exhibit gravel loss over time due to traffic, wind, and rain. Gravel on an unpaved road provides a wear surface and contributes to the structure of the entire road. Unpaved roads typically need to be overlaid with four inches of new gravel every 15 years at a cost of $210,000 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 rehabilitated with a structural treatment. Examples of structural improvement treatments include HMA overlay with or without milling, and crush and shape (Figure 3). The following descriptions outline the main structural improvement treatments used by Troy.

Figure 3: Examples of structural improvement treatments—(from left) HMA overlay on an unmilled pavement, milling asphalt pavement, and pulverization of a road during a crush-and-shape project.

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 3). 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. An HMA overlay lasts approximately five to ten years and costs $600,000 per lane mile. The top layer of severely damaged pavement can be removed by the milling, a technique that helps prevent structural problems from being quickly reflected up to the new surface. Milling is also done to keep roads at the same height of curb and gutter that is not being raised or reinstalled in the project.

Crush and Shape

During a crush and shape treatment, the existing pavement and base are pulverized and then the road surface is reshaped to correct imperfections in the road's profile (Figure 3). An additional layer of gravel is often added along with a new wearing surface such as an HMA overlay or chip seal. Additional gravel and an HMA overlay give an increase in the pavements structural capacity. This treatment is usually done on rural roads with severe structural distress; Adding gravel and a wearing surface makes it more prohibitive for urban roads if the curb and gutter is not raised up. Crush and shape treatments last approximately 14 years and cost $420,000 per lane mile.

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 4). 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 Troy.

Figure 4: 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 4). Troy 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 to five years and costs $4,000 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 Troy 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 4). Fog seals are best for good to very good pavements and last approximately two years at a cost of $1,000 per lane mile.

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 4). 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 its purpose is to help preserve that strength. These treatments last approximately five to ten years and cost $40,000 per lane mile.

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 4). 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 $20,000 per lane mile, while a microsurface treatment tends to last for seven years and costs $25,000 per lane mile.

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 5). 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 $60,000 per mile.

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 5). Crust on an unpaved road is a very tightly compacted surface that sheds water with ease but takes time to be created, so destroying a crusted surface with maintenance grading requires a plan to restore the crust. Maintenance grading often needs to be performed three to five times per year and each grading costs $6,000 per mile.

Dust Control (for Unpaved Roads)

Dust control typically involves spraying chloride or other chemicals on a gravel surface to reduce dust loss, aggregate loss, and maintenance (Figure 5). This is a relatively short-term fix that helps create a crusted surface. Chlorides work by attracting moisture from the air and existing gravel. This fix is not effective if the surface is too dry or heavy rain is imminent, so timing is very important. Dust control is done two to four times per year and each application costs $1,200 per mile.

Figure 5: Examples of capital preventive maintenance treatments, cont'd—(from left) concrete road prepared for partial-depth repair, gravel road undergoing maintenance grading, and gravel road receiving dust control application (dust control photo courtesy of Weld County, Colorado, weldgov.com).

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 millions of dollars 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, [patching] 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 its geographic location in Michigan. Cities and villages are typically responsible for all public roads within its geographic boundary with the exception of the previously mentioned state trunkline roads managed by MDOT. 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.

Troy is responsible for a total of 337.68 centerline miles of public roads, as shown in Figure 6.

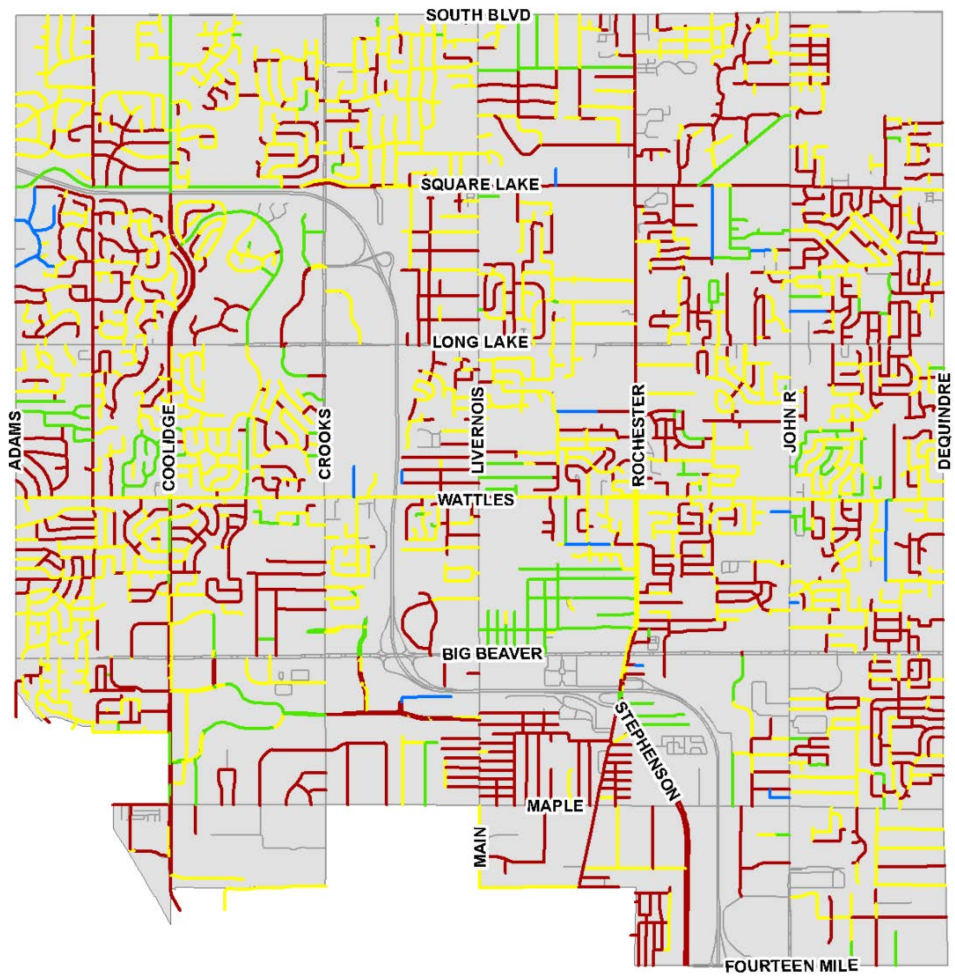


Figure 6: Map showing location of Troy's paved roads (i.e., those managed by Troy) and its current condition for paved roads with green for good (i.e., PASER 10, 9, 8), yellow for fair (i.e., PASER 7, 6, 5), and red for poor (i.e., PASER 4, 3, 2, 1), as well as the location of Troy's unpaved roads in 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 Troy as either city major or city local roads. State statute prioritizes expenditures on the city major road network.

Of the 337.68 centerline miles of public roads owned and/or managed by Troy, approximately 82% of all County Primary roads are classified as federal aid eligible, which allows them to receive federal funding for its maintenance and construction.   Only 1% of County Local roads are considered federal aid eligible, which means state and local funds must be used to manage these roads.

Figure 7 illustrates the percentage of roads owned by Troy that are classified as city major and city local roads.

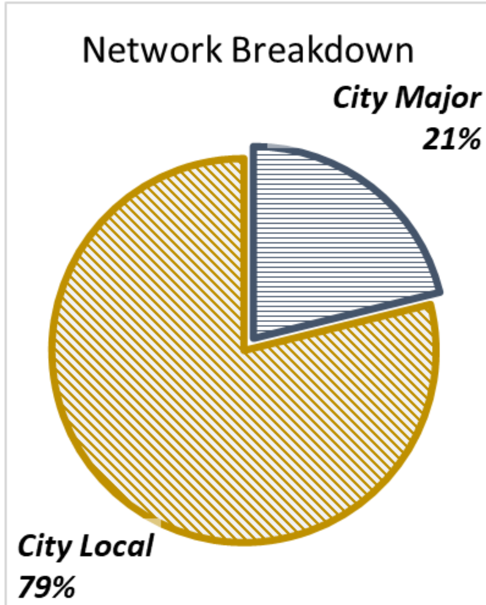


Figure 7: Percentage of city major and city local roads for Troy.

Troy manages 8.242 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 its 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, Troy manages a percentage of those roads located in its jurisdiction, as shown in Figure 8.

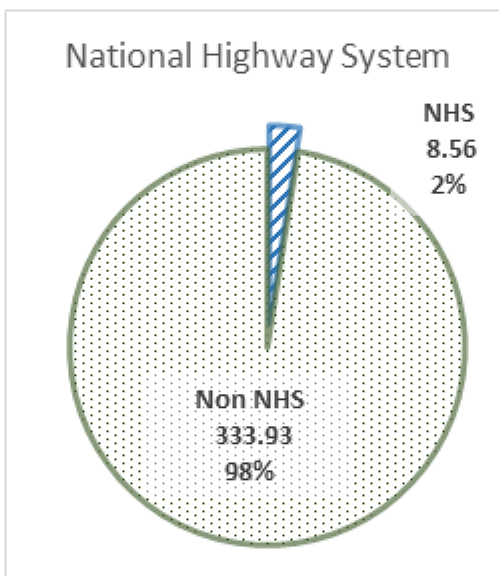


Figure 8: Miles of roads managed by Troy that are part of the National Highway System and condition.

Troy also owns and manages 3.98 miles of unpaved roads.

Types

Troy has multiple types of pavements in its jurisdiction, including: asphalt, chip seal, concrete; it also has unpaved roads (i.e., gravel). 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 9 illustrates the percentage of various pavement types that Troy has in its network.

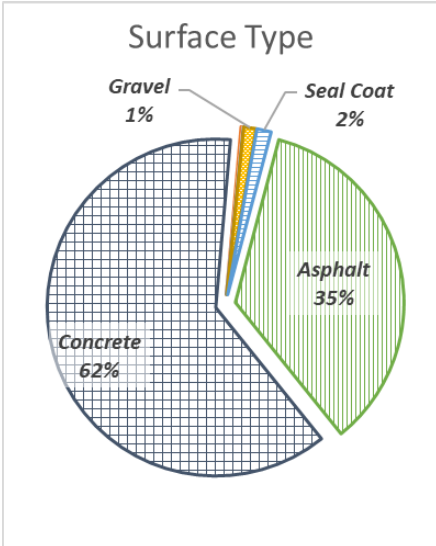


Figure 9: Pavement type by percentage maintained by Troy Undefined pavements have not been inventoried in Troy's asset management system to date, but will be included as data becomes available.

Locations

Locations and sizes of each asset can be found in Troy's Roadsoft database. For more detail, please refer to the Troy's 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. Troy 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 Troy 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

Troy 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. Troy 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.

Troy collects 100 percent of its PASER data every years on roads, including all federal-aid-eligible roads in our network using our own staff and consultant resources.

Troy's 2023 paved city major road network has 16 percent of roads in the TAMC good condition category, 34 percent in fair, and 50 percent in poor (Figure 10A). The paved city local road network has 21 percent in good, 49 percent in fair, and 43 percent in poor (Figure 10B).

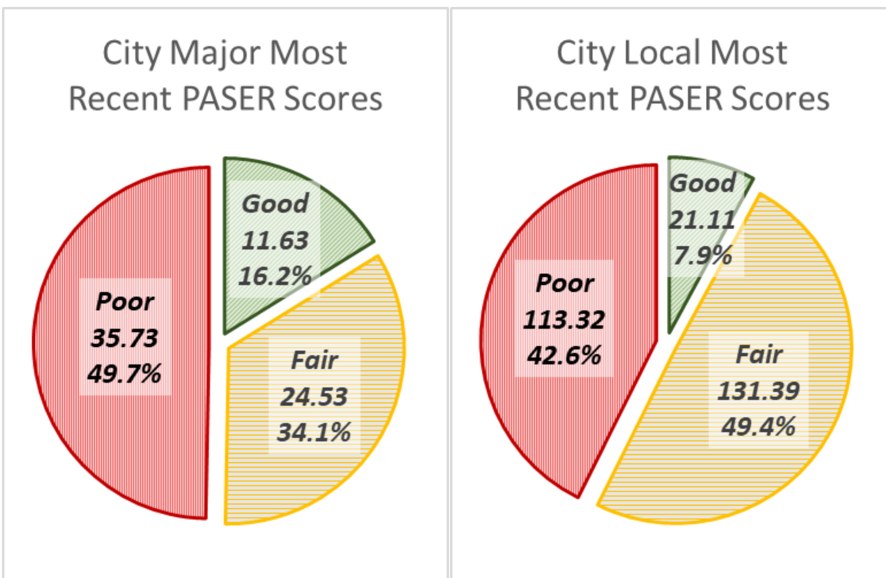


Figure 10: (A) Left: Troy paved city major road network conditions by percentage of good, fair, or poor, and (B) Right: paved city local road network conditions by percentage of good, fair, or poor

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 11A). The statewide paved city local road network has 25 percent in good, 35 percent in fair, and 45 percent in poor (Figure 11B). Comparing Figure 10A and Figure 11A shows that Troy's paved city major road network is similar to similarly-classified roads in the rest of the state, while Figure 10B and Figure 11B show that Troy'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.

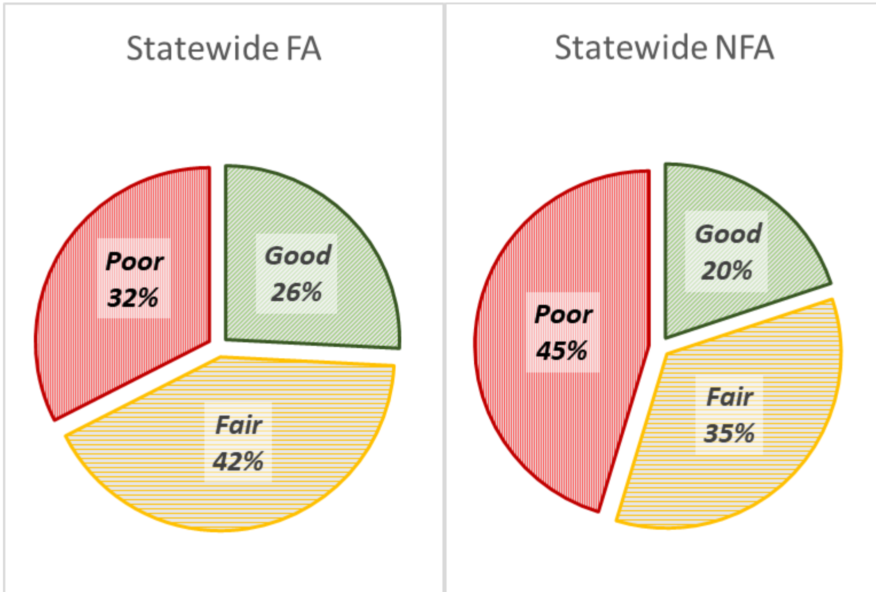


Figure 11: (A) Left: Statewide paved city major road network conditions by percentage of good, fair, or poor, and (B) Right: paved city local road network conditions by percentage of good, fair, or poor

Figure 12 and Figure 13 show the number of miles for Troy's roads with PASER scores expressed in TAMC definition categories for the paved city major road network (Figure 12) and the paved city local road network (Figure 13). Troy 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.

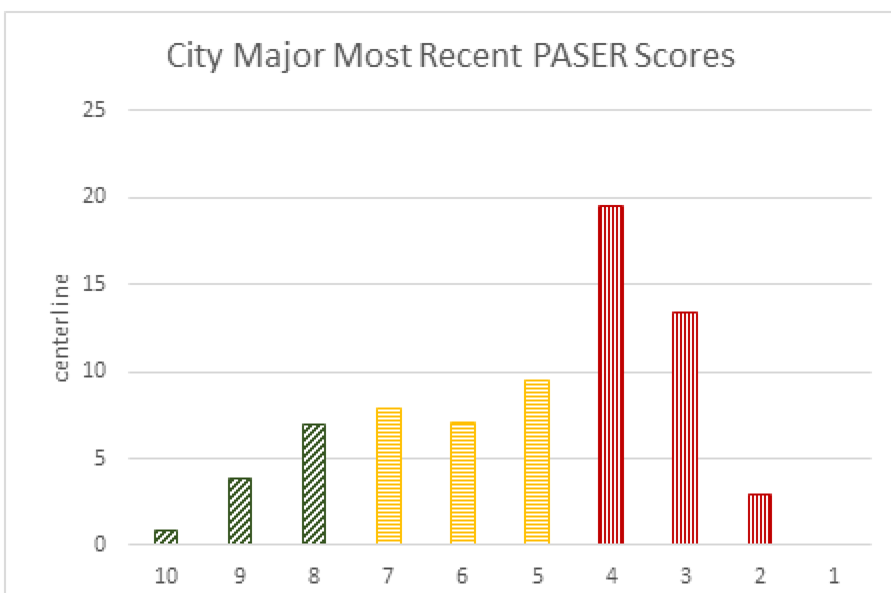


Figure 12: Troy paved city major road network conditions. Bar graph colors correspond to good/fair/poor TAMC designations.

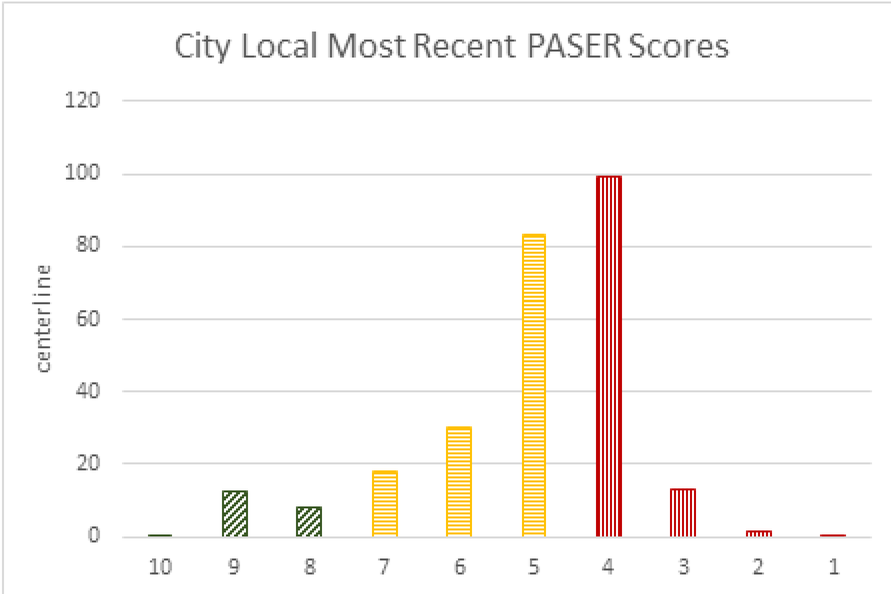


Figure 13: Troy paved city local network condition by PASER rating. Bar graph colors correspond to good/fair/poor TAMC designations.

Figure 14 provides a map illustrating the geographic location of paved roads and its respective PASER condition. An online version of the most recent PASER data is located at https://www.mcgi.state.mi.us/tamcMap/.

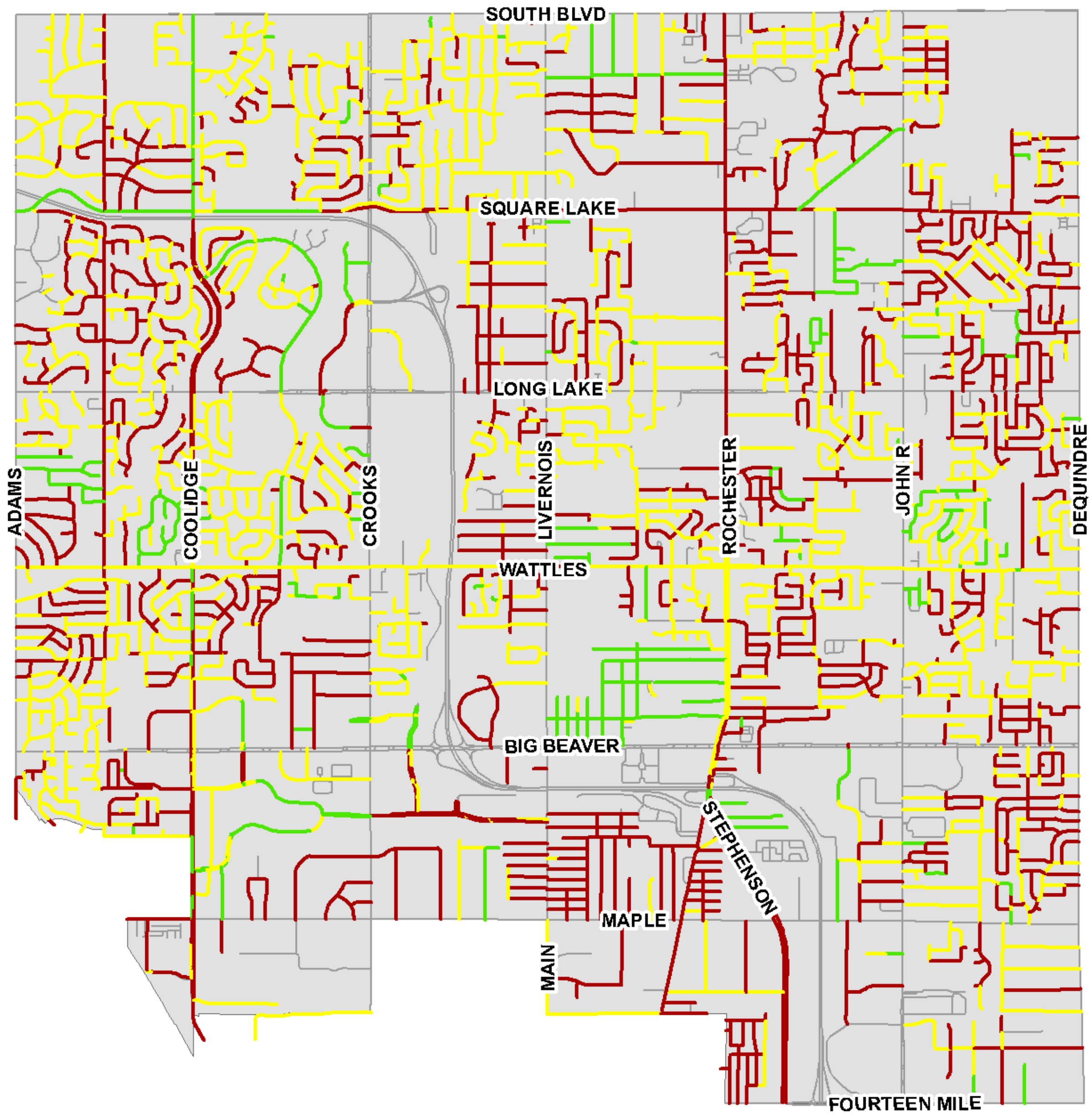


Figure 14: Map of the current paved road condition in good (PASER 10, 9, 8) shown in green, fair (PASER 7, 6, 5) shown in yellow, and poor (PASER 4, 3, 2, 1) shown in red. Only Roads owned by Troy are shown.

Historically, the overall quality of Troy's paved city major roads have been higher, as can be observed in Figure 15. Due to the I-75 reconstruction over the past few years and currently, many major roads projects have been delayed to future years to avoid conflicts with I-75 construction.

Comparing Troy's paved city major road condition trends illustrated in Figure 15 with overall statewide condition trends for similarly-classified roads, which are illustrated in Figure 26, shows similar trend locally as in the rest of the state.

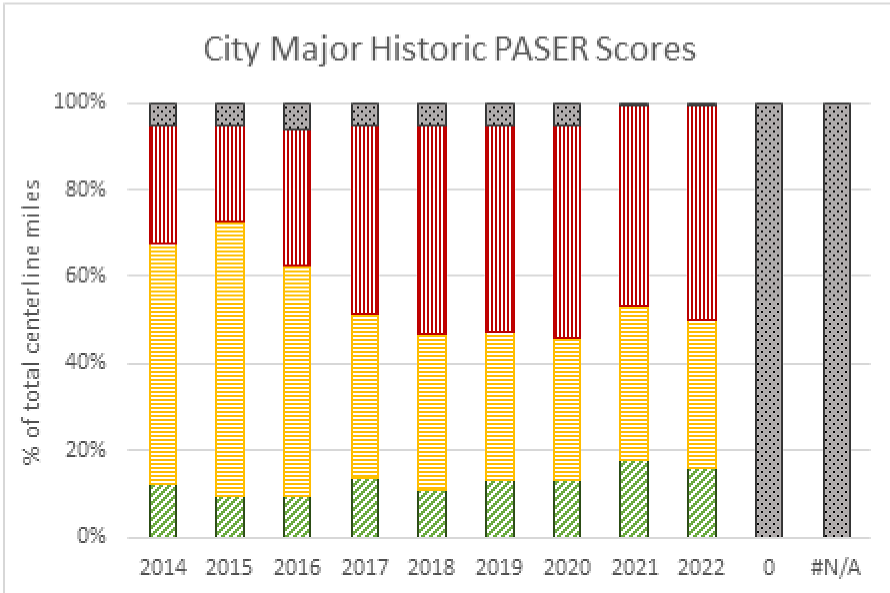


Figure 15: Historical Troy paved city major road network condition trend

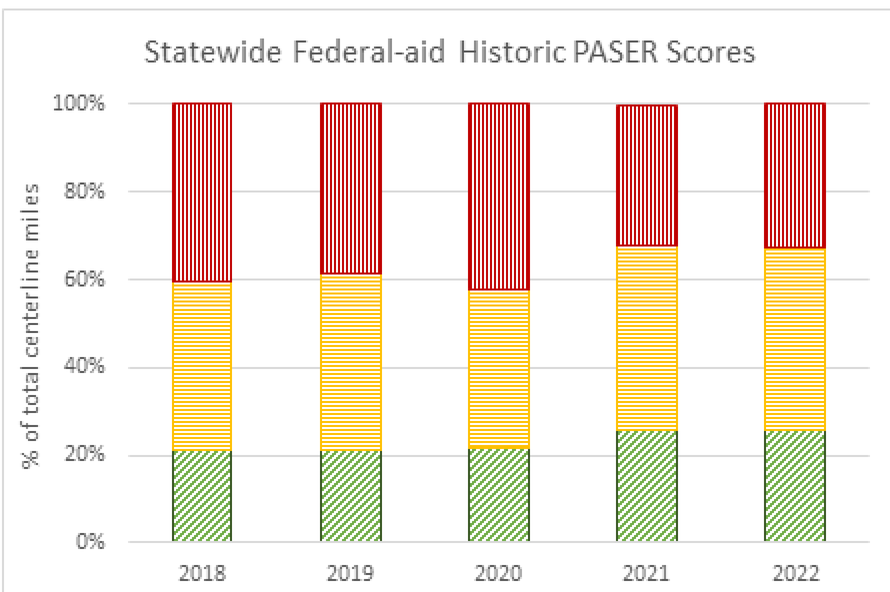


Figure 16: Historical statewide city major road network condition trend

Historically, the overall quality of Troy's paved city local roads has been higher than the paved city major road network because of the increased investment by City Council in local roads and the deferment of major road projects due to the reconstruction of I-75. Figure 17 illustrates the condition of the paved city local road network in Troy while Figure 18 illustrates these conditions statewide.

Comparing Troy's paved city local road condition trends illustrated in Figure 17 with overall statewide condition trends for all paved city local roads illustrated in Figure 18 indicates a better trend locally as compared to the rest of the state.

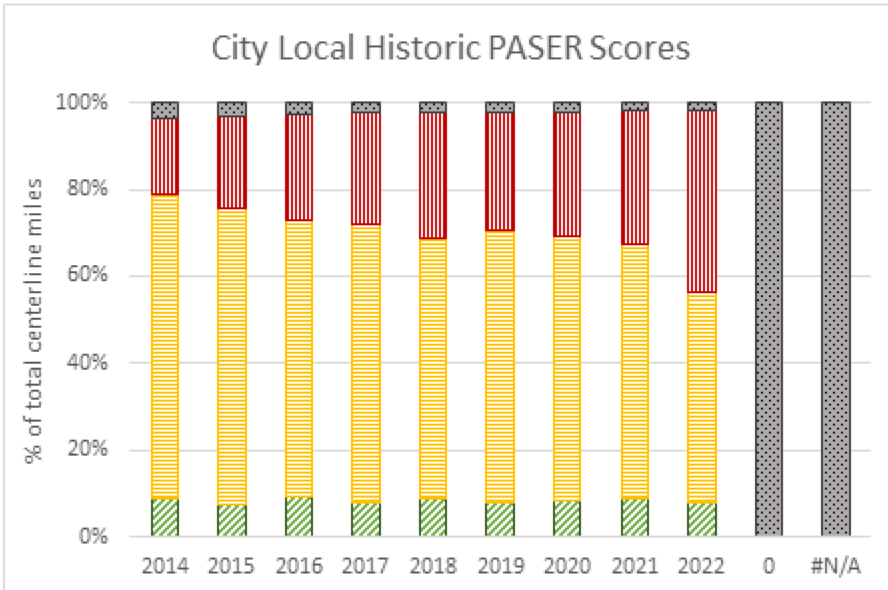


Figure 17: Historical Troy paved city local road network condition trend

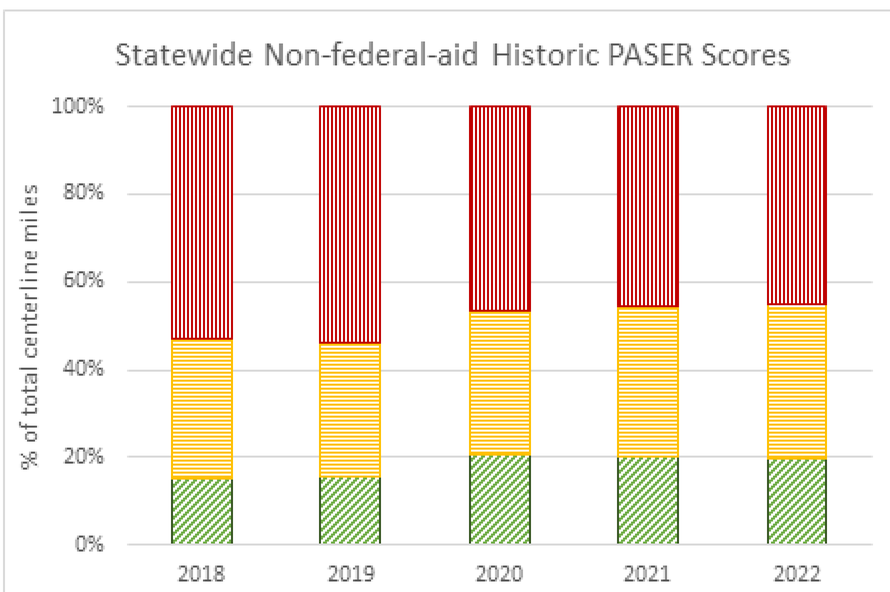


Figure 18: Historical statewide paved city local road network condition trend

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. Troy uses PASER ratings for gravel roads to be consistent with our overall PASER rating process for all roads, regardless of material type.

Figure 19 shows the percentage of unpaved roads in each PASER range.

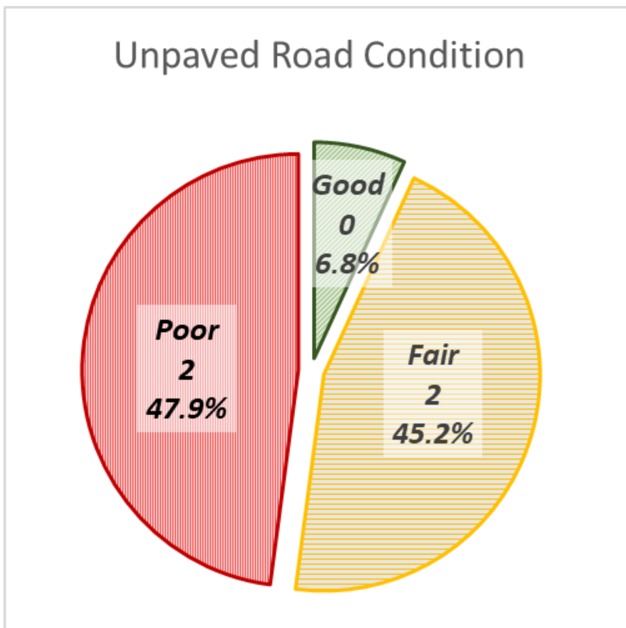


Figure 19: Troy's unpaved road network condition by percentage of roads with PASER numbers of 10, 9, and 8; roads with PASER numbers of 7, 6, and 5; and PASER numbers of 4, 3, 2, and 1

Figure 20 illustrates the geographic location of unpaved roads and the assessment of PASER rating for each unpaved road.

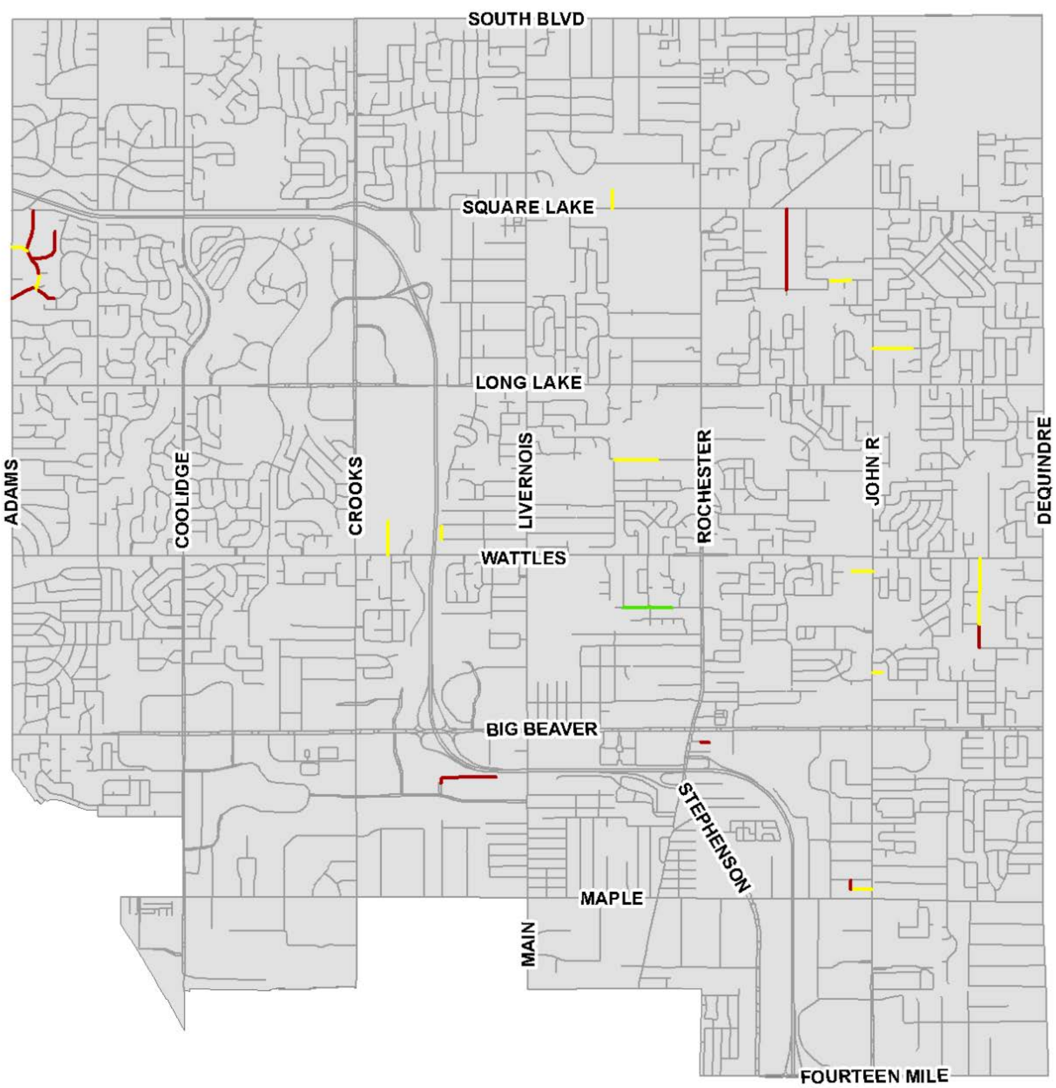


Figure 20: Map of the geographic location and PASER rating for unpaved roads.

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. Troy 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 uses 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 Troy's paved city major road network is to improve major road conditions network-wide at 2023 levels. The baseline condition for this goal is illustrated in Figure 21.

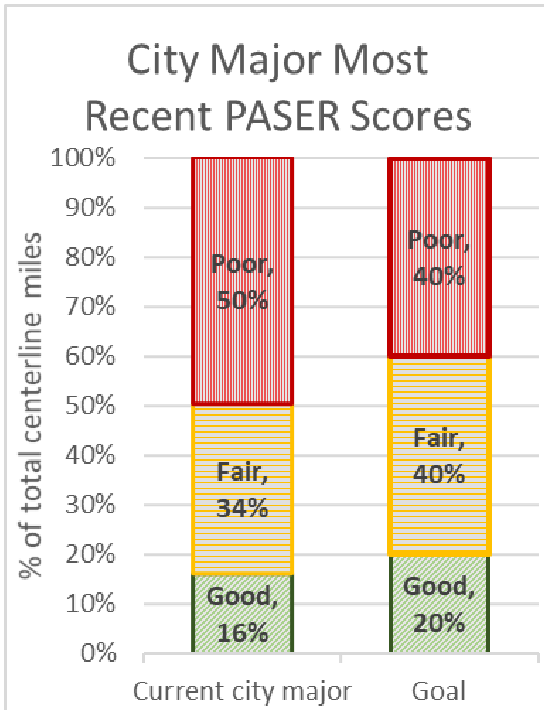


Figure 21: Troy's 2023 city major road network condition by percentage of good/fair/poor

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

1. Prevent its good and fair (PASER 10 - 5) paved city major from becoming poor (PASER 4 - 1).
2. Meet Statewide averages of 20% Good; 40% Fair; and 40% Poor at minimum.

Goals for Paved City Local Roads

The overall goal for Troy's paved city local road network is to maintain or improve road conditions network-wide at 2023 levels. The baseline condition for this goal is illustrated in Figure 22.

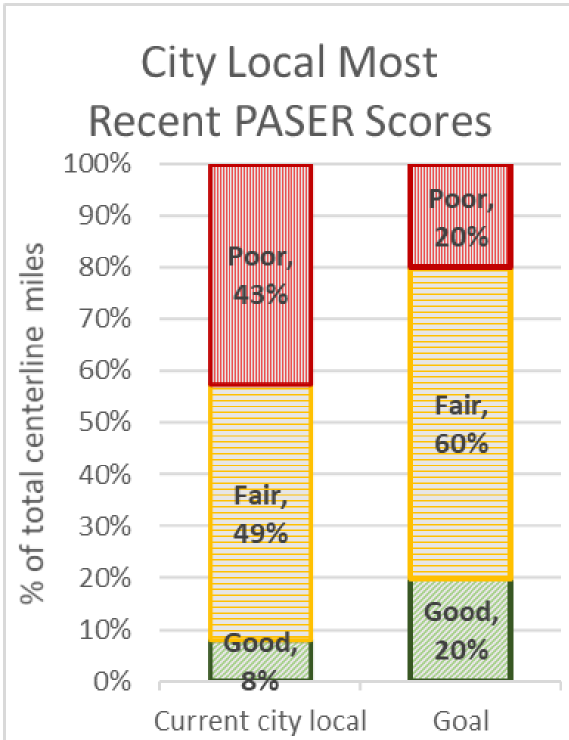


Figure 22: Troy 2023 paved city local road network condition by percentage of good/fair/poor

Troy's network-level pavement condition strategy for paved city local roads is:

1. Prevent our good and fair (PASER 10 - 5) paved city local roads from becoming poor (PASER 4 - 1).
2. Maintain or increase the investment in paved city local roads to maintain and improve our overall network condition.

Goals for Unpaved Roads

The overall goal for Troy'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.

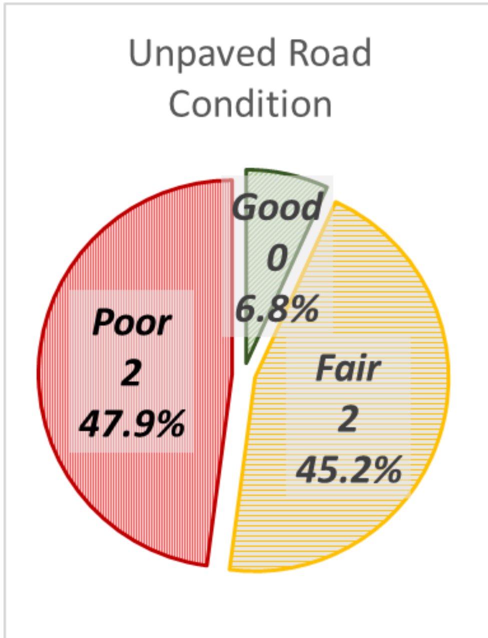


Figure 23: Troy's 2023 unpaved road network condition by percentage of good/fair/poor

Our year-round unpaved roads will be maintained at its current levels. Typically, Special Assessment District (SAD) paving projects are initiated by residents that pave gravel roads every few years which will reduce the number of miles of gravel roads maintained by the city.

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, Troy 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.

Troy 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 Troy'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.

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

Fix Type	Life Extension (in years)* Flexible	Composite	Rigid	PASER
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

Troy 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 is shown in Figure 24.

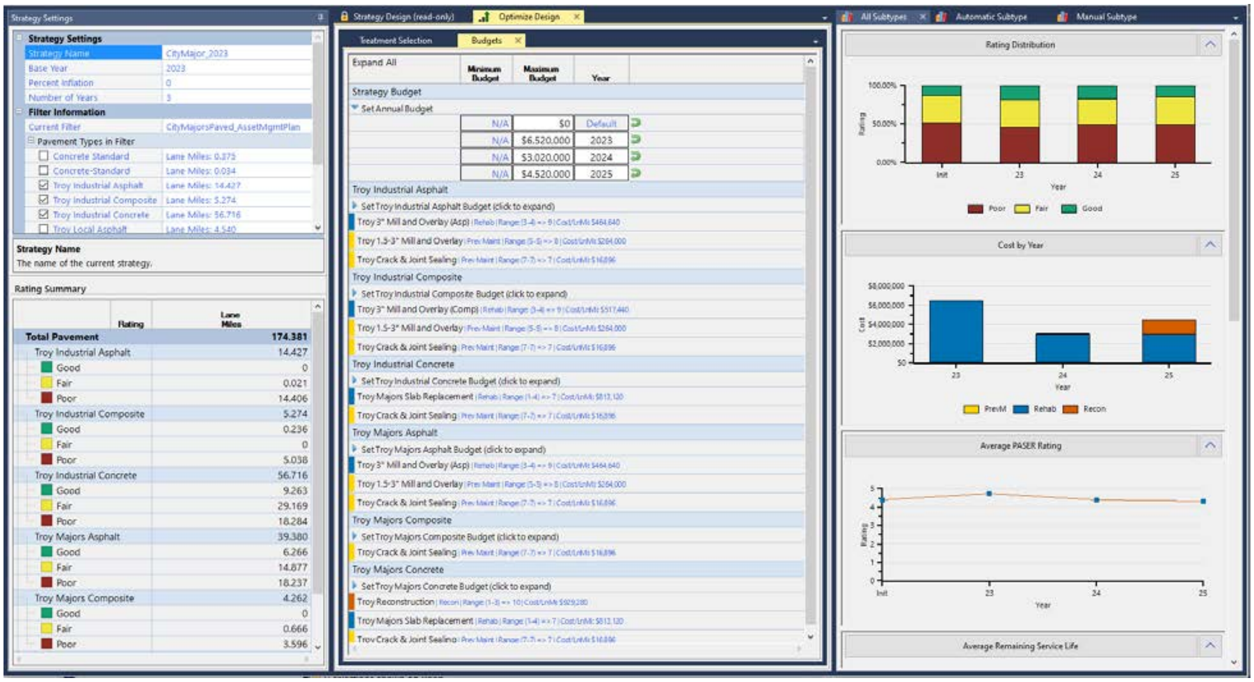


Figure 24: Pavement condition forecast model in the software program Roadsoft.

Paved City Major Roads

Table 2 illustrates the network-level model inputs for Roadsoft on the paved city major road network. Other pavement types in this network were neglected due to its small numbers relative to HMA pavements. The treatments outlined in Table 2 are the average treatment volume of planned projects scheduled to be completed in Troy. 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 Troy'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**
Joint Seal Remove & Replace	3	3	5,8
Overlay	3	15	3, 9
Reconstruction	1	20	1, 10
Slab Replacement	3	15	1-4, 7
Chip Seal (Local Road ONLY)			

Results from the Roadsoft network condition model for the city major roads are shown in Figure 25. The Roadsoft network analysis of Troy's planned projects from its currently-available budget allow Troy to reach its pavement condition goals given the projects planned for the next three years.

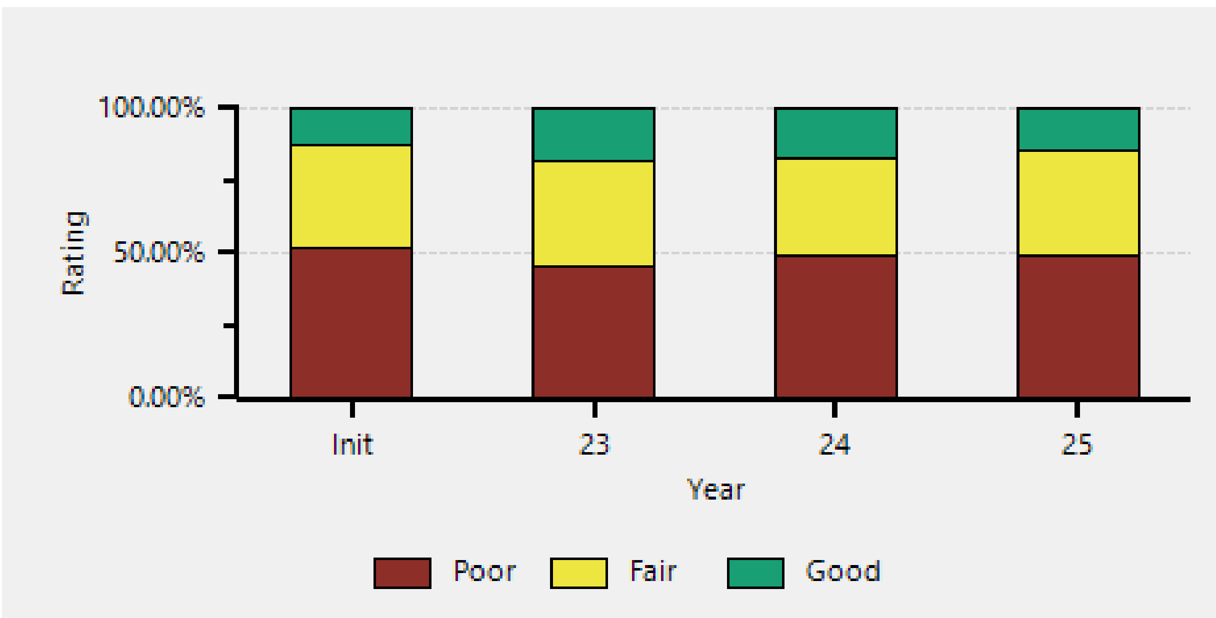


Figure 25: Forecast good/fair/poor changes to Troy network condition from planned projects on the city major road network.

Paved City Local Road

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

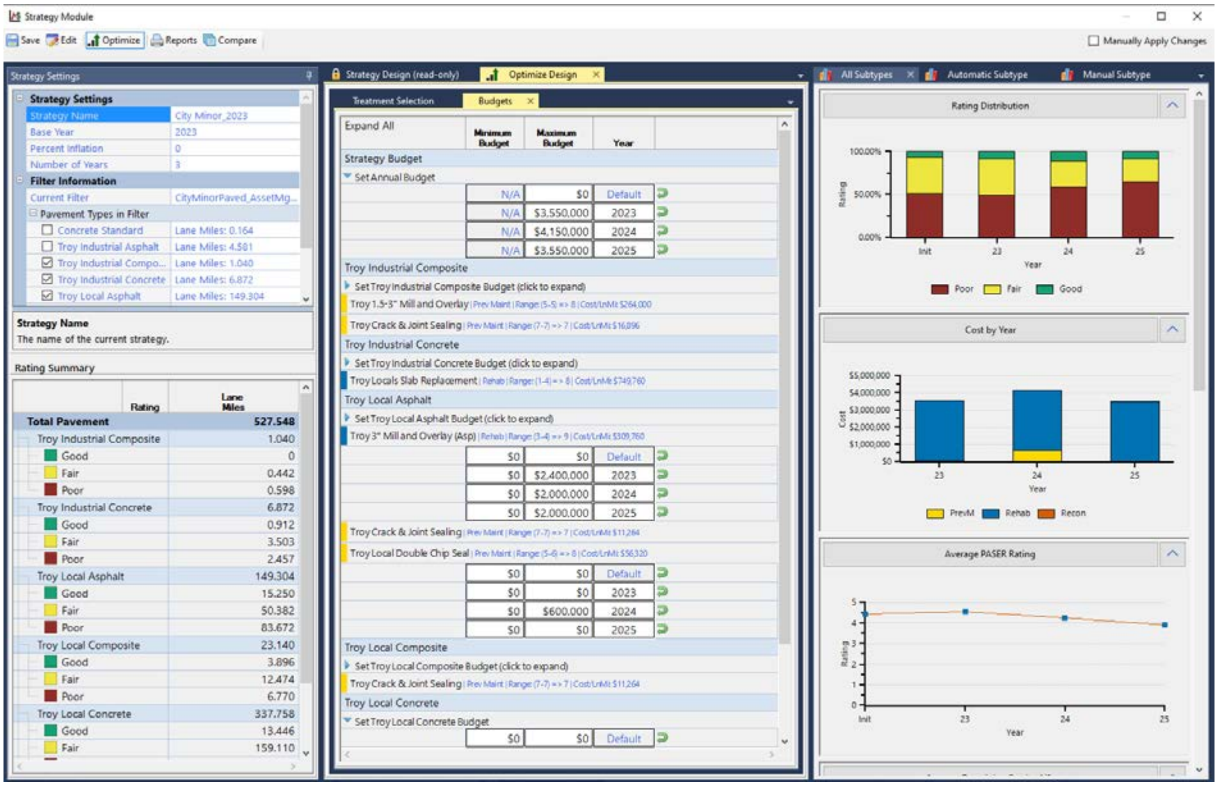


Figure 26: Pavement condition forecast model in the software program Roadsoft.

Table 3 illustrates the network-level model inputs for Roadsoft on the paved city local road network. Other pavement types in this network were neglected due to its small numbers relative to HMA pavements. The treatments outlined in Table 3 are the average treatment volume of planned projects scheduled to be completed in Troy. 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 Troy'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
Joint Seal Remove & Replace	4	3	7–7
Overlay	7	15	3, 4-9
Reconstruction	0	20	1, 2, 3-10
Slab Replacement	3	20	1-4,7
Chip Seal	3	5	5–6,8

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

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

Planned Projects

Troy 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 Troy to alter initial plans. Project planning information is used to predict the future condition of the road networks that Troy maintains. The *1. Pavement Assets*: *Modelled Trends* section of this plan provides a detailed analysis of the impact of the proposed projects on its respective road networks.

For budget year 2024-2026, Troy plans to do the following projects:

Paved City Major Projects

Troy 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. The total cost of these projects is approximately $14,060,000.00.

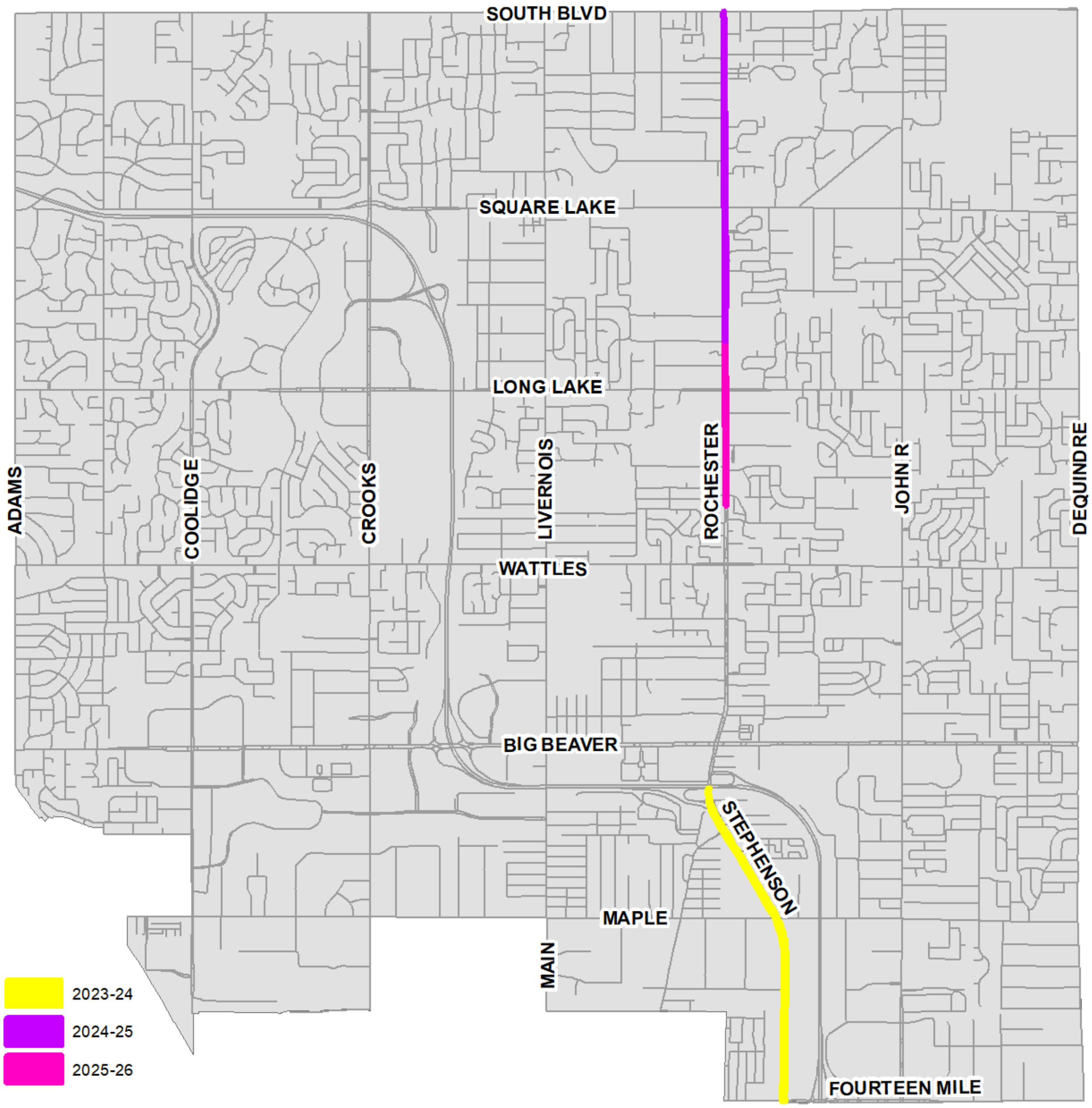


Figure 28: Map showing paved city major road projects planned for FY2024-2026.

Paved City Local Projects

Troy 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 29. The total cost of these projects is approximately $11,250,000.00.

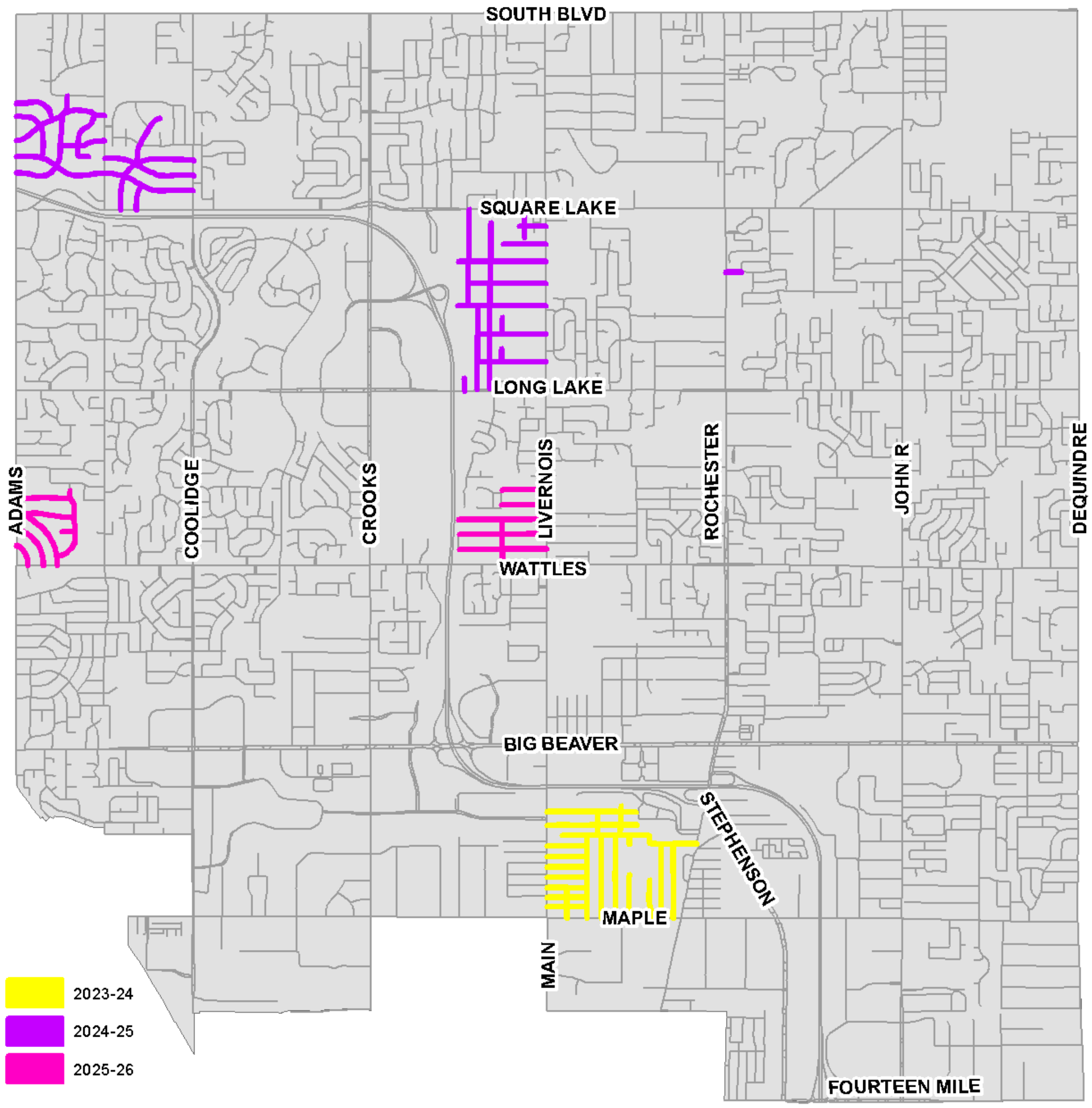


Figure 29: Map showing paved city local road projects planned for FY2024-2026.

Unpaved Road Projects

There are approximately 4 miles of unpaved roads in Troy. Unpaved roads are paved under a Special Assessment District (SAD) initiated by residents in the project area.

The process involves a resident request; mail poll to gauge general interest in paving; if 50% or more of the affected area have interest an informational meeting is set; project information, including a cost estimate and individual amortization schedules, is discussed at the meeting; residents then must circulate a petition that is to be signed by property owners; petitions are filed with the City Clerk; signatures are verified by the City Assessor; if 50% or more of the affected property owners are in favor of a SAD for paving, Resolutions # 1, 2, and 3 (Cost estimates, Informational Meeting and Petition Analysis) are prepared for City Council approval; if Resolutions # 1, 2 and 3 are passed, the City Assessor schedules a public hearing before City Council; Resolution #4 approves the project; and then project design, contract preparation and bidding may proceed.

Assuming bids come in within 5% of the cost estimate then a bid award is sent to City Council for approval. After City Council approval the paving project may proceed.

Gap Analysis

The current funding levels that Troy receives are not sufficient to meet the goals for the paved city major road network, the paved city local road network, and the unpaved 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 shortfall given the current budget. However, Troy 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

Troy 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 Troy'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
Joint Seal Remove & Replace	3	3	7–7
Overlay	3	15	3, 4-9
Reconstruction	1	20	1, 2, 3-10
Slab Replacement	3	15	1-4,7
Chip Seal			

Treatment	Annual Miles of Treatment	Years of Life	Trigger-Reset
Joint Seal Remove & Replace	6	3	7–7
Overlay	6	15	3, 4-9
Reconstruction	3	20	1, 2, 3-10
Slab Replacement	9	15	1-4,7
Chip Seal			

Table 5: Roadsoft Modelled Trends, Planned Projects, and Gap Analysis for Troy'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
Joint Seal Remove & Replace	4	3	7–7
Overlay	7	15	3, 4-9
Reconstruction		20	1, 2, 3-10
Slab Replacement	3	20	1-4,7
Chip Seal	3	5	5–6,8

Additional Work Necessary to Overcome Deficit

Treatment	Annual Miles of Treatment	Years of Life	Trigger-Reset
Joint Seal Remove & Replace	8	3	7–7
Overlay	14	15	3, 4-9
Reconstruction		20	1, 2, 3-10
Slab Replacement	9	20	1-4,7
Chip Seal		5	5–6,8

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. Troy 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 on our website at https://troymi.gov/departments/engineering/index.php or by request submitted to our agency contact (listed in this plan).

Troy has a total budget for pavement asset management of $15,626,600.

City Major Network

Troy has historically spent $9,569,868 annually on pavement-related projects. Over the next three years, Troy plans to spend approximately $8,600,000 annually 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), and federal/state programs.

City Local Network

Troy has historically spent $6,056,751 annually on pavement-related projects. Over the next three years, Troy plans to spend $7,600,329 on city local-network projects consisting of, but not limited to, reconstruction, overlay, culvert replacement, and preventive maintenance.

3. RISK OF FAILURE ANALYSIS

Transportation infrastructure is designed to be resilient. The system of interconnecting roads and bridges maintained by Troy provides road users with multiple alternate options in the event of an unplanned disruption of one part of the system. Issues, including those that meet the following types of situations below are mitigated by the grid major road network and interconnectivity of our local road network:

- **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.

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. Troy communicates with both public and private infrastructure owners to coordinate work in the following ways:

COORDINATED PLANNING

Troy maintains drinking water, sanitary and storm sewer assets in addition to transportation assets. Troy follows an asset management process for all of its assets by coordinating the upgrade, maintenance, and operation of all major assets.

Planned projects for subsurface infrastructure that Troy owns are listed in the following asset management plans: drinking water distribution system asset management plan, wastewater collection system asset management plan, storm sewer system asset management plan. These three sub-surface utility plans are coordinated with the transportation infrastructure plans to maximize value and minimize service disruptions and cost to the public.

Troy 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.
- 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.

SUMMIT

Troy meets with multiple agencies, including MDOT, SEMCOG and neighboring communities to share project related information in an effort to coordinate traffic and minimize inconvenience to the motoring public.

Meetings with private utility companies are becoming more common but work remains on establishing meaningful meetings with all of the major utility companies on an annual basis.

APPENDIX A: PAVED CITY MAJOR ROAD PLANNED PROJECTS

3 Year CIP - Major Roads

Map Number	Project Name	Total Project Cost	Total City Cost	Proposed 2024	2025	2026	Comments
MR-5	Rochester, Barclay to Trinway	34,134,000	9,207,000	7,600,000	2,673,000	1,500,000	Widen & Reconstruct – 2024 – Federal Funds
MR-6	Rochester, Long Lake to South Blvd	524,000	80,000	-	80,000	-	CPR – 2024 – Federal Funds
MR-18	Livernois at Square Lake Traffic Signal	300,000	150,000	150,000	-	-	TS Modernization
MR-19	Rochester at Square Lake Traffic Signal	300,000	300,000	300,000	-	-	TS Modernization
MR-20	Wattles at Northfield Parkway Traffic Signal	250,000	250,000	250,000	-	-	TS Modernization
MR-23	Rochester, Elmwood to Maple	750,000	333,000	-	-	-	Mill & Overlay
MR-24	Lakeview Mid-Block Pedestrian Crossing	150,000	150,000	150,000	-	-	By DPW
MR-30	Oakland Co. Local Road Imp. Program	2,520,000	1,260,000	420,000	420,000	420,000	OCLRP - $210k
MR-36	Stephenson, 14 Mile to Maple	2,000,000	2,000,000	2,000,000	-	-	Mill & Overlay
MR-37	Stephenson, Maple to I75	2,000,000	2,000,000	2,000,000	-	-	Mill & Overlay
MR-38	Coolidge, Maple to Golfview	1,000,000	1,000,000	-	-	-	Mill & Overlay
MR-45	DPW Equipment	450,000	450,000	100,000	70,000	70,000	By DPW
MR-46	Tri-Party	3,600,000	1,200,000	350,000	250,000	-	1/3 - City/County/RCOC
MR-49	Industrial Road Maintenance	13,000,000	13,000,000	1,500,000	2,000,000	2,000,000	Various Locations
MR-50	Slab Replacement - Major Roads	5,5000,000	5,5000,000	500,000	1,500,000	1,500,000	Various Locations
TOTAL:				15,320,000	6,993,000	5,490,000	
Revenue:				11,440,000	4,340,000	2,740,000	

APPENDIX B: PAVED CITY LOCAL ROAD PLANNED PROJECTS

3 Year CIP - Local Roads							
Map Number	Project Name	Total Project Cost	Total City Cost	Proposed 2024	Proposed 2025	Proposed 2026	Comments
LR-1	Concrete Slab Replacement	1,500,000	1,500,000	-	-	-	By DPW
LR-2	Concrete Slab Replacement	1,500,000	1,500,000	-	-	-	By DPW
LR-3	Concrete Slab Replacement	1,300,000	1,300,000	-	-	-	By DPW
LR-4	Concrete Slab Replacement	1,100,000	1,100,000	1,100,000	-	-	By DPW
LR-5	Concrete Slab Replacement	1,500,000	1,500,000	-	1,500,000		By DPW
LR-6	Concrete Slab Replacement	1,500,000	1,500,000	-	-	1,500,000	By DPW
LR-8	Asphalt Pavement Overlay - Sec. 3	2,000,000	2,000,000	-	-	-	By Engineering
LR-9	Asphalt Pavement Overlay - Sec. 20	2,000,000	2,000,000	-	-	-	By Engineering
LR-10	Asphalt Pavement Overlay - Sec. 35	2,200,000	2,200,000	-	-	-	By Engineering
LR-11	Asphalt Pavement Overlay - Sec. 27	2,400,000	2,400,000	2,400,000	-	-	By Engineering
LR-12	Asphalt Pavement Overlay - Sec. 9	2,000,000	2,000,000	-	2,000,000	-	By Engineering
LR-13	Asphalt Pavement Overlay - Sec. 16 &18	2,000,000	2,000,000	-	-	2,000,000	By Engineering
LR-14	Charnwood Hills Chip Seal - 1 &2	600,000	600,000	-	600,000	-	By Engineering
LR-15	Player at Rochester	560,000	560,000	560,000	-	-	By Engineering
TOTALS:		22,160,000	22,160,000	4,060,000	4,100,000	3,500,000	

APPENDIX C: UNPAVED ROAD PLANNED PROJECTS

There are no planned projects for unpaved roads as they fall under a Special Assessment District (SAD) process initiated by residents. Routine maintenance is planned annually and as-needed for unpaved roads.

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.

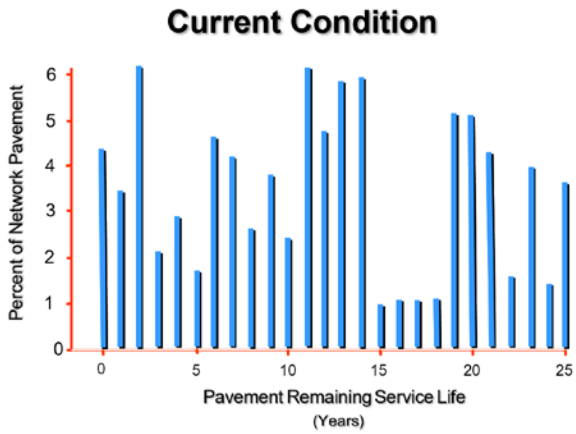


Figure 1 – Current Condition

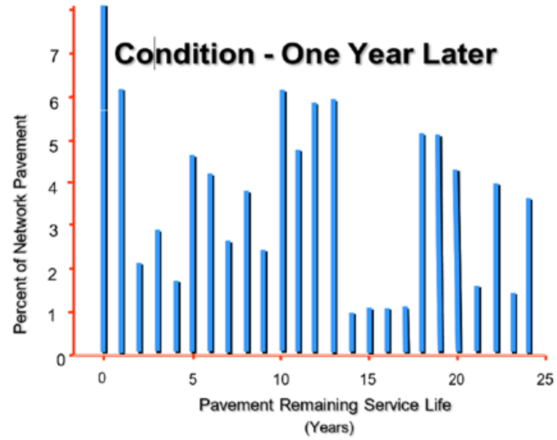


Figure 2 – Condition 1-Year Later

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 ($\leq$ 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

CONCRETE TREATMENTS										
Treatment Name	Type	Min Trigger	Max Trigger	Reset	New Surface	Surface	Shoulder	Cost	TAMC Class	TAMC Life Expectancy
Troy Crack & Joint Sealing	PM (CPM)	7	7	7	No	1.6	0	16896	LCPM	3
Troy Asphalt Overlay	RH (SI)	2	4	9	Yes	18	0	190080	REHAB	0
Troy Locals Slab Replacement	RH (SI)	1	4	8	No	71	0	749760	REHAB	20
Troy Industrials Slab Replacement	RH (SI)	1	4	7	No	75	0	792000	REHAB	15
Troy Majors Slab Replacement	RH (SI)	1	4	7	No	77	0	813120	REHAB	15
Troy Reconstruction	RC (SI)	1	3	10	Yes	88	0	929280	RECON	0

ASPHALT TREATMENTS										
Treatment Name	Type	Min Trigger	Max Trigger	Reset	New Surface	Surface	Shoulder	Cost	TAMC Class	TAMC Life Expectancy
Troy Crack & Joint Sealing	PM (CPM)	7	7	7	No	1.6	0	16896	LCPM	3
Troy Local Double Chip Seal	PM (CPM)	5	6	8	No	8	0	84480	HCPM	5
Troy 1.5-3 Mill and Overlay	PM (CPM)	5	5	8	No	25	0	264000	HCPM	15
Troy 1.5 Mill and Overlay (Asp)	PM (CPM)	5	5	8	No	29	0	306240	HCPM	15
Troy 1.5 Mill and Overlay (Comp)	PM (CPM)	5	5	8	No	37	0	390720	HCPM	15
Troy 3 Mill and Overlay (Asp)	RH (SI)	3	4	9	Yes	44	0	464640	REHAB	15
Troy 3 Mill and Overlay (Comp)	RH (SI)	3	4	9	Yes	49	0	517440	REHAB	15
Troy Pulverize, Reshape & Overlay (Asp)	RH (SI)	1	3	9	Yes	42	0	443520	RECON	15

City of Troy
2023 Bridge
Asset Management Plan

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

Prepared by:
G. Scott Finlay, PE
City Engineer
CityEngineer@troymi.gov

CONTENTS

Table of Figures ii
Table of Tables iii
Executive Summary iv
Introduction 1
Bridge Primer 2
1. Bridge Assets 8
Inventory 9
Goals 11
Prioritization, Programmed/Funded Projects, and Planned Projects 12
Gap Analysis 18
2. Financial Resources 19
Anticipated Revenues 19
Anticipated Expenses 19
3. Risk Management 20
Appendix 1 22
City of Troy 2023 Bridge Inspection Report Summary of Additional Inspection Recommendations 22
Appendix 2 23
City of Troy 2023 Bridge Inspection Report Executive Summary 23
Appendix 3 24
Appendix 4 25
Appendix 5 26

TABLE OF FIGURES

Figure 1: Girder bridge 2

Figure 2: Slab bridge 2

Figure 3: Truss bridge 2

Figure 4: Three-sided box bridge 2

Figure 5: Examples of common bridge construction materials used in Michigan 3

Figure 6: Diagram of basic elements of a bridge 4

Figure 7: Map illustrating locations of Troy's bridge assets 10

Figure 8: Progress tracking graph indicating Troy's historic and current bridge conditions, projected trends, and goals. 12

TABLE OF TABLES

Table 1: Summary of the NBI Rating Scale 3
Table 2: Bridge Assets by Type: Inventory, Size, and Condition...11
Table 3: Summary of Preservation Criteria 13

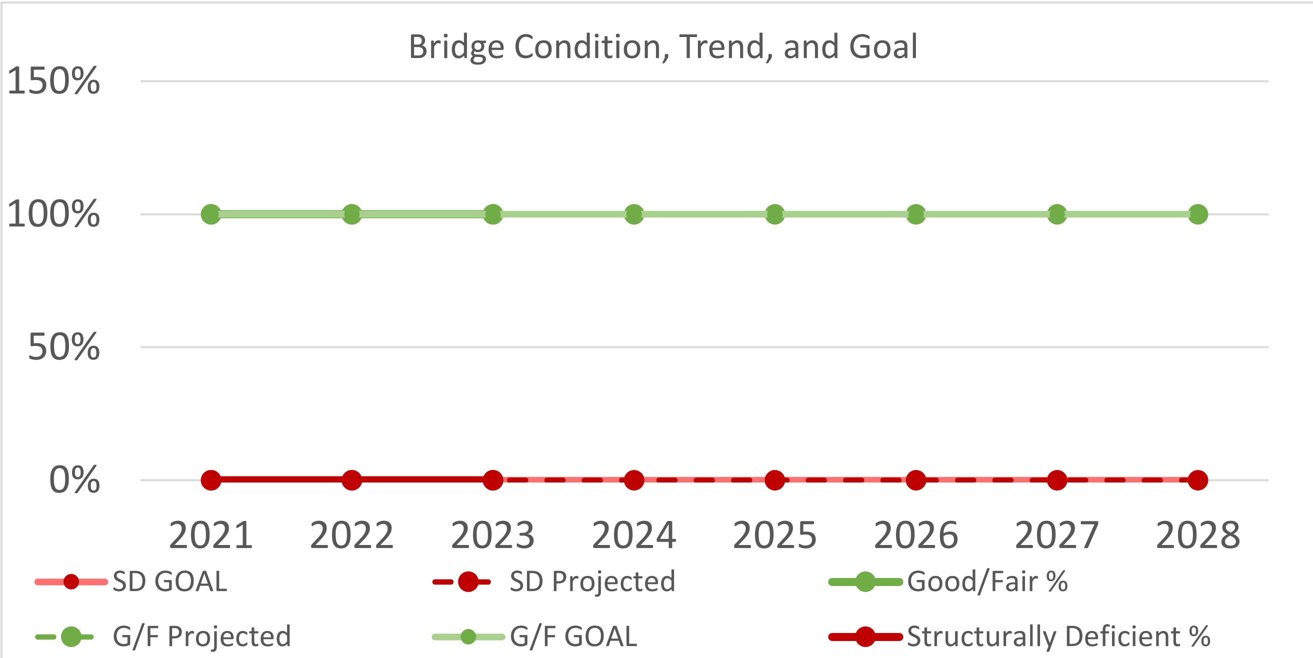
EXECUTIVE SUMMARY

As conduits for commerce and connections to vital services, bridges are among the most important assets in any community along with other assets like roads, culverts, traffic signs, traffic signals, and utilities that support and affect the road network. The City of Troy's (Troy) bridges, other road-related assets, and support systems are some of the most valuable and extensive public assets, all of which are paid for with taxes collected from ordinary citizens and businesses. The cost of building and maintaining bridges, 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 the road and bridge network in an efficient and effective manner. This asset management plan is intended to report on how Troy is meeting its obligations to maintain the bridges for which it is responsible.

This plan overviews Troy's bridge assets and conditions and explains how City of Troy works to maintain and improve the overall condition of those assets. These explanations can help answer:

- What kinds of bridge assets Troy has in its jurisdiction and the different options for maintaining these assets.
- What tools and processes Troy uses to track and manage bridge assets and funds.
- What condition Troy's bridge assets are in compared to statewide averages.
- Why some bridge assets are in better condition than others and the path to maintaining and improving bridge asset conditions through proper planning and maintenance.
- How agency bridge assets are funded and where those funds come from.
- How funds are used and the costs incurred during Troy's bridge assets' normal life cycle.
- What condition Troy can expect of its bridge 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 Troy's bridge assets.

Troy owns and/or manages 12 bridges. A summary of its historical and current bridge asset conditions, projected trends, and goals 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 Troy's obligations towards meeting these requirements. This asset management plan also helps demonstrate Troy's responsible use of public funds by providing elected and appointed officials as well as the general public with inventory and condition information of Troy's bridge assets, and gives taxpayers the information they need to make informed decisions about investing in 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 Troy 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 bridges in City of Troy's road network. Asset management also provides a transparent decision-making process that allows the public to understand the technical and financial challenges of managing infrastructure with a limited budget.

The City of Troy (Troy) has adopted an "asset management" business process to overcome the challenges presented by having limited financial, staffing, and other resources while needing to meet safety standards and bridge users' expectations. Troy is responsible for maintaining and operating 12 bridges.

This 2023 plan outlines how Troy determines its strategy to maintain and upgrade bridge asset condition given agency goals, priorities of its bridge users, and resources provided. An updated plan is to be released approximately every three years to reflect changes in bridge conditions, finances, and priorities.

Questions regarding the use or content of this plan should be directed to G. Scott Finlay at 500 W Big Beaver, Troy, Michigan 48084 or at (248)-524-3383 and/or CityEngineer@troymi.gov . A copy of this plan can be accessed on our website at https://troymi.gov/departments/engineering/index.php.

Key terms used in this plan are defined in Troy'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 an asset class is a crucial starting point to understanding the rationale behind an asset management approach. The following primer provides an introduction to bridges.

Bridge Primer

Bridge Types

Bridges are structures that span 20 feet or more. These bridges can extend across one or multiple spans.

If culverts are placed side by side to form a span of 20 feet or more (for example, three 6-foot culverts with one-foot between each culvert), then this culvert system would be defined as a bridge. (Note: The Compliance Plan Appendix C contains a primer on culverts not defined as bridges.)

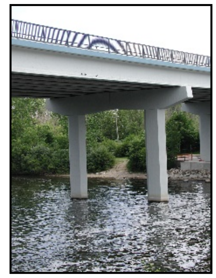


Figure 1: Girder bridge

Bridge types are classified based on two features: design and material.

The most common bridge design is the **girder system** (Figure 1). With this design, the bridge deck transfers vehicle loads to girders (or beams) that, in turn, transfer the load to the piers or abutments (see Figure 6).

A similar design that lacks girders (or beams) is a **slab bridge** (Figure 2, and see Figure 6). A slab bridge transfers the vehicle load directly to the abutments and, if necessary, piers.

Figure 2: Slab bridge

Truss bridges were once quite common and consist of a support structure that is created when structural members are connected at joints to form interconnected triangles (Figure 4). Structural members may consist of steel tubes or angles connected at joints with gusset plates.

Another common bridge design in Michigan is the three-sided pre-cast box or arch bridge (Figure 4).

Michigan is also home to several unique bridge designs.

Figure 3: Truss bridge

Adding another layer of complexity to bridge typing is the primary construction materials used (Figure 5). Bridges are generally constructed from concrete, steel, pre-stressed concrete, or timber. Some historical bridges or bridge components in Michigan may be constructed from stone or masonry.

Figure 4: Three-sided box bridge

Figure 5: Examples of common bridge construction materials used in Michigan

Bridge Condition

Michigan inspectors rate bridge condition on a 0-9 scale known as the National Bridge Inventory (NBI) rating scale (see Table for a summary of the NBI Rating scale). Elements of the bridge's superstructure, deck, and substructure receive a 9 if they are in excellent condition down to a 0 if they are in failed condition. A complete guide for Michigan bridge condition rating according to the NBI can be found in the MDOT Bridge Field Services' *Bridge Safety Inspection NBI Rating Guidelines* (https://www.michigan.gov/documents/mdot/BIR_Ratings_Guide_Combined_2017-10-30_606610_7.pdf).

Table 1: Summary of the NBI Rating Scale

NBI Rating	General Condition
9-7	Like new/good
6-5	Fair
4-3	Poor/serious
2-0	Critical/failed

Bridge Treatments

Replacement

Replacement work is typically performed when a bridge is in poor condition (NBI rating of 4 or less) and will improve the bridge to good condition (NBI rating of 7 or more). The Local Bridge Program, a part of MDOT's Local Agency Program, defines bridge replacement as full replacement, which removes the entire bridge (superstructure, deck, and substructure) before re-building a bridge at the same location (Figure 6). The decision to perform a total replacement over rehabilitation (see below) should be made based on a life-cycle cost analysis. Generally, replacement is selected if rehabilitation costs more than two-thirds of the cost of replacement. Replacement is generally the most expensive of the treatment options.

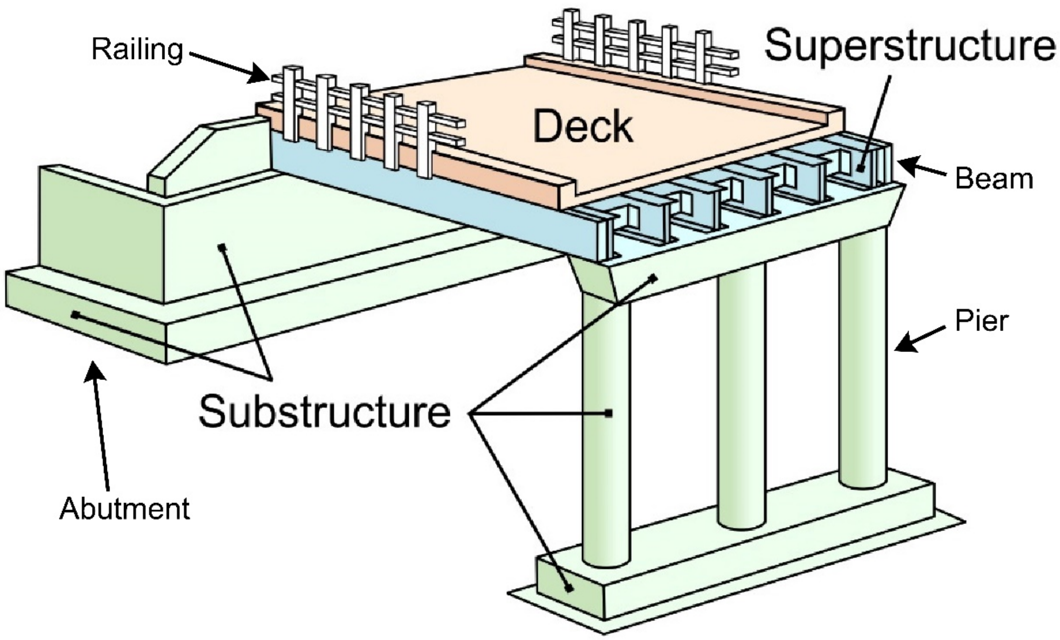


Figure 6: Diagram of basic elements of a bridge

Rehabilitation

Rehabilitation involves repairs that improve the existing condition and extend the service life of the structure and the riding surface. Most often, rehabilitation options are associated with bridges that have degraded beyond what can be fixed with preventive maintenance. Rehabilitation is typically performed on poor-rated elements (NBI rating of 4 or less) to improve them to fair or good condition (NBI rating of 5 or more). Rehabilitation can include superstructure replacement (removal and replacement of beams and deck) or deck replacement. While typically more expensive than general maintenance, rehabilitation treatments may be more cost-effective than replacing the entire structure.

- **Railing retrofit/replacement:** A railing retrofit or replacement either reinforces the existing railing or replaces it entirely (Figure 6). This rehabilitation is driven by a need for safety improvements on poor-rated railings or barriers (NBI rating less than 5).
- **Beam repair:** Beam repair corrects damage that has reduced beam strength (Figure 6). In the case of steel beams, it is performed if there is 25 percent or more of section loss in an area of the beam that affects load-carrying capacity. In the case of concrete beams, this is performed if there is 50 percent or more spalling (i.e., loss of material) at the ends of beams.
- **Substructure concrete patching and repair:** Patching and repairing the substructure is essential to keep a bridge in service. These rehabilitation efforts are performed when the abutments or piers are fair or poor (NBI rating of 5 or 4), or if spalling and delamination affect less than 30 percent of the bridge surface.

Preventive Maintenance

The Federal Highway Administration's (FHWA) *Bridge Preservation Guide* (2018) defines preventive maintenance as "a strategy of extending service life by applying cost-effective treatments to bridge elements…[that] retard future deterioration and avoid large expenses in bridge rehabilitation or replacements."

Preventive maintenance work is typically done on bridges rated fair (NBI rating of 5 or 6) in order to slow the rate of deterioration and keep them from falling into poor condition.

- **Concrete deck overlay:** A concrete deck overlay involves removing and replacing the driving surface. Typically, this is done when the deck surface is poor (NBI rating is less than 5) and the underneath portion of the deck is at least fair (NBI rating greater than 4). A shallow or deep concrete overlay may be performed depending on the condition of the bottom of the deck. The MDOT *Bridge Deck Preservation* matrices provide more detail on concrete deck overlays (see https://www.michigan.gov/mdot/0,4616,7-151-9625_24768_24773---,00.html).

- **Deck repairs:** Deck repairs include three common techniques: HMA overlay with or without waterproof membranes, concrete patching, deck sealing, crack sealing, and joint repair/replacement. An HMA overlay with an underlying waterproof membrane can be placed on bridge decks with a surface rating of fair or lower (NBI of 5 or less) and with deficiencies that cover between 15 and 30 percent of the deck surface and deck bottom. An HMA overlay without a waterproof membrane should be used on a bridge deck with a deck surface and deck bottom rating of serious condition or lower (NBI rating of 3 or less) and with deficiencies that cover greater than 30 percent of the deck surface and bottom; this is considered a temporary holdover to improve ride quality when a bridge deck is scheduled to undergo major rehabilitation within five years. All HMA overlays need to be accompanied by an updated load rating. Patching of the concrete on a bridge deck is done in response to an inspector's work recommendation or when the deck surface is in good, satisfactory, or fair condition (NBI rating of 7, 6, or 5) with minor delamination and spalling. To preserve a good bridge deck in good condition, a deck sealer can be used.

  Deck sealing should only be done when the bridge deck has surface rating of fair or better (NBI of 5 or more). Concrete sealers should only be used when the top and bottom surfaces of the deck are free from major deficiencies, cracks, and spalling. An epoxy overlay may be used when between 2 and 5 percent of the deck surface has delaminations and spalls, but these deficiencies must be repaired prior to the overlay. An epoxy overlay may also be used to repair an existing epoxy overlay. Concrete crack sealing is an option to maintain concrete in otherwise good condition that has visible cracks with the potential of reaching the steel reinforcement. Crack sealing may be performed on concrete with a surface rating of good, satisfactory, or fair (NBIS rating of 7, 6, or 5) with minor surface spalling and delamination; it may also be performed in response to a work recommendation by an inspector who has determined that the frequency and size of the cracks require sealing.

- **Steel bearing repair/replacement:** Rather than sitting directly on the piers, a bridge superstructure is separated from the piers by bearings. Bearings allow for a certain degree of movement due to temperature changes or other forces. Repairing or replacing the bearings is considered preventive maintenance. Girders and a deck in at least fair condition (NBI of 5 or higher) and bearings in poor condition (NBI rating of 4 or less) identifies candidates for this maintenance activity.

- **Painting:** Re-painting a bridge structure can either be done in totality or in part. Total re-painting is done in response to an inspector's work recommendation or when the paint condition is in serious condition (NBI rating of 3 or less). Partial re-painting can either consist of zone re-painting, which is a preventive maintenance technique, or spot re-painting, which is scheduled maintenance (see below). Zone re-painting is done when less than 15 percent of the paint in a smaller area, or zone, has failed while the rest of the bridge is in good or fair condition. It is also done if the paint condition is fair or poor (NBI rating of 5 or 4).

- **Channel improvements:** Occasionally, it is necessary to make improvements to the waterway that flows underneath the bridge. Such channel improvements are driven by an inspector's work recommendation based on a hydraulic analysis or to remove vegetation, debris, or sediment from the channel and banks (Figure 6).

- **Scour countermeasures:** An inspector's work recommendations or a hydraulic analysis may require scour countermeasures (see the *Risk Management* section of this plan for more information on scour). This is done when a structure is categorized as scour critical and is not scheduled for replacement or when NBI comments in abutment and pier ratings indicate the presence of scour holes.

- **Approach repaving:** A bridge's approach is the transition area between the roadway leading up to and away from the bridge and the bridge deck. Repaving the approach areas is performed in response to an inspector's work recommendation, when the pavement surface is in poor condition (NBI rating of 4 or less), or when the bridge deck is replaced or rehabilitated (e.g., concrete overlay).

- **Guardrail repair/replacement:** A guardrail is a safety feature on many roads and bridges that prevents or minimizes the effects of lane departure incidents. Keeping bridge guardrails in good condition is important. Repair or replacement of bridge guardrail should be done when a guardrail is missing or damaged, or when it needs a safety improvement.

Scheduled Maintenance

Scheduled maintenance activities are those activities or treatments that are regularly scheduled and intend to maintain serviceability while reducing the rate of deterioration.

- **Superstructure washing:** Washing the superstructure, or the main structure supporting the bridge, typically occurs in response to an inspector's work recommendation or when salt-contaminated dirt and debris collected on the superstructure is causing corrosion or deterioration by trapping moisture.

- **Drainage system cleanout/repair:** Keeping a bridge's drainage system clean and in good working order allows the bridge to shed water effectively. An inspector's work recommendation may indicate drainage system cleanout/repair. Signs that a drainage system needs cleaning or repair include clogs and broken, deteriorated, or damaged drainage elements.

- **Spot painting:** Spot painting is a form of partial bridge painting. This scheduled maintenance technique involves painting a small portion of a bridge. Generally, this is done in response to an inspector's work recommendation and is used for zinc-based paint systems only.

- **Slope repair/reinforcement:** The terrain on either side of the bridge that slopes down toward the channel is called the slope. At times, it is necessary to repair the slope. Situations that call for slope repair include when the slope is degraded, when the slope has significant areas of distress or failure, when the slope has settled, or if the slope is in fair or poor condition (NBI rating of 5 or less). Other times, it is necessary to reinforce the slope. Reinforcement can be added by installing Riprap, which is a side-slope covering made of stones. Riprap protects the stability of side slopes of channel banks when erosion threatens the surface.

- **Vegetation control and debris removal:** Keeping the area around a bridge structure free of vegetation and debris safeguards the bridge structure from these potentially damaging forces. Removing or restricting vegetation around bridges prevents damage to the structure. Vegetation control is done in response to an inspector's work recommendation or when vegetation traps moisture on structural elements or is growing from joints or cracks. Debris in the water channel or in the bridge can also cause damage to the structure. Removing this debris is typically done in response to an inspector's work recommendation or when vegetation, debris, or sediment accumulates on the structure or channel.

- **Miscellaneous repairs:** These are uncategorized repairs in response to an inspector's work recommendation.

1. BRIDGE ASSETS

Troy seeks to implement an asset management program for its bridge structures. This program balances the decision to perform reconstruction, rehabilitation, preventive maintenance, scheduled maintenance, or new construction, with Troy's bridge funding in order to maximize the useful service life and to ensure the safety of the local bridges under its jurisdiction. In other words, Troy's bridge asset management program aims to preserve and/or improve the condition of its local bridge network within the means of its financial resources.

Nonetheless, Troy recognizes that limited funds are available for improving the bridge network. Since preservation strategies like preventive maintenance are generally a more effective use of these funds than costly alternative management strategies like major rehabilitation or replacement, Troy seeks to identify those bridges that will benefit from a planned maintenance program while addressing those bridges that pose usability and/or safety concerns.

The three-fold goal of Troy's asset management program is the preservation and safety of its bridge network, increase of its bridge assets' useful service life by extending of the time that bridges remain in good and fair condition, and reduction of future maintenance costs. To quantify this goal, Troy specifically aims to have 100% or more of the agency's local bridges in fair to good condition and to have less than 0% classify as structurally deficient over its three-year plan.

Thus, Troy's asset management plan objectives are:

- To establish the current condition of the city's bridges
- To develop a "mix of fixes" that will:
  - Program scheduled maintenance actions to impede deterioration of bridges in good condition
  - Implement selective corrective repairs or rehabilitation for degraded bridge elements order to restore functionality
  - Identify and program those eligible bridges in need of replacement
- To identify available funding sources, such as:

- Dedicated city resources
- County funding through Michigan’s Local Bridge Program
- Opportunities to obtain other funding

- To prioritize the programmed actions within available funding limitations
- To preserve bridges currently rated fair (5) or higher in their current condition in order to extend their useful service life.

Inventory

Troy is responsible for 12 local bridges. Table 2 summarizes Troy’s bridge assets by type, sizes by bridge type, and condition by bridge type. Additional inventory data, condition ratings, and proposed preventive maintenance actions for each bridge are contained in the tables in Appendixes 3, 4, and 5. The bridge inventory data was obtained from MDOT MiBRIDGE and other sources, and the 2023 condition data and maintenance actions are taken from the inspector’s summary report (see Appendix 2).

Types

Of the Troy’s 12 structures, 9 are concrete bridges, 1 are steel bridges, 1 are pre-stressed concrete bridges, and 1 are timber bridges.

Locations and Sizes

Figure 7 illustrates the locations of bridge assets owned by Troy. Details about the locations and sizes of each individual asset can be found in Troy's MiBRIDGE database. For more information, please refer to the agency contact listed in the *Introduction* of this bridge asset management plan.

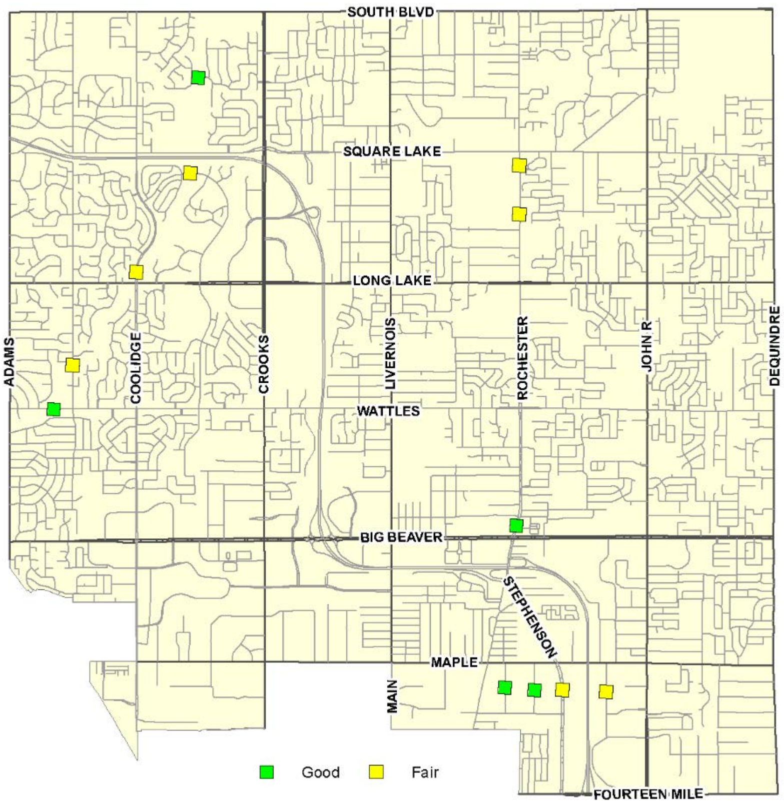


Figure 7: Map illustrating locations of Troy's bridge assets

Condition

Troy evaluates its bridges according to the National Bridge Inspection Standards rating scale, with a rating of 9 to 7 being like new to good condition, a rating of 6 and 5 being fair condition, and a rating of 4 or lower being poor or serious/critical condition. The current condition of Troy's bridge network is 5 (42%) are good, 7 (58%) are fair, and 0 (0%) are poor or lower.

Another layer of classification of Troy's bridge inventory classifies 0 (0%) bridges as structurally deficient, 0 (0) bridges as posted, and 0 (0) bridges as closed. Structurally deficient bridges are those with a deck, superstructure, substructure, and/or culvert rated as "poor" according to the NBI rating scale, with a load-carrying capacity significantly below design standards, or with a waterway that regularly overtops the bridge during floods. Posted bridges are those that have declined in condition to a point where a restriction is necessary for what would be considered a safe vehicular or traffic load passing over the bridge; designating a bridge as "posted" has no influence on its condition rating. Closed bridges are those that are closed to all traffic; closing a bridge is contingent upon its ability to carry a set minimum live load.

Table 2: Bridge Assets by Type: Inventory, Size, and Condition								
Bridge Type	Total Number of Bridges	Total Deck Area (sq ft)	Condition: Structurally Deficient, Posted, Closed			2023 Condition		
			Struct. Defic	Posted	Closed	Poor	Fair	Good
Concrete – Culvert	3	13,695	0	0	0	0	2	1
Concrete continuous – Culvert	6	19,113	0	0	0	0	4	2
Prestressed concrete – Box beam/girders—multiple	1	958	0	0	0	0	1	0
Steel – Culvert	1	1,274	0	0	0	0	0	1
Timber – Slab	1	1,389	0	0	0	0	0	1
Total SD/Posted/Closed			**0**	**0**	**0**			
Total	**12**	**36,429**				**0**	**7**	**5**
Percentage (%)			**0%**	**0**	**0**	**0**	**58**	**42**

Statewide, MDOT’s statistics for local agency bridges show that 11.4% are poor/severe and 88.6% are good/fair, indicating that Troy exceeds the statewide average for local agencies. Correspondingly, Troy has 100% of its bridges in fair/good condition versus the statewide average of 88.6% for local agency bridges. Statewide, 8% of local agency bridge deck area classifies as structurally deficient compared to 0% of Troy’s bridge deck area.

Goals

The goal of Troy’s asset management program is the preservation and safety of its bridge network; it also aims to extend the period of time that bridges remain in good and fair condition, thereby increasing their useful service life and reducing future maintenance costs.

Specifically, this goal translates into long-range goals of having 100% of its bridges rated fair/good and having less than 0% classify as structurally deficient within three years. These goals are juxtaposed with the historic and current condition and the projected trend in Figure 8.

Several metrics will be used to assess the effectiveness of this asset management program. Troy will monitor and report the annual change in the number of its bridges rated fair/good (5 or higher) and the annual change in the number of its bridges classified as structurally deficient.

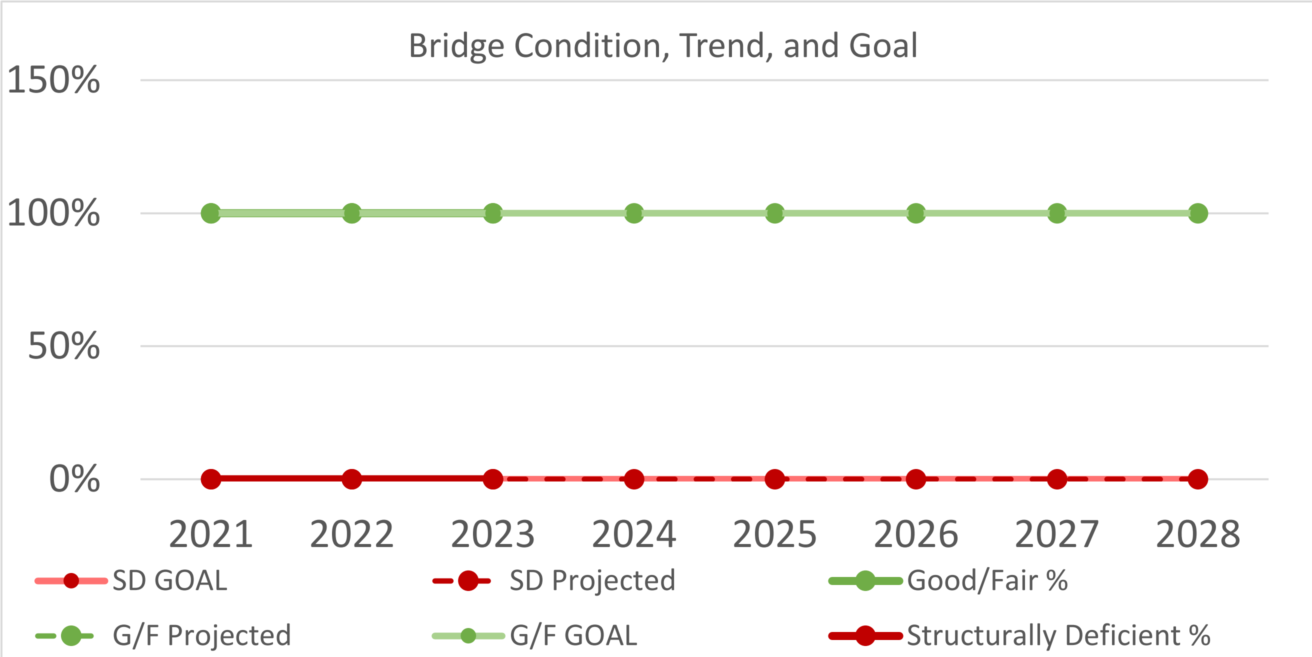


Figure 8: Progress tracking graph indicating Troy's historic and current bridge conditions, projected trends, and goals.

Based on past inspection records and condition ratings, Troy will establish a baseline of past performance by determining the average period of time that a bridge remains in good or fair condition. The performance measure will be the increased average amount of time a bridge is in the good or fair condition status after implementation of the asset management strategy when compared to the baseline time before implementation.

Prioritization, Programmed/Funded Projects, and Planned Projects

Prioritization

Troy's asset management program aims to address the structures of critical concern by targeting elements rated as being in poor condition and to improve and maintain the overall condition of the bridge network to good or fair condition through a "mix of fixes" strategy. Therefore, Troy prioritizes bridges for projects by evaluating five factors and weighting them as follows: condition –30%, load capacity –15%, traffic –15%, safety –30%, and detour –10%. There are several components within each factor that are used to arrive at its score. Each project under consideration is scored, and its total score is then compared with other proposed project to establish a priority order.

Troy bi-annually reviews the current condition of each of the its bridges using the NBIS inspection data contained in the *MDOT Bridge Safety Inspection Report* and the inspector's work recommendations contained in MDOT's *Bridge Inspection Report*. The inspection inventory and condition data are consolidated in spreadsheet format for Troy's bridges in Appendix 3. Troy then determines management and preservation needs and corresponding actions for each bridge (Appendix 4) As well as inspection follow-up actions (Appendix 5). The management and preservation actions are selected in accordance with criteria contained in the *Summary of Preservation Criteria* table (below) and adapted to Troy's specific bridge network.

Table 3: Summary of Preservation Criteria		
Preservation Action	**Bridge Selection Criteria**	**Expected Service Life**
Replacement		
Total Replacement	• NBI rating of 3 or less [1] [2] • *OR* Cost of rehabilitation exceeds cost of replacement [1] • *OR* Bridge is scour critical with no counter-measures available [1]	70 years
Rehabilitation		
Superstructure Replacement	• NBI rating of 4 or less for the superstructure [1] [2] • *OR* Cost of superstructure and deck rehabilitation exceeds cost of replacement [1]	40 years [1]
Deck Replacement Epoxy Coated Steel Black Steel	• Use guidelines in MDOT's Bridge Deck Preservation Matrix [3] [4] • NBI rating of 4 or less for the deck surface and deck bottom [1] [2] • Deck bottom has more than 25% total area with deficiencies [1] • *OR* Replacement cost of deck is competitive with rehabilitation [1]	60+ years [3] [4]
Substructure Replacement (Full or Partial)	• NBI rating of 4 or less for abutments, piers, or pier cap [1] [2] • Has open vertical cracks, signs of differential settlement, or active movement [1] • Pontis rating of 3 or 5 for more than 30 percent of the substructure [1] [5] • *OR* Bridge is scour critical with no counter-measures available	40 years [1*]
Steel Beam Repair	• More than 25% section loss in an area of the beam that affects load carrying capacity [1] • *OR* To correct impact damage that impairs beam strength [1]	40 years [1*]
Prestressed Concrete Beam Repair	• More than 5% spalling at ends of prestressed I-beams [1] • *OR* Impact damage that impairs beam strength or exposes prestressing strands [1]	40 years [1*]
Substructure Concrete Patching and Repair	• NBI rating of 5 or 4 for abutments or piers, and surface has less than 30% area spalled and delaminated [1] [2] • *OR* Pontis rating of 3 or 4 for the column or pile extension, pier wall, and/or abutment wall and surface has between 2% and 30% area with deficiencies [1] [5] • *OR* In response to inspector's work recommendation for substructure patching [1]	
Abutment Repair/Replacement	• NBI rating of 4 or less for the abutment [1] [2] • *OR* Has open vertical cracks, signs of differential settlement, or active movement	
Railing/Barrier Replacement	• NBI rating greater than 5 for the deck [1] [2] • NBI rating less than 5 for the railing with more than 30% total area having deficiencies [1] [2] • *OR* Pontis rating is 4 for railing [1] [5] • *OR* Safety improvement is needed [1]	

Table 3: Summary of Preservation Criteria		
Preservation Action	**Bridge Selection Criteria**	**Expected Service Life**
Culvert Repair/Replacement	• NBI rating of 4 or less for culvert or drainage outlet structure • *OR* Has open vertical cracks, signs of deformation, movement, or differential settlement	
Preventive Maintenance		
Shallow Concrete Deck Overlay	• NBI rating is 5 or less for deck surface, and deck surface has more than 15% area with deficiencies [1] [2] • NBI rating of 4 or 5 for deck bottom, and deck bottom has between 5% and 30% area with deficiencies [1] [2] • *OR* In response to inspector's work recommendation [1]	12 years
Deep Concrete Deck Overlay	• NBI rating of 5 or less for deck surface, and deck surface has more than 15% area with deficiencies [1] [2] • NBI deck bottom rating is 5 or 6, and deck bottom has less than 10% area with deficiencies [1] [2] • *OR* In response to inspector's work recommendation [1]	25 years
HMA Overlay with Waterproofing Membrane	• NBI rating of 5 or less for deck surface, and both deck surface and bottom have between 15% and 30% area with deficiencies [1] [2] • *OR* Bridge is in poor condition and will be replaced in the near future and the most cost-effective fix is HMA overlay [1]	
HMA Overlay Cap without Membrane	• Note: All HMA caps should have membranes unless scheduled for replacement within five years. • NBI rating of 3 or less for deck surface and deck bottom, and deck surface and deck bottom have more than 30% area with deficiencies. Temporary holdover to improve ride quality for a bridge in the five-year plan for rehab/replacement. [1] [2]	3 years
Concrete Deck Patching	• NBI rating of 5, 6, or 7 for deck surface, and deck surface has between 2% and 5% area with delamination and spalling [1] [2] • *OR* In response to inspector's work recommendation [1]	5 years
Steel Bearing Repair/Replacement	• NBI rating of 5 or more for superstructure and deck, and NBI rating 4 or less for bearing [2]	
Deck Joint Replacement	• Always include when doing deep or shallow concrete overlays [1] • NBI rating of 4 or less for joints [1] [2] • *OR* Joint leaking heavily [1] • *OR* In response to inspector's work recommendation for replacement [1]	
Pin and Hanger Replacement	• NBI rating of 4 or less for superstructure for pins and hangers [1] [2] • Pontis rating of 1, 2, or 3 for a frozen or deformed pin and hanger [1] [5] • *OR* Presence of excessive section loss, severe pack rust, or out-of-plane distortion [1]	15 years
Zone Repainting	• NBI rating of 5 or 4 for paint condition, and paint has 3% to 15% total area failing [1] [2] • *OR* During routine maintenance on beam ends or pins and hangers [1] • *OR* less than 15% of existing paint area has failed and remainder of paint system is in good or fair condition [1]	10 years
Complete Repainting	• NBI rating of 3 or less for paint condition [1] [2]	

Table 3: Summary of Preservation Criteria		
Preservation Action	**Bridge Selection Criteria**	**Expected Service Life**
	• *OR* Painted steel beams that have greater than 15% of the existing paint area failing [1]	
Partial Repainting	• See Zone or Spot Painting	
Channel Improvements	• Removal of vegetation, debris, or sediment from channel and banks to improve channel flow • *OR* in response to inspector's work recommendation	
Scour Countermeasures	• Pontis scour rating of 2 or 3 and is not scheduled for replacement [1] [5] • OR NBI comments in abutment and pier ratings indicate presence of scour holes [1] [2]	
Approach Repaving	• Approach pavement relief joints should be included in all projects that contain a significant amount of concrete roadway (in excess of 1000' adjacent to the structure). The purpose is to alleviate the effects of pavement growth that may cause distress to the structure. Signs of pavement growth include: o Abutment spalling under bearings [1] o Beam end contact [1] o Closed expansion joints and/or pin and hangers [1] o Damaged railing and deck fascia at joints [1] o Cracking in deck at reference line (45 degree angle) [1]	
Guard Rail Repair/Replacement	• Guard rail missing or damaged [2*] • *OR* Safety improvement is needed [2*]	
Scheduled Maintenance		
Superstructure Washing	• When salt contaminated dirt and debris collected on superstructure is causing corrosion or deterioration by trapping moisture [1] • *OR* Expansion or construction joints are to be replaced and the steel is not to be repainted [1] • *OR* Prior to a detailed replacement [1] • *OR* In response to inspector's work recommendation [1]	2 years
Drainage System Clean-Out/Repair	• When drainage system is clogged with debris [1] • *OR* Drainage elements are broken, deteriorated, or damaged [1] • *OR* NBI rating comments for drainage system indicate need for cleaning or repair [1] [2]	2 years
Spot Repainting	• For zinc-based paint systems only. Do not spot paint with lead-based paints. • Less than 5% of paint area has failed in isolated areas [1] • *OR* In response to inspector's work recommendation [1]	5 years
Slope Paving Repair	• NBI rating is 5 or less for slope protection [1] [2] • *OR* Slope is degraded or sloughed • *OR* Slope paving has significant areas of distress, failure, or has settled [1]	
Riprap Installation	• To protect surface when erosion threatens the stability of side slopes of channel banks	
Vegetation Control	• When vegetation traps moisture on structural elements [1] • *OR* Vegetation is growing from joints or cracks [1] • *OR* In response to inspector's work recommendation for brush cut [1]	1 year

Table 3: Summary of Preservation Criteria		
Preservation Action	**Bridge Selection Criteria**	**Expected Service Life**
Debris Removal	• When vegetation, debris, or sediment accumulates on the structure or in the channel • *OR* In response to inspectors work recommendation	1 year
Deck Joint Repair	• Do not repair compression joint seals, assembly joint seals, steel armor expansions joints, and block out expansion joints; these should always be replaced. [1] • NBI rating is 5 for joint [1] [2] • *OR* In response to inspector's work recommendation for repair [1]	
Concrete Sealing	• Top surface of pier or abutments are below deck joints and, when contaminated with salt, salt can collect on the surface [1] • *OR* Surface of the concrete has heavy salt exposure. Horizontal surfaces of substructure elements are directly below expansion joints [1]	
Concrete Crack Sealing	• Concrete is in good or fair condition, and cracks extend to the depth of the steel reinforcement [1] • *OR* NBI rating of 5, 6, or 7 for deck surface, and deck surface has between 2% and 5% area with deficiencies [1] [2] • *OR* Unsealed cracks exist that are narrow and/or less than 1/8" wide and spaced more than 8' apart [1] • *OR* In response to inspector's work recommendation [1]	5 years
Minor Concrete Patching	• Repair minor delaminations and spalling that cover less than 30% of the concrete substructure [1] • *OR* NBI rating of 5 or 4 for abutments or piers, and comments indicate that their surface has less than 30% spalling or delamination [1] [2] • *OR* Pontis rating of 3 or 4 for the column or pile extension, pier wall and/or abutment wall, and surface has between 2% and 30% area with deficiencies [1] [5] • *OR* In response to inspector's work recommendation [1]	
HMA Surface Repair/Replacement	• HMA surface is in poor condition • *OR* In response to inspector's work recommendation	
Seal HMA Cracks/Joints	• HMA surface is in good or fair condition, and cracks extend to the surface of the underlying slab or sub course • *OR* In response to inspector's work recommendation	
Timber Repair	• NBI rating of 4 or less for substructure for timber members • *OR* To repair extensive rot, checking, or insect infestation	
Miscellaneous Repair	• Uncategorized repairs in response to inspector's work recommendation	

This table was produced by TransSystems and includes information from the following sources:

[1] MDOT, *Project Scoping Manual*, MDOT, 2019.

[2] MDOT, *MDOT NBI Rating Guidelines*, MDOT, 2017.

[3] MDOT, *Bridge Deck Preservation Matrix - Decks with Uncoated "Black" Rebar*, MDOT, 2017.

[4] MDOT, *Bridge Deck Preservation Matrix - Decks with Epoxy Coated Rebar*, 2017.

[5] MDOT, *Pontis Bridge Inspection Manual*, MDOT, 2009.

* From source with interpretation added.

In terms of management and preservation actions, Troy's asset management program uses a "mix of fixes" strategy that is made up of preventive maintenance.

> **Replacement** involves substantial changes to the existing structure, such as bridge deck replacement, superstructure replacement, or complete structure replacement, and is intended to improve critical or closed bridges to a good condition rating.
>
> **Rehabilitation** is undertaken to extend the service life of existing bridges. The work will restore deficient bridges to a condition of structural or functional adequacy, and may include upgrading geometric features. Rehabilitation actions are intended to improve the poor or fair condition bridges to fair or good condition.
>
> **Preventive maintenance** work will improve and extend the service life of fair bridges, and will be performed with the understanding that future rehabilitation or replacement projects will contain appropriate safety and geometric enhancements. Preventive maintenance projects are directed at limited bridge elements that are rated in fair condition with the intent of improving these elements to a good rating. Most preventive maintenance projects will be one-time actions in response to a condition state need. Routine preventive work will be performed by the agency's in-house maintenance crews while larger, more complex work will be contracted.
>
> Troy's **scheduled maintenance** program is an integral part of the preservation plan, and is intended to extend the service life of fair and good structures by preserving the bridges in their current condition for a longer period of time. Scheduled maintenance is proactive and not necessarily condition driven. In-house maintenance crews will perform much of this work.

Certain of the severely degraded and structurally deficient bridges require replacement or major rehabilitation. Several of the remaining bridges require one-time preventive maintenance actions to repair defects and restore the structure to a higher condition rating. Most bridges are included in a scheduled maintenance plan with appropriate maintenance actions programmed for groups of bridges of similar material and type, bundled by location.

The replacement, rehabilitation, and preventive maintenance projects are not generally eligible for funding under the local bridge program.

To achieve its goals, Troy's asset management program incorporates preservation of bridges currently rated fair (5) or higher in their current condition in order to extend their useful service life. The primary work activities used to meet this preservation objective include preventive maintenance. A bridge-by-bridge preservation—or maintenance—plan is presented in the Appendix 4.

Programmed/Funded Projects

Troy allocated approximately $10,000 in total funding per year for the years 2023-2024. To achieve its goals, Troy anticipates spending approximately $10,000 per year on preventive maintenance of bridges. Troy does not anticipate replacing any bridges. By performing the aforementioned preventive maintenance, Troy will meet its overall bridge network condition goals.

Troy computes the estimated cost of each typical management and/or preservation action using unit prices in the latest *Bridge Repair Cost Estimate* spreadsheet contained in MDOT's *Local Bridge Program Call for Projects*. The cost of items of varying complexity, such as maintenance of traffic, staged construction, scour counter-measures, and so forth, are computed on a bridge-by-bridge basis. The cost estimates are reviewed and updated annually.

Planned Projects

At this time and over the time period covered by this plan, Troy does not have any planned projects beyond routine maintenance as identified by our bi-annual inspections. We have completed several projects over the years, beyond normal maintenance, and typically identify, scope and fund the project as a Capital Improvement Project in our 6-Year CIP as part of our annual budget process.

Gap Analysis

When Troy compares its funding and its programmed/funded projects with our goals for our bridge program, we believe the City should be able to achieve all of its asset management goals for the period of this plan. At this time, we do not anticipate a funding issue for maintenance of bridges. Should a bridge project develop, we will continue to monitor those bridge assets and take any necessary steps within our budget to prevent or mitigate a condition decline or a need to post or close the structure

2. FINANCIAL RESOURCES

Anticipated Revenues

Any projects submitted to the local aid program that are not selected for funding will be added to the agency's program.

Anticipated Expenses

Scheduled maintenance activities and minor repairs that are not affiliated with any applications, grants, or other funded projects will be performed by the agency's in-house maintenance forces and funded through the agency's annual operating budget.

3. RISK MANAGEMENT

Troy recognizes that the potential risks associated with bridges generally fall into several categories:

- Personal injury and property damage resulting from a bridge collapse or partial failure;
- Loss of access to a region or individual properties resulting from bridge closures, restricted load postings, or extended outages for rehabilitation and repair activities; and
- Delays, congestion, and inconvenience due to serviceability issues, such as poor quality riding surface, loose expansion joints, or missing expansion joints.

Troy addresses these risks by implementing regular bridge inspections and a preservation strategy consisting of preventive maintenance.

Troy administers the biennial inspection of its bridges in accordance with NBIS and MDOT requirements. The inspection reports document the condition of Troy's bridges and evaluates them in order to identify new defects and monitor advancing deterioration. The summary inspection report in Appendix 1 identifies items needing follow-up, special inspection actions, and recommended bridge-by-bridge maintenance activities.

Bridges that are considered "scour critical" pose a risk to Troy's road and bridge network. Scour is the depletion of sediment from around the foundation elements of a bridge commonly caused by fast-moving water. According to MDOT's *Michigan Structure Inventory and Appraisal Coding Guide*, a scour critical bridge is one that has unstable abutment(s) and/or pier(s) due to observed or potential (based on an evaluation study) scour. Bridges receiving a scour rating of 3 or less are considered scour critical. Troy has no scour critical bridges.

Troy has no posted or closed bridges that are critical to accessing entire areas or individual properties within its jurisdiction.

The preservation strategy identifies actions in the operations and maintenance plan that are preventive or are responsive to specific bridge conditions. The actions are prioritized to correct critical structural safety and traffic issues first, and then to address other needs based on the operational importance of each bridge and the long-term preservation of the network. The inspection results serve as a basis for modifying and updating the operations and maintenance plan annually.

APPENDIX 1

City of Troy 2023 Bridge Inspection Report Summary of Additional Inspection Recommendations

7986 Rochester Road over Renshaw Drain: reseal culvert joints; repair scour countermeasures on east side; seal cracks in headwall; and repair culvert areas with exposed reinforcement

7987 Rochester Road over Renshaw Drain: repair leaking joints

8307 Coolidge Road over Rouge River: seal all cracks inside culvert

8308 Stephenson Highway over Barnard Drain: repair delaminations and spalls at joint in the concrete culvert; and repair spalls on concrete portion of railing

8309 Rochester Road over Sturgis Drain: underwater inspection recommended for 12-foot RCP portion of pipe located under park (not part of structure, but appears to be on City property)

8310 Souter Road over Barnard Drain: relocate utility in stream; place riprap at downstream end of exposed culvert and wingwalls

8311 Allen Drive over Barnard Drain: seal cracks in culvert

8312 Chicago Road over Barnard Drain: sealing leaking crack in culvert; place riprap at downstream end of exposed culvert; and patch culvert and seal joints

8313 Northfield Parkway over Rouge River: repair spalls at joints and seal joints; and clean/remove debris in both upstream and downstream channel

13610 Wattles Road over Rouge River: remove debris from downstream channel; repair erosion at downstream end of barrels; replace existing concrete segmental bridge barriers with MDOT approved barriers; add approach guardrails; and repair/replace north fascia fencing and install fencing on south fascia

13611 Beach Road over Rouge River: apply for superstructure replaced funding through MDO Local Bridge Program

14273 Basswood Driver over Sprague Drain: no work recommended at this time

APPENDIX 2

City of Troy 2023 Bridge Inspection Report Executive Summary

General Recommendations

- Maintenance repairs identified in the 2023 inspection cycle should be completed within the next 6-24 months
- City will review preventative maintenance (PM) work and consider applying for Local Bridge Program funding under a multiple PM application.
- City to complete underwater inspection for 12’ RCP portion of pipe located under park for Structure No. 8309 (Rochester Road over Sturgis Drain) during 2025 inspection cycle.

APPENDIX 3

Appendix 3 is included on the following page.

APPENDIX 3

APPENDIX A-1

Inventory Data														Inspection Findings												Appraisal				
Bridge Type	Structure Number	Bridge ID	Facility Carried	Features Intersected	Primary or Secondary Route	Structure Type Main Span (Item 43A - Material)	Structure Type Main Span (Item 43B)	Number of Main Span (Item 45)	Total Str Length (Item 49)	Year Built (Item 27)	Year Reconstr (Item 106)	ADT	Year of ADT	Inspection Date	Operational Status (Item 41)	Deck Rating (Item 58)	Deck Bottom Rating (Item XX)	SuperStr Rating (Item 59)	Substr Rating (Item 60)	Channel Rating (Item 61)	Culvert Rating (Item 62)	Surface Rating (Item 58A)	Paint Rtg	Exp Joint Rating (Item XX)	Other Joints	Structure Evaluation	Structurally Deficient	Sufficiency Rating	Section Loss	Scour Critical (Item 113)
Concrete – Culvert	**7986**	634679200084C01	ROCHESTER RD	RENSHAW COUNTY DRAIN	Primary	1	19	2	23	1979		40331	1997	4/20/2023	A	N		N	N	5	6					F				8
Concrete – Culvert	**7987**	634679200084C02	ROCHESTER RD	RENSHAW COUNTY DRAIN	Primary	1	19	2	22.5	1979		42000	1993	4/20/2023	A	N		N	N	5	6					F				8
Concrete continuous – Culvert	**8307**	634679200034B01	COOLIDGE ROAD	ROUGE RIVER	Primary	2	19	2	38	1972		6000	2015	4/20/2023	A	N		N	N	7	6					F	Funct Obs			8
Concrete continuous – Culvert	**8308**	634679200040B01	STEPHENSON HWY	BARNARD DRAIN	Primary	2	19	2	31	1974		23900	2012	4/27/2023	A	N		N	N	7	5					F	Funct Obs			5
Concrete – Culvert	**8309**	634679200084B01	ROCHESTER RD	STURGIS	Primary	1	19	1	30	1975	2000	38500	2011	4/20/2023	A	N		N	N	6	7					G				8
Concrete continuous – Culvert	**8310**	635679200069B01	SOUTER ROAD	BARNARD DRAIN	Secondary	2	19	2	29.5	1974		950	1997	4/27/2023	A	N		N	N	7	7					G				5
Concrete continuous – Culvert	**8311**	635679200070B01	ALLEN DRIVE	BARNARD DRAIN	Secondary	2	19	2	31	1969		2300	1997	4/27/2023	A	N		N	N	5	7					G				8
Concrete continuous – Culvert	**8312**	635679200071B01	CHICAGO ROAD	BARNARD DRAIN	Secondary	2	19	2	35	1971		12700	1997	4/27/2023	A	N		N	N	6	5					F	Funct Obs			5
Concrete continuous – Culvert	**8313**	635679200081B01	NORTHFIELD PARKWAY	ROUGE RIVER	Secondary	2	19	2	36.1	1972		2800	1997	4/20/2023	A	N		N	N	5	5					F				5
Steel – Culvert	**13610**	634679200019C01	WATTLES ROAD	ROUGE RIVER	Primary	3	19	2	27.7	1957	2016	8500	1983	4/20/2023	A	N		N	N	7	7					G				8
Prestressed concrete – Box beam/girders—multiple	**13611**	634679200079B01	BEACH ROAD	ROUGE RIVER	Primary	5	5	1	24	1981		3500	1981	4/20/2023	A	5		5	7	4	N	6	N	N	N	F	Funct Obs		N	5
Timber – Slab	**14273**	635679200998B01	BASSWOOD DRIVE	SPRAGUE DRAIN	Secondary	7	1	1	30	1988		50	2018	4/20/2023	A	7	7	7	7	7	N	7	N	7	N	G			N	8

APPENDIX 4

Appendix 4 is included on the following page.

APPENDIX 4

APPENDIX A-2

Inventory Data											Replacement			
Bridge Type	Structure Number	Bridge ID	Facility Carried	Features Intersected	Structure Type Main Span (Item 43A - Material)	Structure Type Main Span (Item 43B)	Number of Main Span (Item 45)	Total Str Length (Item 49)	Total Str Width (Item 52)	Total Str (sq ft)	Total	Super-structure	Deck	Sub-structure
Concrete – Culvert	**7986**	634679200084C01	ROCHESTER RD	RENSHAW COUNTY DRAIN	1	19	2	23	200	4600				
Concrete – Culvert	**7987**	634679200084C02	ROCHESTER RD	RENSHAW COUNTY DRAIN	1	19	2	22.5	150.9	3395				
Concrete continuous – Culvert	**8307**	634679200034B01	COOLIDGE ROAD	ROUGE RIVER	2	19	2	38	111.5	4237				
Concrete continuous – Culvert	**8308**	634679200040B01	STEPHENSON HWY	BARNARD DRAIN	2	19	2	31	167.3	5186				
Concrete – Culvert	**8309**	634679200084B01	ROCHESTER RD	STURGIS	1	19	1	30	190	5700				
Concrete continuous – Culvert	**8310**	635679200069B01	SOUTER ROAD	BARNARD DRAIN	2	19	2	29.5	62.3	1838				
Concrete continuous – Culvert	**8311**	635679200070B01	ALLEN DRIVE	BARNARD DRAIN	2	19	2	31	72.2	2238				
Concrete continuous – Culvert	**8312**	635679200071B01	CHICAGO ROAD	BARNARD DRAIN	2	19	2	35	65.6	2296				
Concrete continuous – Culvert	**8313**	635679200081B01	NORTHFIELD PARKWAY	ROUGE RIVER	2	19	2	36.1	91.9	3318				
Steel – Culvert	**13610**	634679200019C01	WATTLES ROAD	ROUGE RIVER	3	19	2	27.7	46	1274				
Prestressed concrete – Box beam/girders—multiple	**13611**	634679200079B01	BEACH ROAD	ROUGE RIVER	5	5	1	24	39.9	958		x	x	
Timber – Slab	**14273**	635679200998B01	BASSWOOD DRIVE	SPRAGUE DRAIN	7	1	1	30	46.3	1389				

	Rehabilitation										
Structure Number	Deep Overlay	Shallow Overlay	HMA Overlay w/ Membrane	HMA Cap	Replace/Retrofit Railing	Steel Beam Repairs	P/S Conc Beam Repairs	Repair/Replace Culvert	Repair/Replace Retaining Wall	Geometric Upgrades	Patch Substruct Concrete
7986											
7987											
8307											
8308											
8309											
8310											
8311											
8312											
8313											
13610											
13611											
14273											

	Proposed Preventive Maintenance								
Structure Number	Repair/Replace Deck	Repair/Replace Steel Bearings	Complete Painting	Zone Painting	Epoxy Overlays	HMA Cap w/o Membrane	Concrete Deck Patching	Channel Improvements	Scour Counter Measures
7986									
7987									
8307									
8308									
8309									
8310									
8311									
8312									
8313									
13610									
13611									
14273									

	Proposed Scheduled Maintenance														
Structure Number	Superstruc Washing	Concrete Surface Washing	Vegetation Control	Debris Removal	Clean Drainage System	Spot Painting	Repair/Replace HMA Surface	Seal HMA Cracks/Joints	Seal Concrete Cracks/Joints	Minor Concrete Patching	Timber Repairs	Repair/Replace Guardrails	Repave Approaches	Repair Slopes	Install RipRap
7986															
7987															
8307															
8308															
8309															
8310															
8311															
8312															
8313															
13610															
13611															
14273															

APPENDIX 5

Appendix 5 is included on the following page.

APPENDIX 5

APPENDIX A-3																			
Inventory Data											Inspection Items								
Bridge Type	**Structure Number**	**Bridge ID**	**Facility Carried**	**Features Intersected**	**Structure Type Main Span (Item 43A - Material)**	**Structure Type Main Span (Item 43B)**	**Number of Main Span (Item 45)**	**Total Str Length (Item 49)**	**Total Str Width (Item 52)**	**Total Str (sq ft)**	**Initial Inspection**	**In Depth Steel Inspection**	**Pin and Hanger Inspection**	**Diving Inspection**	**Provide Monitoring**	**Review Scour Criticality**	**Load Rating**	**Update SIA**
Concrete – Culvert	**7986**	634679200084C01	ROCHESTER RD	RENSHAW COUNTY DRAIN	1	19	2	23	200	4600								x
Concrete – Culvert	**7987**	634679200084C02	ROCHESTER RD	RENSHAW COUNTY DRAIN	1	19	2	22.5	150.9	3395								x
Concrete continuous – Culvert	**8307**	634679200034B01	COOLIDGE ROAD	ROUGE RIVER	2	19	2	38	111.5	4237								x
Concrete continuous – Culvert	**8308**	634679200040B01	STEPHENSON HWY	BARNARD DRAIN	2	19	2	31	167.3	5186								x
Concrete – Culvert	**8309**	634679200084B01	ROCHESTER RD	STURGIS	1	19	1	30	190	5700								x
Concrete continuous – Culvert	**8310**	635679200069B01	SOUTER ROAD	BARNARD DRAIN	2	19	2	29.5	62.3	1838								x
Concrete continuous – Culvert	**8311**	635679200070B01	ALLEN DRIVE	BARNARD DRAIN	2	19	2	31	72.2	2238								x
Concrete continuous – Culvert	**8312**	635679200071B01	CHICAGO ROAD	BARNARD DRAIN	2	19	2	35	65.6	2296								x
Concrete continuous – Culvert	**8313**	635679200081B01	NORTHFIELD PARKWAY	ROUGE RIVER	2	19	2	36.1	91.9	3318								x
Steel – Culvert	**13610**	634679200019C01	WATTLES ROAD	ROUGE RIVER	3	19	2	27.7	46	1274								x
Prestressed concrete – Box beam/girders—multiple	**13611**	634679200079B01	BEACH ROAD	ROUGE RIVER	5	5	1	24	39.9	958								x
Timber – Slab	**14273**	635679200998B01	BASSWOOD DRIVE	SPRAGUE DRAIN	7	1	1	30	46.3	1389								x