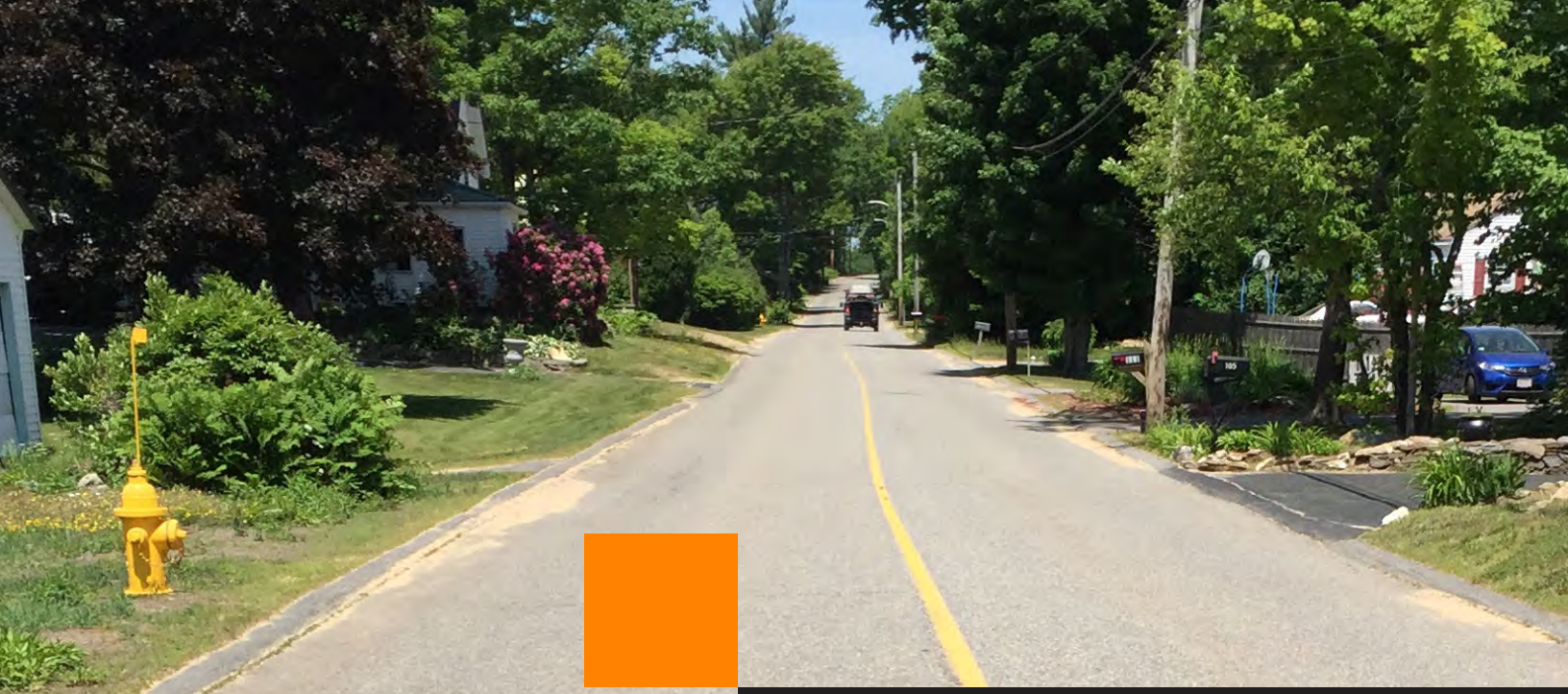

Stantec

PAVEMENT MANAGEMENT STUDY

Templeton, MA

Prepared by Stantec

Date: September 2018

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INTRODUCTION

1

BACKGROUND

The Town of Templeton is located in Worcester County, Massachusetts which straddles Route 2 and comprises four main villages: Templeton Center, East Templeton, Baldwinville, and Otter River. A 70.9 mile public accepted roadway network serves a population of over 8,000 citizens.

The Town of Templeton, in December 2017, retained the firm of Stantec to develop and implement a **Pavement Management System** (PMS) for its roadway system. From the first meeting with Carter Terenzini, Town Administrator and the Office of Public Works, it was clear that the Town of Templeton is committed to improving their roadway infrastructure to the greatest extent possible.
This comprehensive study was undertaken to further the Town's commitment to long-term capital improvement planning and further to develop a new, ongoing preservation maintenance plan with its pavement management system. The pavement management system contains an extensive roadway database describing actual pavement conditions and roadway characteristics in Templeton to better understand future roadway conditions and needs at various funding levels.

This report is designed to be a network-level planning tool and intended to provide a foundation for managing the Town's roadway resources by combining technology, local knowledge, and professional engineering input. Before describing the roadway management study, scope, and findings, an introduction to pavement management concepts and theory is offered.

Town of Templeton STATS

70.9
miles
public accepted roadway

132
streets

8,000
citizens

PAVEMENT MANAGEMENT CONCEPTS

The development of a pavement management system is a logical approach road officials use to allocate cost effective road budgets. The theory of pavement management is based on accurately predicting accelerated roadway deterioration. *Figure 1* dramatically illustrates the key concept of making timely maintenance repairs, thereby averting the need for far more expensive structural repairs. The goal is to save money in both the short and long run by developing a road repair program that minimizes expenditures.

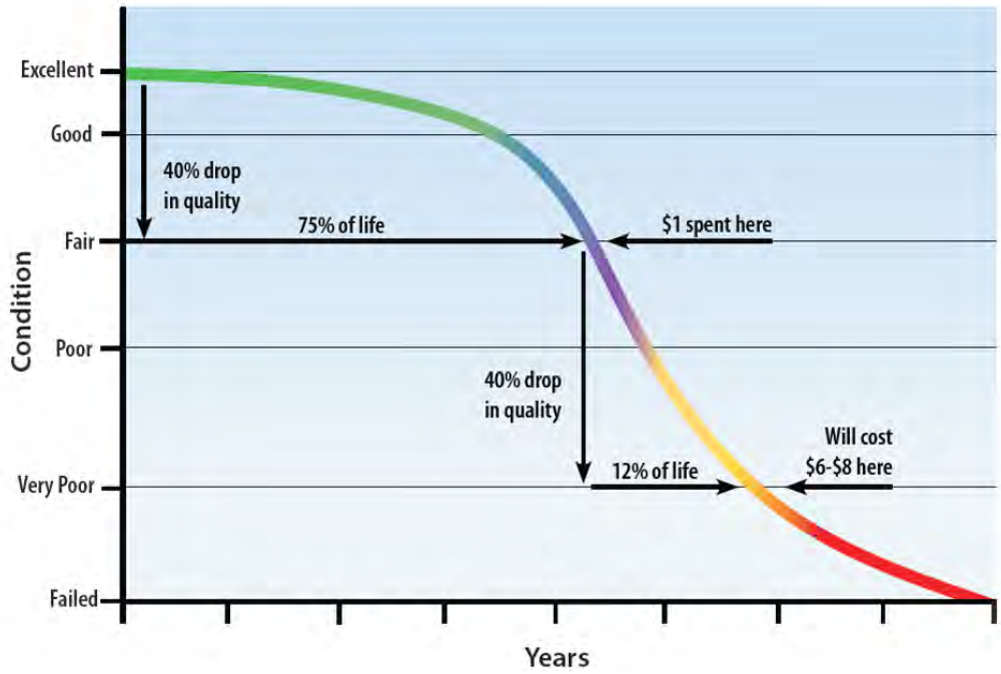


FIGURE 1 Pavement Deterioration Curve

The curve shows the rate at which the pavement condition deteriorates over time (*Figure 1*). A roadway worsens slowly at the beginning of its projected life span (the portion of the graph where the curve is nearly horizontal). This level of deterioration per year increases drastically (the portion where the curve becomes nearly vertical) as the pavement reaches near middle age. When the pavement is near the end of its projected life span, the pavement worsens at a slower rate once again (the curve returns to near horizontal). The point where the pavement approaches middle age, before the curve drops off sharply, is considered the critical zone in the pavement's life. Before this point, it is relatively inexpensive to keep a roadway in good service, while after this point it becomes much more expensive to keep the roadway in good service condition. It is important that *Figure 1* displays a generic pavement deterioration curve,the actual curve depends on the rating scale used to collect the data.

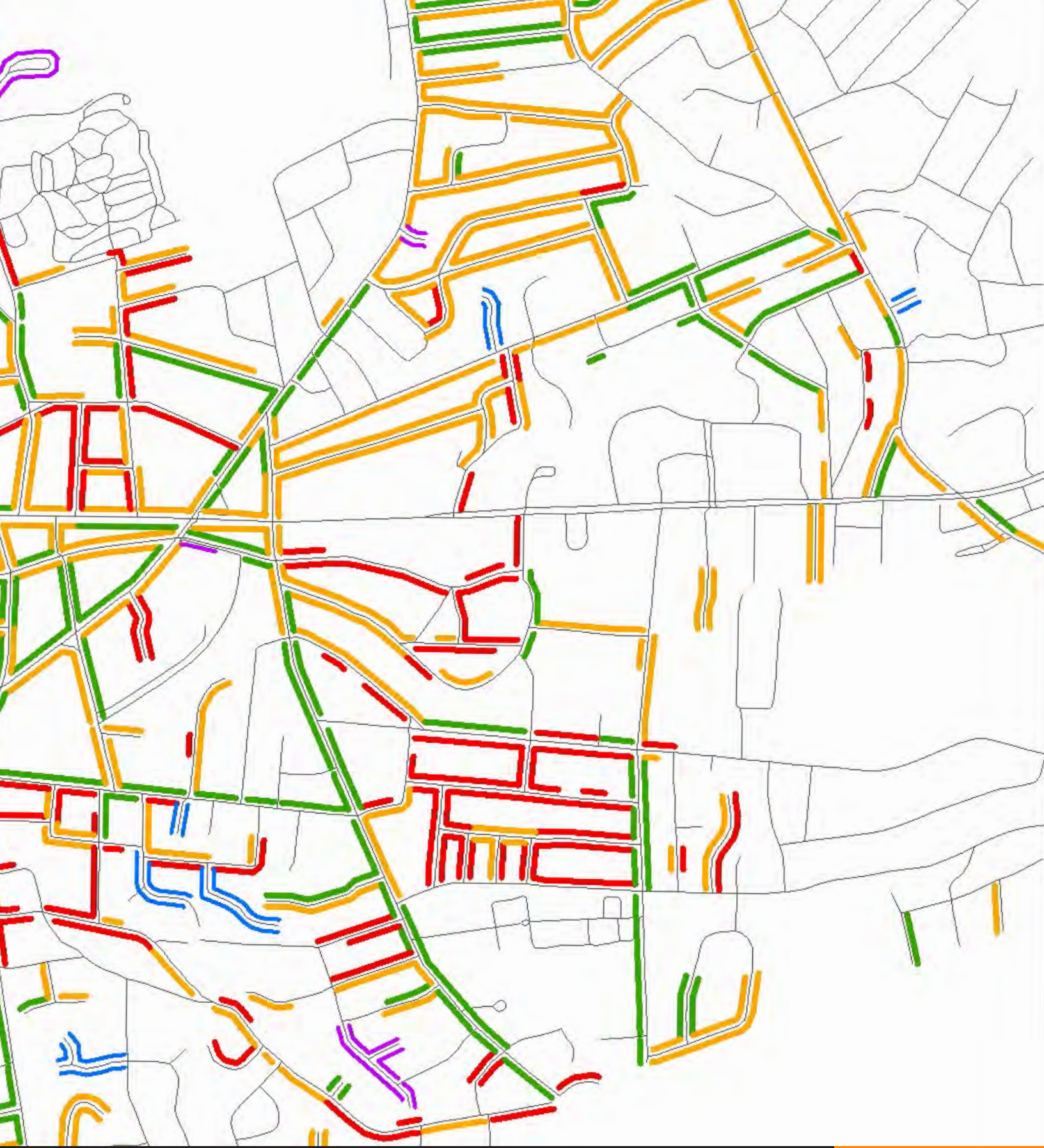
The pavement management system formalizes the process by using computer software. The procedure is to collect, organize, and maintain a complete roadway database that describes a particular road network system. This data is then analyzed to identify existing deterioration levels, prioritize cost-effective repairs, and create an optimal long-term spending plan. Pavement management provides the Town with a tool to make the best use of every available dollar.

STUDY APPROACH

Stantec field engineers, using computer tablets, conducted a town-wide roadway inventory and assessment, which included a detailed evaluation of key distress indicators on the roadway surfaces, to build a comprehensive database. The process entailed breaking out pavement management segments, closely observing and recording individual pavement distresses, and determined roadway sufficiency, such as rideability and drainage conditions.

Roadways were partitioned into “pavement management segments” whenever there was a change in pavement condition, surface type, width, or other distinguishing characteristics. The pavement management sections were then given a descriptive name that would best allow someone in the office to identify the field location. *Appendix A* contains all the pavement management segments identified, and sorted, in alphabetical order.

Following the completion of the pavement segmentation, system configuration meetings with the Office of Public Works were held to gather information for subsequent computer analysis at various funding levels to be performed.



METHODOLOGY

2

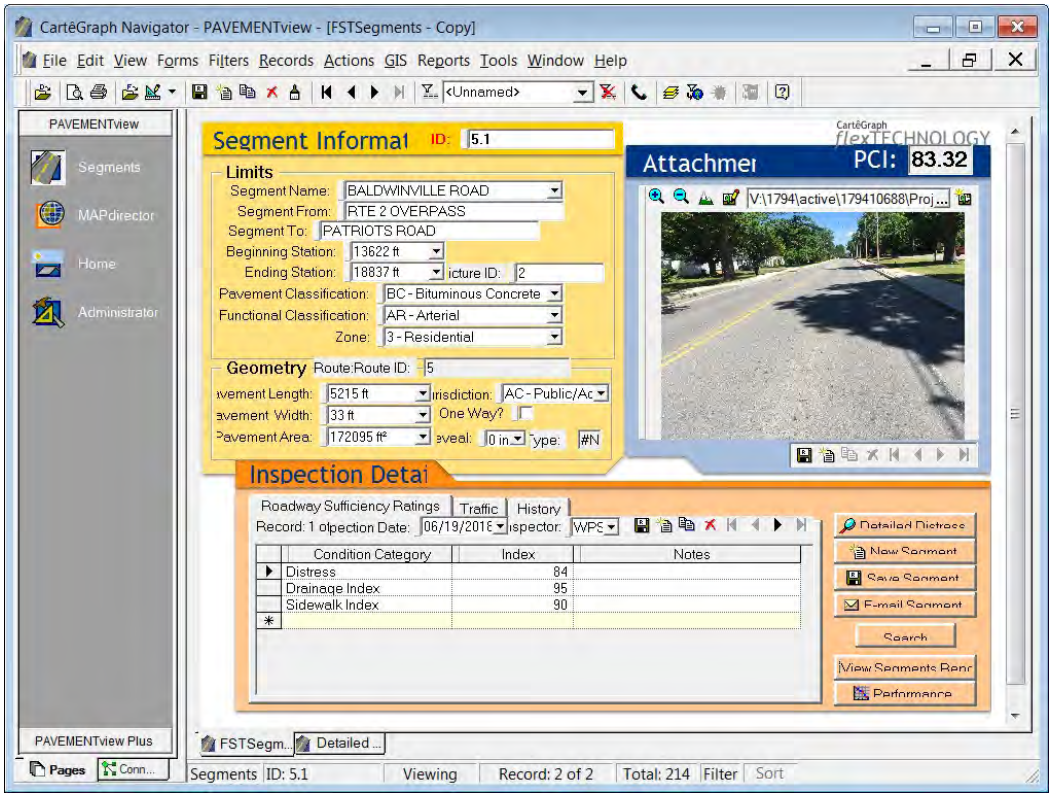
PAVEMENT MANAGEMENT SOFTWARE

Today's computer management technology allows consolidation of multiple data for easy and efficient building, editing, sorting, and reporting. Stantec used Cartêgraph Systems, Inc. — PAVEMENTview®Plus software for storing and analyzing Templeton's roadway data. The database was custom tailored to reflect Templeton's specific decision-making criteria for selecting roadway repair types for available and proposed budgets. Templeton's Office of Public Works and Stantec jointly developed system configuration parameters used in the analysis projections.

What is PCI?

Pavement Condition Index: a method used to quantify pavement condition verified by (APWA)

For analyzing Templeton's roadway system, the Pavement Condition Index (PCI) served as the primary condition index to compare the roadway serviceability and performance. PCI is an American Society for Testing & Materials (ASTM) method used to quantify pavement condition that has been verified and adopted by the American Public Works Association (APWA). For PCI calculation, the severity and extent of major pavement distresses were imported from the data collection into Cartegraph and calculated based on ASTM distress standards within the Cartegraph software. The distresses included: potholes or non-utility patching, alligator cracking, distortion, rutting, block cracking, transverse or longitudinal cracking, bleeding or polished aggregate, surface wear or raveling, and shoving, slippage or corrugations. Two (2) pavement surface types were used for analyzing Templeton's pavements:



- "Hot Mix Asphalt" or "bituminous concrete" roadway is typically engineered with a pavement structure designed to withstand predicted traffic load and volume. The roadway usually has a gravel base, an intermediate course, and a top surface wearing course.

- "Gravel" roads having dirt or gravel unbound road surfaces.

PCI SCALE

100
pavement in *excellent* condition

0
pavement in *extremely poor* condition

THE PAVEMENT CONDITION INDEX (PCI) DEFINED

Recordings of actual field distresses were used to calculate the PCI. A PCI was generated for each inventoried, surfaced, public roadway in Templeton using distress data. PCI is measured on a one hundred to zero scale, with one hundred representing a pavement in excellent condition and zero describing a pavement in extremely poor condition. Each type of observed pavement distress is assigned a deduct value based on the distress type, severity and extent.

More severe distress types, such as potholes, have higher "deduct points" than a lesser distress such as longitudinal cracking. A weighted sum of the deduct points is then subtracted from the perfect "one hundred" road in order to generate a PCI for each roadway. In general, base related (the pavement foundation) distresses are weighted more heavily than surface related distresses.

THE FIVE TREATMENT REPAIR BANDS

Stantec's pavement management software decision matrix uses five broad category ranges to group the calculated PCI numbers into five major repair bands. An individual road segment will fall into a particular band based on user defined criteria such as pavement type, functional classification, and curb reveal. Then each segment is assigned a repair alternative candidate with the prescribed treatment band. Table 1 presents the category ranges represented by the PCI bands.

1. When roads are in near perfect condition, the **Do Nothing** category (Band #1) prescribes no maintenance.

2. **Routine Maintenance** (Band #2) is regularly used on roads in reasonably good condition to prevent deterioration from the normal effects of traffic and pavement age. This treatment category would include either crack sealing and/or local repair of pothole, raveling, poorly constructed utility patch, etc.

TABLE 1 (PCI) Treatment Band Ranges[1]

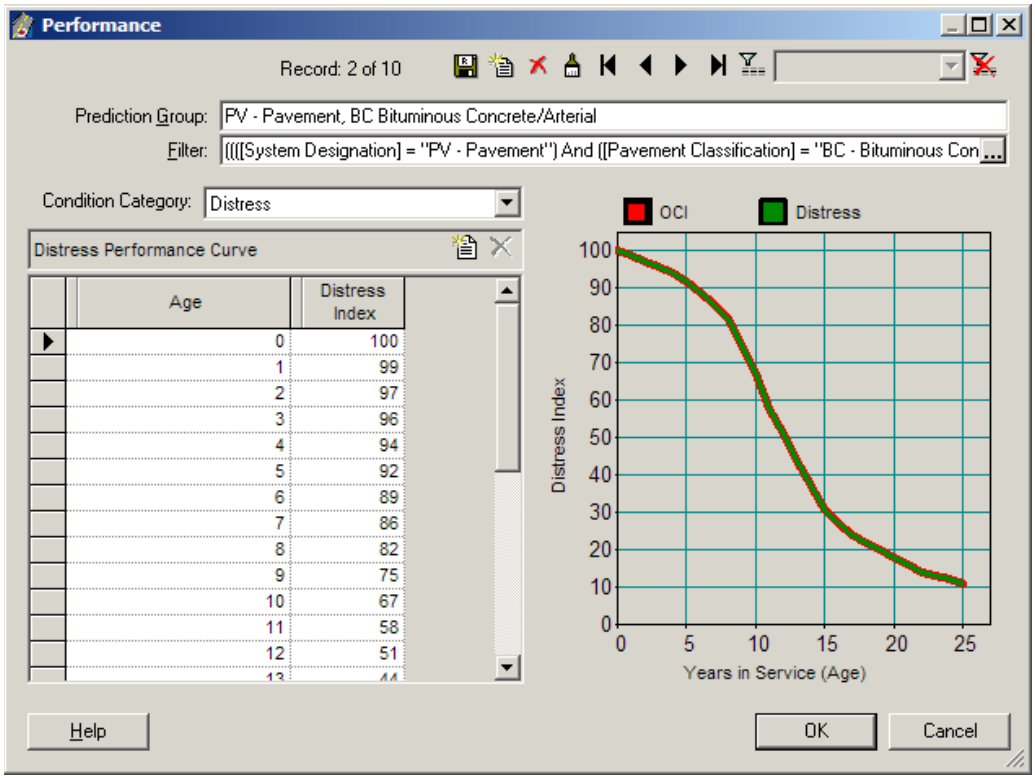
DO NOTHING **PCI Band #1 (100 - 88 PCI)**	Excellent Condition - in need of no immediate maintenance.
ROUTINE MAINTENANCE **PCI Band #2 (87 - 68 PCI)**	Good Condition - may be in need of crack sealing and minor localized repair.
PREVENTIVE MAINTENANCE **PCI Band #3 (67 - 47 PCI)**	Fair Condition - pavement surface in need of patching and thin overlay or surface sealing.
STRUCTURAL IMPROVEMENT **PCI Band #4 (46 - 25 PCI)**	Poor Condition - pavement structure in need of additional thickness to resist traffic loading.
BASE REHABILITATION **PCI Band #5 (24 - 0 PCI)**	Failure Condition - in need of full depth reconstruction/reclamation.

3 **Preventive Maintenance** (Band #3) is a slightly greater response to more pronounced signs of age and wear than that of Band #2. Not only would crack sealing, full-depth utility patching, and minor leveling be included, but also surface treatments such as hot-in-place recycling, micro-surfacing, and thin-lift overlay treatments may apply on selected facilities and pavement types. A road in need of Preventive Maintenance is in the critical zone of the pavement deterioration curve (Figure 1). It is in this range of a pavement's life cycle that the most cost-effective repairs can be made. Further deterioration warrants a significantly more costly response.

4 When the pavement deteriorates beyond the need for surface maintenance applications, but the road base appears to be sound, **Structural Improvement** (Band #4) repairs are in order. They could include structural overlays, shim and overlay, cold planing and overlay, and hot in-place recycling.

5 The **Base Rehabilitation** category (Band #5) represents roads that exhibit weakened pavement foundation base layers. Complete reconstruction and full depth reclamation fall into this category. Quite often, project level pavement evaluation through field sampling and laboratory testing is used to evaluate the existing materials for possible recycling or reuse.

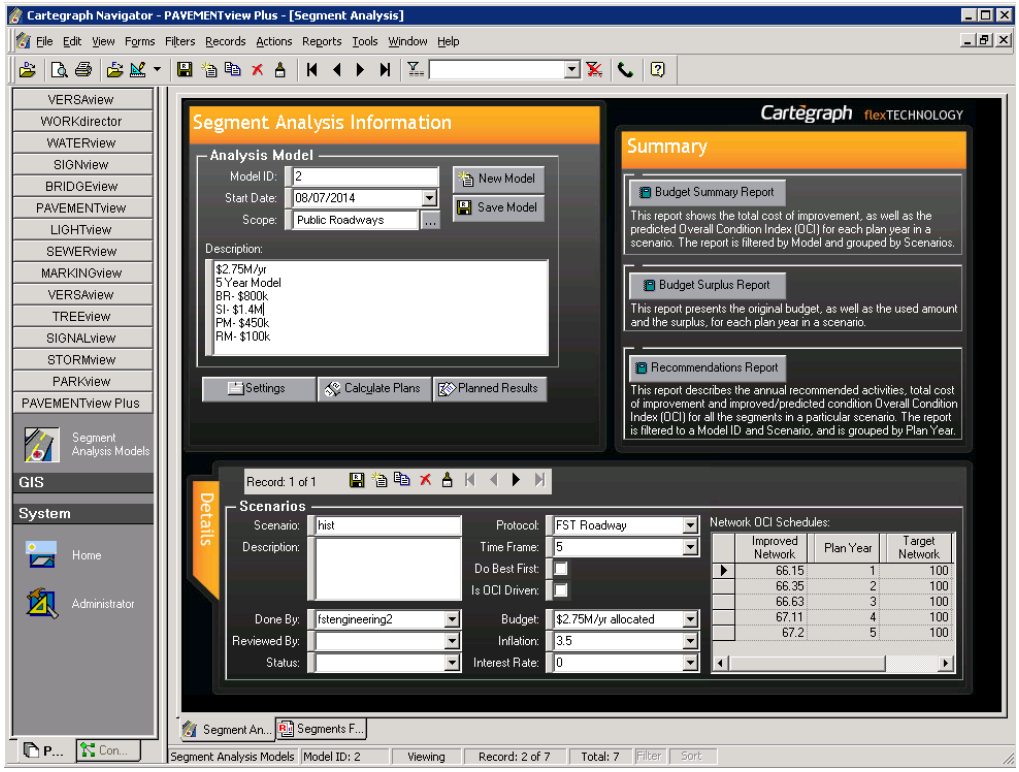
[1]The PCI ranges given in this table are general averages. The actual treatment band threshold numbers depend on pavement surface type and functional classification.



PRIORITY RANKING AND FUTURE PROJECTION

After all pavement segment repairs are assigned, the software prioritizes needed system repairs based on the highest projected Network Priority Ranking (NPR). The NPR value uses variables representing functional classification, pavement type, PCI, and traffic volume. Although road repairs could be prioritized on a “worst first” basis, Stantec and Templeton Office of Public Works chose to maximize its available funds road funds by generating an NPR that favors cost-effective repairs that improve and/or maintain salvageable pavement segments. This would delay repair actions on those segments that require reconstruction or major rehabilitation; i.e., their condition cannot deteriorate much further. After the relatively good roads are “preserved,” future repairs are then directed toward the poorer, heavily traveled roads.

In order to properly plan future repairs, the software utilizes several different deterioration curves.



These pavement performance curves depict four (4) major categories relative to functional classification (arterial roads in one curve, collectors in one curve, local through roads in one curve, and local dead-end roads in another curve); and two (2) fundamental pavement systems (a curve for Hot Mix Asphalt pavements and a curve for gravel surfaces). When a road segment is evaluated as to whether it should be included in future repair programs, it deteriorates according to the applicable curve for the model duration, thereby accounting for the differential effects of traffic volume and pavement type.

Each plan year, the software prepares a future roadway condition projection, exhausts the assigned budget, and then produces an annual list of road segments to include in the repair program. The system also takes inflation into account for the time value of money. Over the past 3 – 5 years, construction costs have been relatively stable rising 2 – 2.5% annually. Rates are currently trending upwards. For the analyses herein a 2.9% inflation rate was used. Having explained the methodology built into the pavement management software, the next section describes the existing conditions on public roads in Templeton.

EXISTING CONDITIONS

3

ROADWAY MILEAGE AND CURRENT PCI

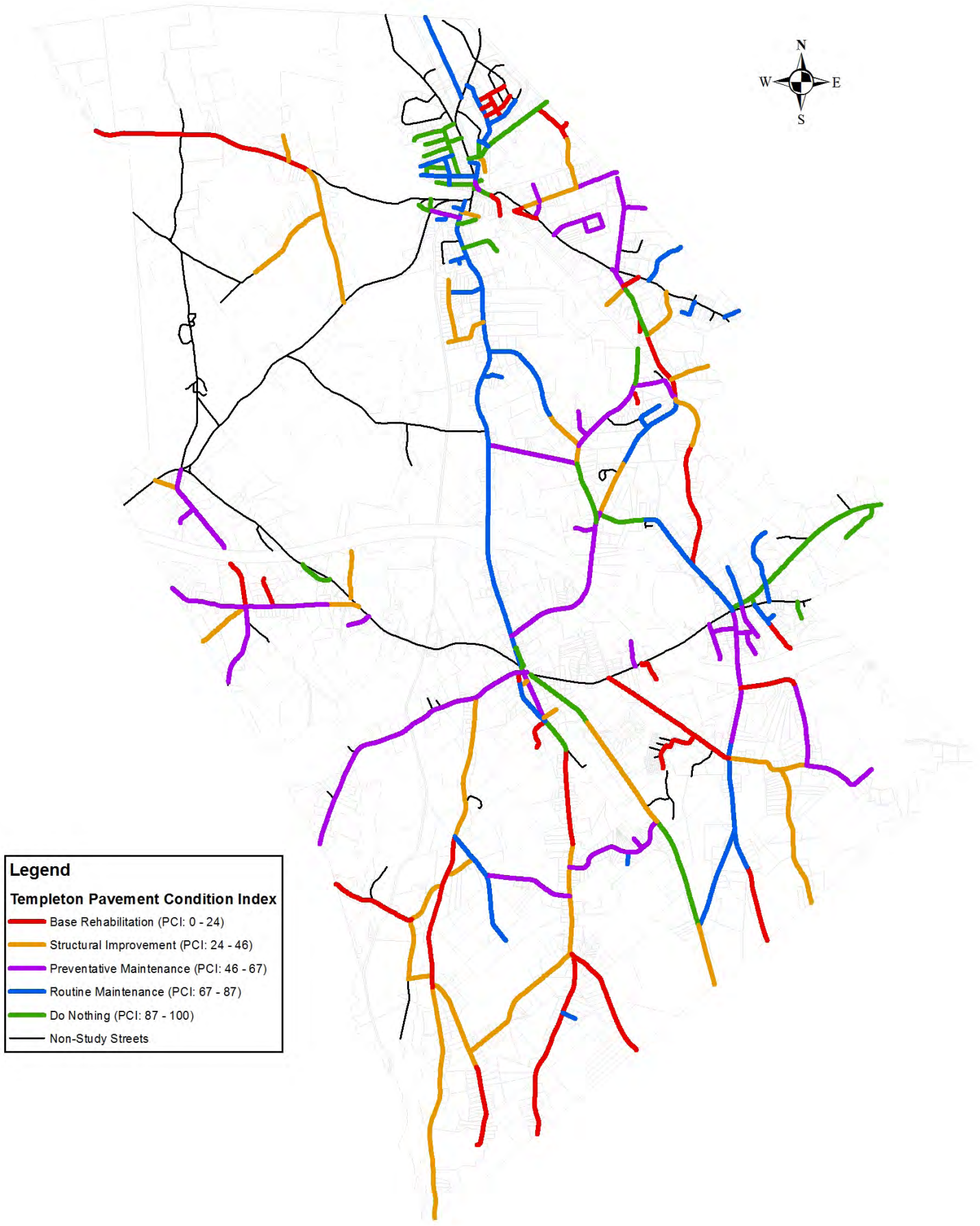
Templeton has 132 streets that make up 70.9 public miles. This public roadway system is predominantly hot mix asphalt (bituminous concrete) roadway surfaces.

Stantec identified 170 pavement management segments, and determined that the Town's average road network PCI in the Summer of 2018 was 53.7, placing Templeton's typical road conditions in the bottom of the Preventive Maintenance treatment band (PCI range from 67 to 47). This PCI average value generally represents a roadway in "fair" condition.

An average road condition in this range by definition means that sensible resources will be needed to sustain network wide road conditions as a significant portion of the network is in Preservation Maintenance. It is likely that while any proposed pavement management spending plan will strive to maximize the benefit of each dollar spent, without a pre-emptive strike the system will undoubtedly continue to lose roads from the routine and preventive maintenance category into the structural improvement and base rehabilitation treatment bands. This very costly loss will present a challenge to Templeton officials if the Town wants to retain its roads in good condition.

The map on the next page shows current pavement conditions in the town of Templeton. The following photographs illustrate examples of Templeton roadways that fall into each of the five treatment repair bands, and a roadway representative of the average town roadway condition.The photographs also show, for each treatment band, the location and the PCI value.

Townwide Pavement Conditions



PCI = 98
DO NOTHING

Bridge Street from Holman Street to Winchendon Townline

PCI = 70
ROUTINE MAINTENANCE

Winchester Street from Winchendon Road to Harris Street

PCI = 56
PREVENTIVE MAINTENANCE

Norcross Street from Highland Avenue to State Road

PCI = 38
STRUCTURAL IMPROVEMENT

Depot Road from Main Street to Graves S Entrance

PCI = 13
BASE REHABILITATION

Turner Lane from South Main Street to 2100’ E of South Main Street

TOWN AVERAGE PCI = 53.7

Main Street from State Road to 150’ S of Liberty Street

DISTRIBUTION OF PAVEMENT CONDITIONS

A categorization of the surveyed pavement segments show that 13% (9.4 miles) of the roadways fall into the “Do Nothing” band; 23% (16.4 miles) of the roads are in the “Routine Maintenance” band; 19% (13.4 miles) of the roads are in the “Preventive Maintenance” band; 28% (19.5 miles) of the roads are in need of “Structural Improvement”; and 17% (12.2 miles) of the pavement segments are in need of “Base Rehabilitation”. The distribution of treatment band miles in Templeton is in pretty rough shape as 45% of the network requires ‘Base Rehabilitation’ and ‘Structural Improvement’ band. It is vital for the Town to adapt a pavement management strategy for future years to reverse distribution of network miles.

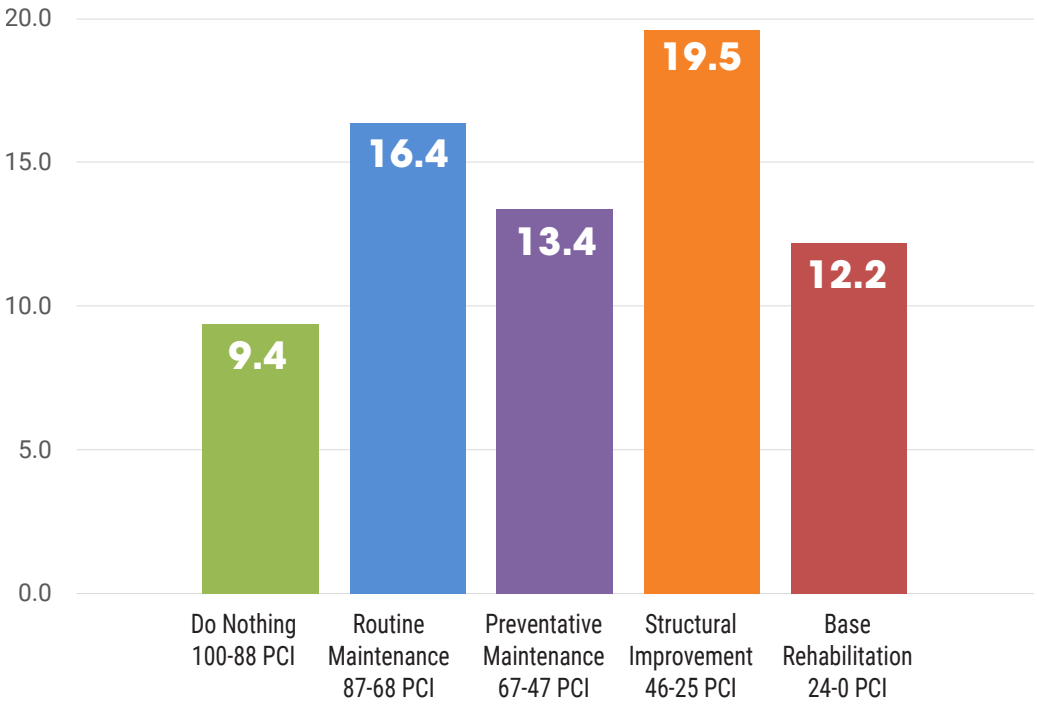


FIGURE 2 PCI Distribution in Miles by Treatment Band

For planning purposes, Base Rehabilitation type repairs range between $30-$45 per square yard, depending on the functional classification and drainage conditions. Structural overlay improvement costs range between $18-$25 per square yard, depending on the thickness of the pavement being resurfaced. Preventive maintenance costs range between $6-$12, and routine maintenance is in the $1-$2 per square yard range.

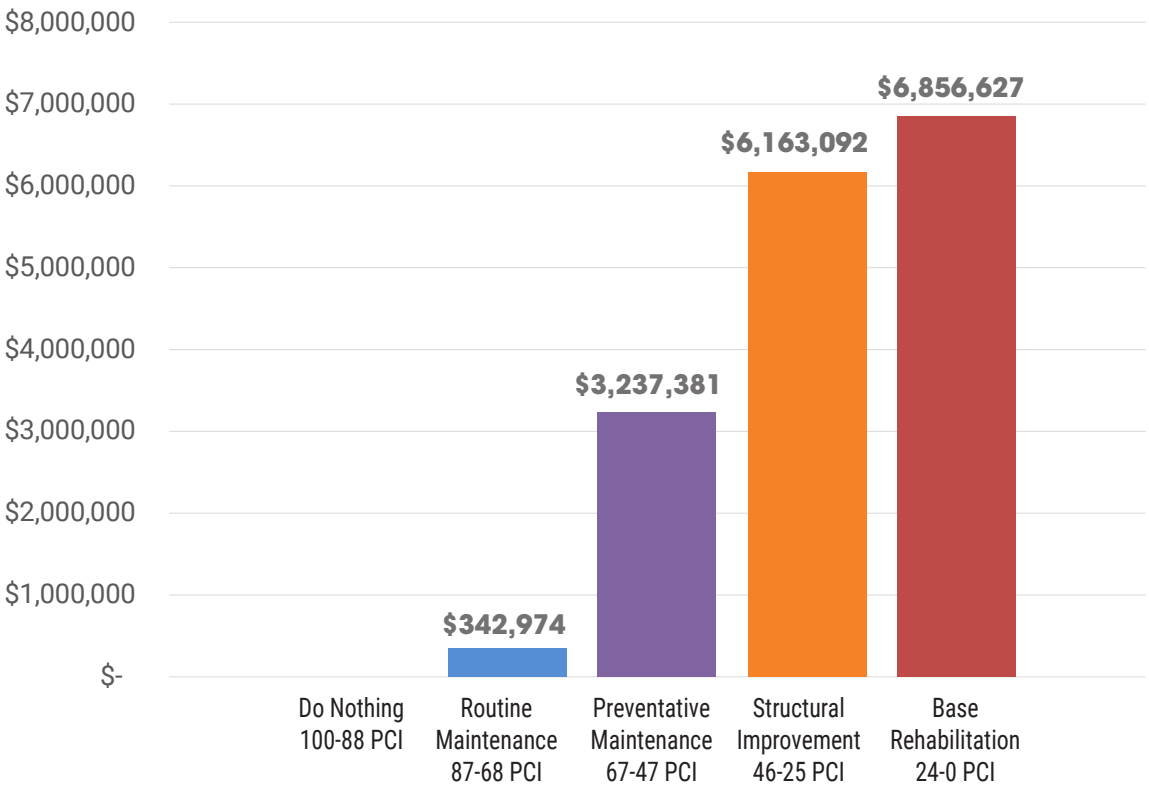
These cost ranges only represent pavement related work only, it excludes drainage, sidewalks, and other peripheral work typically addressed at the time of roadway improvement projects.

CURRENT ROADWAY BACKLOG

Backlog is defined as the cost of repairing all the roads within one year and bringing the average PCI to a near perfect 100. Backlog is a "snapshot" or relative measure of outstanding repair work. The backlog not only represents how far behind the Templeton roadway network is in terms of its present physical condition, but its cost value serves as a benchmark to measure the impact of various funding scenarios. A backlog offers a basis for comparison to future and/or past year's backlog(s). Backlog dollars represent the pavement structure only; it does not include related repair cost for sidewalk, pedestrian ramps, improvements utilities, drainage, signals, etc.

As of August 2018, Templeton's backlog of pavement repair work totaled $16,600,074. This cost estimate consists of $6,856,627 in base rehabilitation; $6,163,092 in structural improvement work; $3,237,381 in preventive maintenance, and $342,974 in routine maintenance. The figure below summarizes costs by treatment band. Note that the nearly 78% of the backlog is dedicated to expensive capital repair bands making it vital that the Town further fund its roadway improvement projects.

FIGURE 3 Dollar Backlog of Outstanding Repairs



MODEL/PLANNING PROCESS

4

BUDGET ANALYSIS

The analysis software of the pavement management system is where financial determinations and projections are made. Consideration is given to the required budget, by repair type, based on the supplied information from meetings with the Office of Public Works staff and Stantec, for overall desired roadway network conditions.

Current PCI

53.7 Preventative Maintenance

A **regressive** spending program occurs when insufficient funds are invested in road repairs, resulting in an ever-increasing repair backlog. An **equilibrium** program spends just enough money each year to keep the average PCI stable. A **progressive** program provides sufficient improvement funds to result in a reduction of the backlog over time. Various scenarios were analyzed for Templeton to measure the effects of alternative funding levels, and to determine the funding needed to avoid regressive spending. The following scenarios are compared to today's current backlog (**$16,600.074**), along with the average PCI of 53.7 for the road network.

The planning process determines the most beneficial improvement plan based on the dollars available for each repair type and other factors. Pavement management pulls together these components in its Network Priority Ranking (NPR) value in order to develop a cost-effective program. As previously stated, the NPR was configured to maximize roadway funds. In all of the following model projections (except the Historical Budget Worst-First), the power of the software was used to allocate funding amounts by best NPR value, based on the pavement management theory. Pavement management theory recognizes that roads deteriorate in an accelerated fashion after the first 75% of their service life and consequently, programs timely road expenditures to avert far more costly and widespread repairs.

SCENARIO FINDINGS

What follows is an overview of the budget/planning model results. Five budget/planning scenarios were modeled:

- Zero Budget Scenario
- Historical Budget (Worst First)
- Historical Budget (Pavement Management Strategy)
- Equilibrium (Maintain PCI) Funding Scenario
- Progressive Funding Scenario

After establishing Templeton's current backlog of work, Stantec projected the network average pavement condition index and backlog at a zero annual appropriation rate for ten years; the expected historical appropriation rate for ten years with a priority on repairing the worst streets first; and the same historical allotment with a priority on repairing the best streets first; then a ten year scenario showing funding levels needed to maintain the current PCI; and finally, the impact of a progressive ten year funding scenario.

All the scenarios accounted the "optimum" NPR with the exception of the Historical Budget (Worst First) where NPR focuses on repairing the worst segments first. The dollar amounts appropriated incorporate a 2.90% annual inflation rate. **Therefore, where the annual roads program appropriation appears to remain the same, it in fact represents a net budget decrease due to the impact of inflation.**

In the scenario specific summary tables that follow, each plan begins with the same network average PCI, and then shows the new network average PCI at the end of each plan period. The tables also uses the same amount of outstanding repair work (current backlog) at the start of each plan period, so the first plan year backlog will appear the same for each of the scenarios. The successive years document the impact of the funding plan in comparison of road network average conditions and backlog.

ZERO BUDGET SCENARIO

In recent history, funding for Templeton road repairs has come primarily from State Aid sources. Given the unreliability of consistent State funding, a worst-case scenario was developed to show how severely the Town would be impacted, over a ten-year period, by not funding any road repairs.

TABLE 2 Zero Budget

In a ten-year period, the scenario shows that with no road maintenance

YEAR	FUNDING	PCI LEVEL	BACKLOG
Present		53.6	$16,600,074
FY 2020	$0	50.0	$18,616,630
FY 2021	$0	45.4	$21,495,851
FY 2022	$0	40.9	$24,260,699
FY 2023	$0	36.9	$27,924,282
FY 2024	$0	33.2	$31,366,947
FY 2025	$0	29.8	$34,074,855
FY 2026	$0	26.8	$37,901,506
FY 2027	$0	24.2	$41,854,545
FY 2028	$0	21.8	$46,236,643
FY 2029	$0	19.7	$52,842,041

funding, the network average PCI dropped from a PCI of 54 (the bottom of the Preventive Maintenance band) down to a PCI of 20 (the top of the Base Rehabilitation band). Further, the numbers show the repair backlog is nearly 3 times the original backlog of $16.6 million at $52.8 million. The system-wide deterioration was dramatic because the concentration of roads in the Preventive Maintenance band quickly slipped into the Structural Improvement type repairs, and roads in the Structural Improvement band fell into the most expensive repair band, the Base Rehabilitation treatment range. This is regressive spending at its worst and this level of deterioration would not be expected to occur.

HISTORICAL BUDGET (WORST FIRST)

Stantec met with Templeton's Public Works staff to review historic funding levels and decided to use $330k/year as the Historical Budget for future scenarios.

The Historical Budget (Worst First) scenario prioritized the worst street segments first, since these represent most citizen complaints and repair requests.

TABLE 3 Historical Budget (Worst-First)

The network average PCI dropped from a PCI of 54 (the bottom of the

YEAR	FUNDING	PCI LEVEL	BACKLOG
Present		53.6	$16,600,074
FY 2020	$330,000	51.0	$18,287,161
FY 2021	$330,000	47.7	$20,637,186
FY 2022	$330,000	44.2	$23,032,928
FY 2023	$330,000	41.2	$25,754,908
FY 2024	$330,000	38.7	$28,358,338
FY 2025	$330,000	36.5	$30,563,699
FY 2026	$330,000	34.4	$33,387,644
FY 2027	$330,000	32.7	$36,430,000
FY 2028	$330,000	31.3	$39,762,789
FY 2029	$330,000	30.0	$44,346,403

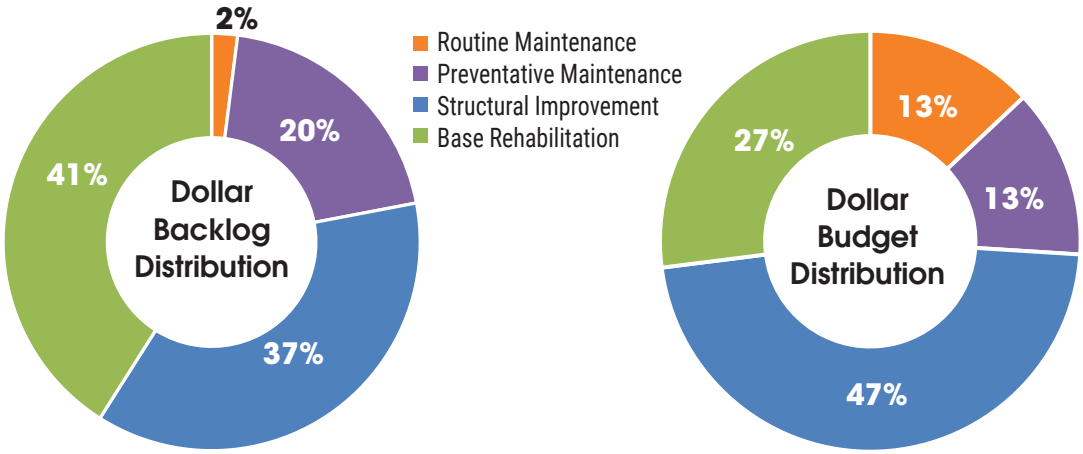
Preventive Maintenance band) down to a PCI of 30 (the middle of the Structural Improvement band). If this funding level remains unchanged, by the year 2029, the present backlog of $16,600,074 will have grown to $44,346,403 in the tenth year of the projection. This reflects a serious regressive spending program.

HISTORICAL BUDGET (PAVEMENT MANAGEMENT STRATEGY)

This Historical Budget uses the same funding level as the previous scenario, except it utilizes Pavement Management Strategies to optimize the budget. The following strategies are used to optimize budget:

1 Create budget allocations based on the percentage of current miles and backlog costs dedicated for each treatment band. This strategy helps the Town understand how the miles are distributed and allocates funds to ensure negative trends do not occur over time. For this budget the following allocations were used:

FIGURE 4 Backlog Distribution vs. Budget Allocation



As can be seen, a higher percentage was emphasized in Routine Maintenance, Structural Improvement, and Base Rehabilitation, and a lower percentage relative to the total backlog was spent on Preservation Maintenance. While 13% of the budget is a sufficient portion to dedicate to Preservation Maintenance, this percentage can increase with time once the Town finds a successful treatment with good return on value. The Pavement Management strategy helps ensure that not only the “fair” segments (Preventative Maintenance) are treated, but more segments get resurfaced (Structural Improvement) before they get into the Base Rehabilitation treatment band.

2 In order to get the most of the allocations - a worst-first approach is used within each budget allocation. This strategy is employed to utilize the budget to select segments which are on the verge of falling into more expensive treatment bands. By treating these segments now- the Town saves money based on the potential unit cost jump each segment would require.

3 Create a Network Priority Ranking (NPR) system which will prioritize "good" roads but also take into account factors such as 'Functional Classification' and 'Traffic' to ensure road segments that are more frequently traveled on get attended to first.

By addressing this pavement management philosophy and deferring the "poorer" roads, the network average PCI still regresses significantly, but is 9 points higher than the Worst-First approach. More importantly, by simply changing repair strategy – reallocating budget towards cost-effective repairs, at the end of this ten-year scenario, theoretically the town will have saved nearly $4.2 million dollars (note: the backlog difference in FY 2029) by adhering to the pavement management concept.

TABLE 4 Historical Budget (Pavement Management Strategy)

YEAR	FUNDING	PCI LEVEL	BACKLOG
Present		53.7	$16,600,074
FY 2020	$330,000	52.2	$18,299,291
FY 2021	$330,000	49.7	$20,184,659
FY 2022	$330,000	41.0	$22,121,506
FY 2023	$330,000	45.2	$24,275,413
FY 2024	$330,000	44.3	$26,199,628
FY 2025	$330,000	42.8	$27,620,059
FY 2026	$330,000	41.3	$30,946,268
FY 2027	$330,000	40.0	$33,260,690
FY 2028	$330,000	38.8	$36,097,689
FY 2029	$330,000	37.9	$40,160,761

While this budget represents regressive spending, the scenario illustrates the importance of not directing roadway funds towards the worst streets, but rather "preservation" maintenance repair types such as crack sealing and surface treatments. It is important to note that even with the best use of the current budget, the PCI still drops 15 points into "poor conditions'. This trend shows that current funding is not enough to prevent segments from dropping to more expensive treatment bands resulting in an exponentially growing backlog.

Figure 5 shows the histogram of current network conditions broken down by 5 PCI points to further demonstrate the need to increase funding on the road network.

FIGURE 5 PCI Histogram of Network Conditions

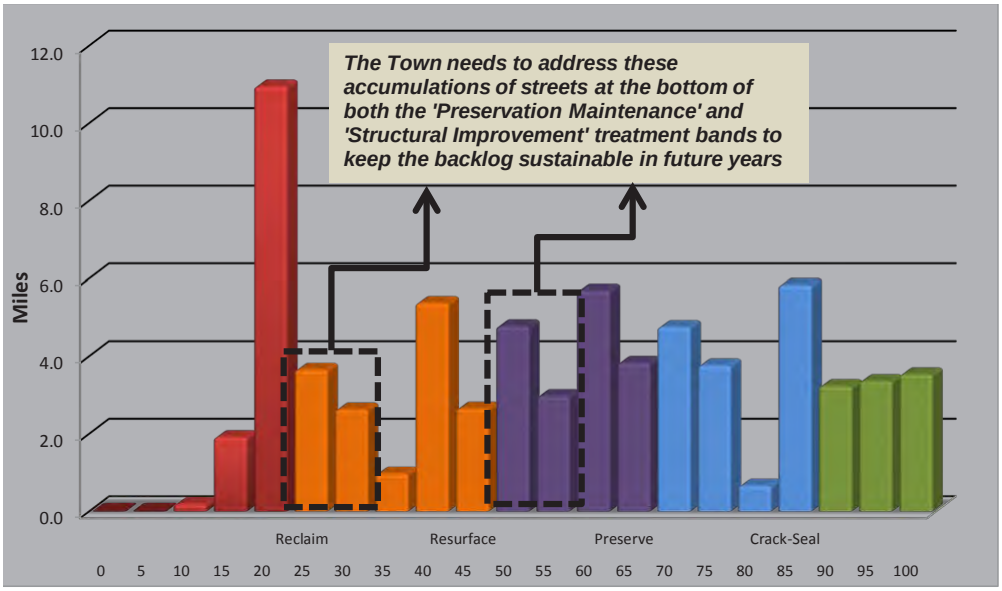


Figure 5 shows why Templeton is in such a critical time from a pavement management standpoint. Templeton currently has a good distribution of miles trending higher towards the 'Do Nothing' treatment band. The majority of the Town's road network requires 'Preservation Maintenance' with still a substantial amount of mileage dedicated to Capital Construction.

In order for the Town to maintain this distribution, it is vital to sufficiently fund the mileage at the bottom of both the 'Structural Improvement' and 'Preservation Maintenance' treatment band to prevent roadways from deteriorating into more expensive treatment bands and thus inflating the backlog - as shown in the dashed boxes in Figure 5.

EQUILIBRIUM FUNDING SCENARIO

Recognizing that an increase in local dollars will be needed to maintain Town-wide road conditions, a scenario that would keep the PCI at today's levels over a ten-year time period, was evaluated.

This alternative would perform cost-effective repair work identified by existing conditions to maintain the current network conditions. The work would be done over a ten-year period, costing $11,000,000 of which would require $1,100,000 per year.

TABLE 5 Maintain PCI Funding Scenario

YEAR	FUNDING	PCI LEVEL	BACKLOG
Present		53.7	$16,600,074
FY 2020	$1,100,000	53.7	$17,637,918
FY 2021	$1,100,000	53.3	$18,802,724
FY 2022	$1,100,000	52.9	$19,487,913
FY 2023	$1,100,000	53.6	$20,327,368
FY 2024	$1,100,000	53.7	$20,653,510
FY 2025	$1,100,000	53.7	$20,890,467
FY 2026	$1,100,000	54.4	$22,334,591
FY 2027	$1,100,000	56.1	$23,375,241
FY 2028	$1,100,000	56.8	$24,879,950
FY 2029	$1,100,000	57.3	$25,944,579

This funding would allow the Town to spend sufficiently on streets in need of capital repair, while also maintaining a preservation and routine maintenance program. With the PCI finishing slightly higher than current levels, 57 (in the middle of the Preservation Maintenance band), and the backlog of repair work only increasing $9 million over the next ten years, this scenario represents how much the Town should strive to spend at a minimum.

By spending $7.25 million dollars more over ten years than the current budget, this scenario allows for a more aggressive resurfacing program which leads to fewer segments in the 'Base Rehabilitation' treatment band, and a backlog which is over $68 million less after 10 years compared to the historical budget.

PROGRESSIVE FUNDING SCENARIO

Lastly, a scenario to improve system wide conditions was investigated. This scenario looks at spending the $18,000,000 over the next ten years. As can be seen from the table below, the conditions of the network improve to 72, which is the bottom of the Routine Maintenance treatment band, while the backlog decreases by nearly $2.5 million dollars.

TABLE 6 Progressive Funding Scenario

YEAR	FUNDING	PCI LEVEL	BACKLOG
Present		53.7	$16,600,074
FY 2020	$1,800,000	55.8	$16,827,700
FY 2021	$1,800,000	56.8	$17,339,085
FY 2022	$1,800,000	57.6	$16,986,352
FY 2023	$1,800,000	59.9	$16,221,735
FY 2024	$1,800,000	62.1	$15,892,470
FY 2025	$1,800,000	63.6	$15,217,755
FY 2026	$1,800,000	66.7	$14,838,795
FY 2027	$1,800,000	69.2	$14,364,252
FY 2028	$1,800,000	70.6	$14,455,447
FY 2029	$1,800,000	71.9	$14,198,301

The Town would benefit with a PCI improvement of 18 points and a significant backlog reduction.

SUMMARY OF ROADWAY FUNDING SCENARIOS

FIGURE 6 Average PCI

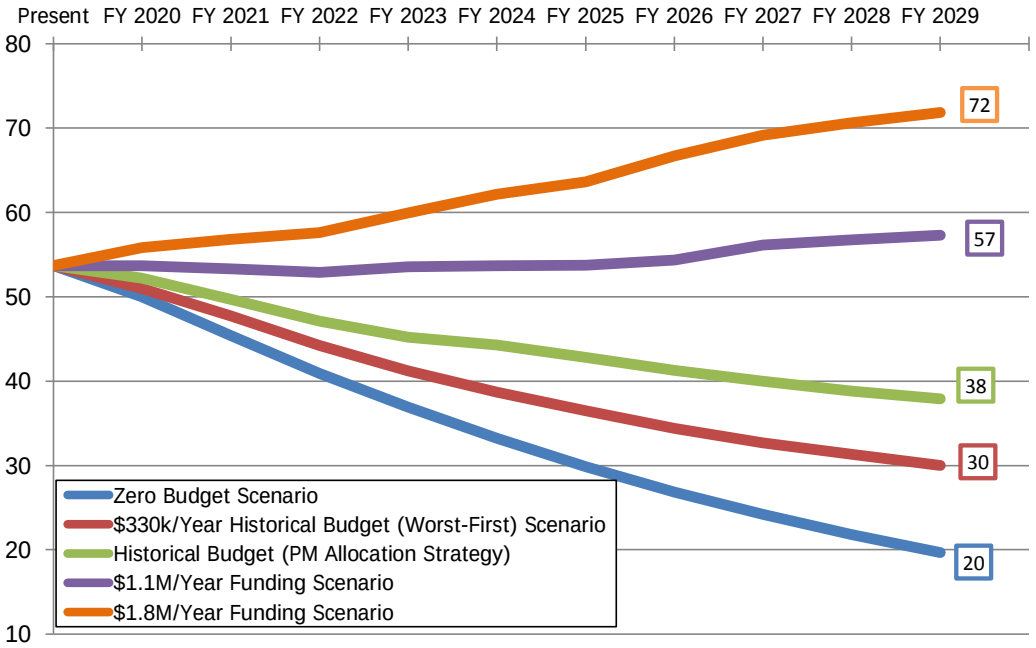
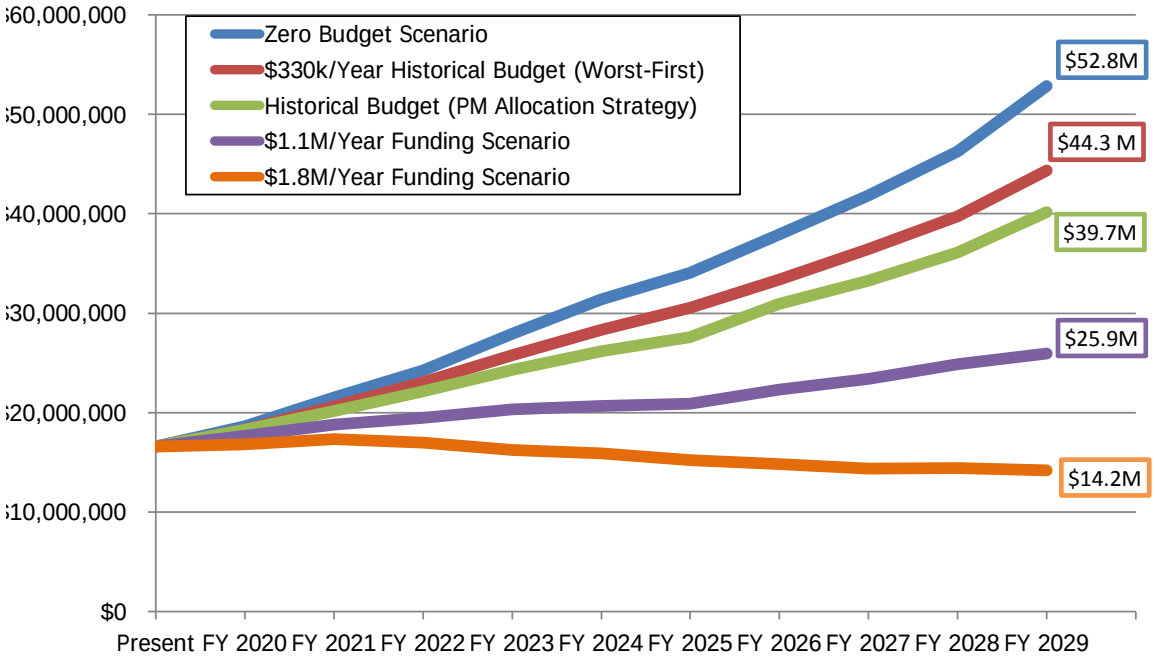


FIGURE 7 Future Backlog




HOT
3257
29062

CONCLUSION 5

RECOMMENDED PLAN OF ACTION

The overall roadway network in the Town of Templeton is currently in fair to poor condition. This study shows that the Town is in a critical point from a pavement management persective and future diligence will be necessary to improve Town-wide pavement conditions.

The findings in this report illustrate current funding levels are low and will not prevent expected roadway deterioration unless additional funding beyond Chapter 90 apportionment is budgeted. Future roadway funding levels need to be increased, as Templeton's annual budget needs to include an aggressive maintenance program for its currently fair condition streets, while also addressing extensive structural and base rehabilitation needs. Additionally, it is recommended that roads be reviewed each year to confirm that deterioration is occurring at the expected computer model rates. Based on these reviews and inspections, an update to the pavement management software will provide the Town with a better understanding of its roadway degradation and confirmation of appropriate funding needs to prevent it.

If pre-emptive action is not taken, the large mileage of streets currently in need of routine and preventive maintenance will rapidly digress to poorer conditions that would subject the Town to far more expensive roadway work. Today's roadway network currently sits at the "critical point" where the window of opportunity to perform cost-effective and major capital roadway repairs is presented.

The unit cost price for repairing segments increases drastically as the treatment bands worsen. For example, it is almost twice as expensive to repair segments in the 'Structural Improvement' band compared to those in the 'Preservation Maintenance' band. An optimum pavement management strategy was considered in which segments are treated at the most ideal time within each treatment band. This strategy recognizes which segments are on the verge of multiplying in repair expense and treats them to maximize taxpayer dollars. In executing this strategy, Stantec recognized that Templeton's current budget is not sufficient to treat enough of these segments and too many are seeping into the more expensive treatments. It is because of this that Stantec recommends that the Town should strive to secure $18,000,000 for the next ten years, to address its roadway backlog, as found in the **Progressive Funding Scenario,** and gain control of its deteriorating roadways. Also, the Town should continue keeping abreast of the latest developments in pavement restoration technology that might offer a more cost-effective alternative to pavement maintenance or rehabilitation over the pavement's life cycle.

It's easy to forget that pavements are of a community's single largest asset. The Town has a major investment in its 71-mile public roadway network. Simply considering the pavement surface alone, without water, sewer, drainage, curbing, or sidewalks assets, it would cost Templeton almost $50,000,000 in today's dollars to completely replace the existing pavement infrastructure. Pavements are not perpetual, they're one of the Town's fastest deteriorating assets, due to environmental effects, increased traffic loading, and utility cuts.

Additional roadway funding will protect Templeton's pavement assets, resulting in better overall roadway conditions, and satisfaction that taxpayer dollars have been well spent.

$$$

It is almost **twice as expensive** to repair segments in the 'Structural Improvement' band compared to those in the 'Preservation Maintenance' band

FUTURE PAVEMENT MANAGEMENT

Pavement management is a systematic process that needs the long-term commitment of Town decision-makers and support of practitioners to adopt a pavement management plan.

- Begin to explore borrowing/bonding money to fund an affordable and effective roadway improvement program that funds both maintenance and capital improvement projects. Road maintenance on roads in "good" condition cost less to maintain.
- Institute a regular drainage maintenance program that focuses on cutting back sand buildup at the edge of roads, re-establishing drainage swales to low points, and ensuring debris free catch basins and pipes.

  During our survey it well noted that annual sweeping of winter sand was deficient. Remants of sand was evident well after the spring season. Furthermore, nearly 30% of drainage conditions found on Templeton roadways attributed to accelerated pavement deterioration, i.e. lack of shedding/blockage of positive water runoff, and erosion of shoulders.

- Explore low cost base rehabilitation treatments such as asphalt stabilized base, leveling and chip seals.
- Post all annual pavement management segment improvements into the database. Re-inspect roadways every 3 years, or 1/3rd annually.
- Add any new roadways to the database as soon as the Town accepts them. Pavement and roadside data can be added as it becomes available.
- Implement a sound departmental quality control/assurance program, with particular focus on major pay items such as hot mix asphalt.

Stantec can support this proposed action plan using our transportation expertise and talents. In summary, the pavement management system should serve as a valuable tool to the Town of Templeton and to Templeton decision-makers in their pro-active approach to managing Templeton's roadways.

APPENDIX A

Public Roadway Backlog

ID	Street	From	To	PavementClassification	Length	PCI	NPR	Plan Activity	Cost
1	ALBERT DRIVE	OTTER RIVER ROAD	CUL-DE-SAC	BC - Bituminous Concrete	1360	71.5	32.6	BC - Crack Seal	$ 4,483
1016	ALEXANDRIA AVENUE	BALDWINVILLE ROAD	DEAD END	BC - Bituminous Concrete	754	69.6	33.2	BC - Crack Seal	$ 2,918
1027	APRIL CIRCLE	LORD ROAD	END	BC - Bituminous Concrete	539	18.5	48.9	BC - 2" Mill & Overlay Local	$ 27,721
4	BAKER LANE	PATRIOTS ROAD	DEAD END	BC - Bituminous Concrete	673	99	24.1	Do Nothing	$ -
171	BALDWIN DRIVE	STATE ROAD	BALDWIN DRIVE	BC - Bituminous Concrete	3565	59.1	48	BC - 1-1/2" Mill & Overlay	$ 175,596
5	BALDWINVILLE ROAD	MAPLE STREET	RTE 2 OVERPASS	BC - Bituminous Concrete	13622	81.9	56.4	BC - Crack Seal	$ 64,432
5.1	BALDWINVILLE ROAD	RTE 2 OVERPASS	PATRIOTS ROAD	BC - Bituminous Concrete	5215	83.2	55.9	BC - Crack Seal	$ 24,667
6	BAPTIST COMMON ROAD	BALDWINVILLE ROAD	LORD ROAD	BC - Bituminous Concrete	3586	66.2	45.8	BC - 1-1/2" Mill & Overlay	$ 176,631
7	BARRE ROAD	PETERSHAM ROAD	COOK ROAD	BC - Bituminous Concrete	5600	41.2	68.9	BC - 3" Overlay Art/Col	$ 491,288
7.1	BARRE ROAD	COOK ROAD	GRAY ROAD	BC - Bituminous Concrete	5975	19.6	75.5	BC - Reclaim Art	$ 888,874
7.2	BARRE ROAD	GRAY ROAD	HUBBARDSTON TOWN LINE	BC - Bituminous Concrete	9181	36	70.5	BC - 3" Overlay Art/Col	$ 805,449
8	BEECH STREET	WINCHESTER STREET	GRAVES AVENUE	BC - Bituminous Concrete	1247	17	60.9	BC - Reclaim Local	$ 108,029
9	BOYNTON ROAD	BALDWINVILLE ROAD (N)	BALDWINVILLE ROAD (S)	BC - Bituminous Concrete	913	98.9	35.7	Do Nothing	$ -
10	BRANCH LANE	COTTAGE LANE	DEAD END	BC - Bituminous Concrete	328	85.3	28.4	Do Nothing	$ -
172	BRANDIN DRIVE	RICE ROAD W	CUL-DE-SAC	BC - Bituminous Concrete	772	63.8	35	BC - 1-1/2" Mill & Overlay	$ 35,100
1013	BRENDA LANE	HIGHLAND AVE	DEAD END	BC - Bituminous Concrete	680	66.4	45.7	BC - 1-1/2" Mill & Overlay	$ 33,494
12	BRIDGE STREET	ELM STREET	HOLMAN STREET	BC - Bituminous Concrete	390	92.8	49.2	Do Nothing	$ -
12.1	BRIDGE STREET	HOLMAN STREET	WINCHENDON TOWN LINE	BC - Bituminous Concrete	3433	99.9	47	Do Nothing	$ -
13	BROOKS ROAD	BALDWINVILLE ROAD	ENTRANCE	BC - Bituminous Concrete	3870	73.6	43.5	BC - Crack Seal	$ 13,868
13.1	BROOKS ROAD	ENTRANCE	LORD ROAD	BC - Bituminous Concrete	1653	26.2	58.1	BC - 2" Overlay Local	$ 89,997
14	BROOKS VILLAGE ROAD	RICE ROAD	1250' W OF PATRIOTS ROAD	BC - Bituminous Concrete	3215	58.3	48.2	BC - 1-1/2" Mill & Overlay	$ 146,175
14.1	BROOKS VILLAGE ROAD	1250' W OF PATRIOTS ROAD	PATRIOTS ROAD	BC - Bituminous Concrete	1250	45.6	52.1	BC - 2" Overlay Local	$ 65,333
15	CARDINAL LANE	MAIN STREET	DEAD END	BC - Bituminous Concrete	514	18.9	48.8	BC - 2" Overlay Local	$ 16,791
1020	CARRUTH ROAD	QUEEN LAKE ROAD	TOWN LINE	BC - Bituminous Concrete	3006	59	48	BC - 1-1/2" Mill & Overlay	$ 125,283
16	CEDAR DRIVE	PROSPECT STREET	DEAD END	BC - Bituminous Concrete	501	69.3	33.3	BC - Crack Seal	$ 1,580
17	CENTRAL STREET	ELM STREET	STATE ROAD	BC - Bituminous Concrete	800	99.8	50.8	Do Nothing	$ -
19	CHERRY STREET	FESSENDEN STREET	PLEASANT STREET	BC - Bituminous Concrete	473	98.7	35.8	Do Nothing	$ -
20	CHESTNUT STREET	WINCHESTER STREET	GRAVES AVENUE	BC - Bituminous Concrete	1186	16.3	61.2	BC - Reclaim Local	$ 140,106
22	CHURCH HILL ROAD	PATRIOTS ROAD	DEAD END	BC - Bituminous Concrete	1828	34.4	44	BC - 2" Overlay Local	$ 71,658
23	CIRCLE STREET	ELM STREET (N)	ELM STREET (S)	BC - Bituminous Concrete	1015	70.7	44.4	BC - Crack Seal	$ 3,928
1014	CIRCLE STREET #1	ELM STREET	CENTRAL STREET	BC - Bituminous Concrete	368	55.2	60.7	Art/Col	$ 24,315
24	CLAIRE AVENUE	CHESTNUT STREET	WALNUT STREET	BC - Bituminous Concrete	993	9.42	63.3	BC - Reclaim Local	$ 117,306
25	COLUMBUS AVENUE	CHERRY STREET	SUMMER STREET	BC - Bituminous Concrete	816	88	39.1	Do Nothing	$ -
26	CONTI AVENUE	LAKE AVENUE	SOUTH MAIN STREET	BC - Bituminous Concrete	940	59.3	47.9	BC - 1-1/2" Mill & Overlay	$ 40,958
27	COOK ROAD	BARRE ROAD	HASKELL ROAD	BC - Bituminous Concrete	1924	75.1	43	BC - Crack Seal	$ 5,515
27.1	COOK ROAD	HASKELL ROAD	SOUTH ROAD	GR - Gravel	3452	48.5	39.7	GR - New Gravel	$ 30,631
28	COTTAGE LANE	PATRIOTS ROAD	150' S OF BRANCH LANE	BC - Bituminous Concrete	915	85.5	39.9	BC - Crack Seal	$ 2,492
28.1	COTTAGE LANE	150' S OF BRANCH LANE	CUL-DE-SAC	BC - Bituminous Concrete	1282	19	48.8	BC - 2" Overlay Local	$ 53,046
29	COTTAGE STREET	BALDWINVILLE ROAD	DEAD END	BC - Bituminous Concrete	691	35.7	43.6	BC - 2" Mill & Overlay Local	$ 33,923
30	CROSS ROAD	SOUTH MAIN STREET	HUBBARDSTON ROAD	BC - Bituminous Concrete	4061	68.3	56.7	BC - Crack Seal	$ 13,970
31	CROTTY AVENUE	STATE ROAD	WINCHENDON TOWN LINE	BC - Bituminous Concrete	1919	81	41.2	BC - Crack Seal	$ 7,151
32	DAVIS STREET	STATE RD	DEAD END	BC - Bituminous Concrete	1000	17.9	60.7	BC - Reclaim Local	$ 74,818
33	DENNISON STREET	WINCHENDON ROAD	END OF PAVEMENT	BC - Bituminous Concrete	3439	70.8	44.4	BC - Crack Seal	$ 8,873
34	DEPOT ROAD	MAIN STREET	GRAVES S ENTRANCE	BC - Bituminous Concrete	2290	37.7	66.1	BC - 3" Overlay Art/Col	$ 168,498
34.1	DEPOT ROAD	GRAVES S ENTRANCE	NORTH MAIN STREET	BC - Bituminous Concrete	4876	23.9	70.3	BC - 3" Overlay Art/Col	$ 358,776

Public Roadway Backlog

ID	Street	From	To	PavementClassification	Length	PCI	NPR	Plan Activity	Cost
37	DRURY LANE	PATRIOTS ROAD (W)	PATRIOTS ROAD (E)	BC - Bituminous Concrete	1298	97.9	36	Do Nothing	$ -
38	DUDLEY ROAD	PATRIOTS ROAD	BARRE ROAD	BC - Bituminous Concrete	2297	61	62.8	BC - Crack Seal	$ 10,536
39	EDGAR STREET	BRIDGE STREET	DEAD END	BC - Bituminous Concrete	758	42.4	41.6	BC - 2" Overlay Local	$ 33,015
42	EXCHANGE STREET	CIRCLE STREET	DEAD END	BC - Bituminous Concrete	271	98.5	24.3	Do Nothing	$ -
43	FARNSWORTH ROAD	SOUTH ROAD	GRAY ROAD	BC - Bituminous Concrete	5660	39.1	54.1	BC - 2" Overlay Local	$ 246,524
1017	FERN STREET	BALDWINVILLE ROAD	CUL-DE-SAC	BC - Bituminous Concrete	1738	40.7	53.6	BC - 2" Overlay Local	$ 102,194
45	FESSENDEN STREET	FOREST STREET	DEAD END	BC - Bituminous Concrete	1316	86.4	39.6	BC - Crack Seal	$ 4,150
48	FISHER STREET	ELM STREET	DEAD END	BC - Bituminous Concrete	1730	98.9	24.2	Do Nothing	$ -
49	FOREST STREET	FISHER STREET	PLEASANT STREET	BC - Bituminous Concrete	1924	94.3	37.2	Do Nothing	$ -
51	FRENCH ROAD	SOUTH ROAD	HUBBARDSTON TOWN LINE	BC - Bituminous Concrete	4613	17.2	60.9	BC - Reclaim Local	$ 381,464
52	GARDNER ROAD	NORTH MAIN STREET	GARDNER TOWN LINE	BC - Bituminous Concrete	7281	89.3	38.7	Do Nothing	$ -
1024	GARY ROAD	VICTORIA LANE	CUL-DE-SAC	BC - Bituminous Concrete	480	66.4	34.2	BC - Crack Seal	$ 1,926
53	GAVINS ROAD	ROYALSTON ROAD	DEAD END	BC - Bituminous Concrete	1022	26.3	46.5	BC - 2" Overlay Local	$ 48,965
54	GRANDVIEW TERRACE	SOUTH ROAD	DEAD END	BC - Bituminous Concrete	583	26.7	46.4	BC - 2" Overlay Local	$ 27,932
56	GRAY ROAD	BARRE ROAD	650' S OF FARNSWORTH ROAD	BC - Bituminous Concrete	3733	29.4	57.1	BC - 2" Overlay Local	$ 195,112
56.1	GRAY ROAD	650' S OF FARNSWORTH ROAD	DEAD END	BC - Bituminous Concrete	3163	16.8	61	BC - Reclaim Local	$ 298,925
58	GROVE STREET	MAPLE STREET	PROSPECT STREET EXTENSION	BC - Bituminous Concrete	438	98.7	35.8	Do Nothing	$ -
59	HAMLET MILL ROAD	MAIN STREET	STATE ROAD	BC - Bituminous Concrete	2124	26.1	58.1	BC - 2" Overlay Local	$ 106,389
60	HAPPY HOLLOW ROAD	OLD WINCHENDON ROAD	WINCHENDON TOWN LINE	BC - Bituminous Concrete	832	56.2	48.9	BC - 1-1/2" Mill & Overlay	$ 34,676
1021	HARLEY HILL ROAD	BARRE ROAD	COOK ROAD	BC - Bituminous Concrete	1234	40.4	53.7	BC - 2" Overlay Local	$ 48,373
61	HARRIS STREET	HOLMAN STREET	BRIDGE STREET	BC - Bituminous Concrete	408	71.4	44.2	BC - Crack Seal	$ 1,754
62	HASKELL ROAD	COOK ROAD	DEAD END	GR - Gravel	2761	82.9	17.6	GR - Grade	$ 11,105
64	HENSHAW ROAD	BARRE ROAD (N)	BARRE ROAD (S)	BC - Bituminous Concrete	5152	24.6	58.6	BC - 2" Overlay Local	$ 269,278
65	HIGH STREET	WINTER STREET	DEAD END	BC - Bituminous Concrete	903	65.2	34.6	BC - Crack Seal	$ 2,847
66	HIGHLAND AVENUE	STATE ROAD	HOSPITAL ROAD	BC - Bituminous Concrete	2253	27	57.9	BC - 2" Overlay Local	$ 112,850
66.1	HIGHLAND AVENUE	HOSPITAL ROAD	WINCHENDON TOWN LINE	BC - Bituminous Concrete	1684	54	49.5	BC - 1-1/2" Mill & Overlay	$ 73,376
1015	HIGHLAND STREET	STATE ROAD	DAVIS STREET	BC - Bituminous Concrete	324	18.5	60.5	BC - Reclaim Local	$ 25,517
68	HOLMAN STREET	HARRIS STREET	BRIDGE STREET	BC - Bituminous Concrete	605	90.9	38.2	Do Nothing	$ -
69	HOSPITAL ROAD	BRIDGE STREET	400' S OF SHAW ROAD	BC - Bituminous Concrete	1650	17.7	60.7	BC - Reclaim Local	$ 155,936
69.1	HOSPITAL ROAD	400' S OF SHAW ROAD	HIGHLAND AVENUE	BC - Bituminous Concrete	2550	39.3	54.1	BC - 2" Overlay Local	$ 133,280
70	HUBBARDSTON ROAD	PATRIOTS ROAD	3000' S OF PATRIOTS ROAD	BC - Bituminous Concrete	2905	92.9	49.1	Do Nothing	$ -
70.1	HUBBARDSTON ROAD	3000' S OF PATRIOTS ROAD	VICTORIA LANE	BC - Bituminous Concrete	4700	42.7	64.6	BC - 3" Overlay Art/Col	$ 332,525
70.2	HUBBARDSTON ROAD	VICTORIA LANE	CROSS ROAD	BC - Bituminous Concrete	4380	93	49.1	Do Nothing	$ -
70.3	HUBBARDSTON ROAD	CROSS ROAD	HUBBARDSTON TOWN LINE	BC - Bituminous Concrete	2383	33.2	67.5	BC - 3" Overlay Art/Col	$ 168,597
71	JOHNSON AVENUE	PATRIOTS ROAD	DEAD END	BC - Bituminous Concrete	1006	59.8	36.2	BC - 1-1/2" Mill & Overlay	$ 47,645
74	LADDER HILL TERRACE	PATRIOTS ROAD	DEAD END	BC - Bituminous Concrete	1011	18.4	49	BC - 2" Overlay Local	$ 52,842
75	LAKE AVENUE	PATRIOTS ROAD	DEAD END	BC - Bituminous Concrete	1435	58.4	36.7	BC - 1-1/2" Mill & Overlay	$ 62,526
76	LAMB CITY ROAD	PATRIOTS ROAD	RICE ROAD	GR - Gravel	935	35.4	43.7	Improvement	$ 11,062
77	LAMONT STREET	MOUNTAIN VIEW STREET	DEAD END	BC - Bituminous Concrete	170	75.1	31.5	BC - Crack Seal	$ 487
1019	LEDGE DRIVE	BALDWINVILLE ROAD	WARE DRIVE	BC - Bituminous Concrete	1341	67.8	45.3	BC - 1-1/2" Mill & Overlay	$ 68,592
79	LIBERTY STREET	DEPOT ROAD	DEAD END	BC - Bituminous Concrete	959	31.1	45	BC - 2" Overlay Local	$ 37,593
80	LORD ROAD	OTTER RIVER ROAD	BAPTIST COMMMON ROAD	BC - Bituminous Concrete	2415	100	35.4	Do Nothing	$ -
80.1	LORD ROAD	BAPTIST COMMMON ROAD	BROOKS ROAD	BC - Bituminous Concrete	701	38.7	54.3	BC - 2" Overlay Local	$ 36,639
80.2	LORD ROAD	BROOKS ROAD	50' N OF WILLOW STREET	BC - Bituminous Concrete	3329	50.5	50.6	BC - 1-1/2" Mill & Overlay	$ 151,358
80.3	LORD ROAD	50' N OF WILLOW STREET	DEAD END	BC - Bituminous Concrete	1375	97.6	36.1	Do Nothing	$ -

Public Roadway Backlog

ID	Street	From	To	PavementClassification	Length	PCI	NPR	Plan Activity	Cost
81	MAIN STREET	STATE ROAD	150' S OF LIBERTY STREET	BC - Bituminous Concrete	948	51.2	62	Art/Col	$ 55,268
81.1	MAIN STREET	150' S OF LIBERTY STREET	HAMLET MILL ROAD	BC - Bituminous Concrete	1957	93.6	48.9	Do Nothing	$ -
81.2	MAIN STREET	HAMLET MILL ROAD	DEPOT ROAD	BC - Bituminous Concrete	2804	18.1	72.1	BC - Reclaim Col	$ 376,771
83	MASON STREET	FOREST STREET	ELM STREET	BC - Bituminous Concrete	553	92.2	37.8	Do Nothing	$ -
1028	MEADOWBROOK LANE	OTTER RIVER ROAD	END	BC - Bituminous Concrete	772	61.6	35.7	BC - 1-1/2" Mill & Overlay	$ 39,488
84	MECHANIC STREET	GARDNER ROAD	PATRIOTS ROAD	BC - Bituminous Concrete	316	99.4	35.6	Do Nothing	$ -
85	MEMORIAL STREET	ELM STREET	DEAD END	BC - Bituminous Concrete	1486	93.2	26	Do Nothing	$ -
87	MILL STREET	STATE ROAD	DEAD END	BC - Bituminous Concrete	920	17.1	49.4	BC - Reclaim Local	$ 90,569
1030	MINUTEMAN DRIVE	PATROITS ROAD	CUL-DE-SAC	BC - Bituminous Concrete	2000	51.6	50.3	BC - 1-1/2" Mill & Overlay	$ 106,089
1025	MITCHELL ROAD	VICTORIA LANE	CUL-DE-SAC	BC - Bituminous Concrete	474	67.8	33.8	BC - Crack Seal	$ 1,902
88	MORSE AVENUE	STATE ROAD	WINCHENDON TOWN LINE	BC - Bituminous Concrete	613	71.3	44.2	BC - Crack Seal	$ 2,021
89	MOUNTAIN VIEW STREET	BALDWINVILLE ROAD	DEAD END	BC - Bituminous Concrete	649	82.4	29.3	BC - Crack Seal	$ 1,860
1029	MUSKETT DRIVE	PATRIOTS ROAD	MINUTEMAN DRIVE	BC - Bituminous Concrete	1500	48.2	51.3	BC - 1-1/2" Mill & Overlay	$ 79,567
90	MYRTLE STREET	FOREST STREET	DEAD END	BC - Bituminous Concrete	1047	93.2	26	Do Nothing	$ -
91	NORCROSS HILL ROAD	ROYALSTON ROAD	GRAVEL ROAD SURFACE	BC - Bituminous Concrete	3578	24.1	58.7	BC - 2" Overlay Local	$ 179,218
92	NORCROSS STREET	HIGHLAND AVENUE	STATE ROAD	BC - Bituminous Concrete	640	56.2	48.9	BC - 1-1/2" Mill & Overlay	$ 30,311
93	NORTH MAIN STREET	OTTER RIVER ROAD	ANDERSON DRIVE	BC - Bituminous Concrete	1861	99.9	47	Do Nothing	$ -
93.1	NORTH MAIN STREET	ANDERSON DRIVE	DEPOT ROAD	BC - Bituminous Concrete	2691	74.6	54.8	BC - Crack Seal	$ 9,257
93.2	NORTH MAIN STREET	DEPOT ROAD	PATRIOTS ROAD	BC - Bituminous Concrete	2540	83.8	51.9	BC - Crack Seal	$ 10,922
94	OAK STREET	FOREST STREET	DEAD END	BC - Bituminous Concrete	851	93.3	25.9	Do Nothing	$ -
98	OLD WINCHENDON ROAD	STATE ROAD	WINCHENDON TOWN LINE	BC - Bituminous Concrete	3639	58.2	48.3	BC - 1-1/2" Mill & Overlay	$ 193,029
99	ORCHARD LANE	GARDNER ROAD	DEAD END	BC - Bituminous Concrete	1515	74.2	31.8	BC - Crack Seal	$ 4,777
100	OTTER RIVER ROAD	DEPOT ROAD	350' N OF EVANS CIRCLE	BC - Bituminous Concrete	3380	69.9	44.7	BC - Crack Seal	$ 12,112
100.1	OTTER RIVER ROAD	350' N OF EVANS CIRCLE	NORTH MAIN STREET	BC - Bituminous Concrete	2125	35.9	55.1	BC - 2" Overlay Local	$ 115,694
100.2	OTTER RIVER ROAD	NORTH MAIN STREET	BALDWINVILLE ROAD	BC - Bituminous Concrete	6625	56.2	48.9	BC - 1-1/2" Mill & Overlay	$ 376,521
101	PAIL FACTORY ROAD	SOUTH MAIN STREET	SHADY LANE	BC - Bituminous Concrete	2157	39	54.2	BC - 2" Overlay Local	$ 108,042
101.1	PAIL FACTORY ROAD	SHADY LANE	TURNER LANE	BC - Bituminous Concrete	1031	29.5	57.1	BC - 2" Overlay Local	$ 53,887
101.2	PAIL FACTORY ROAD	TURNER LANE	DEAD END	BC - Bituminous Concrete	2956	65.8	45.9	BC - 1-1/2" Mill & Overlay	$ 123,200
102	PARTRIDGEVILLE ROAD	PATRIOTS ROAD	SOUTH MAIN STREET	BC - Bituminous Concrete	5640	14.5	61.7	BC - Reclaim Local	$ 510,808
104	PETERSHAM ROAD	BARRE ROAD	PHILLIPSTON TOWN LINE	BC - Bituminous Concrete	9036	61.2	62.7	BC - Crack Seal	$ 41,445
105	PHEASANT LANE	LORD ROAD	CUL-DE-SAC	BC - Bituminous Concrete	1049	60.8	35.9	BC - 1-1/2" Mill & Overlay	$ 53,656
106	PHILLIPSTON ROAD	RICE ROAD	PHILLIPSTON TOWN LINE	BC - Bituminous Concrete	2122	36.1	55.1	BC - 2" Overlay Local	$ 110,910
107	PINE DRIVE	STATE ROAD	CUL-DE-SAC	BC - Bituminous Concrete	844	67.7	33.8	BC - Crack Seal	$ 4,476
108	PINE STREET	WINCHESTER STREET	CLAIRE AVENUE	BC - Bituminous Concrete	492	12.3	62.4	BC - Reclaim Local	$ 58,122
109	PLANT ROAD	GARDNER ROAD	DEAD END	BC - Bituminous Concrete	1679	91.3	26.5	Do Nothing	$ -
110	PLEASANT STREET	ELM STREET	DEAD END	BC - Bituminous Concrete	2079	85.1	28.4	Do Nothing	$ -
111	PROSPECT STREET	KING PHILLIPS TRAIL	BALDWINVILLE ROAD	BC - Bituminous Concrete	1126	58.2	48.3	BC - 1-1/2" Mill & Overlay	$ 46,929
112	EXTENSION	KING PHILLIPS TRAIL	MAPLE STREET	BC - Bituminous Concrete	619	98.7	35.8	Do Nothing	$ -
113	QUEEN LAKE ROAD	PHILLIPSTON ROAD	PHILLIPSTON TOWN LINE	BC - Bituminous Concrete	3277	60	47.7	BC - 1-1/2" Mill & Overlay	$ 148,994
116	RESERVOIR STREET	BALDWINVILLE ROAD	DEAD END	BC - Bituminous Concrete	1516	87.9	27.6	Do Nothing	$ -
117	RICE ROAD E	PATRIOTS ROAD	CUL-DE-SAC	BC - Bituminous Concrete	1845	13.1	50.6	BC - Reconstruction Local	$ 213,282
118	RICE ROAD W	PATRIOTS ROAD	CUL-DE-SAC	BC - Bituminous Concrete	3706	59.8	36.2	BC - 1-1/2" Mill & Overlay	$ 154,458
119	RIDGEWOOD HEIGHTS	BROOKS VILLAGE ROAD	CUL-DE-SAC	BC - Bituminous Concrete	1181	17.1	49.3	BC - Reclaim Local	$ 130,214
120	RIVER ROAD	MAIN STREET	STATE ROAD	BC - Bituminous Concrete	692	19.5	60.2	BC - Reclaim Local	$ 59,949
123	ROAD TO SCHOOL	WELLINGTON ROAD	SOUTH ROAD	BC - Bituminous Concrete	328	24.2	58.7	BC - 2" Overlay Local	$ 17,144

Public Roadway Backlog

ID	Street	From	To	PavementClassification	Length	PCI	NPR	Plan Activity	Cost
125	ROYALSTON ROAD	KING PHILLIPS TRAIL	OLD ROYALSTON ROAD	BC - Bituminous Concrete	5390	24	74.1	BC - 3" Overlay Art/Col	$ 381,342
125.1	ROYALSTON ROAD	OLD ROYALSTON ROAD	NOWERS ROAD	BC - Bituminous Concrete	5160	17.7	76.1	BC - Reclaim Art	$ 619,057
125.2	ROYALSTON ROAD	NOWERS ROAD	PHILLIPSTON TOWN LINE	BC - Bituminous Concrete	3389	18.5	75.8	BC - Reclaim Art	$ 406,586
128	SANDY PINE ROAD	PATRIOTS ROAD	CUL-DE-SAC	BC - Bituminous Concrete	888	64.9	34.7	BC - 1-1/2" Mill & Overlay	$ 40,374
129	SAWYER STREET	PATRIOTS ROAD	DEAD END	BC - Bituminous Concrete	3047	81.5	29.5	BC - Crack Seal	$ 8,735
131	SCHOOL STREET	GARDNER ROAD	DEAD END	BC - Bituminous Concrete	1468	60.2	36.1	BC - 1-1/2" Mill & Overlay	$ 58,402
133	SHADY LANE	PAIL FACTORY ROAD	HUBBARDSTON TOWN LINE	BC - Bituminous Concrete	5454	45.3	52.2	BC - 2" Overlay Local	$ 237,552
134	SHORE DRIVE	PARTRIDGEVILLE ROAD	DEAD END	BC - Bituminous Concrete	2376	17.5	60.8	BC - Reclaim Local	$ 215,192
136	SOUTH MAIN STREET	PATRIOTS ROAD	RTE 2 OVERPASS	BC - Bituminous Concrete	2563	46.6	63.4	BC - 3" Overlay Art/Col	$ 203,092
136.1	SOUTH MAIN STREET	RTE 2 OVERPASS	700' N OF PARTRIDGEVILLE RD	BC - Bituminous Concrete	2585	65.5	57.5	BC - Crack Seal	$ 10,374
136.2	SOUTH MAIN STREET	700' N OF PARTRIDGEVILLE RD	1465' S OF PAIL FACTORY ROAD	BC - Bituminous Concrete	2165	70.9	55.9	BC - Crack Seal	$ 8,689
136.3	SOUTH MAIN STREET	1465' S OF PAIL FACTORY ROAD	1500' S OF CROSS ROAD	BC - Bituminous Concrete	2850	70.5	56	BC - Crack Seal	$ 11,438
136.4	SOUTH MAIN STREET	1500' S OF CROSS ROAD	HUBBARDSTON TOWNLINE	BC - Bituminous Concrete	2966	18.5	72	BC - Reclaim Col	$ 341,604
137	SOUTH ROAD	BALDWINVILLE ROAD	STAR FIRE AVENUE	BC - Bituminous Concrete	2263	48.5	51.2	BC - 1-1/2" Mill & Overlay	$ 98,604
137.1	SOUTH ROAD	STAR FIRE AVENUE	100' S OF DOLBIER HILL ROAD	BC - Bituminous Concrete	1382	98.3	35.9	Do Nothing	$ -
137.2	SOUTH ROAD	100' S OF DOLBIER HILL ROAD	1000' N OF VICTORIA LANE	BC - Bituminous Concrete	3695	17.8	60.7	BC - Reclaim Local	$ 392,852
137.3	SOUTH ROAD	1000' N OF VICTORIA LANE	FRENCH ROAD	BC - Bituminous Concrete	4435	45.9	52	BC - 2" Overlay Local	$ 231,803
137.4	SOUTH ROAD	FRENCH ROAD	HUBBARDSTON TOWN LINE	BC - Bituminous Concrete	7273	18.3	60.5	BC - Reclaim Local	$ 687,347
138	STARFIRE ROAD	SOUTH ROAD	DEAD END	BC - Bituminous Concrete	1265	18.8	48.8	BC - 2" Overlay Local	$ 60,608
140	STONE BRIDGE ROAD	HENSHAW ROAD	PHILLIPSTON TOWN LINE	BC - Bituminous Concrete	3330	16	61.2	BC - Reclaim Local	$ 314,707
141	SUMMER STREET	FESSENDEN STREET	MEMORIAL STREET	BC - Bituminous Concrete	1086	84.6	40.1	BC - Crack Seal	$ 3,425
143	TURNER LANE	SOUTH MAIN STREET	2100' E OF SOUTH MAIN STREET	BC - Bituminous Concrete	2170	12.6	62.3	BC - Reclaim Local	$ 222,169
143.1	TURNER LANE	2100' E OF SOUTH MAIN STREET	PAIL FACTORY ROAD	BC - Bituminous Concrete	3238	53.9	49.6	BC - 1-1/2" Mill & Overlay	$ 134,953
144	TURNER ROAD	MAIN STREET	GARDNER CITY LINE	BC - Bituminous Concrete	1526	26.1	58.1	BC - 2" Overlay Local	$ 76,436
146	VERNON STREET	BALDWINVILLE ROAD	DEAD END	BC - Bituminous Concrete	702	98.5	24.3	Do Nothing	$ -
1026	VICTORIA LANE	SOUTH ROAD	HUBBARDSTON ROAD	BC - Bituminous Concrete	4539	51.3	50.4	BC - 1-1/2" Mill & Overlay	$ 240,769
147	WALNUT STREET	WINCHESTER STREET	GRAVES AVENUE	BC - Bituminous Concrete	1451	75.3	43	BC - Crack Seal	$ 6,447
1018	WARE DRIVE	FERN STREET	CUL-DE-SAC	BC - Bituminous Concrete	2373	45.8	52.1	BC - 2" Overlay Local	$ 139,532
148	WELLINGTON ROAD	PATRIOTS ROAD	DUDLEY ROAD	BC - Bituminous Concrete	305	16.8	61	BC - Reclaim Local	$ 26,423
148.1	WELLINGTON ROAD	DUDLEY ROAD	SOUTH ROAD	BC - Bituminous Concrete	1955	86.2	39.6	BC - Crack Seal	$ 7,286
1022	WHITE CIRCLE	SOUTH ROAD	CUL-DE-SAC	BC - Bituminous Concrete	543	86	28.2	Do Nothing	$ -
150	WILLIAM STREET	BALDWINVILLE ROAD	DEAD END	BC - Bituminous Concrete	360	86.9	27.9	Do Nothing	$ -
151	WILLOW STREET	LORD ROAD	MAIN STREET	BC - Bituminous Concrete	1955	46.3	51.9	BC - 2" Overlay Local	$ 102,181
154	WINCHESTER STREET	WINCHENDON ROAD	HARRIS STREET	BC - Bituminous Concrete	2587	69.5	44.8	BC - Crack Seal	$ 11,124
155	WINTER STREET	SOUTH MAIN STREET	SCHOOL STREET	BC - Bituminous Concrete	698	63.3	46.7	BC - 1-1/2" Mill & Overlay	$ 30,413
									$ 16,600,074

APPENDIX B

2018 Repair Alternative Cost Summary

Activity	Description	Cost
Do Nothing	Do Nothing at this time	$ -
BC - Crack Seal	Crackseal and surface patch	$ 1.20
BC - Crack Seal or Patch	Crackseal or surface patch	$ 1.50
BC - Chip Seal	Double lift Chip Seal with leveling course	$ 8.50
BC - 1-1/2" Mill & Overlay	1-1/2" Mill, 1-1/2" HMA, adjust structures, patching, crackseal, tack, police detail & line paint	$ 16.00
BC - 2" Overlay Local	2" HMA, adjust structures, crackseal, tack, police detail & line paint	$ 17.70
BC - 2" Mill & Overlay Local	2" mill, 2" HMA, crackseal, tack, police detail & line paint	$ 19.00
BC - 3" Overlay Art/Col	3" HMA, adjust structures, crackseal, tack, police detail & line paint	$ 23.00
BC - 3" Mill & Overlay Art/Col	2" mill, 3" HMA, crackseal, tack, police detail & line paint	$ 25.30
BC - Reclaim Local	Reclaim, 4" HMA, remodel structures, police detail & line paint	$ 32.00
BC - Reclaim Col	Reclaim, 6" HMA, remodel structures, police detail & line paint	$ 38.00
BC - Reclaim Art	Reclaim, 6" HMA, remodel structures, police detail & line paint	$ 38.00

APPENDIX C

GLOSSARY OF TERMS

ASSET MANAGEMENT SYSTEM (AMS): similar to a Pavement Management System, has all the database attributes describing an infrastructure network such as water, wastewater or drainage system. This additional data to the management system database may include drainage features, utilities, traffic signs, pavement markings, sidewalks, pedestrian ramps and other road related elements within the right of way. Because the roadway network system serves as a common location and identification system for roadside elements, the database can be comprehensively evaluated for infrastructure system wide planning and management.

DEDUCT POINTS: Points representing the penalty assessed for each identified distress used in the calculation of the Pavement Condition Index. Each distress has multiple severity and extent levels, with a specific number of points at each level. Deduct points may be modified for all nine pavement distress types. The deduct points are ultimately subtracted from a perfect pavement condition of 100.

DETERIORATION RATE: a rate that predicts of the anticipated change in a roadway's condition over time.

DISTRESS: a physical defect or deficiency on the pavement surface that can be observed and quantified through visual inspection of the pavement surface. Broad categories include surface cracking, base related cracking, patching, and surface wear.

DRAINAGE CONDITION INDEX (DCI): an index derived from controlled measurements and evaluations of pavement surface drainage deficiencies and conditions. It is a serviceability rating established for determining the present stature or performance of the drainage features on a scale from 0 to 100, with 100 being excellent.

FUNCTIONAL CLASSIFICATION: Road functional classification places all streets and roads in the network into one of four general categories - arterial, collector, local, or dead end - according to vehicular volume, roadway geometry, and traffic characteristics.

NETWORK LEVEL: an assessment of conditions and/or program needs across the entire roadway system encompassed by the pavement management study.

NETWORK PRIORITY RANKING (NPR): a value computed by PAVEMENTview®Plus at the time it determines the most beneficial recommended repair for a particular pavement section. The Network Priority Ranking formula is:

NPR = (.40 x PCI) + (.50 x Functional Class. Priority) + (.30 x Pavement Class. Priority) + (.10 ADT)

Where NPR = Network Priority Ranking equals 40% Pavement Condition Index plus 50% Functional Classification Priority Rank plus 30% Pavement Classification Priority Rank and plus 10% Average Daily Traffic.

OVERALL CONDITION INDEX (OCI): an index derived from controlled measurements of pavement condition, rideability, drainage condition, safety, utility condition, traffic control, sidewalk condition, and roadside maintenance. An acceptable scale for roads and streets is 0 to 100, with 100 being excellent.

PAVEMENT CONDITION INDEX (PCI): an index derived from established measurements of pavement surface condition distress or deficiencies. It is a serviceability rating established under controlled conditions having a scale of 0 to 100, with 100 being excellent.

PAVEMENT CLASSIFICATION: Pavement classification identifies the pavement material for streets and roads in the network. There are four categories: BC = Bituminous Concrete, BR = Brick, PC= Portland Concrete, and GR = Gravel.

PAVEMENT MANAGEMENT (PM): is the effective and efficient directing of the various activities involved in providing and sustaining pavements in a condition acceptable to the traveling public at the lowest life-cycle cost.

PAVEMENT MANAGEMENT SYSTEM (PMS): an established, documented procedure treating many or all of the Pavement Management activities in a systematic and coordinated manner. It consists of five essential elements structured to serve decision-making responsibilities at various management levels.

1. Pavement surveys related to condition and serviceability;
2. Database containing all pavement-related information;
3. Analysis scheme;
4. Decision criteria;
5. Implementation procedures.

PAVEMENT PERFORMANCE: the assessment of how well the pavement serves the user over time. The engineer often associates pavement condition with an arbitrary, but quantifiable, value relating to pavement roughness, pavement distress, or pavement strength. Performance is the measured change of condition and/or serviceability over increments of time.

PREVENTATIVE MAINTENANCE: activities performed at planned intervals to protect and seal the pavement. Generally these activities lead to pavement preservation. Seals are designed to provide one or more of the following benefits:

1. Prevent the intrusion of air and moisture;
2. Fill small cracks and voids;
3. Rejuvenate an oxidized binder;
4. Provide a new wearing surface.

PROJECT LEVEL: a detailed assessment or identification of needs relative to a specific roadway, or a section thereof, as opposed to network level applications. It may include on site pavement testing, lab evaluation, life cycle cost analysis, and treatment recommendation for the particular pavement section.

RECONSTRUCTION: the complete removal and replacement of a failed pavement, which might also involve widening, realignment, traffic control devices, safety hardware, and major base and drainage work.

REHABILITATION: any work needed to restore the pavement to a condition that will allow it to perform satisfactorily for several years. Rehabilitation also includes the work necessary to prepare the pavement for an overlay. The major activities involved in the rehabilitation process are:
1. Partial depth patching;
2. Full depth patching;
3. Joint and crack sealing.
4. Grouting and undersealing (filling voids);
5. Grinding and milling (removal of high spots in the pavement.);
6. Overlays.

REPAIR STRATEGIES: PAVEMENTview®Plus represents repair strategies as a decision of user defined "if, then" statements used in the PAVEMENTview®Plus. The recommended repairs are based on five decision factors: Functional Classification, Surface Type, PCI range, curb reveal, and Sidewalk Condition Index (SCI). These criteria input into the decision matrix represent the various conditions for each decision factor.

REPAIR TYPES: the various choices of treatment available for providing a solution to a pavement deficiency or problem. The associated repair type cost is based on a locality's past experience.

RIDEABILITY INDEX (RI): a measure of the smoothness of a pavement, (traveled surface) as perceived by the public traveling in a vehicle at a speed appropriate for the particular surface. It is a serviceability rating having a scale of 0 to 100, with 100 being excellent. A controlled measurement of longitudinal profile pavement surface condition distress or deficiencies can be made using a profilometer and can be correlated to a roughness scale.

ROADSIDE MAINTENANCE INDEX (RMI): an index derived from evaluations of required roadside maintenance activity levels, such as mowing, litter collection, overhanging branches, and sand residue from plowing operations. It is a rating established for determining the present status or relative condition of the roadside maintenance, and is measured on a scale of 0 to 100, with 100 being excellent.

ROUTINE MAINTENANCE: activities performed or steps taken to correct a specific pavement failure or distress area. Routine maintenance usually addresses localized pavement defects and includes activities such as:

1. Full depth patching - more than 2" deep, requiring saw cutting distressed area and removal of pavement and gravel base to a depth of 8", followed by placement of new dense graded gravel base and hot mix asphalt in multiple layers;
2. Skin patching - less than 2" deep, typically no cutting required, placement of hot mix asphalt in 1 layer;
3. Crack sealing – sealing of surface cracks to prevent water intrusion

SIDEWALK CONDITION INDEX (SCI): an index derived from controlled measurements and evaluations of sidewalk and/or walkway and/or pedestrian ramp deficiencies and conditions. It is a serviceability rating established for determining the present status or performance of sidewalks and pedestrian ramps, and is measured on a scale of 0 to 100, with 100 being excellent.

STRUCTURAL IMPROVEMENT: activites performed when the pavement deteriorates beyond the need for preventive maintenance applications and the road base is structurally sound. Activites could include:

1. Thick Overlays;
2. Cold Planning and Overlay;
3. Hot in Place Recycling – Re-heating, scarifying, and adding rejuvenator to existing surface to a depth of 1-1/4" followed by an overlay.

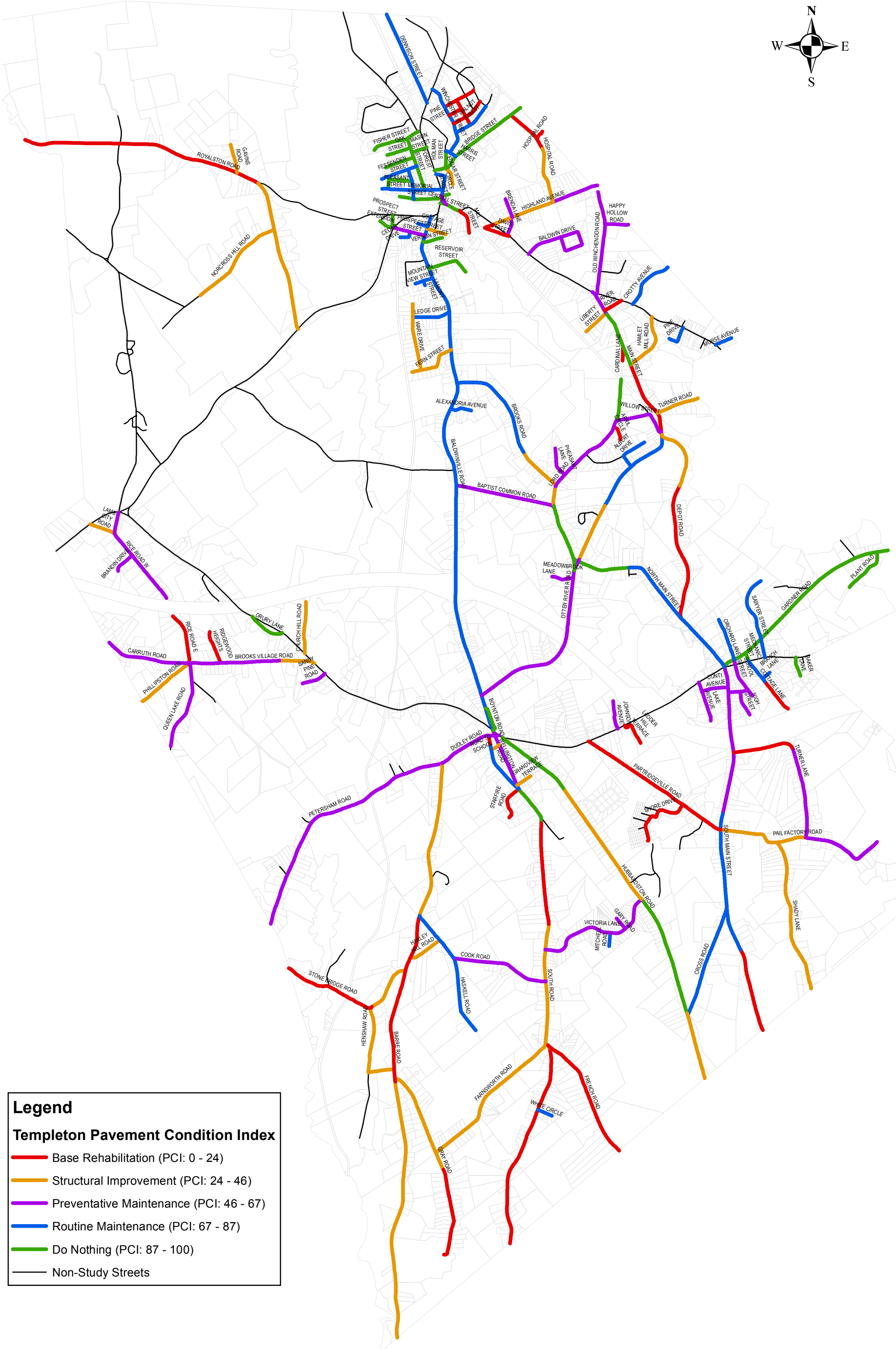
TRAFFIC CONTROL INDEX (TCI): an index derived from factors pertaining to traffic control measures such as traffic signs and signals, lighting, and other warning devices. It is a rating established for determining the performance of the roadway as it relates to traffic control, and is measured on a scale of 0 to 100, with 100 being excellent.

TRAFFIC SAFETY INDEX (TSI): an index derived from measurements and evaluations of stopping sight distance, horizontal and vertical curves, accident data, geometry and other factors which may affect the public safety while traveling on the roadway. It is a rating established for determining the performance of the roadway as it relates to safety, and is measured on a scale of 0 to 100, with 100 being excellent.

UTILITY CONDITION INDEX (UCI): an index derived from controlled measurements and evaluations of utility cuts/patches in the pavement surface area. It is a serviceability rating established for determining the present status or performance of the utility patch on a scale from 0 to 100, with 100 being excellent.

APPENDIX D

2018 Townwide Pavement Conditions



Legend

Templeton Pavement Condition Index

- Base Rehabilitation (PCI: 0 - 24)
- Structural Improvement (PCI: 24 - 46)
- Preventative Maintenance (PCI: 46 - 67)
- Routine Maintenance (PCI: 67 - 87)
- Do Nothing (PCI: 87 - 100)
- Non-Study Streets